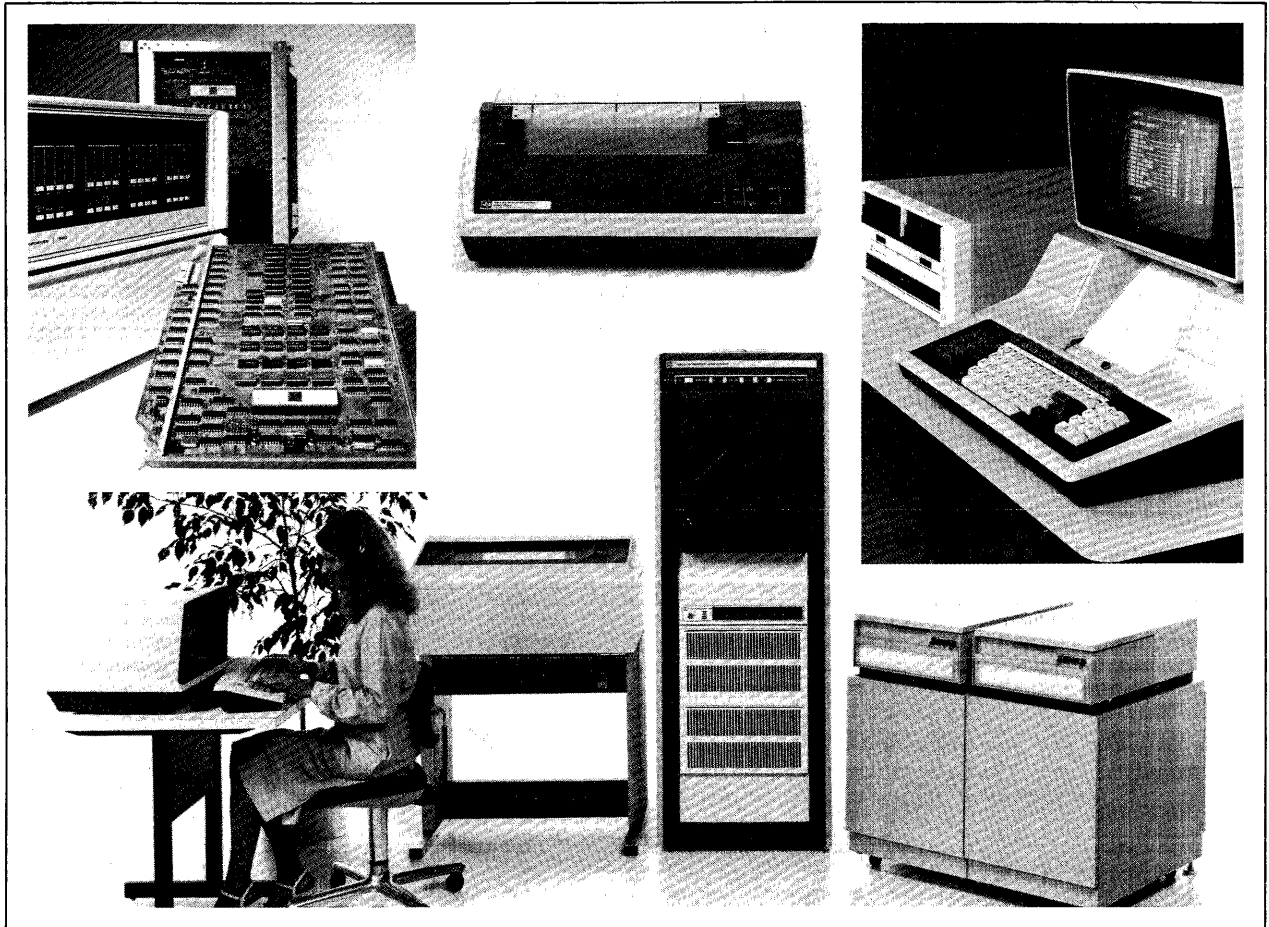

Model 990 Computer Model DS10 Cartridge Disk System Field Maintenance Manual



Part No. 945419-9702 *B
15 August 1980



TEXAS INSTRUMENTS

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES AND DESTROY SUPERSEDED PAGES

Note: The portion of the text affected by the changes is indicated by a vertical bar in the outer margins of the changed page.

Model 990 Computer Model DS10 Cartridge Disk System
Field Maintenance Manual (945419-9702)

Original Issue 1 May 1979
Change 1 15 January 1980
Change 2 15 August 1980 (MCR 000298)

Total number of pages in this publication is **175** consisting of the following:

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
Cover	2	1-24	0	3-2 - 3-31	0
Eff. Pages	2	1-25	2	3-32 - 3-34	2
iii - iv	2	1-26	0	3-34A - 3-34B	2
v - vi	2	1-27 - 1-28	2	3-35 - 3-37	2
vii	1	1-29 - 1-49	0	3-38 - 3-56	0
viii - ix	2	1-50	2	3-57	1
1-0 - 1-1	2	1-51 - 1-52	0	3-58	2
1-2	0	1-53	2	3-59	0
1-3 - 1-4	2	1-54 - 1-55	0	3-60 - 3-66	2
1-6	0	1-56	2	3-67	1
1-7	2	1-57	0	3-68 - 3-69	2
1-8	0	1-58	2	3-70	1
1-9 - 1-12	2	1-59 - 1-62	0	3-71 - 3-74	2
1-12A - 1-12B	2	1-63 - 1-64	2	3-75 - 3-78	1
1-13	0	2-1 - 2-3	2	A-1 - A-6	0
1-14	2	2-4 - 2-6	1	Index-1	0
1-14A - 1-14B	2	2-7	2	Index-2 - Index-5	1
1-15 - 1-16	0	2-8	1	Index-6	0
1-17	1	2-9	2	User's Response	2
1-18 - 1-18B	2	2-10	1	Business Reply	2
1-19	2	2-10A - 2-10B	2	Sales and Service	1
1-20	0	2-11 - 2-12	2	Cover	1
1-21 - 1-23	2	3-1	2		

© Texas Instruments Incorporated 1979, 1980
All Rights Reserved

The information and/or drawings set forth in this document and all rights in and to inventions disclosed herein and patents which might be granted thereon disclosing or employing the materials, methods, techniques or apparatus described herein are the exclusive property of Texas Instruments Incorporated.



PREFACE

This manual provides field-level maintenance and operation information required to service a Model DS10 Cartridge Disk System installed with a Model 990 Computer. The information in this manual is divided into three major sections and one appendix as follows:

Section

- 1 Model DS10 Cartridge Disk System Description — provides a system overview, specifications, configurations, interface description, physical descriptions and locations of replaceable components, and basic operating procedures.
- 2 Preventive Maintenance — provides schedules and procedures for routine maintenance to forestall failures and extend the operating life of the equipment.
- 3 Corrective Maintenance — provides troubleshooting procedures, component/part removal and replacement procedures, and alignment and adjustment procedures necessary to restore a failed or degraded system to fully operational status.

Appendix

- A Disk Controller and Disk Drive Interface Signals

The following documents contain additional information related to the disk system:

Title	Part Number
<i>Model 990/10 Computer System Hardware Reference Manual</i>	945417-9701
<i>Model 990 Computer Diagnostics Handbook</i>	945400-9701
<i>Model 990 Computer Model DS10 Cartridge Disk System Installation and Operation</i>	946261-9701
<i>Model 990 Computer DS10 Cartridge Disk Controller Depot Maintenance Manual</i>	946202-9701
<i>Model 990 Computer Family Maintenance Drawings, Volumes I and II</i>	945421-9701, 945421-9702
<i>Control Data Cartridge Disk Drive Model 9427H Hardware Reference Manual</i>	(Control Data Corporation part number 77834675, TI specification number 937517)



TABLE OF CONTENTS

Paragraph	Title	Page
SECTION 1. MODEL DS10 CARTRIDGE DISK SYSTEM DESCRIPTION		
1.1	Introduction	1-1
1.1.1	General Description	1-1
1.1.2	Disk System Specifications	1-1
1.1.3	System Configuration	1-3
1.1.3.1	Subsystem Interfaces	1-7
1.1.3.2	Disk Controller Physical Characteristics	1-11
1.1.3.3	Disk Drive Physical Characteristics	1-11
1.1.4	Field-Replaceable Part/Component Descriptions	1-17
1.1.4.1	I/O Board	1-17
1.1.4.2	Head Carriage Actuator	1-47
1.1.4.3	AGC Servo Preamplifier Board	1-47
1.1.4.4	Servo Board	1-47
1.1.4.5	Power Supply Board No. 2	1-47
1.1.4.6	Power Supply Board No. 1	1-47
1.1.4.7	Sector Board	1-48
1.1.4.8	Read/Write/Erase (R/W/E) Board	1-48
1.1.4.9	Data Recovery Board	1-48
1.1.4.10	Control Board	1-49
1.2	Operating Instructions	1-49
1.2.1	Hardware Startup/Shutdown Procedures	1-54
1.2.1.1	Operating Precautions	1-54
1.2.1.2	Carriage Lock Pin Removal	1-54
1.2.1.3	Switch and Control Settings	1-55
1.2.1.4	Power Application for On-Line Operation	1-56
1.2.1.5	Disk Cartridge Installation	1-57
1.2.1.6	Disk Cartridge Removal (Normal)	1-59
1.2.1.7	Disk Cartridge Removal (During Power Failure or Emergency)	1-59
1.2.1.8	Write-Protect Operation	1-60
1.2.1.9	Fault Operating Procedures	1-60
1.2.1.10	Normal or Emergency Power Down	1-61
1.2.2	Programming the Disk Controller	1-61
SECTION 2. PREVENTIVE MAINTENANCE		
2.1	Introduction to Preventive Maintenance	2-1
2.2	Preventive Maintenance Supplies	2-1
2.3	Preventive Maintenance Schedule and Procedures	2-2
2.3.1	Daily User PM Procedures	2-2
2.3.2	Monthly User PM Procedures	2-2
2.3.3	PM 090 Procedure	2-5
2.3.4	PM 180 Procedure	2-7
2.3.5	Disk Inspection and Cleaning	2-9
2.3.5.1	Disk Inspection General Notes	2-9
2.3.5.2	Disk Cartridge or Fixed Disk Inspection Procedure	2-9
2.3.5.3	Qualified Vendor or Manufacturer Disk Pack Preventive Maintenance	2-10
2.3.6	Final Systems Integrity Check	2-11



TABLE OF CONTENTS (Continued)

Paragraph	Title	Page
SECTION 3. CORRECTIVE MAINTENANCE		
3.1	Corrective Maintenance Introduction	3-1
3.2	Corrective Maintenance Supplies	3-1
3.3	Troubleshooting	3-1
3.4	Removal and Replacement Procedures	3-14
3.4.1	DS10 Cartridge Disk Controller Removal and Replacement	3-14
3.4.1.1	Removal	3-14
3.4.1.2	Replacement	3-15
3.4.2	Actuator Assembly Removal and Replacement	3-15
3.4.2.1	Removal	3-15
3.4.2.2	Replacement	3-19
3.4.3	Head Removal and Replacement	3-21
3.4.3.1	Cartridge Disk Head Removal (#0 or #1)	3-21
3.4.3.2	Cartridge Disk Head Replacement (#0 or #1)	3-21
3.4.3.3	Fixed Disk Head Removal (#2 or #3)	3-22
3.4.3.4	Fixed Disk Head Replacement (#2 or #3)	3-23
3.4.4	EOT Assembly Removal and Replacement	3-23
3.4.4.1	Removal	3-23
3.4.4.2	Replacement	3-24
3.4.5	Fixed Disk Removal and Replacement	3-24
3.4.5.1	Removal	3-24
3.4.5.2	Replacement	3-26
3.4.6	Position Transducer Scale Removal and Replacement	3-26
3.4.6.1	Removal	3-26
3.4.6.2	Replacement	3-28
3.4.7	Velocity Transducer Removal and Replacement	3-31
3.4.7.1	Removal	3-31
3.4.7.2	Replacement	3-31
3.4.8	Velocity Transducer Magnet Removal and Replacement	3-33
3.4.8.1	Removal	3-34
3.4.8.2	Replacement	3-34A
3.4.9	Spindle Assembly Removal and Replacement	3-36
3.4.9.1	Removal	3-36
3.4.9.2	Replacement	3-38
3.4.10	Cartridge Disk Index/Sector Transducer Removal and Replacement	3-39
3.4.10.1	Removal	3-39
3.4.10.2	Replacement	3-40
3.4.11	Fixed Disk Index/Sector Transducer Removal and Replacement	3-40
3.4.11.1	Removal	3-40
3.4.11.2	Replacement	3-41
3.4.12	Sector Ring Removal and Replacement	3-42
3.4.12.1	Removal	3-42
3.4.12.2	Replacement	3-42
3.4.13	Cartridge-on Switch Removal and Replacement	3-42
3.4.13.1	Removal	3-42
3.4.13.2	Replacement	3-43

**TABLE OF CONTENTS (Continued)**

Paragraph	Title	Page
3.4.14	Disk Brush Assembly Removal and Replacement	3-45
3.4.14.1	Removal	3-45
3.4.14.2	Replacement	3-46
3.4.15	Spindle Drive Motor Assembly Removal and Replacement	3-47
3.4.15.1	Removal	3-47
3.4.15.2	Replacement	3-47
3.4.16	Card Cage Printed Circuit Board Removal and Replacement	3-48
3.4.16.1	Removal	3-48
3.4.16.2	Replacement	3-49
3.4.17	Power Supply Removal and Replacement	3-49
3.4.17.1	Removal	3-49
3.4.17.2	Replacement	3-51
3.4.18	Piggyback Power Board Removal and Replacement	3-51
3.4.18.1	Removal	3-51
3.4.18.2	Replacement	3-52
3.4.19	Card Cage/Motherboard Removal and Replacement	3-52
3.4.19.1	Removal	3-52
3.4.19.2	Replacement	3-53
3.4.20	Blower Motor Assembly Removal and Replacement (Base Cabinet)	3-54
3.4.20.1	Removal	3-54
3.4.20.2	Replacement	3-55
3.4.21	Blower Motor Assembly Removal and Replacement (Rackmount)	3-55
3.4.21.1	Removal	3-55
3.4.21.2	Replacement	3-55
3.5	Disk Drive Alignments and Adjustments	3-55
3.5.1	Temperature Stabilization	3-56
3.5.2	Servo Preamplifier and Transducer Check and Adjustment	3-56
3.5.3	FEOT Check and Adjustment	3-63
3.5.4	Head Alignment Check and Adjustment	3-67
3.5.5	Index-to-Burst Period Check and Adjustment	3-70
3.5.6	Track Indicator Check and Adjustment	3-74
3.5.7	Static Eliminator Check	3-75
3.5.8	Cartridge Index/Sector Transducer Check and Adjustment	3-75
3.5.9	Fixed Disk Index/Sector Transducer Check and Adjustment	3-76
3.5.10	Cartridge-on Switch Check and Adjustment	3-77

APPENDIXES

Appendix	Title	Page
A	Disk Controller and Disk-Drive Interface Signals	A-1



LIST OF ILLUSTRATIONS

Figure	Title	Page
1-1	Model DS10 Cartridge Disk System	1-0
1-2	DS10 Disk System Basic Functional Block Diagram	1-2
1-3	DS10 System Interconnections — Single Drive	1-4
1-4	DS10 System Interconnections — Two Drives	1-5
1-5	Pedestal-Mounted DS10 Disk Drive — Rear View	1-6
1-6	DS10 Disk Controller Interface Signals	1-8
1-7	DS10 Disk System Interface Diagram	1-9
1-8	DS10 Cartridge Disk Controller (PWB)	1-12
1-8A	Model DS10 Cartridge Disk Controller (Fine Line PWB)	1-12A
1-9	TILINE Slave Address Switches and Settings	1-13
1-10	Disk Controller Standard Jumpers	1-14
1-11	Disk Controller LED Configurations	1-14A
1-12	Rear View of Disk Drive, Electronics Cover Removed	1-15
1-13	Disk Drive Printed Wiring Board (PWB) Locations	1-16
1-14	Disk Drive Switch Setting Label	1-17
1-14A	Winchester I/O Board	1-18A
1-15	Disk Drive Replaceable Unit Locations	1-29
1-16	R/W/E Simplified Block Diagrammed Head Connections	1-49
1-17	Data Recovery Board Simplified Block Diagram	1-50
1-18	DS10 Disk Drive Control and Indicator Locations	1-50
1-19	Brush Indicator	1-53
1-20	Carriage Lock Pin Location	1-55
1-21	Disk Designation Reversing Jumper on Cable Adapter	1-56
1-22	DS10 Disk Cartridge Installation	1-58
1-23	Cartridge Locks	1-60
1-24	Model DS10 Disk System Status and Control Word Formats	1-62
2-1	DS10 Disk Drive Filter Mounting	2-6
2-2	Disk Contaminants	2-10A
3-1	Initial Troubleshooting	3-3
3-2	Off-line Troubleshooting	3-5
3-3	DOCS Diagnostic	3-8
3-4	Disk Operational Fault Troubleshooting	3-10
3-5	Velocity Transducer Location	3-17
3-6	Actuator, Magnet, and EOT Sensor Mounting	3-18
3-7	Actuator Assembly — Heads Installed	3-20
3-8	Head Removal and Replacement	3-20
3-9	Front Panel Removal	3-25
3-10	Fixed Disk Removal	3-27
3-11	Thermal Link Removal and Replacement	3-29
3-12	Actuator Assembly	3-30
3-13	Packlock and Brush Assemblies	3-44
3-14	Power Supply Assembly	3-50
3-15	Power Supply Board No. 2	3-53
3-16	Servo Preamp Board Adjustment Location	3-57
3-17	Position Transducer Waveform	3-58
3-18	Actuator Assembly	3-59
3-19	One Track Seek Unbalanced	3-62
3-20	One Track Seek Balanced	3-62

**LIST OF ILLUSTRATIONS (Continued)**

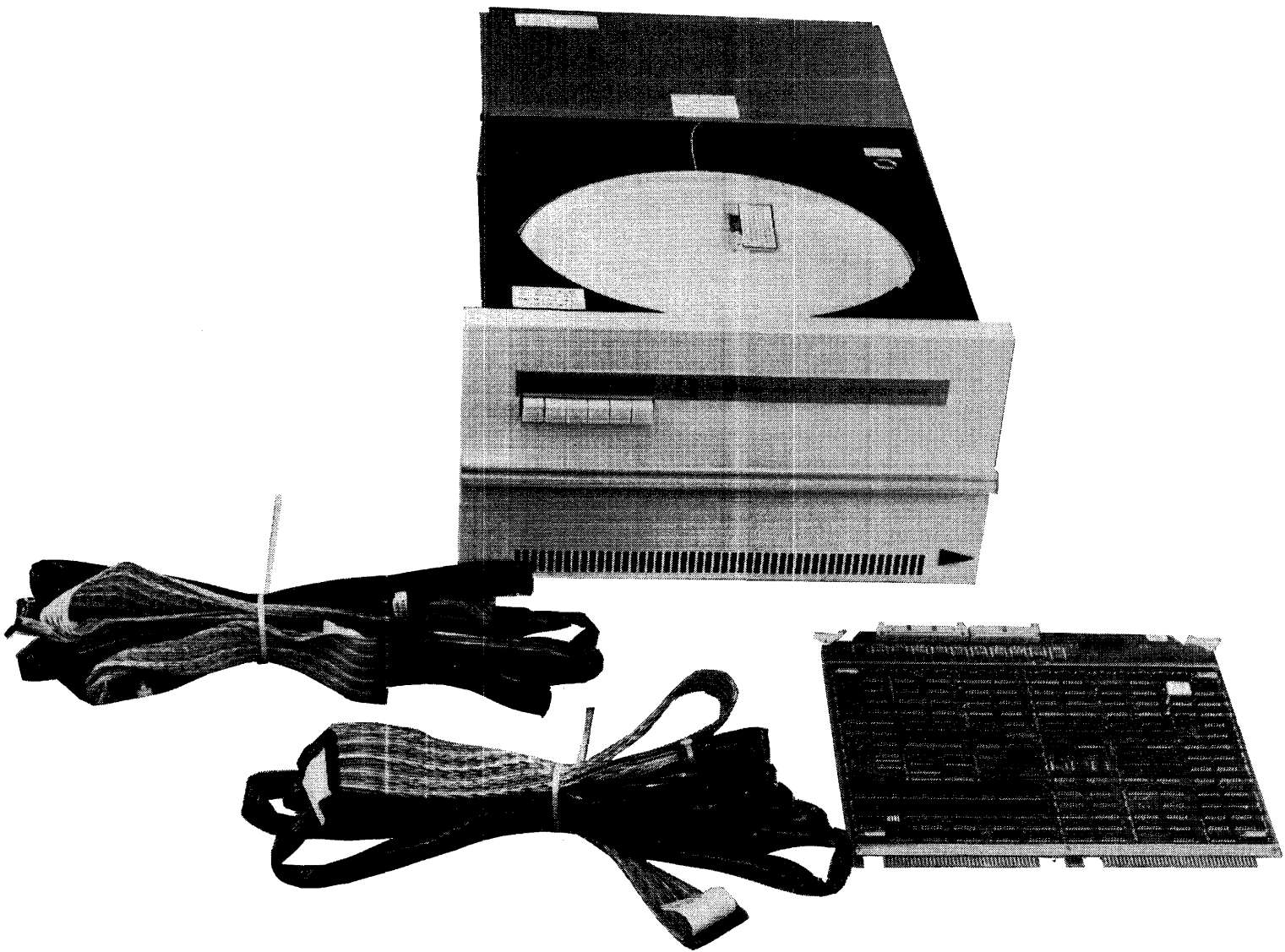
Figure	Title	Page
3-21	Two Track Seek Within Tolerance	3-64
3-22	Forward Seek	3-64
3-23	Reverse Seek	3-64
3-24	Servo Board Assembly	3-66
3-25	FEOT Waveforms	3-67
3-26	Head Alignment Waveform	3-70
3-27A	Index-to-Burst Period Waveform	3-73
3-27B	Index-to-Burst Waveforms	3-73
3-28	Track Indicator	3-76
3-29	Index/Sector Transducer Adjustment	3-76
3-30	Fixed Disk Index/Sector Transducer Adjustment	3-77

LIST OF TABLES

Table	Title	Page
1-1	Model DS10 Cartridge Disk System Specifications	1-2
1-2	DS10 Cartridge Disk System Major Items	1-7
1-3	Field Replaceable Subassemblies and Parts for DS10 Disk Drive	1-18B
1-4	Disk Drive Controls and Indicators	1-51
2-1	Preventive Maintenance Supplies	2-1
2-2	Preventive Maintenance (PM) Schedule and Descriptions	2-3
3-1	Special Tools and Test Equipment for Corrective Maintenance	3-2
3-2	Index to Removal and Replacement Procedures	3-15
3-3	Index to Alignments and Adjustments	3-56



945419-9702



(A)143228

Figure 1-1. Model DS10 Cartridge Disk System



SECTION 1

MODEL DS10 CARTRIDGE DISK SYSTEM DESCRIPTION

1.1 INTRODUCTION

The Model DS10 Cartridge Disk System (figure 1-1) is a moving-head magnetic disk system which stores approximately 10 megabytes of data: 5 megabytes on a removable 5440-type cartridge and 5 megabytes on a fixed disk. This system may be used with any member of the Model 990 Computer Family or Model 774 Intelligent Terminal Family that incorporates the TILINE high-speed parallel bus.

The disk system consists of:

- Single-board disk controller
- One or two disk drives
- Cable adapter for each drive
- Interconnecting cables

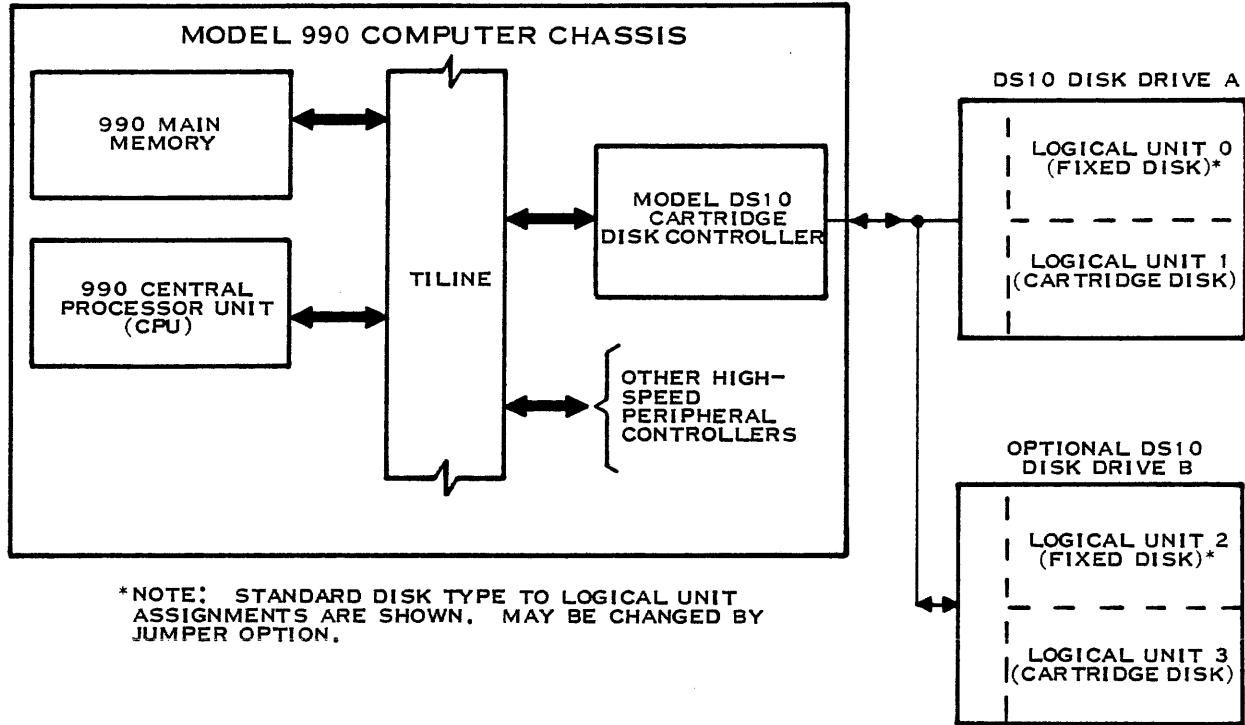
1.1.1 GENERAL DESCRIPTION. Figure 1-2 shows the basic functional relationship of the disk system and the computer/intelligent terminal system. The disk controller logic board occupies a full slot in the 990 chassis and communicates with the central processor unit (CPU) and memory over the TILINE data bus.

The TILINE address space includes an address range specifically reserved for control of high-speed peripherals, such as tape drives and magnetic disk storage systems. Disk operations are programmed by a control block of eight words in this address range. These words are transmitted from the CPU to the disk controller using any of the 990/9900 instructions which involve transfer to memory. The disk controller independently controls the requested operation, including data transfers between the disk media and the 990 main memory.

These control and operation features are transparent to the user of a Texas Instruments operating system, but are very important to the field engineer who will have to enter commands via the 990 Programmer Panel, Maintenance Diagnostic Unit (MDU), or a terminal under the data entry features of Texas Instruments diagnostic software.

The fixed disk and the removable cartridge in a DS10 disk drive are assigned separate logical unit numbers as though they were physically separate, independent devices. This prevents spillover of data from one disk to the other within the same drive. Actually, the two disks share a common spindle, head carriage, and electronics.

1.1.2 DISK SYSTEM SPECIFICATIONS. Table 1-1 summarizes the specifications and environmental requirements of the Model DS10 Cartridge Disk System. Altitude, condensation, and temperature requirements are of special concern when dealing with any hard disk or floppy-disk system. These specifications assume an uncontaminated atmosphere and low vibration, such as an office or laboratory environment. The specifications also assume a good, clean disk cartridge which meets Texas Instruments standards for this media.



(A) 138650

Figure 1-2. DS10 Disk System Basic Functional Block Diagram

Table 1-1. Model DS10 Cartridge Disk System Specifications

Item	Specification
Recording Media	Removable 5440-type cartridge, fixed disk built into drive.
Recording Surfaces	4 (2 per disk)
Tracks per surface	408, numbered 0-407
Tracks per cylinder, each disk	2 (For data recording purposes, a cylinder does not extend between the two disks)
Sectors per track	20 (hard sectors)
Words per sector, one track	144 (16-bit words)
Record format	Variable, 1 sector per record to 20 sectors per record.
Format overhead	48 words per record
Recording mode	Double frequency (FM)
Recording density (maximum)	2200 bits per inch (inner track)



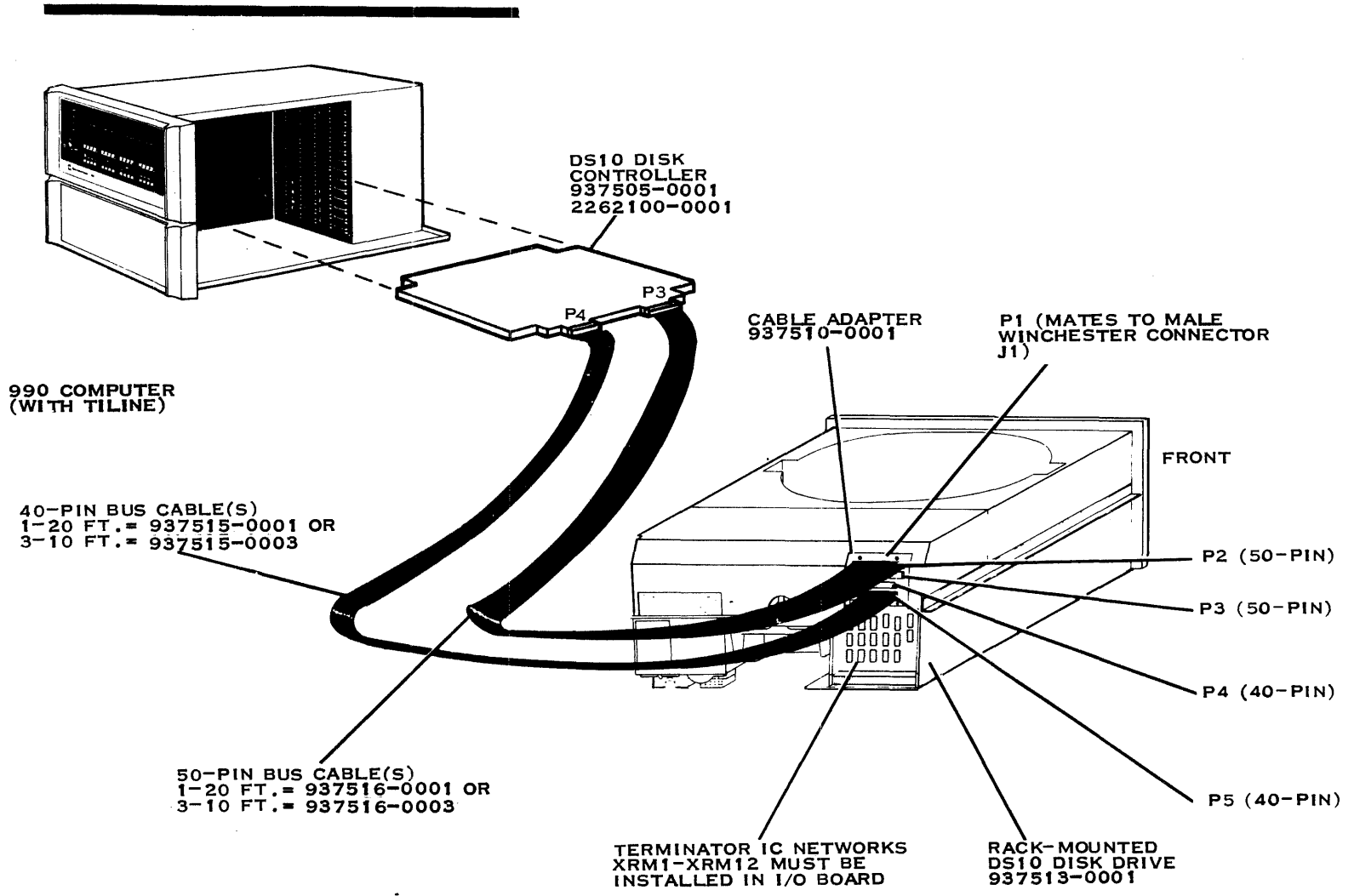
Table 1-1. Model DS10 Cartridge Disk System Specifications (Continued)

Item	Specification
Track density	200 tracks per inch
Average access time	35 milliseconds
Track-to-track access time	7 milliseconds
Average rotational latency	12.5 milliseconds
Maximum access time	60 milliseconds
Bit rate	2.5 megahertz
Total capacity (unformatted)	12.6 megabytes
Total capacity (formatted)	9.4 megabytes (4.7 megabytes per disk)
Disk drives per controller	2 (maximum), each with one fixed and one removable disk
Spindle speed	2400 rpm with $\pm 2\%$ speed variation with input frequency $\pm .05$ Hz and input voltage $+10\%$, -15%
Temperature	16° to 32°C (60° to 90°F) with a maximum gradient of 6.7°C per hour
Humidity	10 to 90% relative with no condensation
Altitude	305 metres (1,000 feet) below sea level to +3,048 metres (10,000 feet)
Disk drive ac power	120 Vac, 60 ± 0.5 Hz at 4.6 amperes (10.0 amperes for 8 second startup) multiple voltage/frequency options selectable by jumpers
Disk controller dc power	+5.0 Vdc at 5.5 amperes, -12.0 Vdc at 0.03 amperes, supplied by Model 990 Computer Chassis
Weight	Rackmount — 67 Kg (148 lbs.)

1.1.3 SYSTEM CONFIGURATION. Figure 1-3 shows the configuration for a disk system with a single rackmount drive. Note that the cable adapter mounts directly on the Winchester I/O board of the rackmount drive. Also, note that the resistive terminator networks must be installed in sockets XRM1 through XRM12 on the I/O board.

Figure 1-4 shows the configuration for a disk system with dual rackmount disk drives. Note that the resistive terminators are removed from the drive in the center of the daisy chain, leaving one set of terminators at the end of the chain.

Cabling configurations for the pedestal-mounted drives are similar, except for the physical location of the cable adapter, which is in the lower bay of the pedestal (figure 1-5).

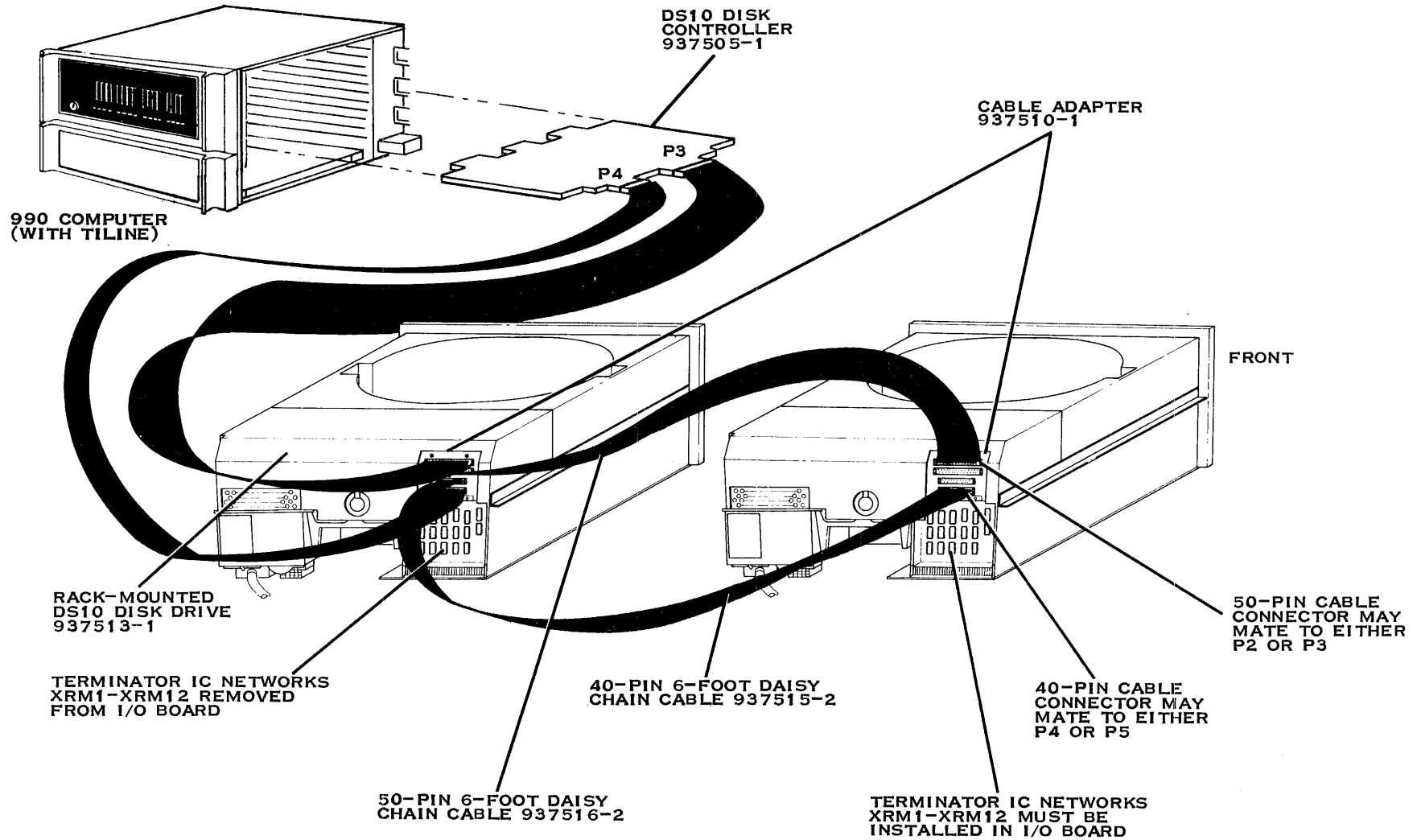


(A) 137630B

Figure 1-3. DS10 System Interconnections — Single Drive



945419-9702



(A) 137631

Figure 1-4. DS10 System Interconnections — Two Drives



945419-9702

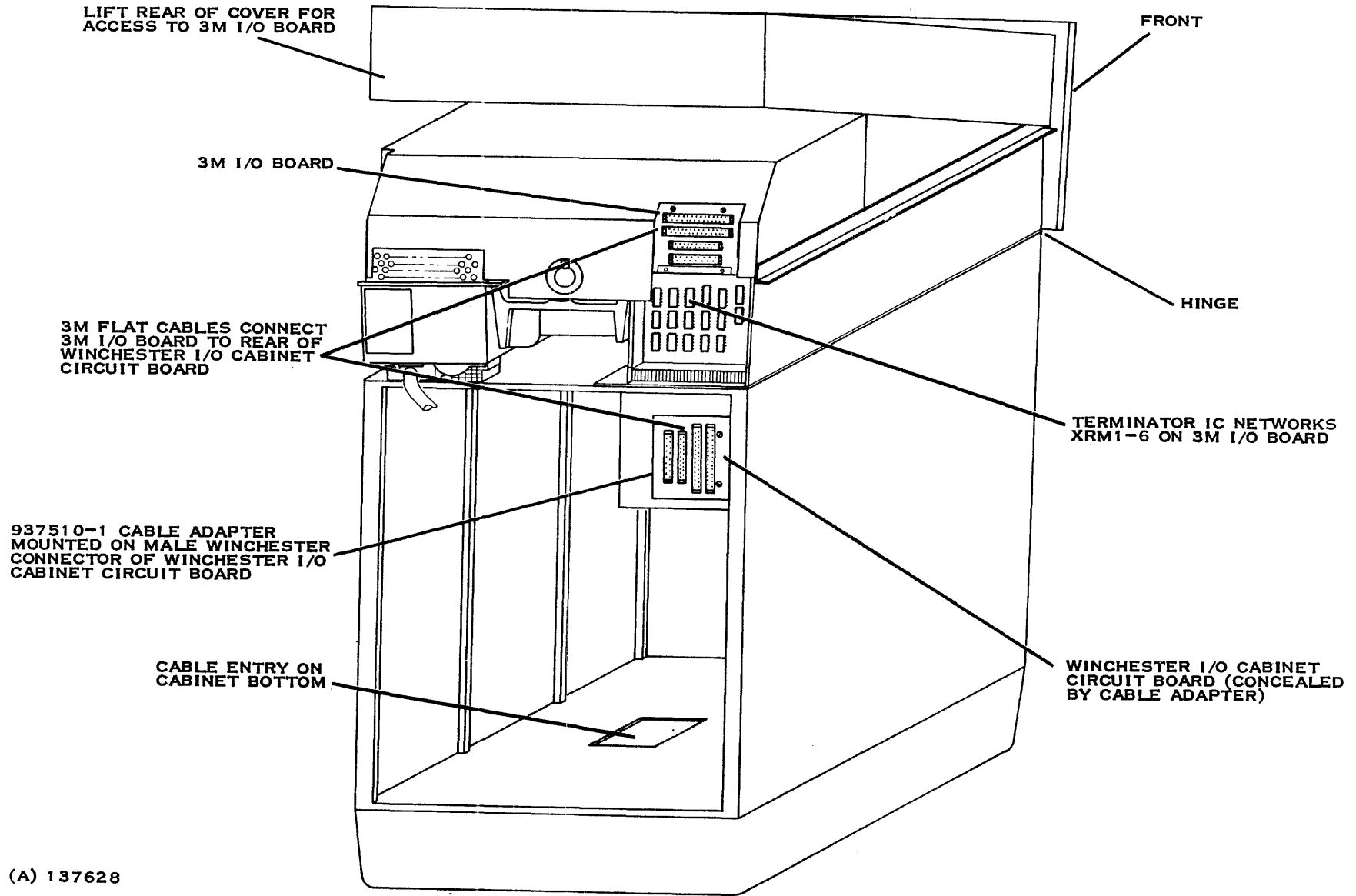


Figure 1-5. Pedestal-Mounted DS10 Disk Drive — Rear View



The Model DS10 Cartridge Disk System is available in master kits and secondary (add-on) kits with both rackmounted and quietized pedestal-mounted drives. Table 1-2 summarizes the composition of these kits.

The disk controller, cables, and cable adapter are considered to be field replaceable assemblies. The DS10 disk drive (CDC 9427H "Hawk") is a field-repairable unit which contains a significant number of field-replaceable subassemblies and parts, as listed in table 1-3.

Table 1-2. DS10 Cartridge Disk System Major Items

Description	Part Number	Rackmount Version		Quietized Pedestal Version	
		Master	Sec.	Master	Sec.
Disk Controller (PWB)	937505-0001	X		X	
Disk Controller (Fine Line PWB)	2262100-0001	X		X	
Disk drive	937513-0001	X	X		
Disk drive	937513-0005			X	X
Disk cartridge	937507-0001	X	X	X	X
Cable carrier	996745-0001	X			
Cable adapter	937510-0001	X	X	X	X
40 pin, 6 m (20 ft.) bus cable assy.	937515-0001	X		X	
40 pin, 1.8 m (6 ft.) bus cable assy.	937515-0002		X		X
50 pin, 6 m (20 ft.) bus cable assy.	937516-0001	X		X	
50 pin, 1.8 m (6 ft.) bus cable assy.	937516-0001		X		X
Installation and Operation Manual	946261-9701	X		X	

1.1.3.1 Subsystem Interfaces. Figure 1-6 is a simplified block diagram which stresses the interface signals between the computer, disk controller, and disk drive. The signals are divided into functional groupings. The disk controller-to-computer interface is the TILINE. This interface is common to all high-speed peripherals. Detailed information is available in the hardware reference manual or field maintenance manual for the applicable 990 computer. Signal names (signatures) and controller pin number assignments are included in the interface diagram, figure 1-7.

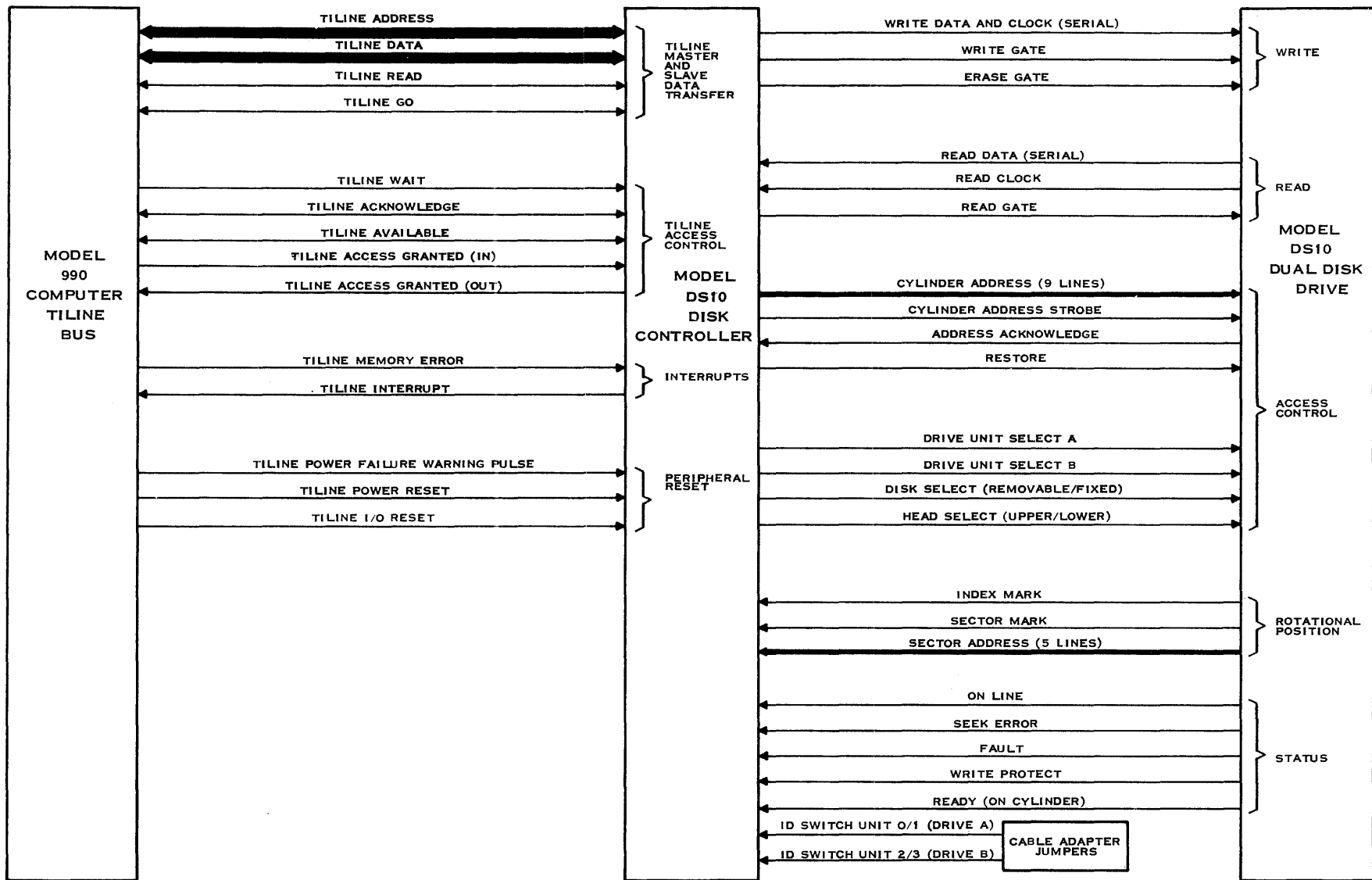
The controller-to-disk-drive interface signals are unique to the DS10 disk system. Appendix A provides controller pin numbers, disk-drive connector pin numbers and functional descriptions for all the controller-to-disk drive signals. Pin number assignments are also included in figure 1-7.

Figure 1-7 is the functional block diagram of the disk system. The major blocks of the disk controller are provided for reference only, as field maintenance for the disk controller consists of determining if it is good or bad and replacing it if a fault is traced to the controller.

Unlike the disk controller, the disk drive includes a significant number of individually replaceable electronic and mechanical assemblies. Mechanical assemblies and minor electronic assemblies are described in table 1-3. The major circuit boards are described in paragraph 1.1.4 and subparagraphs 1.1.4.1 through 1.1.4.9.

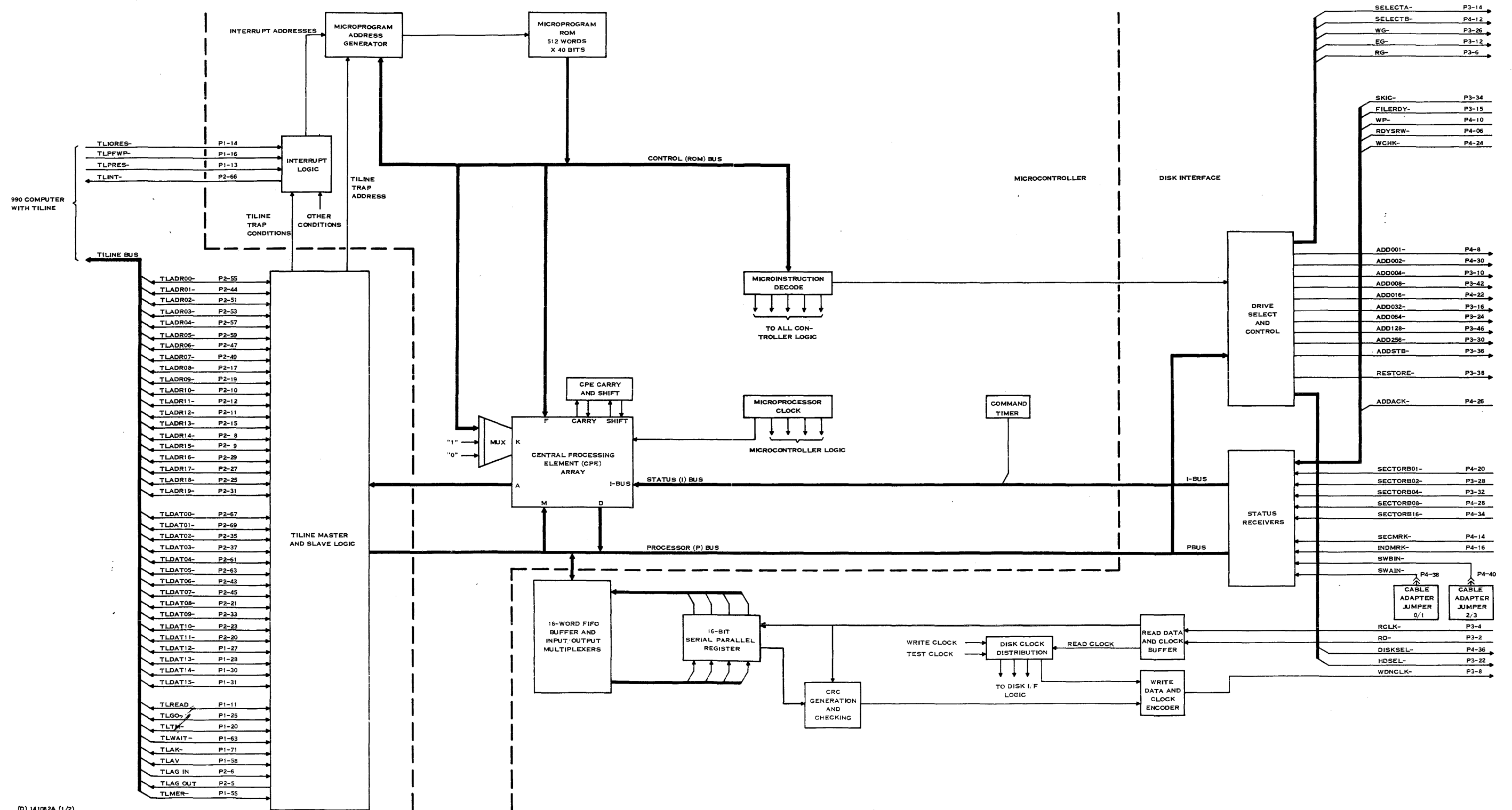


945419-9702



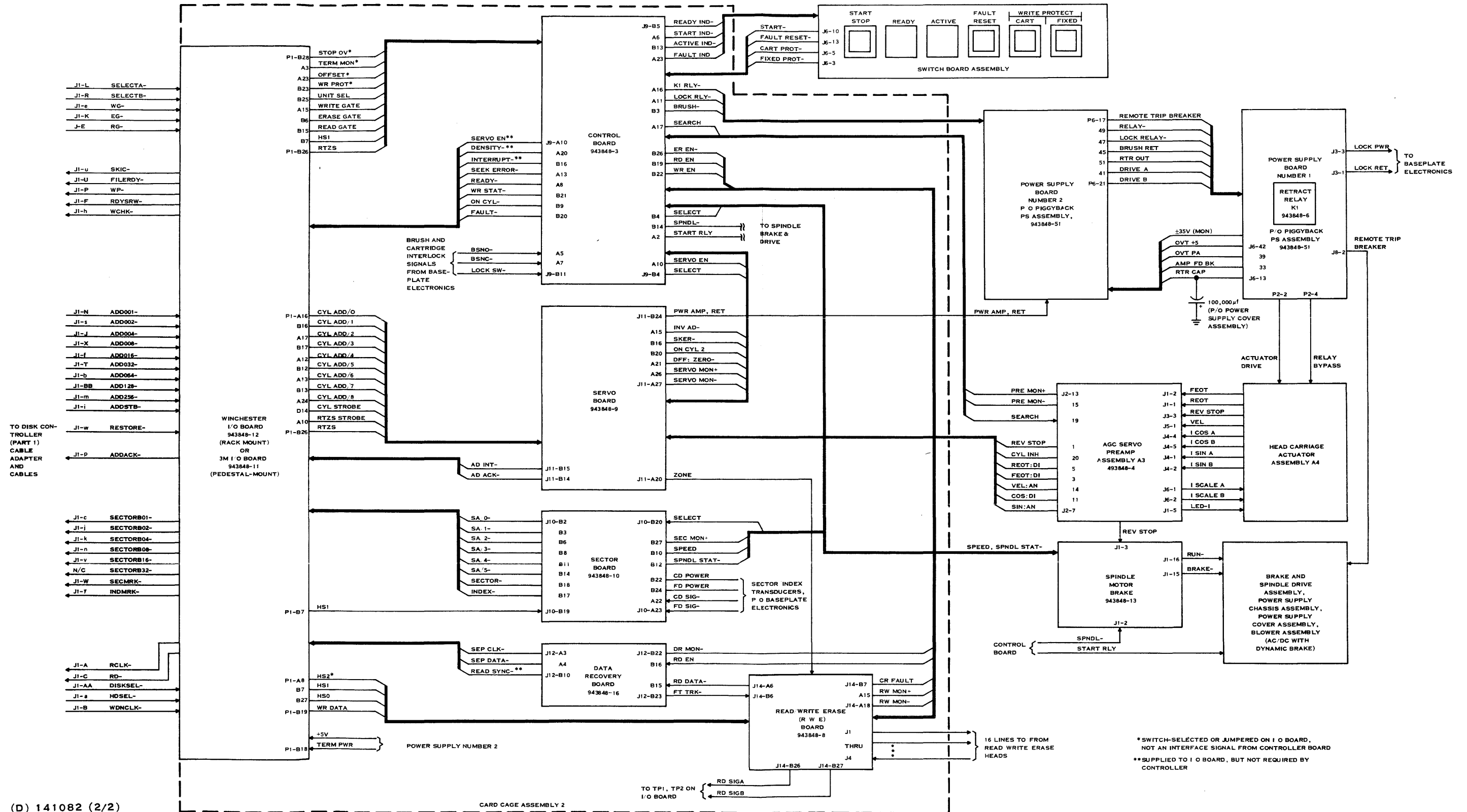
(B) 137640

Figure 1-6. DS10 Disk Controller Interface Signals



(D) 141062A (1/2)

Figure 1-7. DS10 Disk System Interface Diagram (Sheet 1 of 2)



* SWITCH-SELECTED OR JUMPERED ON I/O BOARD, NOT AN INTERFACE SIGNAL FROM CONTROLLER BOARD
 ** SUPPLIED TO I/O BOARD, BUT NOT REQUIRED BY CONTROLLER

(D) 141082 (2/2)

Figure 1-7. DS10 Disk System Interface Diagram (Sheet 2 of 2)



1.1.3.2 Disk Controller Physical Characteristics. Figures 1-8 and 1-8A are photographs of the two versions of the DS10 Disk Controllers. Connectors P1 and P2 mate with the motherboard of the 990 chassis. The controller-to-disk-drive cables mate with 100-mil grid connectors P3 and P4. The disk controller is considered a field replaceable rather than a field repairable item. However, there are on-board switch settings and jumpers which should be checked prior to replacement. The board also includes some helpful maintenance indicators.

The TILINE base address for the disk controller board is determined by the setting of the slave address switches on each controller board (figures 1-8 and 1-8A). Figure 1-9 shows the switch sections and gives the switch settings to select a given TILINE address. Note that the “all OFF” switch setting corresponds to the preferred TILINE base address (CPU byte address F800). Note also that the switch sections are not physically arranged in binary order.

Figure 1-10 shows the standard on-board jumper positions for the PWB version and fine line PWB version of the disk controller board. The detailed logic board photographs (figures 1-8 and 1-8A) show the physical locations of these jumpers. A “long diagnostic test” jumper is temporarily installed at SPAREIN2 during unit test. This jumper should be removed prior to system installation.

There are four light-emitting diodes (LEDs) on the top right corner of the controller. These indicators can be used when troubleshooting the controller to give some idea of what it is doing or what may be wrong. Three of the LEDs are green and one is red. The order of the LEDs is shown in figure 1-11.

The Clock LED is used to designate the state of the controller clock circuitry. There are two distinct states that this LED could be indicating:

- OFF — Light extinguished — Clock is hung in memory cycle or clock oscillator is bad.
- ON — Bright, clock in ON state — Normal

The Busy LED is used to tell when the controller is executing a command. When the light is off (extinguished) the controller is not executing any commands and is in the idle loop. When the controller is executing a command, the busy light will illuminate and stay on until that command is terminated, at which time it will become extinguished again. When executing multiple commands, the LED will appear to be dimly lighted.

The Interrupt LED is used to display the state of the interrupt line from the disk controller to the 990 computer. When this light is on (illuminated) the controller has issued an interrupt to the computer. This light will stay on until the interrupt condition is reset by the computer.

The Fault LED is used to display two different things. This light will be turned on by the command timer reaching its maximum count. When this happens, the LED (red) will be illuminated and will remain on until cleared by proper sequencing through the microcode terminate routine. This LED is also set (illuminated) at the beginning of the self-diagnostic test and cleared (turned off) at the successful completion of the diagnostic test.

1.1.3.3 Disk Drive Physical Characteristics. Figure 1-12 is a rear view of the disk drive with the electronics cover removed. The ac and dc circuit breakers, voltage option plug and line cord entry are at the right rear, below the power supply assembly.

Most of the disk-drive electronics circuits are mounted on printed wiring boards mounted within the card cage assembly (A2). A cutout at the rear of the card cage allows access to the connectors, option switches, and cable terminators on the input/output board.



945419-9702

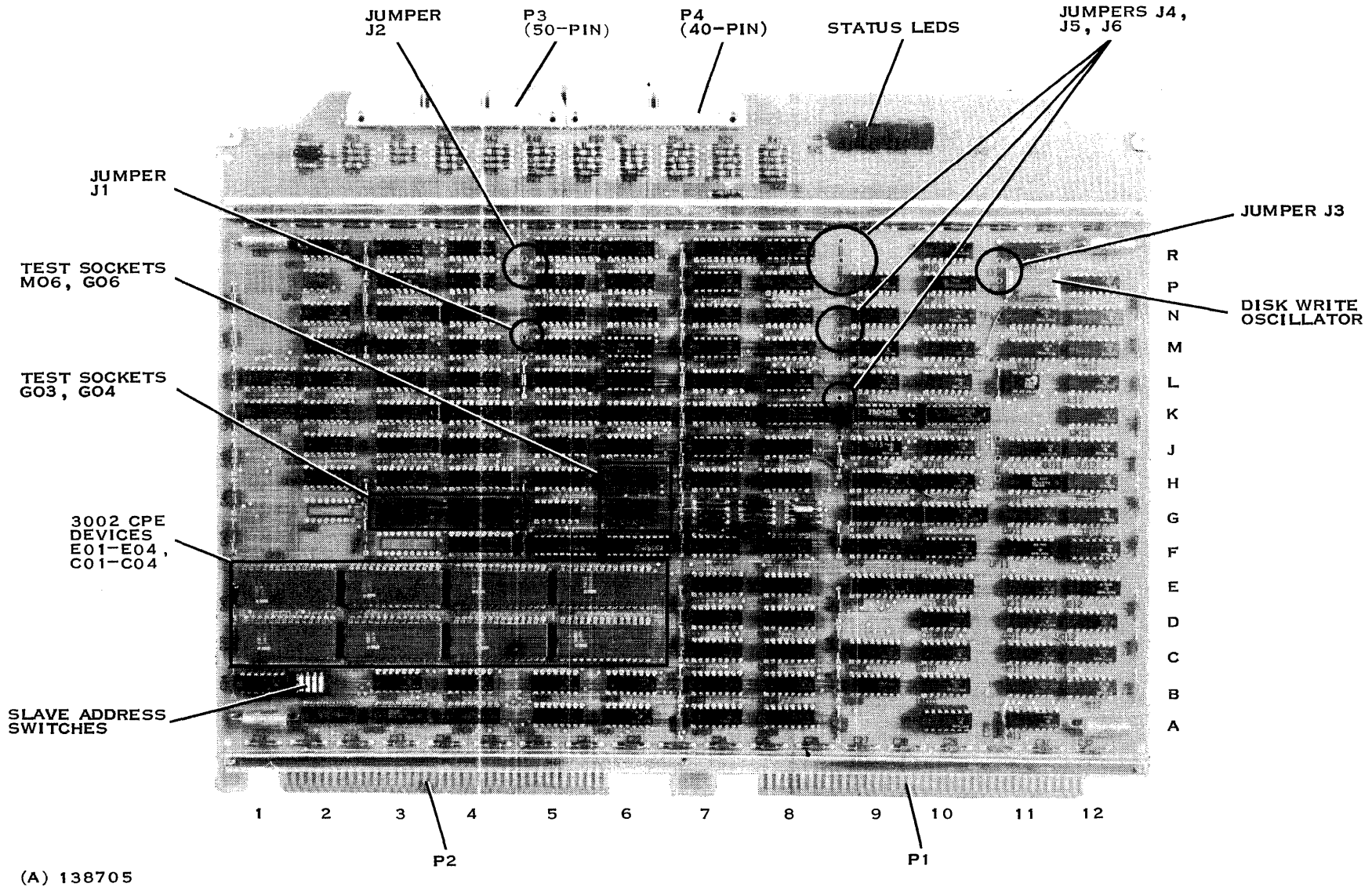
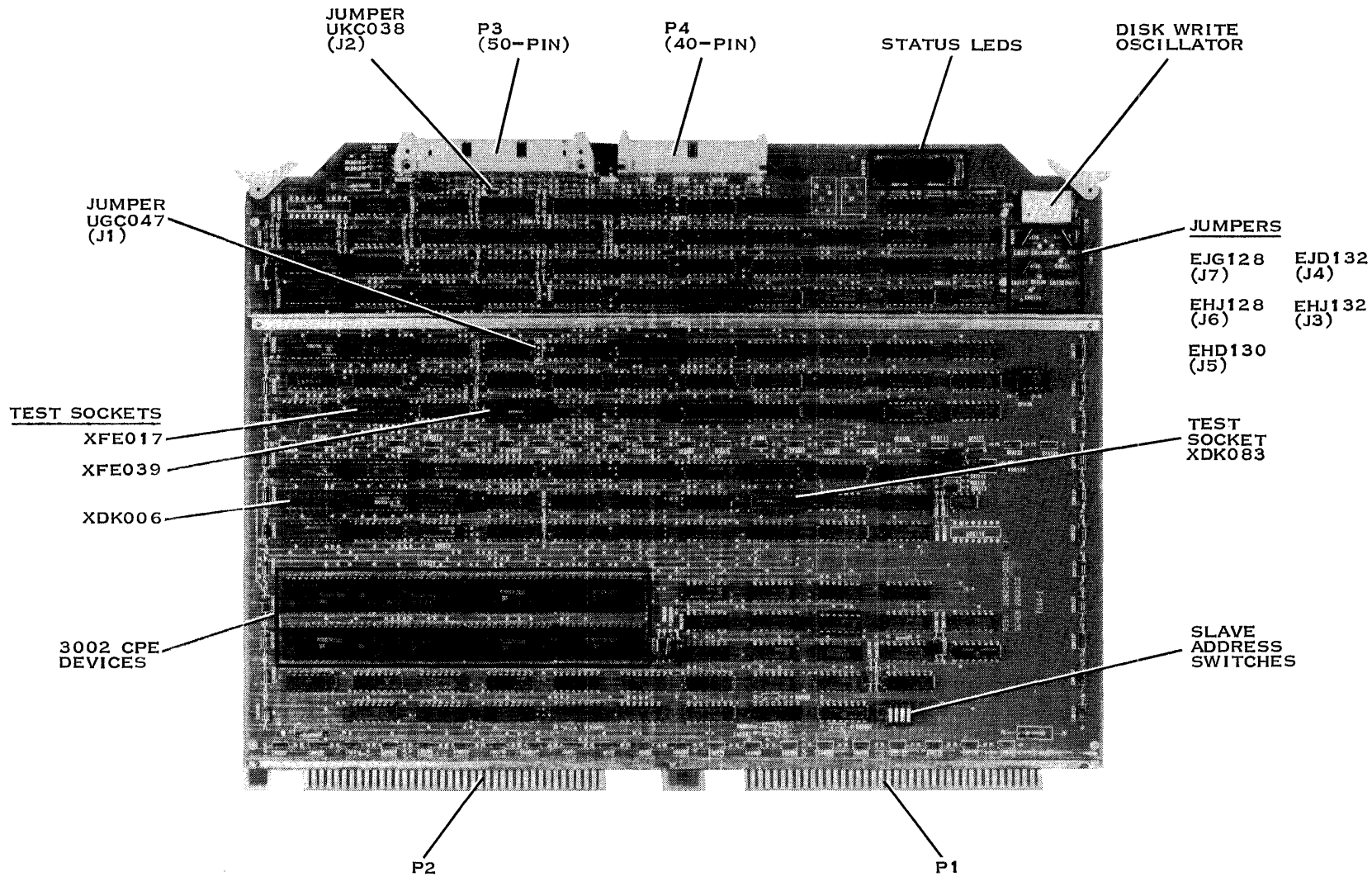


Figure 1-8. Model DS10 Cartridge Disk Controller (PWB)

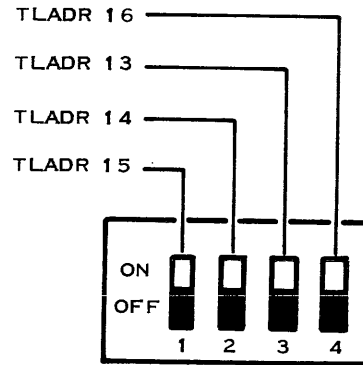


(A)143533

Figure 1-8A. Model DS10 Cartridge Disk Controller (Fine Line PWB)



(A) 137250

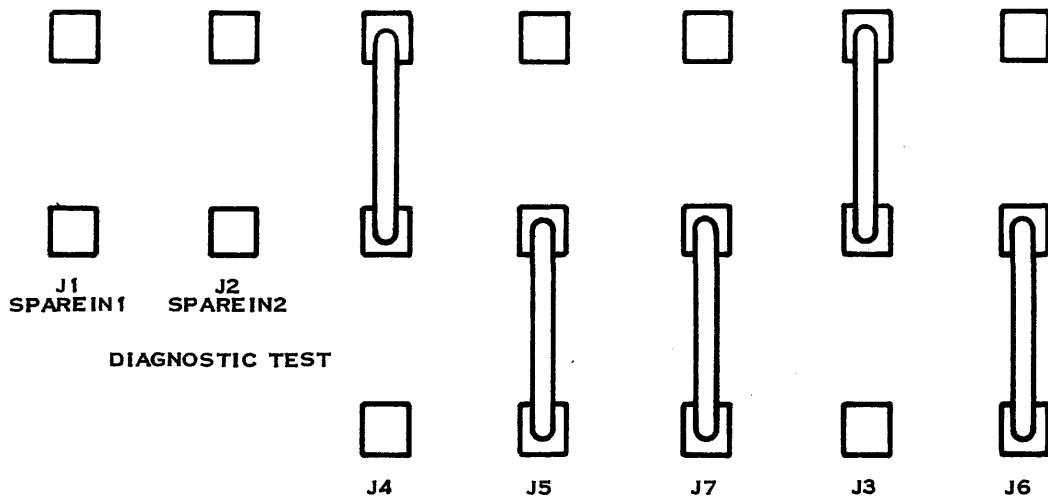


TILINE Address (Hex)	CPU Address (Hex)	Switches			
		1	2	3	4
FFC00	F800	Off	Off	Off	Off
FFC08	F810	Off	Off	Off	On
FFC10	F820	On	Off	Off	Off
FFC18	F830	On	Off	Off	On
FFC20	F840	Off	On	Off	Off
FFC28	F850	Off	On	Off	On
FFC30	F860	On	On	Off	Off
FFC38	F870	On	On	Off	On
FFC40	F880	Off	Off	On	Off
FFC48	F890	Off	Off	On	On
FFC50	F8A0	On	Off	On	Off
FFC58	F8B0	On	Off	On	On
FFC60	F8C0	Off	On	On	Off
FFC68	F8D0	Off	On	On	On
FFC70	F8E0	On	On	On	On
FFC78	F8F0	On	On	On	On

Figure 1-9. TILINE Slave Address Switches and Settings

Figure 1-13 shows the disk drive with the card cage cover and cover clamp removed. Callouts show the circuit board mounting locations within the card cage. The spindle drive motor cover is visible just behind the card cage (as viewed from the rear). The spindle pulley and belt are underneath the main deck casting, as are the blower and air filtration systems.

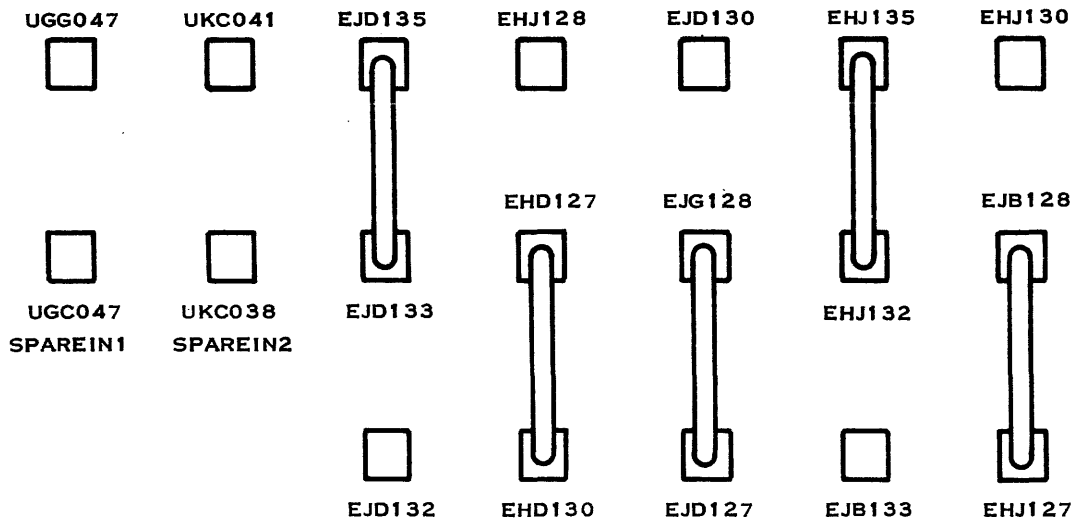
The disk-drive circuit boards feature a number of switch-selected options. A label on the power supply cover shows the locations and the mandatory positions of these switches. Figure 1-14 is a copy of the switch setting label.



NOTE:

THE LONG SELF-TEST JUMPER MAY BE INSTALLED BETWEEN THE SPAREIN2 LINE (J2) AND GROUND FOR TEST PURPOSES ONLY. IT MUST BE REMOVED TO RESUME NORMAL OPERATIONS.

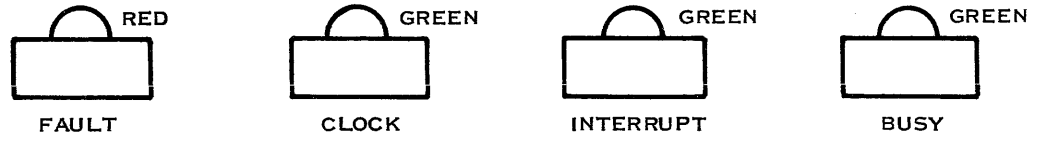
PWB VERSION



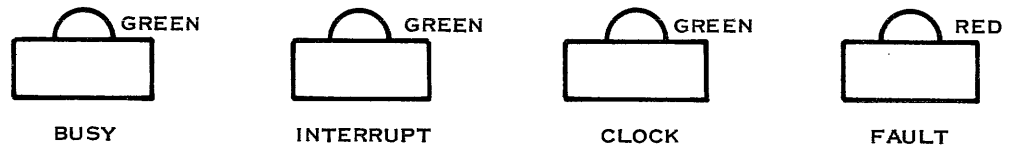
FINE LINE PWB VERSION

(A)143534

Figure 1-10. Disk Controller Standard Jumpers



PWB VERSION



FINE LINE PWB VERSION

(A)143535

Figure 1-11. Disk Controller LED Configurations



945419-9702

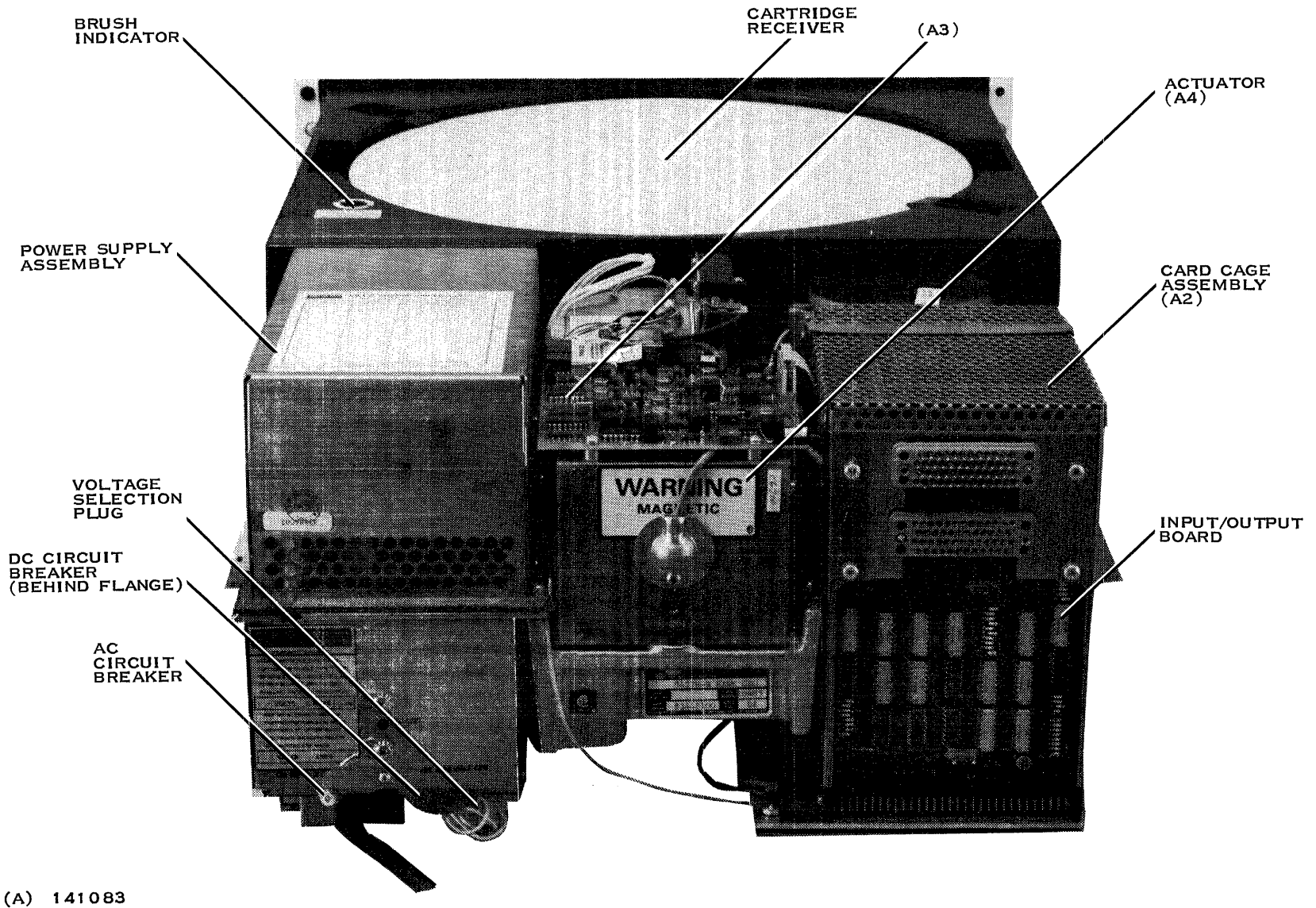
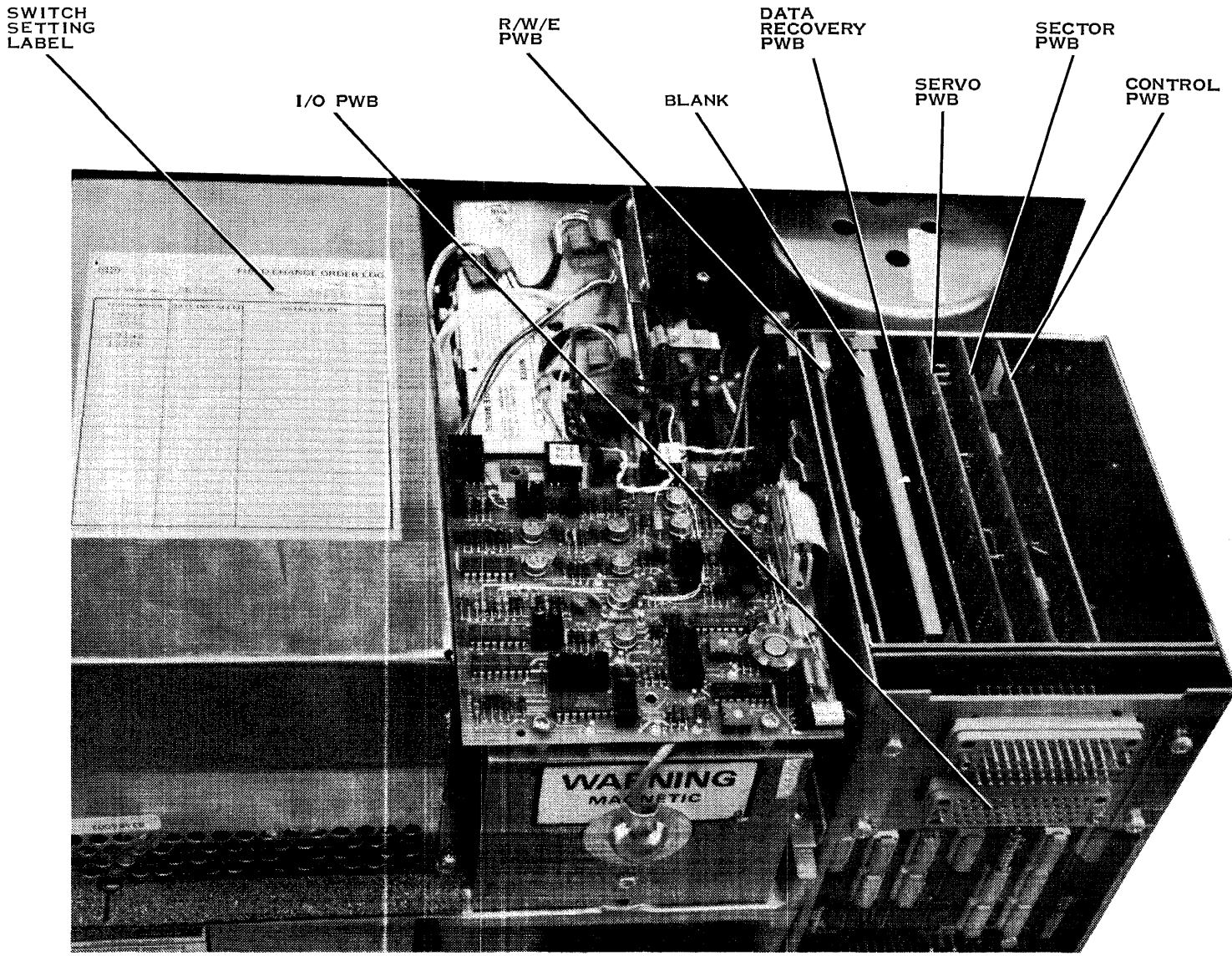


Figure 1-12. Rear View of Disk Drive, Electronics Cover Removed



945419-9702



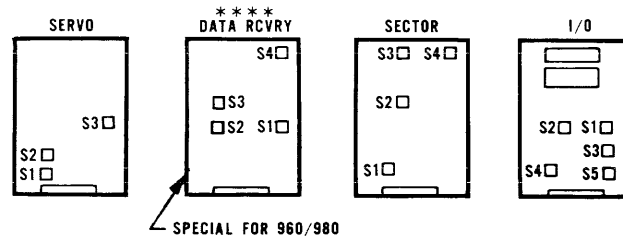
(A) 141084

Figure 1-13. Disk Drive Printed Wiring Board (PWB) Locations



SWITCH DESIGNATOR	CONTROL BOARD		SERVO BOARD			DATA RCVRY BOARD				SECTOR BOARD				I/O BOARD				
SWITCH POSITION	S1	S1	S2	S3	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S5	
1	0	1	0	**	0	0	1	0	1	1	0	0	UN1	INT1	0	0	0	
2	1	1	0	**	1	0	0	0	1	0	0	0	UN2	INT2	1	1	0	
3	1	1	0	1	0	1	0	1	0	0	0	0	UN3	INT3	0	**	1	
4	0	1	0	1	0	**	0	1	1	1	0	1	UN4	INT4	0	1	0	
5	0	1	0		**	**	1	1	0	0	1	0	0	**	0	0	0	
6	0	1	0		**	**	0	0	0	0	0	1		0		0	0	
7	1	1	0		1	1	1	1	1	0	1		1			0	0	
8	0	1	0							0	1	0		0		1	0	
9			1	0										0				
10			0	1												1		

* S1 AND S2 - UN AND INT SWITCHES MUST HAVE SAME UNIT SELECTED
 ** SWITCHES ARE REVERSED FOR 960/980 APPLICATIONS
 *** 1=ON, 0=OFF
 **** CDC PN 75886537 OR 75297105 FOR 990, CDC PN 75881050 FOR 960/980



DS10 SWITCH SETTINGS
 THIS UNIT SET FOR 990 960/980

Figure 1-14. Disk Drive Switch Setting Label

1.1.4 FIELD-REPLACEABLE PART/COMPONENT DESCRIPTIONS. The disk controller, cables, and cable adapter are considered to be field-replaceable assemblies. The DS10 disk drive (CDC 9427H "Hawk") is a field-repairable unit which contains a significant number of field-replaceable subassemblies and parts, as listed in table 1-3. Table 1-3 should be used in conjunction with figure 1-15 which shows the individual field-replaceable parts and the disassembly required to replace parts. As a guide to assembly location, the fifth column of table 1-3 contains references to the applicable sheet of figure 1-15. The item numbers which appear in figure 1-15 are vendor item numbers (not part numbers). The vendor item numbers are supplied to correlate figure 1-15 to the vendor documentation.

The following paragraphs describe the functions of the major replaceable assemblies of the disk drive.

1.1.4.1 I/O Board. All signals between a disk drive and the controller pass through an I/O board at the rear of disk-drive card cage assembly A2. This is either a Winchester I/O board (rackmount drive) or a 3M I/O board (pedestal-mount drive). These boards are identical except for the I/O connectors at the top of the board.

All input signals from the controller are terminated (110 ohms to +5 Vdc, 330 ohms to ground) by resistive networks in removable 16-pin DIP packages. The disk drive supplies +5 Vdc power to the terminators through an option jumper (J6). Figure 1-14A is a photograph of a Winchester I/O



- board showing the locations of the resistive terminator packages. Table 1-3 specifies the value (110 or 330 ohms) of the resistors in each package.

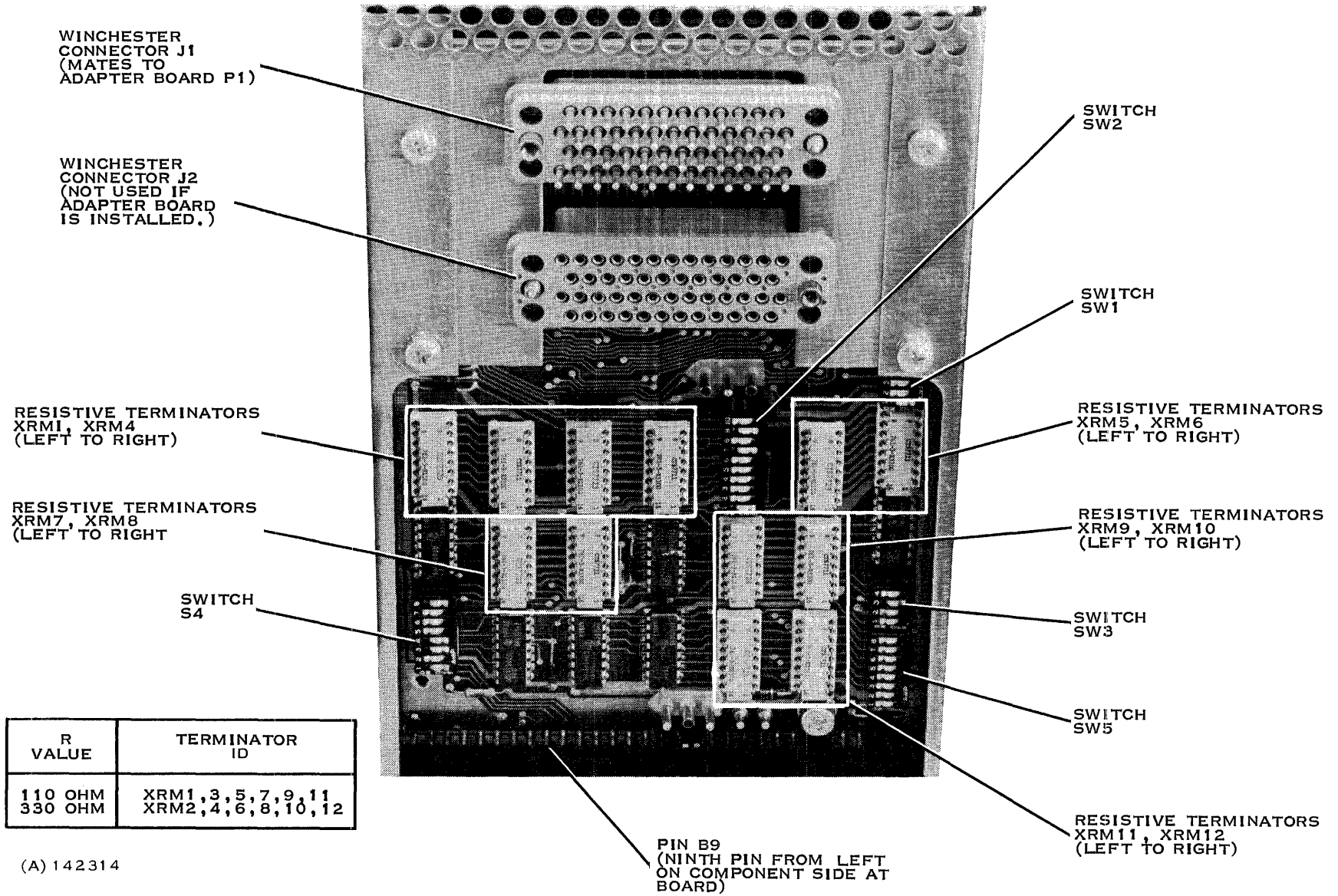


Figure 1-14A. Winchester I/O Board

Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Brake and Spindle Drive Assy		943848-XXXX		Sheet 3	
	Relay	-0006	22940804	Sheet 4	Brake relay. The triple pole, double throw (TPDT) electromechanical relay which controls inputs to start and run windings of spindle drive motor. De-energized, connects start/run windings to start/run solid state relays. Energized (by BRAKE-), applies dc braking voltages. Physically interchangeable with retract relay in power supply bd No 1.
	Switch, Solid State 600 volts	-0018	75885250	Sheet 4	Run relay, start relay. Solid state relays which control application of ac voltage to the run and start windings of the spindle drive motor. See brake relay, above.
	Capacitor	-0046	94255105	Sheet 4	Motor starting capacitor. Clip-mounted capacitor connected in series with start winding of spindle drive motor. Observe polarity when changing.
	Bridge Rectifier	-0048	95582004	Sheet 4	Full-wave rectifier bridge which develops dc braking voltage for spindle drive motor. See brake relay, above.
	Card Brake	-0013	75866206	Sheet 4	Spindle motor brake component board. Contains logic which develops the RUN- and BRAKE- signals which control the run and brake relays.
	Motor and Brake Assy.	-0047	83467401	Sheet 4	Spindle drive motor.
	Drive Belt	-0054 (E)	75722930	Sheet 4	Spindle drive belt - see idler arm.



Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)



945419-9702

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
		943848-XXXX			
Idler Assembly		-0040	75895411	Sheet 3	The idler assembly maintains spindle drive belt tension. The snubbing clutch and the idler spring are both springs which maintain the idler wheel in tension against the drive belt. The ball bearing assembly is an insert within the idler wheel which allows the wheel to rotate without drag on the spindle drive belt.
	Clutch, Snubbing	-0039	8344301	Sheet 5	
	Spring, Idler	-0038	70308503	Sheet 5	
	CR bearing, ball	-0065	92054227	Sheet 5	
Spindle Assembly				Sheet 6	The belt-driven spindle is shared by the fixed disk and the cartridge disk. The fixed disk is hard-mounted to the spindle by a circular clamp and six machine screws. The cartridge disk rests on the polished upper section of the spindle which protrudes through the cartridge disk receiver. The sector ring for the fixed disk is mounted to the bottom of the spindle. The temperature-compensating mounting arm for the carriage position transducer scale is hard-mounted to a non-rotating sleeve on the spindle assembly.
	Spindle Assembly	-0036	75286701	Sheet 6	
	Spring, static guard	-0037	40054700	Sheet 3	



Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Spindle Assembly (Continued)		943848-XXXX			
	Sensor cable, lower	-0044	75793803	Sheet 3	Sector sensor/cable for the fixed disk. This 3-wire magnetic sensor with integral cable is clamped in a movable block below the fixed disk sector ring. The block is adjustable to place the sensor over concentric rings of holes on the sector ring. The position of the block and the divider switch settings on the sector board determine the number of sectors (20 for DS10 drive in a 990 system).
	Sensor cable, upper	-0030	75793802	Sheet 9	Sector sensor/cable for the removable disk cartridge. This magnetic sensor with 3-wire cable is mounted on a bracket at the bottom of the cartridge receiver. The sensor detects the sector/index slots of the cartridge and supplies sector pulse outputs to the sector board.
Brush Assembly				Sheet 6	
	Brush Motor Assembly	-0031	75740701	Sheet 7	Ac drive motor (with 2-wire cable and connector) which sweeps the brushes across the disk surfaces as part of the disk start operation.
	Brush, disk	-0032	40024501	Sheet 7	Brush which sweeps lower surface of the fixed or removable disk platter.
	Brush, disk	-0033	40024502	Sheet 7	Brush which sweeps upper surface of fixed or removable disk platter.

Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Brush Assembly (Continued)		943848-XXXX			
	Switch, pivot lever 1	-0071	36159806	Sheet 7	Brush switch. SPDT miniature switch with pivot lever. The state of the switch contacts notifies the control board that the brush arm has properly completed the sweep. Switch outputs are BSNC-- and BSNO--.
Pack Lock Assembly		-0063	83457901-3	Sheet 6	
	Solenoid	-0042	94357803	Sheet 7	Dc pack lock solenoid. Spring-loaded plunger of this solenoid prevents opening of the pack locks unless LOCK PWR is applied. The solenoids of the two pack lock assemblies are electrically in series.
	Spring	-0068	75779867	Sheet 7	Pack lock spring.
	Switch, Sub-miniature	-0070	77598501	Sheet 7	Pack lock switch. Both pack lock switches must be closed to pass the LOCK SW signal to the control board, indicating that the cartridge disk is properly latched in place.
Air filtration & cooling				Sheet 3	
	Blower	-0041	83457100	Sheet 3	Blower assembly which includes 30 Vac motor/fan, starting capacitor, and 90-degree air duct segment.
	Filter, air	-0034	83437400	Sheet 3	Air filter assembly which includes absolute filter in an air duct segment.
	Pre-filter filter	-0053	7760400	Sheet 3	A filter placed at the main filter input, between the air duct expander and the air filter, applies to rack-mounted units only.





Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
		943848-XXXX			
Air filtration & cooling (Continued)	Air filter, cabinet	-0049	75804800	Sheet 17	Intake filter for cabinet-mounted drives which replaces the pre-filter filter. Located at front of cabinet, just below drive.
	Gasket, Blower	-0043	77599600	Sheet 17	Gasket which surrounds the round air intake hole cut into the front of the cabinet frame, just underneath the blower assembly. Applies to cabinet mounted units only.
	Gasket, Supply/Divert				Refer to power supply assembly.
Control Switch Assembly				Sheet 6	
	Switch Assembly	-0052	75299103	Sheet 6	Control switch and indicator assembly. Includes switch/indicators and indicator drivers.
	Lamp	-0021	77832393	Sheet 8	Bayonet-mounted indicator lamp for switch/indicators.
Power Supply Assembly				Sheet 9	
	Power Supply Board Assembly, Piggyback	-0051	83475106	Sheet 10	Assembly which consists of power supply board No. 1 and power supply board No. 2 mounted in a piggyback configuration, separated by a metal frame. These boards are involved in servo power amplification and the emergency retract function, as well as dc voltage distribution. Refer to paragraphs 1.1.4.5 and 1.1.4.6.

Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Power Supply Assembly (Continued)		943848-XXXX			
	Relay	-0006	22940804	Sheet 10	TPDT normal/emergency retract relay. This relay is interchangeable with the brake relay in the brake and spindle drive assembly. When energized, the servo power amplifier output is routed to the actuator voice coil. When deenergized, the emergency retract timer and capacitor circuit is connected to the actuator voice coil, driving the carriage to the fully retracted position.
	Capacitor	-0072	75774406	Sheet 10	Retract capacitor (100,000 microfarad). Stores the energy necessary to drive the carriage to the fully-retracted position during an emergency retract operation. The capacitor is mounted on the power supply cover, adjacent to the 2 filter capacitors for the ± 35 Vdc power supply.
	Transformer	-0066	75305002	Sheet 11	Main power transformer with multiple input voltage taps, autotransformer taps for blower and spindle power, and isolated center-tapped secondaries for the ± 35 Vdc supply and the retract capacitor charging circuit.
	Gasket, Supply/Divert	-0035 (E)	75794902	Sheet 11	Gasket at the junction of the air filter outlet and the power supply air inlet.





945419-9702

Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Head Carriage Assembly		943848-xxxx		Sheet 12	
	Head Assembly, 200/SE/24	-0014	75037504	Sheet 12	Lower head assembly — 200 tracks per inch, straddle erase, 2400 rpm. Gimbaled aerodynamic read/write head and flexible arm. Two identical assemblies are required, one for the lower surface of the cartridge, one for the lower surface of the fixed disk.
					CAUTION The read/write heads feature precision micro-miniature gaps and highly polished surfaces. Heads must not be allowed to contact each other, the disk, or any hard, contaminated, or abrasive surface. A slightly damaged head can quickly ruin itself, the disk and the disk data.
	Head Assembly, 200/SE/24	-0015	75037505	Sheet 12	Upper head assembly — 200 tracks per inch, straddle erase, 2400 rpm. Similar to lower head assembly, except that the upper head assembly reads and writes from the upper surface of the cartridge or fixed disk. Observe the CAUTION note in the lower head assembly description.
	Card, End of Travel	-0067	75318901	Sheet 13	Circuit board which optically detects head carriage forward end of travel (FEOT) and reverse end of travel (REOT) positions. Part of EOT assembly, 83447301, (943848-017).



945419-9702

Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Head Carriage Assembly (Continued)		943848-XXXX			
	Switch, Subminiature	-0069	92549007	Sheet 13	SPDT reverse stop (REV STOP) detector switch which opens when the carriage reaches the fully retracted position.
	Xducer Scale PWB Assy	-0027	75315405	Sheet 12, 15	Fixed scale portion of the head carriage position transducer. Physically located adjacent to the moveable parts of the head carriage, but mounted on a thermal-compensation link bar which fastens to a stationary mount on the spindle assembly.
	POS Xducer SL-C0	-0064	83475401	Sheet 12	<p style="text-align: center;">CAUTION</p> <p>If the scale assembly is not absolutely parallel with the carriage-mounted slider (next entry), a damaging collision may result as the carriage moves.</p> <p>Movable slider portion of the head carriage position transducer, mounted on head carriage. 50 KHz excitation to alternate strips on the slider capacitively couples modulated 50 KHz waveforms to the fixed scale as the carriage moves. Zero crossings of the modulated SIN waveform are used by the servo system to locate track centers.</p>



Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Head Carriage Assembly (Continued)		943848-XXXX			
	Vel Xducer Mag	-0026	75319802	Sheet 14	Magnetic core of carriage velocity transducer. The velocity transducer core is mounted to the moveable section of the head carriage, while the outer sleeve and windings are fixed. The core is included in the spares list because it is brittle and subject to breakage if the actuator is mishandled or the outer sleeve is bent.
	Vel Xducer Conn Assy	-0025	75317102	Sheet 14	Velocity transducer and connector assembly. Sleeve, windings, cable and connector of the carriage velocity transducer. Head carriage motion induces a voltage proportional to carriage velocity by moving the magnetic core (see description above) relative to the windings. The output signal, after amplification, is used for servo feedback.
Card Cage				Sheet 16	
	Card, Motherboard	-0020	75870203	Sheet 16	Motherboard card which includes connectors and interconnect wiring for the plug-in circuit cards.
	Card, I/O, Winch.	-0012	75857706	Sheet 16, 1	Input/output board with Winchester connectors. This version of the I/O board is used in the rackmounted disk drives, with the TI cable adapter directly mounted to the upper Winchester connector (J1). Both versions of the I/O board are functionally identical and include removable resistor modules. Refer to paragraph 1.1.4.1.

Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)

Next Higher Assembly	Replaceable Unit Name	TI Part Number 943848-XXXX	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
Card Cage (Continued)	Card, I/O, 3M	-0011	75858205	Sheet 16, 1	Input/output board with 3M connectors. This version of the I/O board is used in the cabinet (pedestal)- mounted disk drives. 3M-type flat cables connect the I/O board to a 3M to Winchester adapter in the lower bay of the pedestal. The TI cable adapter mounts on the Winchester connector. Both versions of the I/O board are functionally identical and include removable resistor modules. Refer to paragraph 1.1.4.1. Also see resistor module in this table.
	Card, Control	-0003	75297507	Sheet 1	Control Board. Refer to paragraph 1.1.4.10.
	Card, R/W/E	-0008	75296311	Sheet 1	Read/write/erase board. Includes removable resistor networks. Refer to paragraph 1.1.4.8. Also, see resistor module in this table.
	Card, Data Recovery	-0016	75886537 or 75297105	Sheet 1 Sheet 1	Data recovery board. Two versions are accepted for use with the 990 computer.
	Card, Sector	-0010	75883201	Sheet 1	Sector board. Refer to paragraph 1.1.4.7.
	Card, Servo	-0009	77831400	Sheet 1	Servo board. Refer to paragraph 1.1.4.4.



Table 1-3. Field Replaceable Subassemblies and Parts for DS10 Disk Drive (Continued)



Next Higher Assembly	Replaceable Unit Name	TI Part Number	CDC Part Number	Refer to Figure 1-15 Sheet XX	Description
None Applicable		943848-XXXX			
	Card, Servo AGC	-0004	77831200	Sheet 1, 6	Servo preamplifier board. Mounts above head carriage actuator, rather than in the electronics card cage. Refer to paragraph 1.1.4.3.
R/W/E Board					
	Resistor Module	-0019	7530020		Resistor IC's RM1 and RM2. Selected as part of the drive option package.
I/O Board					
	Resistor Module	-0055	75738604		Resistor IC's (110 ohm) which form part of the line termination networks (XRM 1, 3, 5, 7, 9, 11).
	Resistor Module	-0056	85838607		Resistor IC's (330 ohm) which form part of the line termination networks (XRM 2, 4, 6, 8, 10, 12).

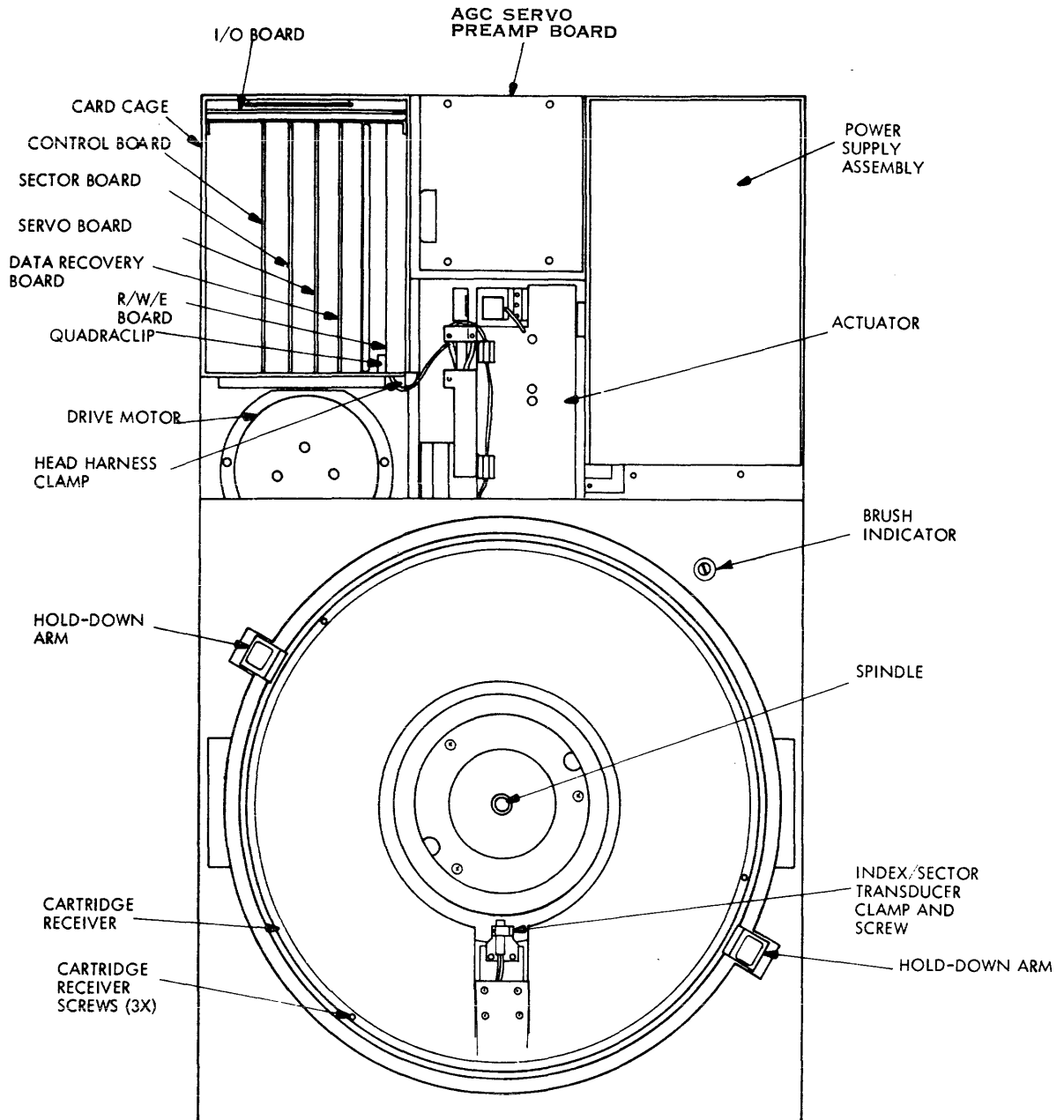


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 1 of 18)

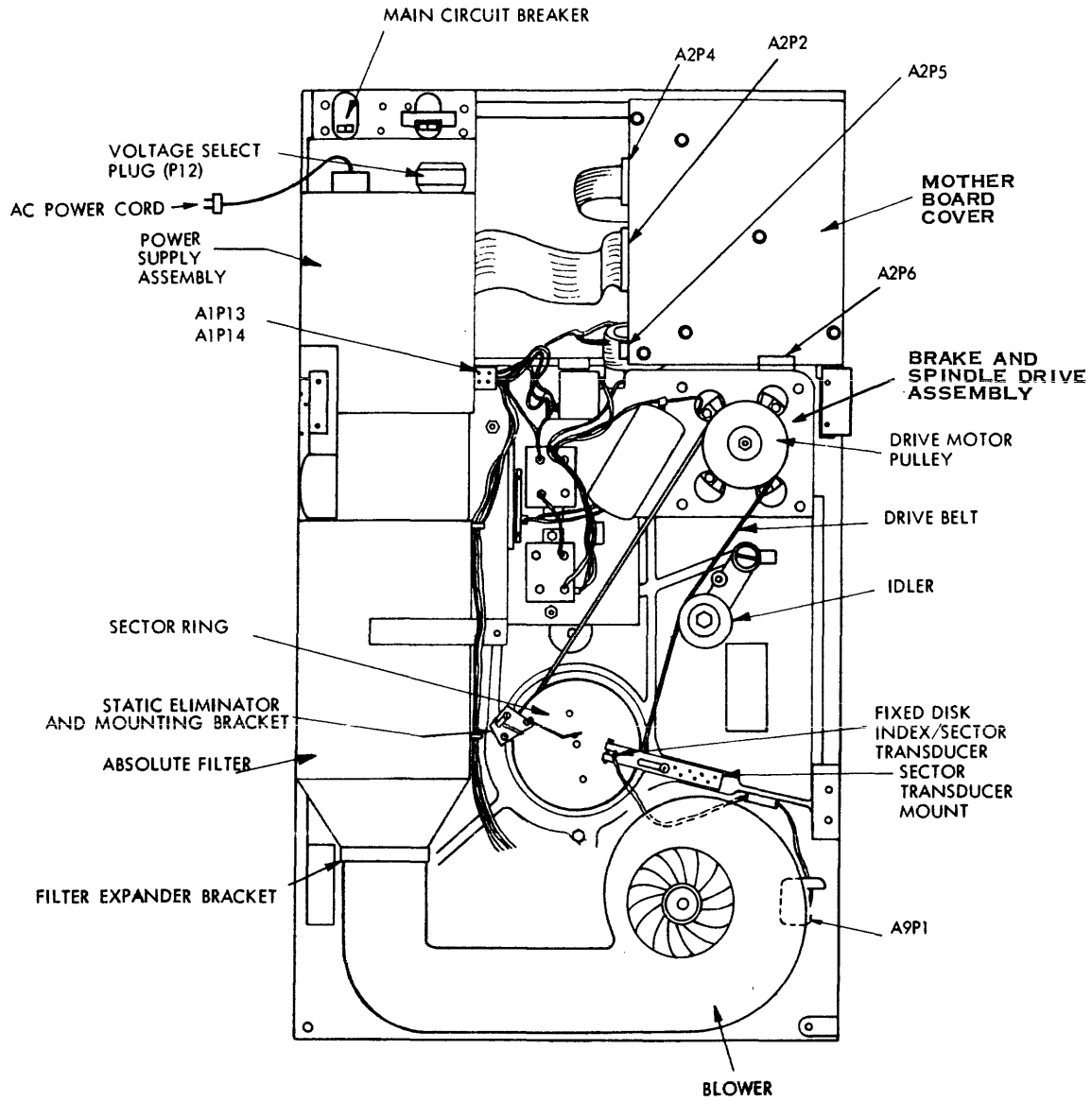


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 2 of 18)

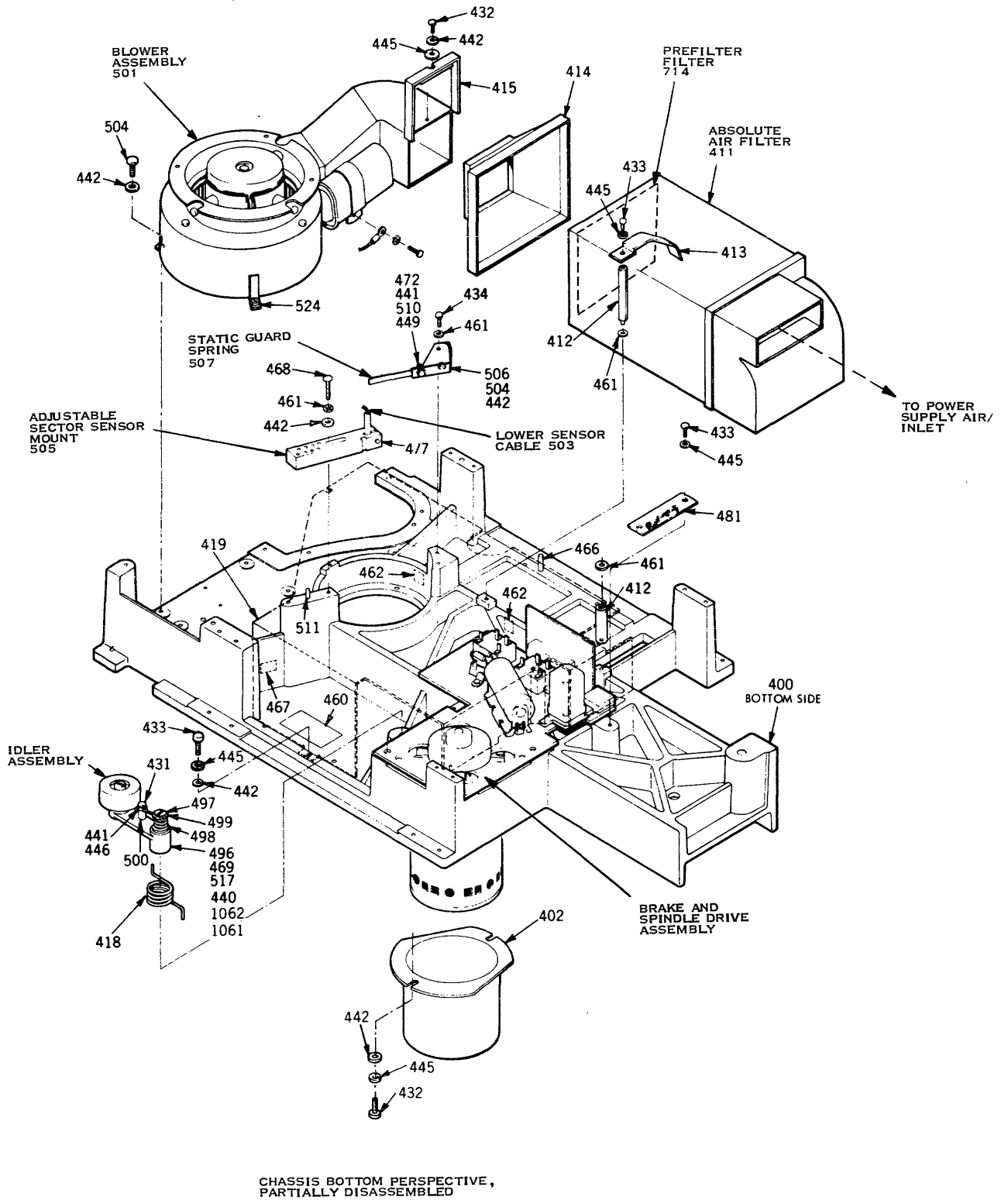


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 3 of 18)

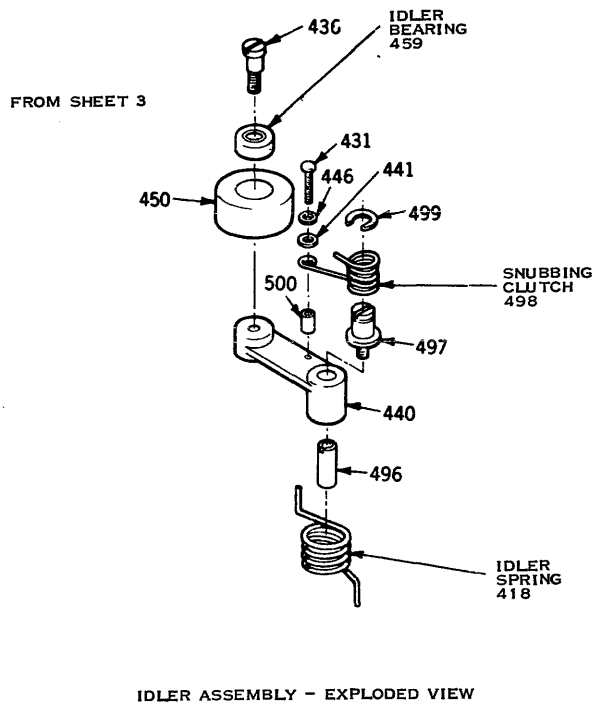


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 5 of 18)

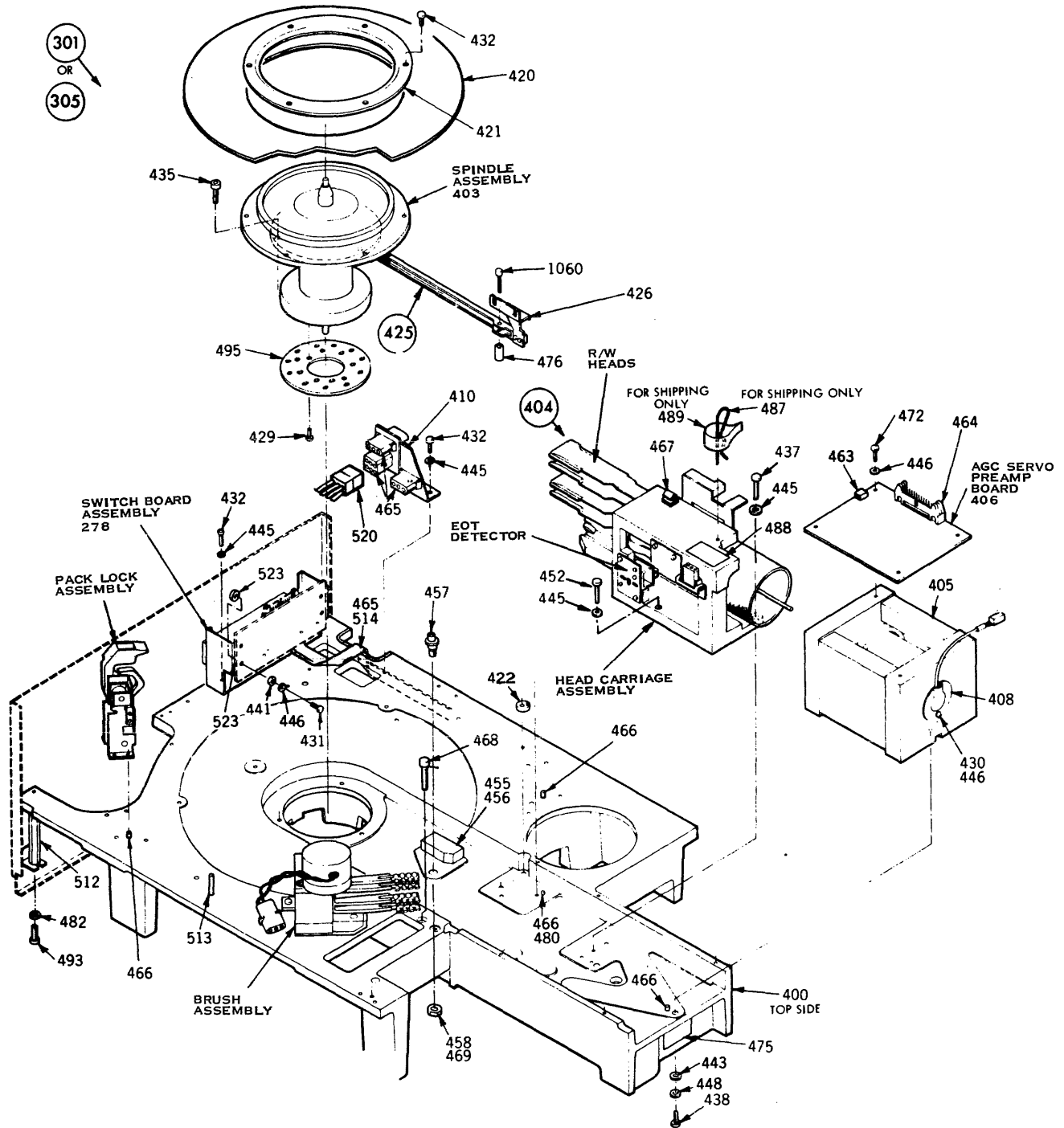
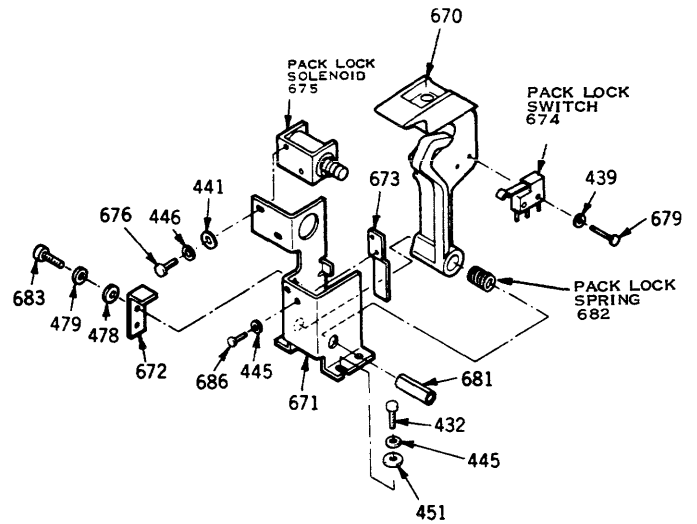
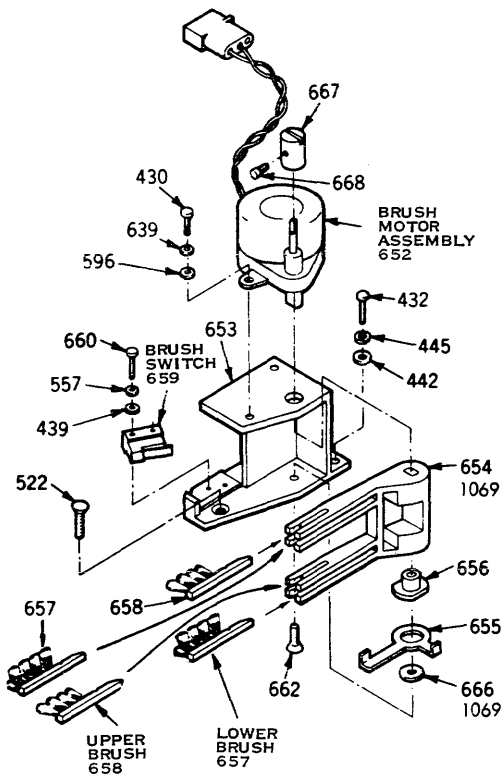


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 6 of 18)

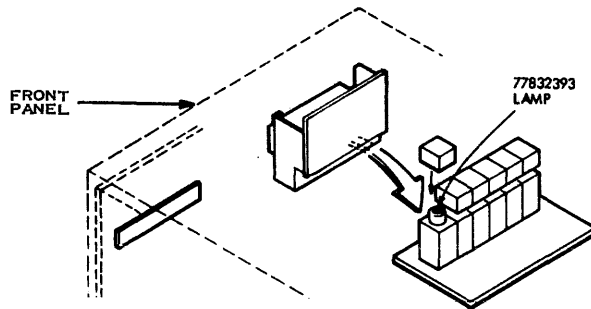


PACK LOCK ASSEMBLY - EXPLODED VIEW



BRUSH ASSEMBLY - EXPLODED VIEW

Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 7 of 18)



SWITCH BOARD ASSEMBLY - LAMP REPLACEMENT

Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 8 of 18)

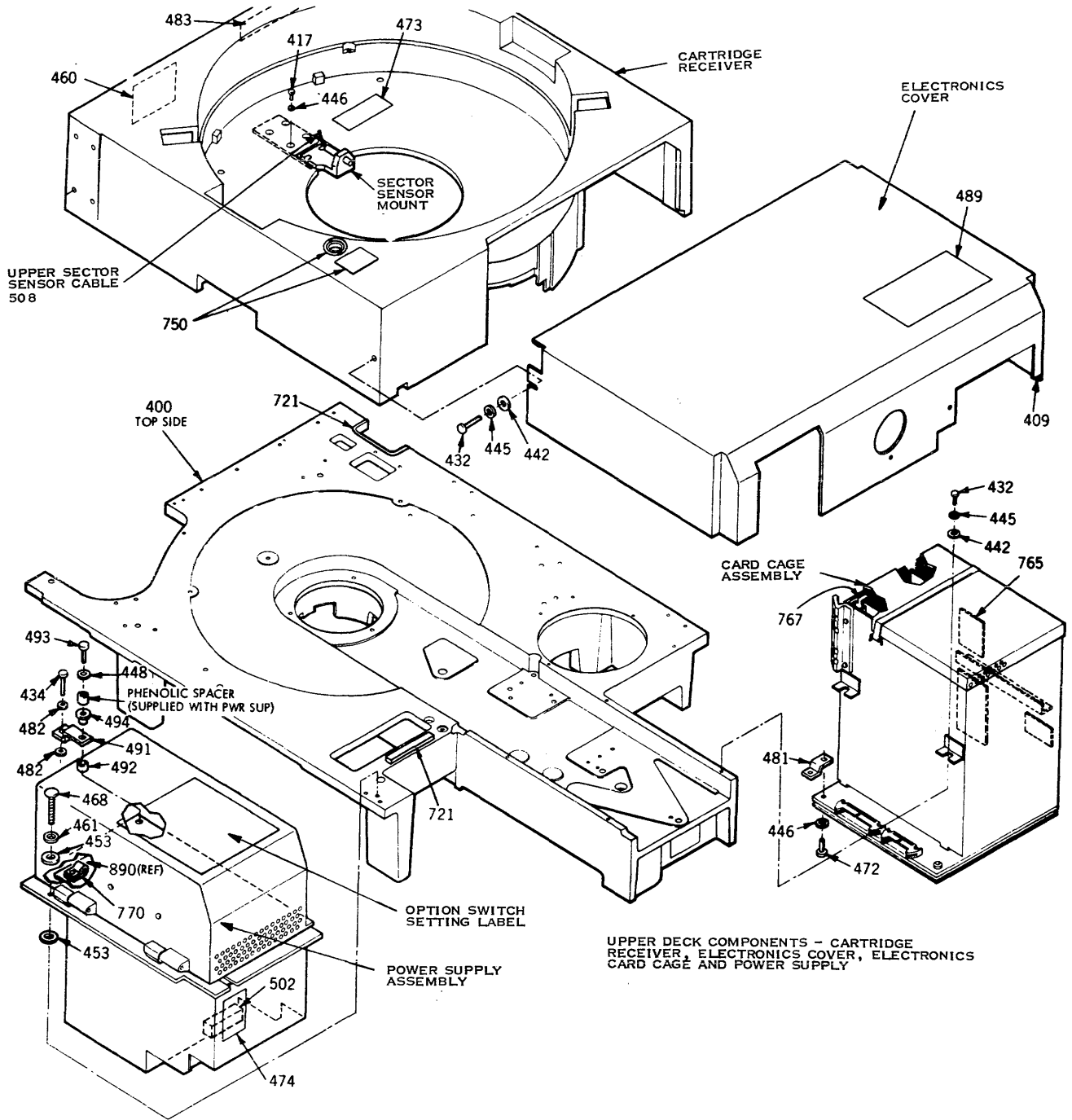


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 9 of 18)

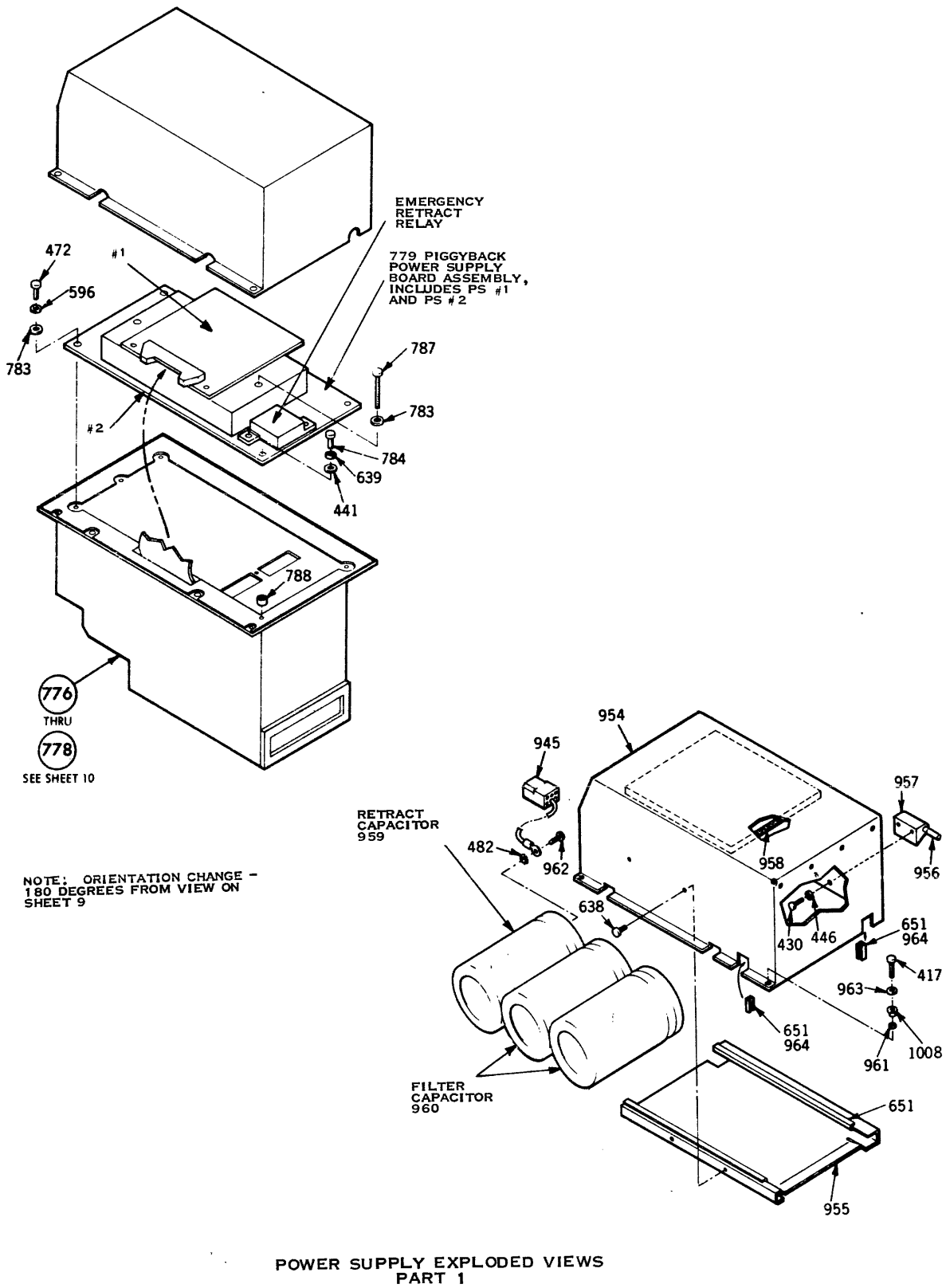


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 10 of 18)

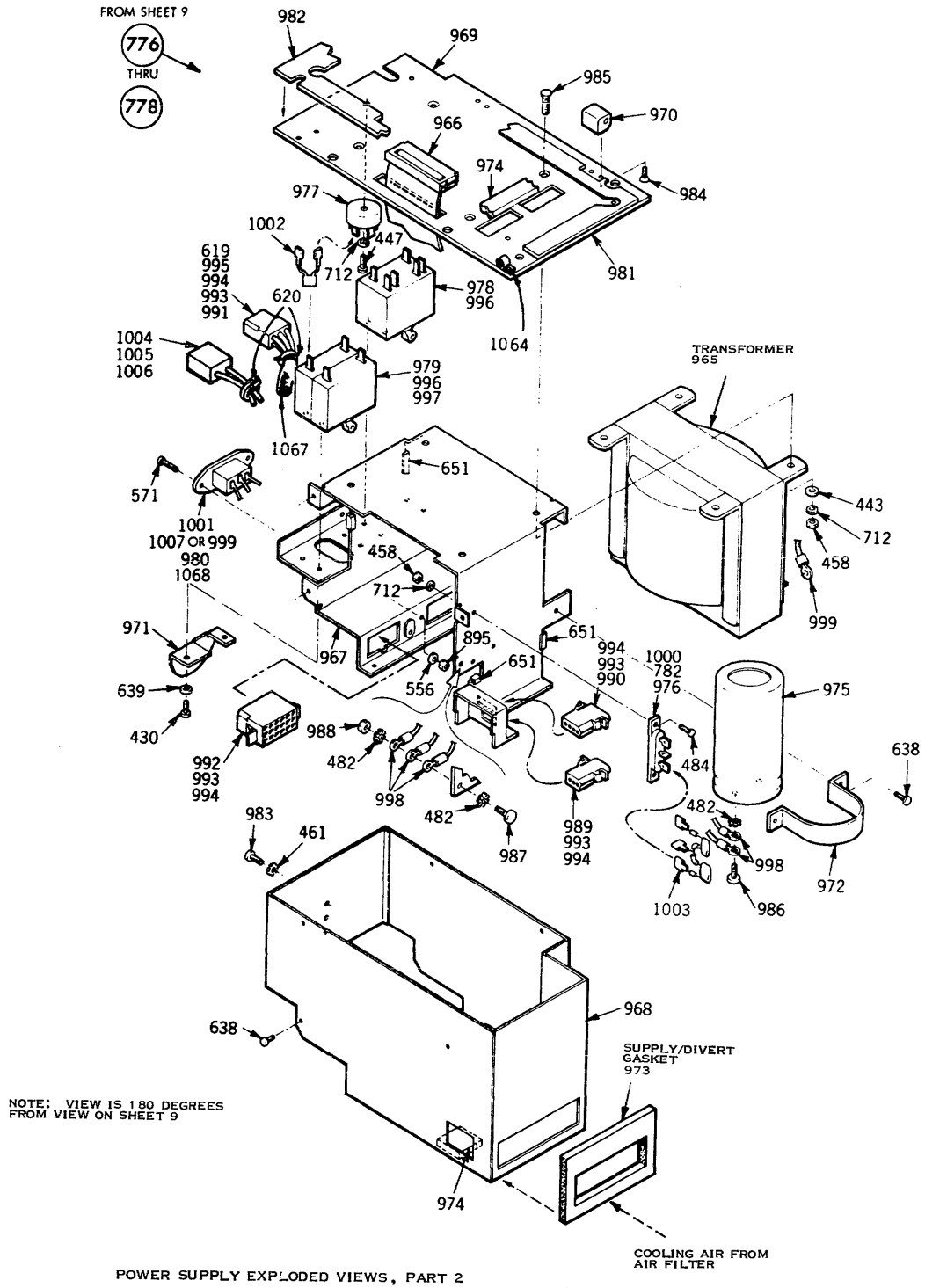
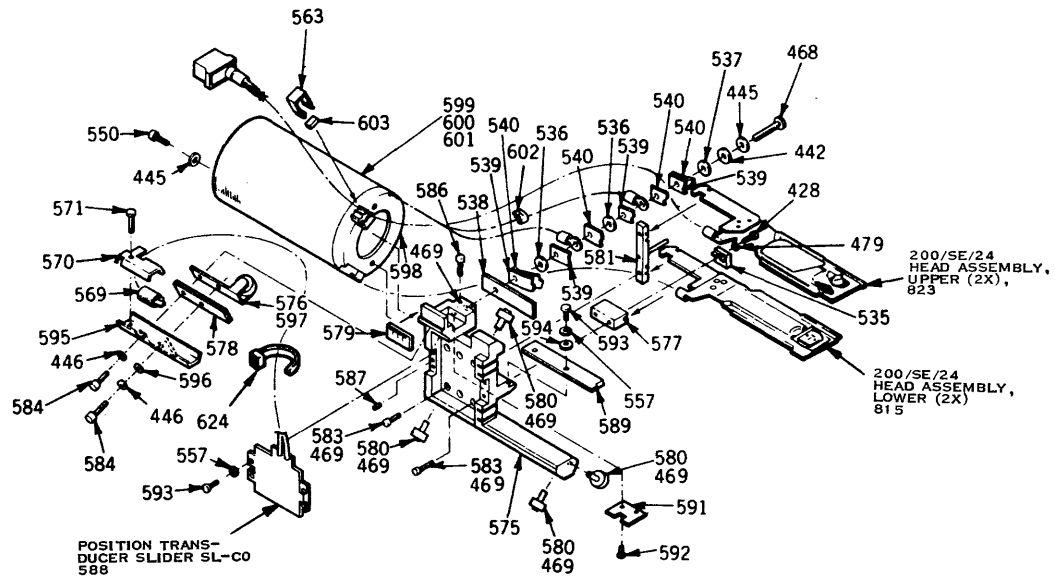
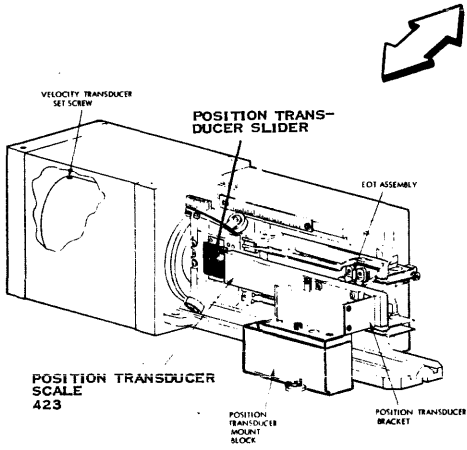


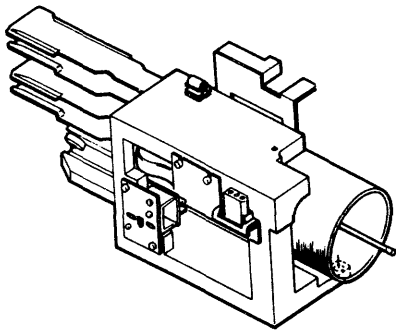
Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 11 of 18)



EXPLODED VIEW



RIGHT SIDE VIEW

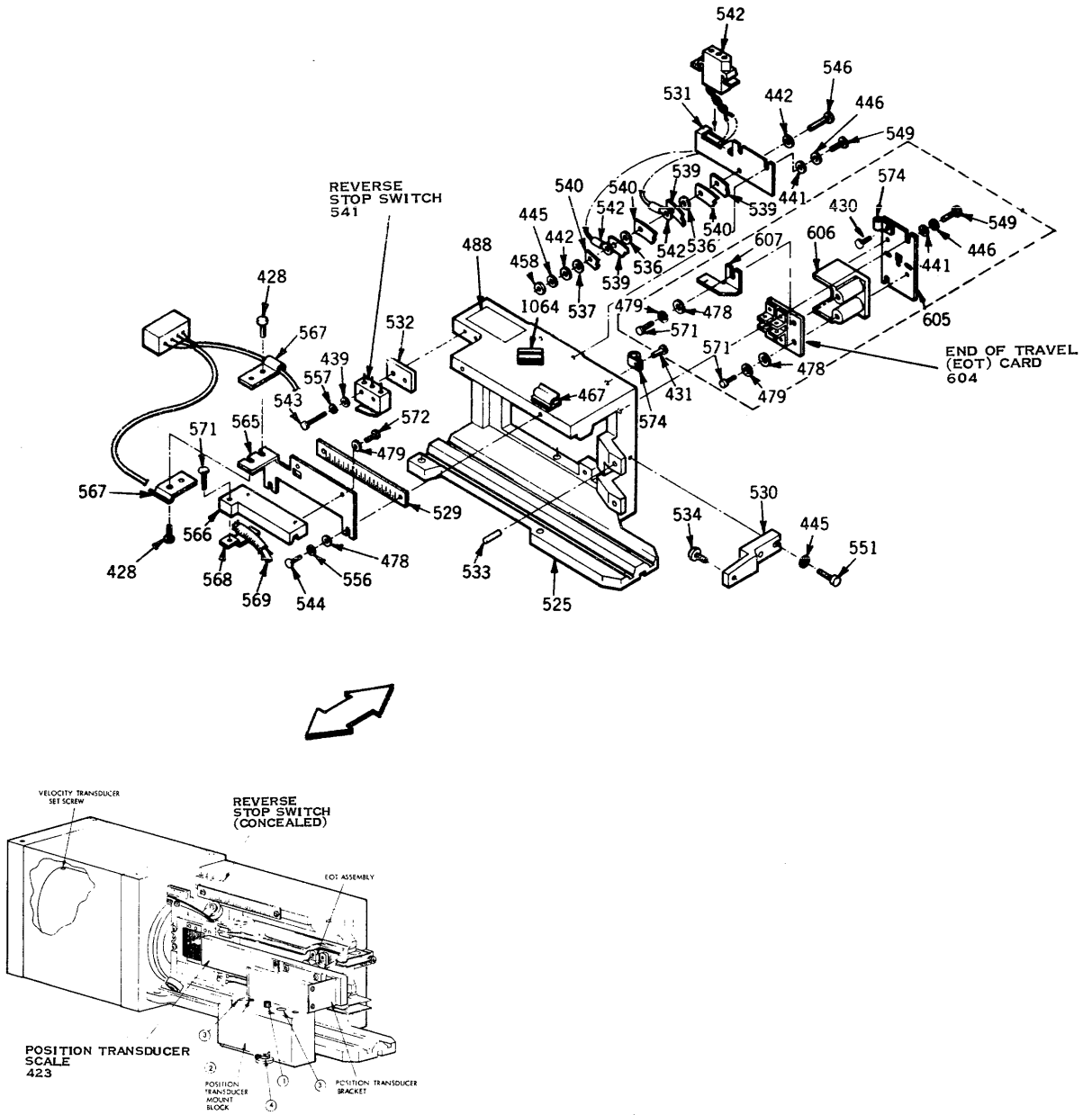


LEFT SIDE VIEW

NOTES:
 1-POSITION TRANSDUCER SCALE AND BRACKET ARE MOUNTED (VIA TEMPERATURE COMPENSATING ARM) TO A FIXED POINT ON THE SPINDLE. SEE SHEET 15
 2-ACTUATOR MAGNET NOT SHOWN IN EXPLODED VIEW.

HEAD CARRIAGE AND ACTUATOR VIEWS
PART 1

Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 12 of 18)



HEAD CARRIAGE AND ACTUATOR VIEWS
PART 2

Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 13 of 18)

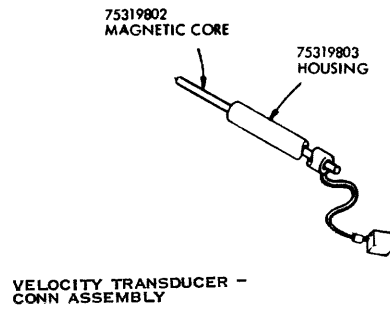


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 14 of 18)

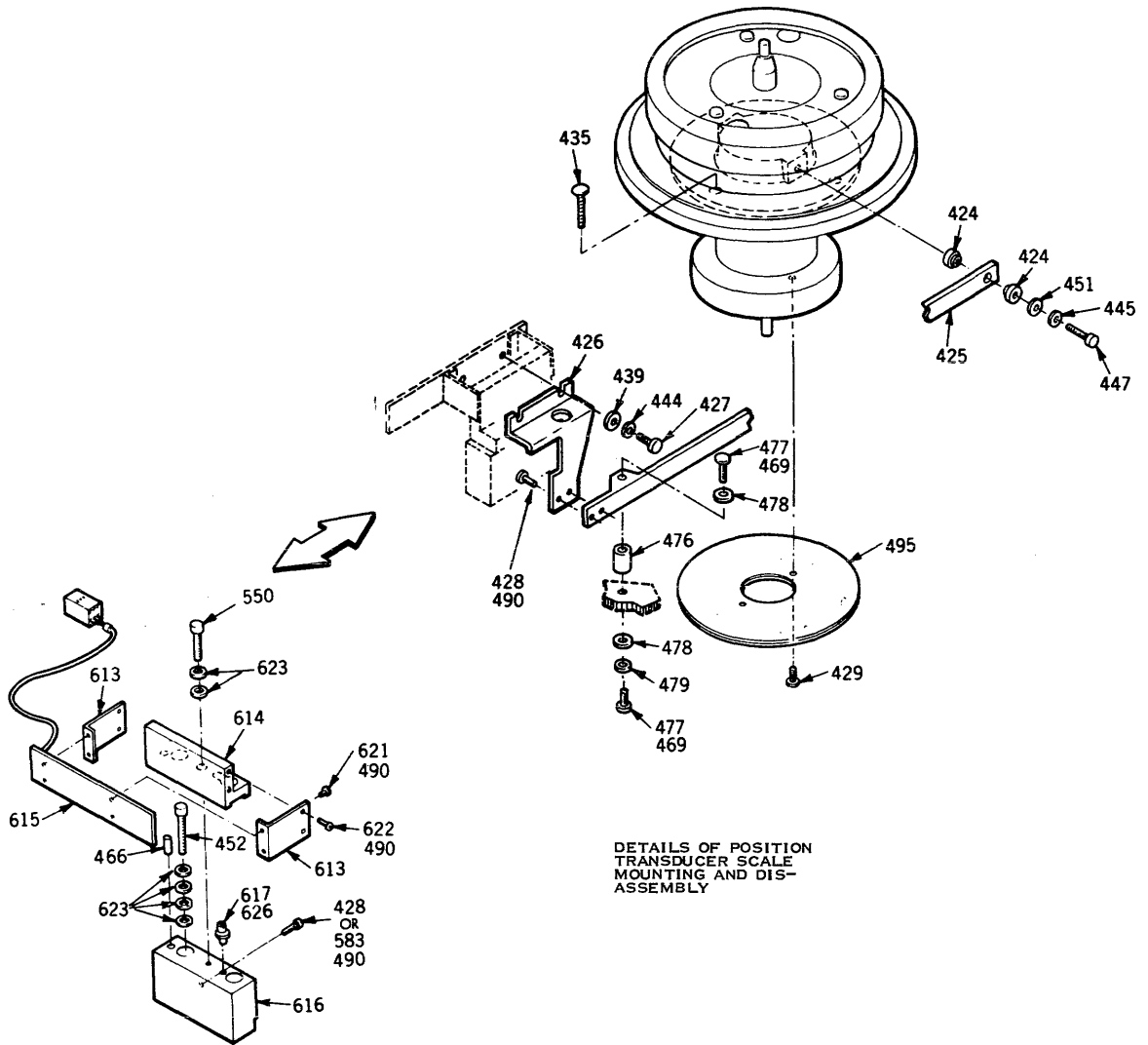


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 15 of 18)

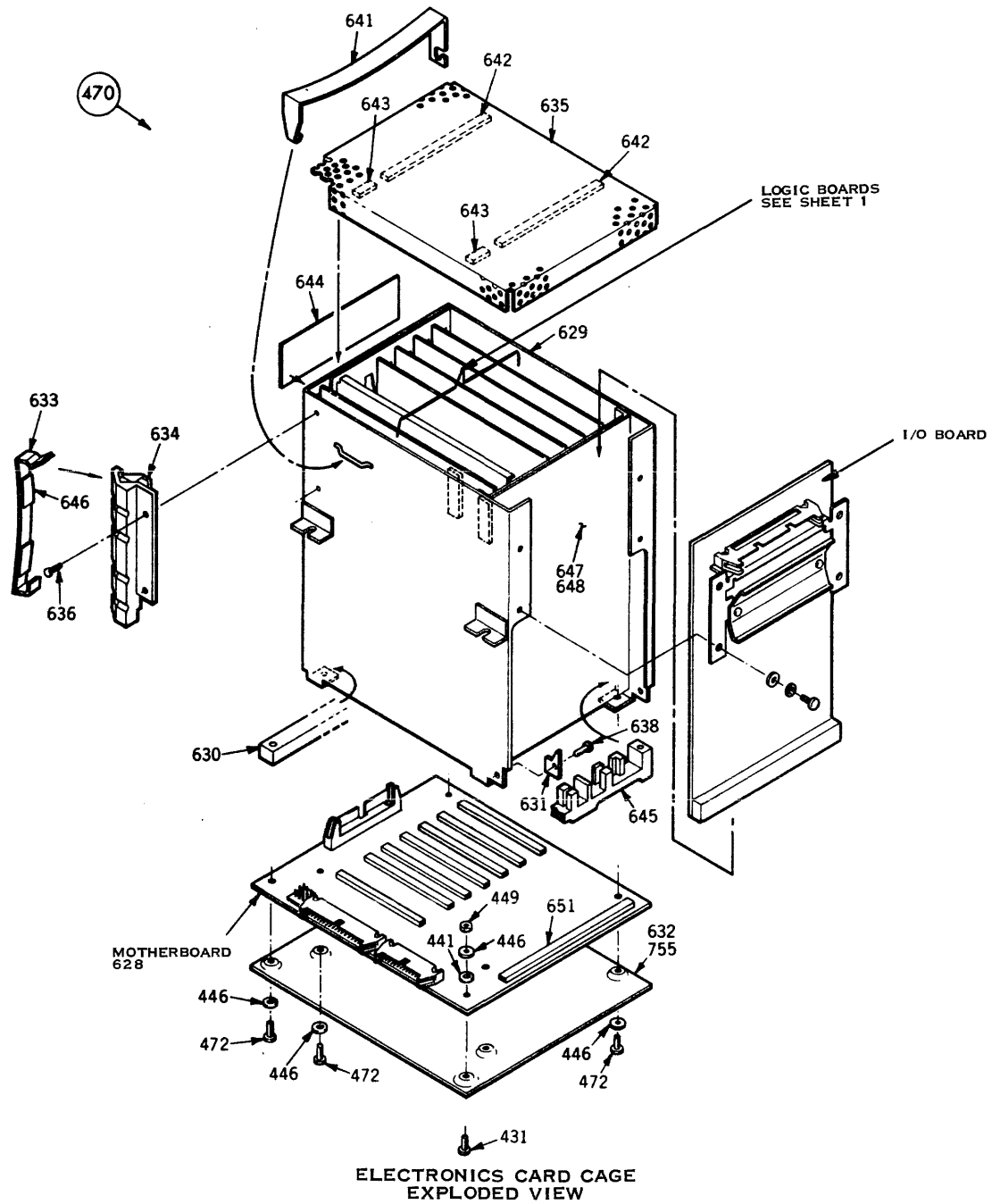


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 16 of 18)

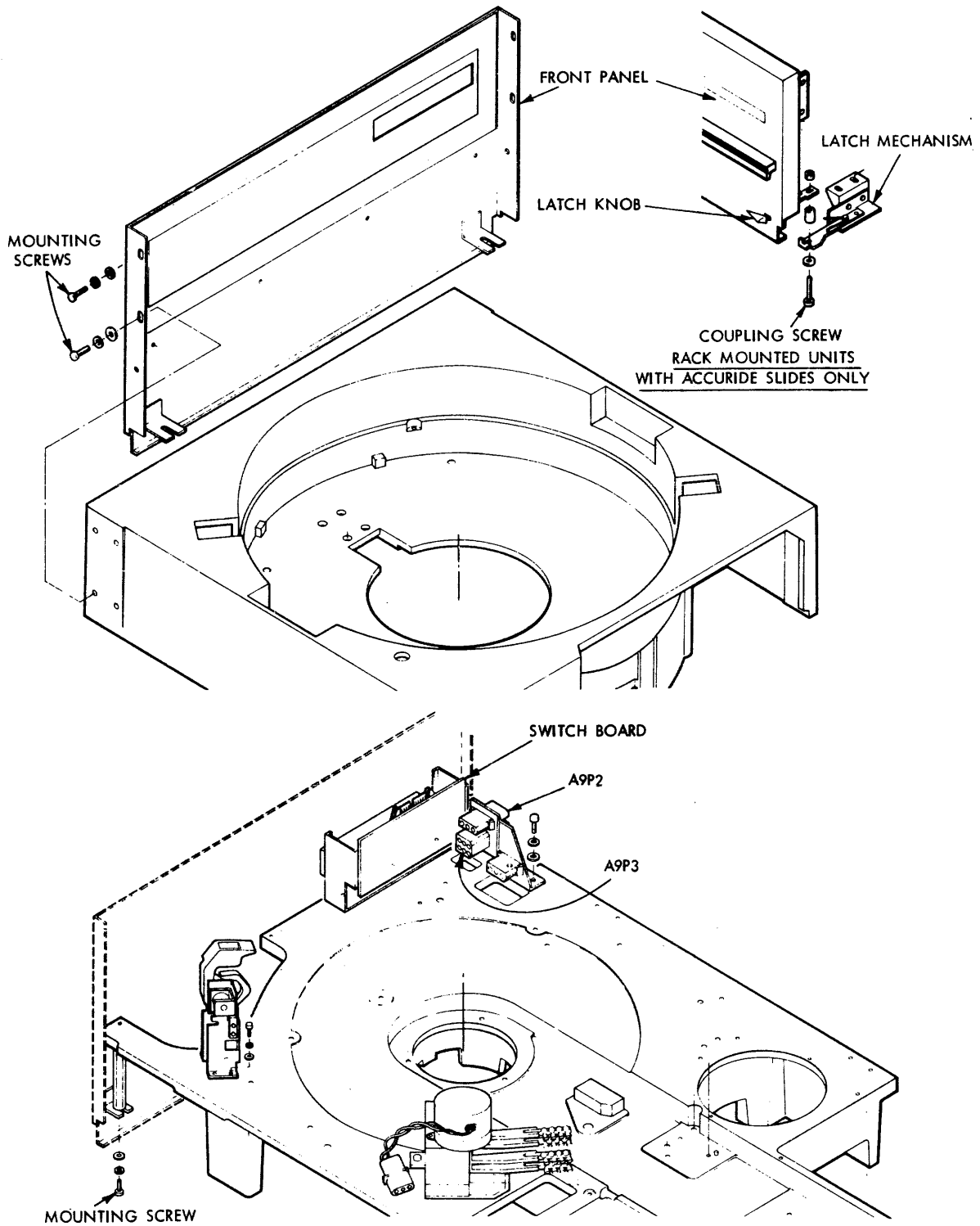


Figure 1-15. Disk Drive Replaceable Unit Locations (Sheet 18 of 18)



1.1.4.2 Head Carriage Actuator. The movable part of the head carriage is driven into and out of the disk area by a linear motor. This motor consists of a hollow voice coil suspended in a powerful magnetic field. The interaction of the permanent magnetic field with the voice coil electromagnetic field provides the force which moves the carriage. The limits of allowable carriage travel are set by a forward end of travel (FEOT) optical sensor, a reverse end of travel (REOT) optical sensor, and a carriage retracted (REV STOP) switch.

The head carriage assembly provides position and velocity feedback to the servo system. The position sensor is a capacitively-coupled scale-slider combination. The slider is mounted to the moveable part of the head carriage and the scale is mounted to the fixed part of the carriage. The entire carriage is not a field-replaced item. A number of components of the head carriage are field replaceable as described in table 1-3.

1.1.4.3 AGC Servo Preamplifier Board. A voltage regulator on the servo preamplifier board supplies LED power for the optical forward and reverse end of travel sensors. The sensor outputs, FEOT and REOT, are applied to threshold comparators, and digital outputs FEOT:DI and REOT:DI are passed on to the servo board. The actuator velocity signal, VEL, is amplified and passed on to the servo board.

The servo preamplifier contains amplifiers and demodulators for the outputs of the linear position transducer.

1.1.4.4 Servo Board. The servo board develops a servo control voltage (PWR AMP) based upon a desired position supplied by the controller, current position as recorded by the servo board logic, and position, velocity, and limit transducer outputs from the servo preamplifier. This control voltage is amplified in power supply boards 2 and 1 and is routed through the emergency retract relay (K1) before it actually drives the actuator voice coil.

1.1.4.5 Power Supply Board No. 2. Power supply board no. 2 is located on a piggy-back assembly in the power supply rather than in the card cage. Power supply board no. 2, despite the name, is dedicated to servo control of the actuator and to safety interlocks.

The servo power amplifier circuitry is divided between power supply board no. 1 and power supply board no. 2. Power supply board no. 2 accepts the unbalanced PWR AMP output of the servo board, and supplies the amplified, balanced DRIVE A and DRIVE B outputs to the output stages of the servo power amplifier.

A safety triac in the DRIVE A - DRIVE B circuit disables drive to the higher level stages if a fault is detected. A separate circuit can remotely trip the main ac power breaker (REMOTE TRIP BREAKER) if the 5-volt power supply thermister (OVT +5) or servo amplifier thermister (OVT PA) indicates overheating.

1.1.4.6 Power Supply Board No. 1. Power supply board no. 1 includes +22Vdc, -22Vdc, and +5Vdc regulators, the output stage of the servo power amplifier, emergency retract relay K1, the 6-volt charger for the retract capacitor, and the driver circuit for the pack-lock solenoids.



The servo amplifier output is wired in parallel to three sets of normally-open contacts on relay K1. The amplifier output is also wired around the relay (RELAY BYPASS) to the actuator drive connector, P2. During head alignment K1 is removed and connector P2 is reversed so that RELAY BYPASS drives the actuator directly. This allows access to the heads.

CAUTION

Removing relay K1 disables the emergency retract safety feature. Extreme care must be used to avoid damage to the disk or heads.

1.1.4.7 Sector Board. The sector board supplies power to magnetic sector/index transducers which monitor rotation of the fixed disk and the disk cartridge.

The sector board supplies the SECTOR-, INDEX-, and sector address outputs to the disk controller. The sector board also supplies the SPEED and SPNDL STAT- signals to the control board and the spindle motor brake. SPEED is generated when disk speed exceeds approximately 1000 rpm. The control board uses this input to determine if it is safe to load the heads or if an emergency retract is necessary. SPNDL STAT- is active (low) if the spindle is rotating. It is used as an interlock signal to prevent the pack locks from being opened before the spindle stops rotating.

The 5440-type cartridge supplied for use with the DS10 disk drive has 20 sector slots and an index slot milled into a ring which is mounted on the bottom of the cartridge. When the cartridge is installed on the drive spindle, the sector ring is adjacent to a sector/index transducer mounted in the bottom of the sheet metal cartridge receiver. Since the number of physical sector slots is equal to the number of sectors required by the controller, the sector pulse division switches are set for $\div 1$ (SW2-1 ON).

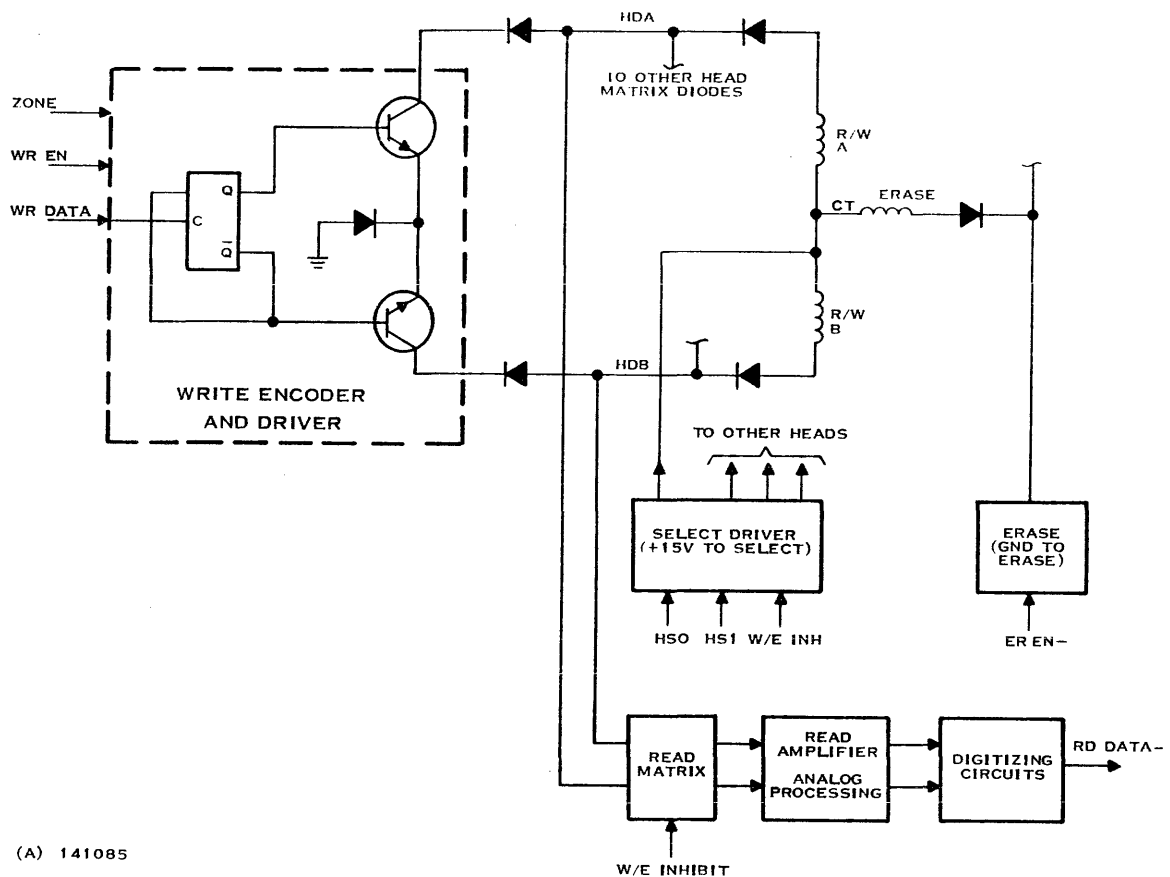
The sector pulses for the fixed disk are picked up from a sector ring which is hard-mounted to the spindle. This ring, which is underneath the main deck casting, contains eight concentric rings of holes. The eight rings, adjustable transducer, and division switch settings allow a variety of sector/revolution options. For 20 sectors per revolution, the sector transducer must be set at ring 2 (second from inside), which has 40 holes. The sector board division switches must be set for $\div 2$ (SW4-6 ON).

1.1.4.8 Read/Write/Erase (R/W/E) Board. The R/W/E board performs those operations directly involved in recording and recovering a waveform on the disk. These functions include head selection, encoding the write data (and clock) waveform in a format compatible with recording, supplying write current, supplying erase current, amplifying, shaping and digitizing the signals picked up by the recording/reproduction process, and supplying a summary (CR FAULT) to the control board.

The heads are connected to the R/W/E board by a special cable from the actuator assembly to four connectors on the upper right corner (component side) of the board. Each head has four connections: two read/write coil connections, a center tap, and an erase coil connection, as shown in figure 1-16.

1.1.4.9 Data Recovery Board. The data recovery board accepts a multiplexed clock and data waveform read from the disk and supplies separate clock and data waveforms to the disk controller.

Clock/data separation in the data recovery board is based on phase-lock techniques. A voltage-controlled oscillator in the data recovery circuit is phase-locked to the clock pulses read from the disk. Clock and data sampling windows, derived from the phase-locked oscillator output, control output gates fed by the multiplexed read and clock waveform. This gating demultiplexes the clock and data waveforms onto separate output lines (figure 1-17).



(A) 141085

Figure 1-16. R/W/E Simplified Block Diagrammed Head Connections

1.1.4.10 Control Board. The control board circuitry is involved with operator interface functions, operating sequence control, interlock monitoring, and fault detection.

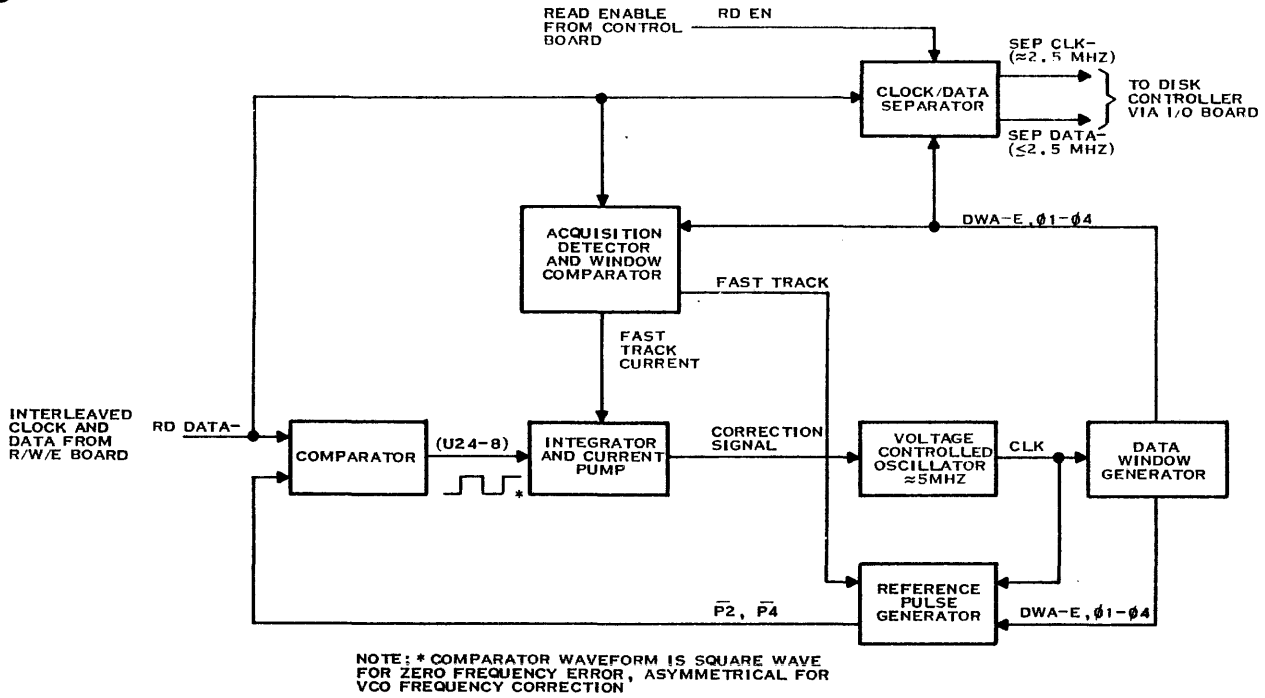
The control board receives inputs from the START/STOP, FAULT RESET, WRITE PROTECT-CART and WRITE PROTECT-FIXED switches for operator control. Control board outputs control the START/STOP, READY, ACTIVE, and FAULT RESET indicators.

The control board monitors voltage regulator outputs from the other logic boards and monitors interlock switches and status indications. The control board checks for illegal combinations of input conditions to detect disk-drive fault conditions.

Faults are classed as potentially damaging or nondamaging. The control board disables the servo system and initiates an emergency retract cycle upon detecting a potentially damaging fault. These faults are cleared by repairing the fault condition and cycling the START/STOP switch. Nondamaging faults may be cleared via the FAULT RESET switch.

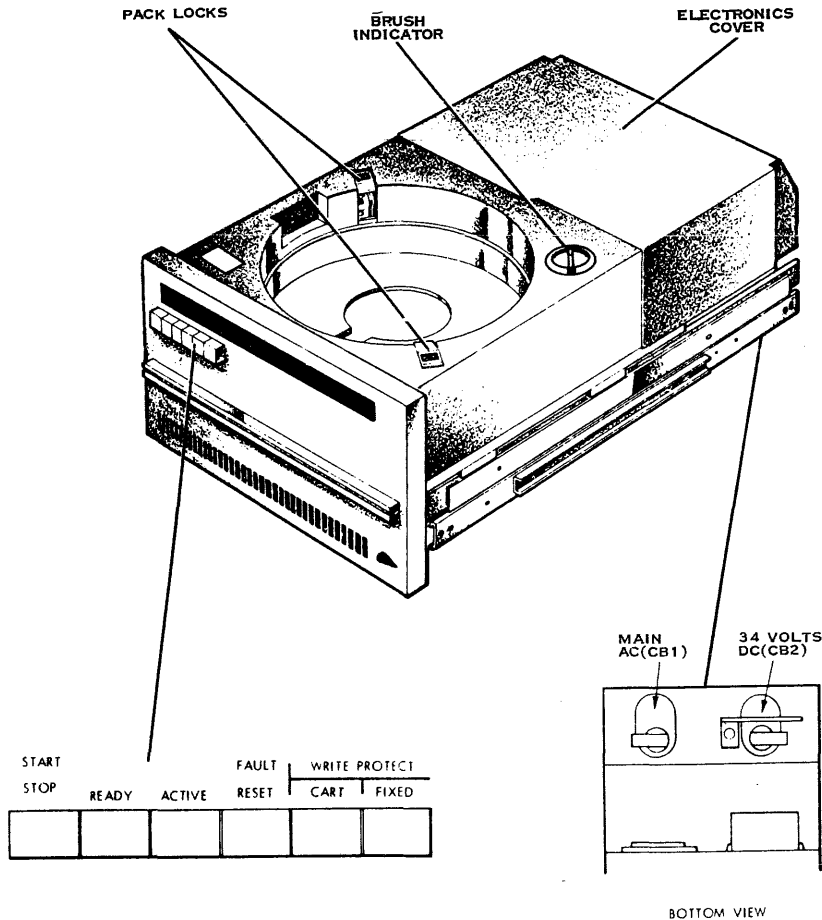
1.2 OPERATING INSTRUCTIONS

Figure 1-18 shows the locations of the disk drive operating controls and indicators. Table 1-4 describes the operation of these controls and indicators.



(A)141086

Figure 1-17. Data Recovery Board Simplified Block Diagram



(A)137350A

Figure 1-18. DS10 Disk Drive Control and Indicator Locations

**Table 1-4. Disk Drive Controls and Indicators**

Control/Indicator	Function
Dc Circuit Breaker	<p>The dc circuit breaker (labeled 34 VOLTS) on the rear of the disk drive provides the logic circuitry with overload protection due to circuit malfunctions. Normally, the breaker is set during installation and checkout of the disk drive and left on.</p> <p style="text-align: center;">CAUTION</p> <p>The dc circuit breaker must be set before the ac breaker applies to the disk drive. Otherwise, the powerup logic will not be energized correctly.</p>
Ac Circuit Breaker	<p>The ac circuit breaker (labeled MAIN) on the rear of the disk drive protects the disk-drive power supply, spindle motor, and fan motor from damage due to overload conditions. The ac circuit breaker may be remotely tripped by potentially damaging faults in the servo system or in the power supply. The ac circuit breaker is used as the main power switch for the drive unit.</p> <p style="text-align: center;">CAUTION</p> <p>A carriage lock pin holds the head carriage in the retracted position for shipping or handling. This pin must be removed prior to applying power to the drive. Refer to paragraph 1.2.1.2.</p>
Brush Indicator (not on all models)	<p>The brush position indicator, figure 1-19, is linked to a brush assembly which sweeps the disk as part of the START operation. If the brush indicator shows the brushes extended into the disk area, an attempt to remove the cartridge will damage the disk surface.</p>
START/STOP Switch/Indicator	<p>The START/STOP switch/indicator is an alternate action switch with a lighted pushbutton. If the indicator is not lighted and is operational, pressing the switch energizes the spindle motor and initiates the first seek mode provided the following conditions exist:</p> <ul style="list-style-type: none">• Circuit breakers closed• Disk cartridge dust cover properly installed• Cartridge hold-down arms properly positioned

**Table 1-4. Disk Drive Controls and Indicators (Continued)**

Control/Indicator	Function
START/STOP Switch/Indicator (Continued)	<p>When the spindle motor is energized, the START/STOP indicator is lighted and remains lighted until the spindle motor stops in response to START/STOP switch operation. Pressing the START/STOP switch while the indicator is lighted (spindle motor is energized) deenergizes the spindle motor.</p> <p>When the START/STOP switch is pressed to deenergize the spindle motor, the indicator remains lighted until the following occurs:</p> <ul style="list-style-type: none">• Disk rotation stops• Interlock solenoids energize to release the disk cartridge
	<p style="text-align: center;">NOTE</p> <p>The first seek mode is automatic and requires approximately 65 seconds. The disk drive can be reset at any time after initiation of the start sequence. In the event of a potentially damaging fault during the first seek mode, the heads automatically retract and the disk drive stops.</p>
READY Indicator	<p>The READY indicator is lighted when the spindle motor has reached operating speed, the heads are loaded, and the disk drive is ready for use. The READY indicator is extinguished during any fault, emergency retract, or stop operation.</p>
ACTIVE Indicator	<p>The ACTIVE indicator lights to indicate that the disk drive is actively engaged in seeking and writing or reading data.</p>
FAULT RESET Indicator/Switch	<p>The FAULT RESET indicator/switch is lighted to indicate any fault except ac power failure. If a momentary ac power drop occurs, the heads automatically go into emergency retract and the disk drive stops. The disk drive automatically starts when ac power returns to normal.</p> <p>The FAULT RESET indicator lights to indicate the occurrence of a nondamaging fault, i.e., more than one head selected, simultaneous read and write</p>



Table 1-4. Disk Drive Controls and Indicators (Continued)

Control/Indicator	Function
FAULT RESET Indicator/Switch (Continued)	instructions, etc. The FAULT RESET indicator is extinguished by a return-to-zero-seek (restore) command. If a momentary nondamaging fault occurs, pressing the FAULT RESET switch clears the fault logic and extinguishes the indicator. The FAULT RESET switch cannot be used to clear a persistent fault or one which causes an emergency head carriage retraction.
W/PROT CART Indicator/Switch	The W/PROT CART indicator/switch is an alternate-action pushbutton switch with a lighted pushbutton. Pressing the switch when the indicator is not lighted inhibits writing and erasing of data on the disk and lights the indicator. When the indicator is lighted, the pushbutton remains partially depressed. Pressing the pushbutton with the indicator lighted removes the protect condition and extinguishes the indicator.
W/PROT FIXED Indicator/Switch	The W/PROT FIXED indicator/switch is an alternate-action pushbutton switch with a lighted pushbutton. Pressing the switch when the indicator is not lighted inhibits writing and erasing of data on the fixed disk and lights the indicator. When the indicator is lighted, the pushbutton remains partially depressed. Pressing in the pushbutton with the indicator lighted removes the protect condition and extinguishes the indicator.
Pack Locks	The pack locks may be considered controls in the sense that the drive will not reach the READY condition unless the pack locks are properly secured. Refer to the disk cartridge installation procedure.

CAUTION

DO NOT REMOVE THE DISK
CARTRIDGE UNLESS THE
SLOT IS IN THE BLACK AREA.

A COIN MAY BE USED TO
MAKE THE ALIGNMENT.

BRUSH
INDICATOR

(A) 137259A

Figure 1-19. Brush Indicator



1.2.1 HARDWARE STARTUP/SHUTDOWN PROCEDURES. The following paragraphs describe standard procedures for disk-drive operation, including:

- Precautions
- Carriage lock pin removal
- Switch and control settings
- Power application for on-line operation
- Disk cartridge installation
- Disk cartridge removal (normal and power-failure/emergency)
- Write protect
- Fault operating procedures
- Power removal procedures (normal/emergency)

1.2.1.1 Operating Precautions. The following precautions should be observed while operating the disk system:

1. Do not apply power to the disk drive if the carriage lock pin is installed. The carriage lock pin holds the head carriage safely retracted for shipping or other handling of the drives. Refer to the carriage lock pin removal procedure of paragraph 1.2.1.2.
2. If a pinging or scratching noise is heard (caused by head-to-disk contact), stop the disk drive by using the disk-drive stopping and power removal instructions in paragraph 1.2.1.10.

NOTE

Appropriate steps should be taken to safeguard data until the problem can be remedied. Such steps may include leaving the disk drive deenergized, replacing the disk cartridge with a scratch cartridge, and/or immediate transfer of the data on fixed disk.

3. Follow the disk cartridge power-off removal procedures described in paragraph 1.2.1.7.
4. Never attempt to override any interlock, except where specifically directed by a detailed maintenance procedure.

1.2.1.2 Carriage Lock Pin Removal. The carriage lock pin is removed as follows:

1. Remove the dustcover (cabinet-mount drive only) by lifting straight up.
2. Remove the sheet metal electronics dustcover, which is held by three screws (left side, right side, rear, just below circular cutout).



3. Refer to figure 1-20 and remove the carriage lock pin by rotating the head 90 degrees counterclockwise and pulling straight up. Store the pin on the side of the actuator magnet.
4. Reinstall the electronics dustcover and (if applicable) the cabinet dustcover.

The carriage lock pin should be installed if the drive is to be shipped or subjected to extensive physical handling. Reverse steps 3, 2, and 1 to install the lock pin.

1.2.1.3 Switch and Control Settings. Before the disk drive is initially powered up, the switch settings on the disk drive logic boards should be verified. The proper settings are shown in figure 1-14, which is a reproduction of the setting label affixed to the drive.

The TILINE base address switches on the disk controller board should be set to a value which agrees with that expected by the software. The default setting is CPU byte address F800₁₆ (all switches off). Refer to figure 1-9 for other address settings. Standard jumpers for the disk controller are shown in figure 1-10.

The cable adapter includes a set of reversing jumpers for fixed/removable disk logical unit selection.

The fixed disk in the primary (or only) disk drive is normally designated disk 0, and the cartridge is designated disk 1. The corresponding designations for the secondary disk drive are disks 2 and 3. A jumper on the cable adapter board permits reversing the designations for a given disk drive.

The jumper plug is normally stored as shown in figure 1-21. To reverse designations for disks 0 and 1, remove the jumper plug and insert it to connect J1 and J3. To reverse designations for disks 2 and 3, remove the jumper plug and insert it to connect J1 and J4.

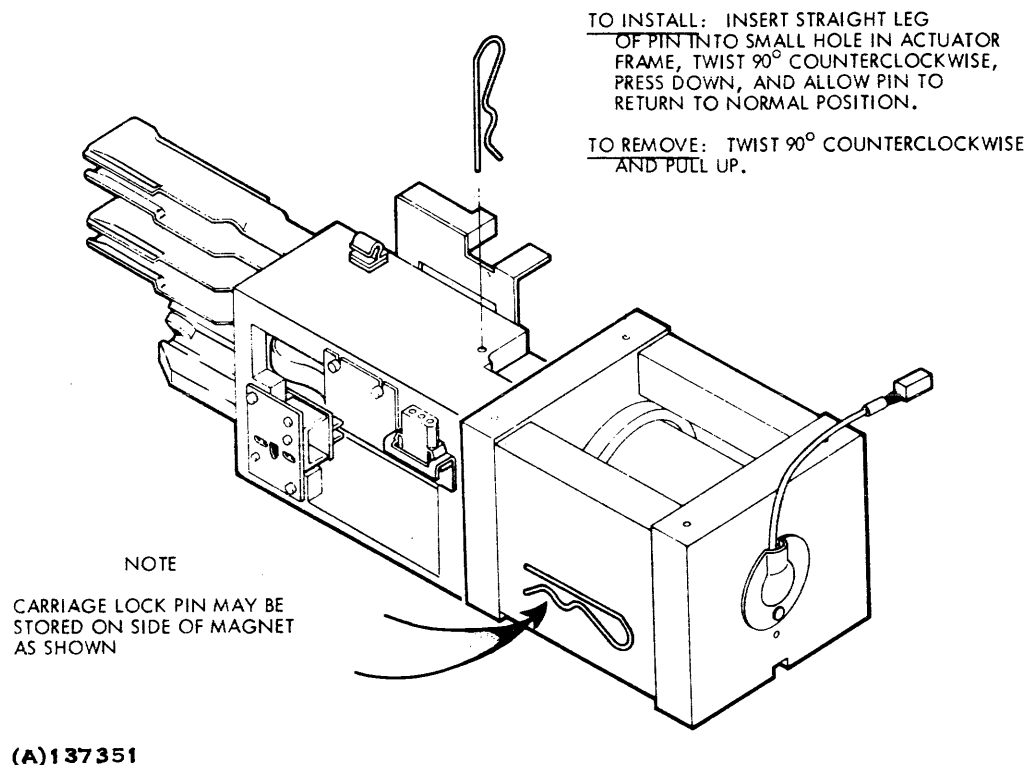
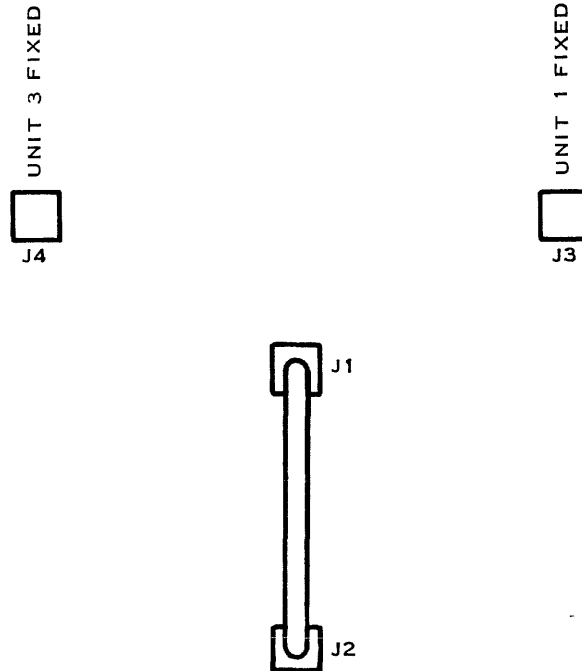


Figure 1-20. Carriage Lock Pin Location



(A)137558A

Figure 1-21. Disk Designation Reversing Jumper on Cable Adapter

1.2.1.4 Power Application for On-Line Operation. Apply power for on-line operations as follows:

1. Ensure that all system interconnection cables and power cables are properly connected and in good condition.
2. Verify that the disk drive is properly configured for local ac line power.
3. Ensure that the START/STOP switch/indicator is in the STOP position (pushbutton raised and indicator extinguished).
4. Close the dc circuit breaker. This must be performed before the ac breaker is closed.
5. Close the ac (MAIN) circuit breaker and verify the operation of the blower motor.
6. Install the disk cartridge in accordance with paragraph 1.2.1.5.
7. Press the START/STOP switch/indicator. Ensure that the pushbutton stays partially depressed and that the indicator lights.
8. Verify that the FAULT indicator/switch remains extinguished.

NOTE

If the FAULT indicator lights, perform the fault operating procedure in paragraph 1.2.1.9.



9. Approximately 65 seconds after pressing the START/STOP switch, the READY indicator lights and the disk drive is ready for operation by the computer.

1.2.1.5 Disk Cartridge Installation. Install the disk cartridge (refer to figure 1-22) as follows:

1. Pull the disk drive out of the rack. (Raise the cartridge access door of a cabinet-mount drive.)

NOTE

Power must be on and the START/STOP lamp must be extinguished to release the lock on the hold-down arms.

2. Pull back the hold-down arms.
3. Set the disk cartridge upright on a firm supportive surface.

NOTE

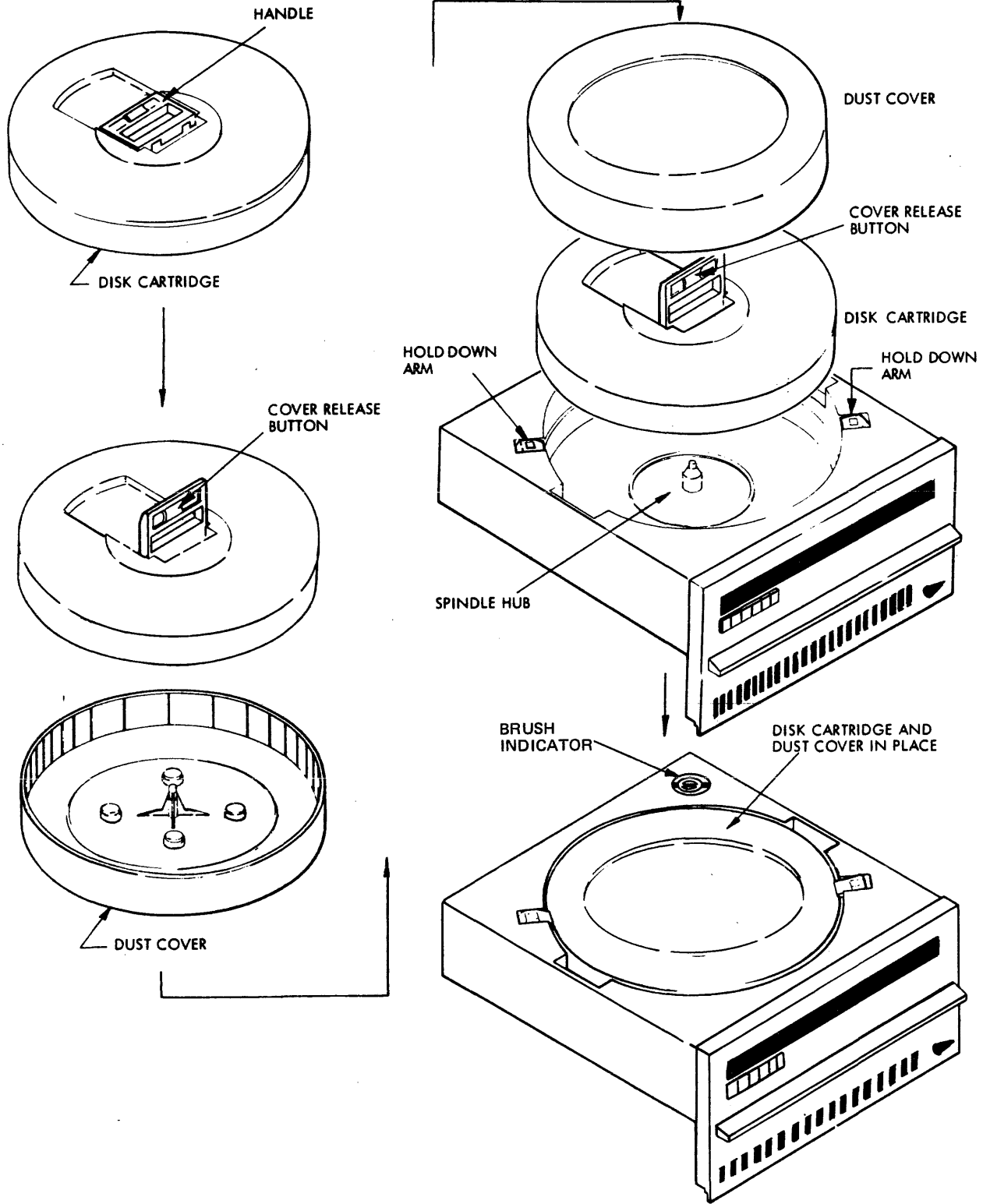
Two types of disk cartridges are provided for the DS10. One type features a dust cover lock which releases when moved to the left. The other type releases the lock when the button is pushed to the center of the handle.

4. Hold the disk cartridge cover release button in the unlocked position while lifting the cartridge handle to separate the dust cover and disk.
5. Disengage the dust cover from the disk. Set the cover aside.

CAUTION

Do not make abusive contact between the disk and the spindle. Ensure that the read/write heads are fully retracted and the brushes are completely out of the disk area. Remove any dust from the magnetic chuck.

6. Position the head opening of the disk toward the rear of the disk drive, and place the disk onto the spindle hub.
7. Rotate the cartridge slowly back and forth until the cartridge seats over the spindle.
8. Turn the handle down to seat the cartridge.
9. Place the dust cover (removed in step 5) open end down over the cartridge.
10. Position the hold-down arms over the cartridge and dust cover.
11. Push the disk drive into the rack. (Lower the cartridge access door of a cabinet-mount drive.)



(A) 137260A

Figure 1-22. DS10 Disk Cartridge Installation



1.2.1.6 Disk Cartridge Removal (Normal). Remove the disk cartridge as follows:

1. Press the START/STOP switch and wait for the START/STOP indicator to be extinguished and for the brush indicator to align with the black mark, figure 1-19.

CAUTION

If the START/STOP indicator is still illuminated after 2-1/2 minutes or if the brushes are not fully retracted, initiate corrective maintenance.

2. Pull the disk drive out of the rack. (Raise cartridge access door for cabinet-mounted disk.)
3. Pull back the hold-down arms. (The arms will not move until the cartridge rotation has stopped.)
4. Remove the cartridge dust cover.

NOTE

Two types of disk cartridges are provided for the DS10. One type features a dust cover lock which releases when moved to the left. The other type releases the lock when the button is pushed to the center of the handle.

5. Lift the cartridge handle, hold the cover release button in the unlocked position, and lift the cartridge up and out of the disk drive by the handle.
6. Place the cartridge inside the dust cover and fold down the handle until a snap is heard, indicating that the cartridge and dust cover are locked together.
7. Push the disk drive back into the rack. (Lower cartridge access door into position for cabinet-mounted disk.)

1.2.1.7 Disk Cartridge Removal (During Power Failure or Emergency). Perform power down procedure of paragraph 1.2.1.10.

1. Wait approximately three minutes for the cartridge to stop spinning.
2. Pull the disk drive out of the rack.
3. Release the pack locks by inserting a flat head screwdriver (or similar object) into the hole on top of the pack lock (see figure 1-23). Press the solenoid plunger into the solenoid, and tilt the pack lock.
4. Pull back the hold-down arms.
5. Remove the cartridge dust cover.
6. Lift the cartridge handle, hold the cover release button in the unlocked position, and lift the cartridge up and out of the disk drive by hand.



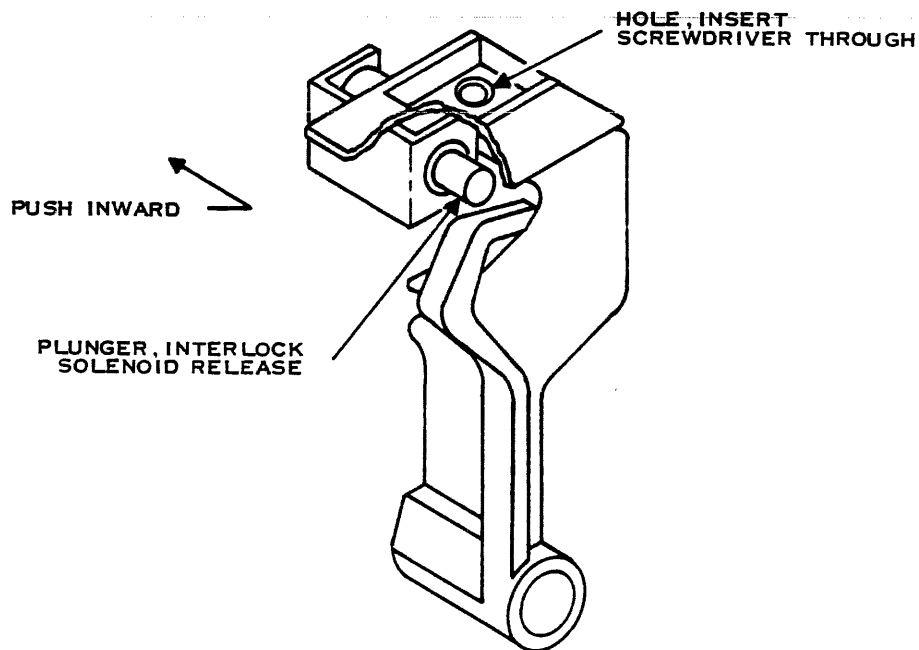
7. Place the cartridge inside the dust cover and fold down the handle until a snap is heard, indicating that the cartridge and dust cover are locked together.
8. Initiate corrective maintenance, if applicable.

1.2.1.8 Write-Protect Operation. Independent alternate-action switches on the disk-drive front panel allow the operator to select write protection for the cartridge and/or the fixed disk. Selecting write-protect mode prevents the writing of data on the disk. To select write protection for a disk:

1. Observe that WRITE PROTECT CART (WRITE PROTECT DISK) is not lighted.
2. Depress the WRITE PROTECT CART (WRITE PROTECT DISK) switch. Observe that the indicator lights and remains latched in a partially depressed position.

1.2.1.9 Fault Operating Procedures. If the FAULT RESET indicator lights during normal operation or power application, proceed as follows:

1. Press the FAULT RESET switch. If the FAULT RESET indicator is extinguished, normal operation can be continued. If the FAULT RESET indicator remains lighted, proceed to step 2.
2. Press the START/STOP switch, and allow the spindle to stop rotating.
3. Press the START/STOP switch, and observe the FAULT RESET indicator. If the FAULT RESET indicator is extinguished, normal operation can be resumed. If the FAULT RESET indicator remains lighted, initiate corrective maintenance.



(A) 137261

Figure 1-23. Cartridge Locks



1.2.1.10 Normal or Emergency Power Down. When no operations are contemplated for a relatively short time, the disk drive is normally left in the STOP mode. In this mode, ac and dc power are applied, and the cooling blower operates, but the head carriage is retracted and the spindle motor is off. If it is necessary to completely power down the system, perform the following steps:

1. If START/STOP is lighted, depress to initiate STOP mode.
2. Move MAIN ac breaker (rear of drive) to OFF position.
3. Do not attempt to remove the disk cartridge until the spindle has come to a complete stop. Power-off cartridge removal procedures are given in paragraph 1.2.1.7.

1.2.2 PROGRAMMING THE DISK CONTROLLER. Control pushbuttons on the disk drive unit allow an operator to start or stop the drive, clear the fault latches (and execute a restore operation), or to individually write protect the fixed and the removable disks. All other normal control of the disk system is implemented by programming the controller via the 990 computer. The device service routines and the diagnostic test incorporate the programming requirements described in this paragraph. The field engineer should understand controller programming because it may prove necessary to enter manual control programs while troubleshooting. These control programs may be entered from a terminal, under control of the Diagnostic Operation Control System (DOCS) software, from the 990 Programmer Panel or from the Maintenance Diagnostic Unit (MDU).

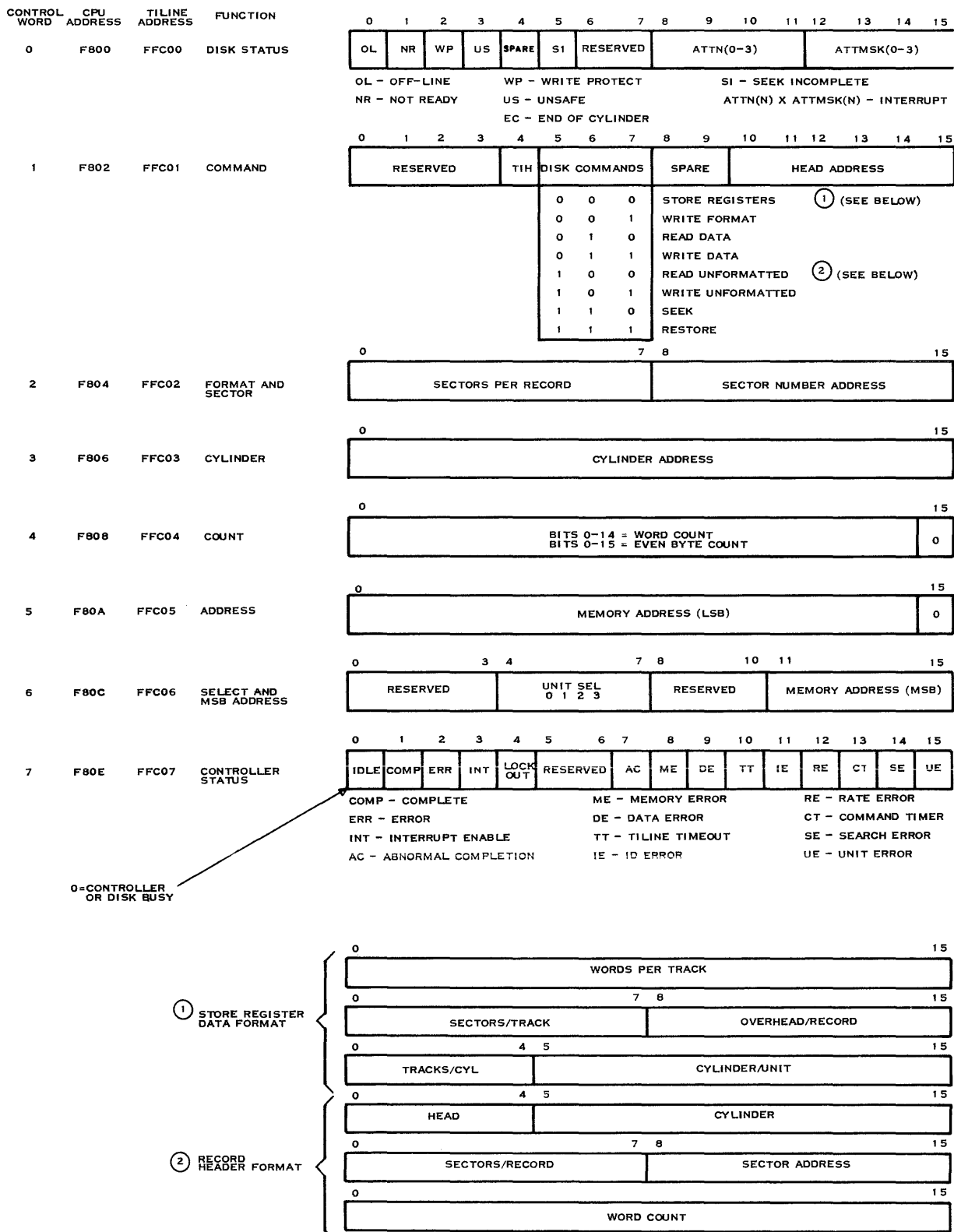
The Model 990 computer sets up the disk controller by transmitting a group of eight control words, W0-W7, over the TILINE to the disk controller. These control words specify the operation to be performed, precondition the controller, and supply parameters to the controller. These parameters include the disk logical unit number, the number of words to be read or written, cylinder, head and starting sector address, and the starting address of the assigned 990 memory buffer area.

The control words initially supplied to the controller are modified during the course of the operation. At the completion of the operation, the control words contain status information which may be read back by the 990 computer to determine if the operation completed normally. If the operation did not complete normally, the status words identify the errors detected during the attempted operation.

Figure 1-24 shows the formats of the disk controller control and status words. Formats for the data sent to the CPU as a result of Store Registers and Read Data Unformatted commands are shown at the bottom of the figure.

Bits 5-7 of control word W1 specify the basic command which is to be executed by the DS10 Cartridge Disk System. The basic commands are:

- Store Registers (000) — Used to supply disk system parameters to the Model 990 computer. These parameters (as shown in figure 1-24) are: words per track, sectors per track, number of overhead words per record, number of tracks per cylinder, and the number of cylinders per logical unit.
- Write Format (001) — Used for formatting or reformatting a single track.
- Read Data (010) — Reads formatted data from disk and transfers the data to the specified TILINE address.
- Write Data (011) — Transfers data from a TILINE address and controls formatted data being written on disk.



(B) 138691

Figure 1-24. Model DS10 Disk System Status and Control Word Formats



- Read Unformatted (100) — Reads data from disk without regard to record ID or record boundaries and transfers the data to the specified TILINE address.
- Write Unformatted (101) — Transfers data from a TILINE address and writes the data on the disk without regard to record boundaries.
- Seek (110) — Dummy command that is accepted and completed normally but does not actually move heads. Independent seek is not possible in a DS10 drive because the head carriage is common to two logical units, the fixed disk and the cartridge.
- Restore (111) — Positions the head over cylinder 0. A restore is implemented by a movement of the head carriage to forward end of travel, then back to track 0. It also clears disk faults. The specified command requires setup parameters from words W0-W7 and is not executed until W7 forces the controller out of the Idle state.

The control words are located at consecutive word address, (even byte addresses) starting at the base address determined by the switch settings on the controller board. The nominal base address is F800, which maps to TILINE address FFC00.

Examples of control word sequences are included in Section 3 of this manual. Refer to paragraph 3.4.7.2, steps 12 and 14, paragraph 3.4.8.2, steps 16 and 18, or to paragraph 3.5.2, steps 17 and 19. These sequences use the program loading capabilities of the Diagnostic Operation Control System (DOCS) software to translate the given addresses to the proper TILINE addresses. ■



SECTION 2

PREVENTIVE MAINTENANCE

2.1 INTRODUCTION TO PREVENTIVE MAINTENANCE

Preventive maintenance (PM) is planned and scheduled maintenance which is performed on operable equipment in order to prevent problems which could cause the equipment to become inoperable. Preventive maintenance should be scheduled in a flexible manner which allows adjustment due to the equipment environmental conditions and past operating experience in that environment. Those users who run their equipment near specification limits (particularly temperature limits) will invariably experience a higher than average failure rate. If the environment cannot be improved, the PM schedules should be compressed in the areas which can forestall these failures.

2.2 PREVENTIVE MAINTENANCE SUPPLIES

Table 2-1 lists the test equipment, tools, and consumable supplies required to perform the PM procedures in this manual.

Table 2-1. Preventive Maintenance Supplies

Item	TI Part Number	CDC Part Number	Use/Comment
Lint-free soft cloth	(commercially available)		For general cleaning by operator. Also required by field service head cleaning procedures.
Isopropyl alcohol (91%)	(commercially available)		Head cleaning
Scratch disk pack	943849-0203		Disk pack should not have valuable data stored on it.
Absolute filter	(see field replaceable parts list, table 1-3.)		
Dual-Trace oscilloscope			Tektronix 475 or equivalent
Torque screwdriver: 1-30 in-lbs. with hex and Phillips adapters	943849-0209		
Head alignment tool	943849-0206	75797900	
CE alignment disk pack	943849-0201	89296000	
Portable vacuum cleaner	(commercially available)		
High intensity light	(commercially available)		



2.3 PREVENTIVE MAINTENANCE SCHEDULE AND PROCEDURES

Table 2-2 provides schedules and descriptions for preventive maintenance of the disk drive and the disk cartridges. The paragraph number of the appropriate procedure is referenced to facilitate finding the correct procedure to use in each case.

This preventive maintenance schedule is an approximation which is based on operation in a clean office or laboratory environment. If the environment includes air-borne contaminants, such as lint, dust, or concentrations of cigarette smoke, the cleaning and inspection schedule must be compressed. Similarly, if the equipment is operated near specification limits for temperature, altitude, or humidity, the PM schedule must be compressed.

The user is responsible for maintaining the operating environment within the established specifications for this equipment, the proper training of equipment operators, and the timely reporting of equipment errors.

CAUTION

Do not smoke while performing preventive or corrective maintenance on the disk drive. Smoke particles are a serious contaminant to any modern, high-speed disk storage system.

2.3.1 DAILY USER PM PROCEDURE. This procedure should be performed daily if the disk drive is used in an environment where condensation forms on the magnetic chuck.

1. Ensure that the drive is not being used and that it is not needed for at least 15 minutes.
2. Depress the START/STOP switch to the STOP position and wait for the spindle to stop rotating.
3. Remove the disk cartridge.
4. If condensation has formed on the magnetic chuck, wipe it dry with a clean, lint-free, absorbent cotton cloth. Avoid contact with the heads and do not smoke while working with the drive.
5. Insert the disk pack and bring the drive to RUN.
6. Restart the system using the normal procedures.

2.3.2 MONTHLY USER PM PROCEDURE. This procedure should be performed monthly.

1. Pedestal mounted units:
 - a. Remove the front panel from the base cabinet and then remove the prefilter. The prefilter is located at the top of the base cabinet area in an aluminum frame. The prefilter may be removed by pulling on the aluminum frame.
 - b. Remove the prefilter element from the aluminum frame and clean the element by washing it in warm water and soap.
 - c. Rinse and dry the prefilter element and reinstall it in the aluminum frame.

Table 2-2. Preventive Maintenance (PM) Schedule and Descriptions

PM Number	Authorized Personnel	Frequency*	Approximate Time Required	Material Required	Description
N/A	Operator	Daily or before each 8 hour shift if condensation forms on the magnetic chuck.	10 minutes	Lint-free soft cloth	Cartridge receiver cleaning and cartridge inspection procedure. (see paragraph 2.3.1.)
N/A	Operator	Monthly	15 minutes	Warm water, soap.	Clean prefilter. (See paragraph 2.3.2.)
090	Field Service	3-month intervals	1 hour	Lint-free soft cloth, isopropyl alcohol, tongue depressors, scratch disk cartridge, vacuum cleaner, high intensity light, DOCS software and loading media.	Head cleaning, prefilter cleaning vacuuming, Visual inspection of drive and user disk cartridge, performance demonstration under DOCS software. Refer to paragraph 2.3.3 for PM090 procedure.
180	Field Service	6-month intervals	2 hours	Same as PM090, above, plus: absolute filter, head alignment tool, torque screwdriver, CE alignment pack, dual-trace oscilloscope	Same as PM 090, plus absolute filter replacement, head alignment check, head inspection and fixed disk inspection. Refer to paragraph 2.3.4 for the PM 180 procedure.
N/A	Field Service	When head-to-disk interference is suspected.	5 minutes	High intensity light source	Disk cartridge inspection. Refer to paragraph 2.3.5.





Table 2-2. Preventive Maintenance (PM) Schedule and Descriptions (Continued)

PM Number	Authorized Personnel	Frequency*	Approximate Time Required	Material Required	Description
N/A	Field service disk system technical specialist or qualified disk pack cleaning service vendor	6 months	15 minutes per cartridge	91% isopropyl alcohol or other media cleaner approved by disk cartridge manufacturer, soft, lint-free cloth, tongue depressor or cleaning paddle	Disk cartridge cleaning. A general procedure is provided in paragraph 2.3.5.3. Texas Instruments recommends the services of a qualified disk pack cleaning/maintenance/inspection vendor.

* — frequency is based on an office or laboratory environment. Use in a contaminated atmosphere will require more frequent preventive maintenance and will accelerate wear on the drive unit.



- d. Reinstall the prefilter in the cabinet. Ensure that the expanded metal screen is pointing upward.
- e. Replace the front panel.
2. Rackmounted units (with external prefilter):
 - a. Remove the prefilter assembly. It is located near the bottom of the front panel and is held on by magnetic strips.
 - b. Remove and clean the prefilter element by washing it in warm water and soap.
 - c. Rinse and dry the prefilter element and reinstall it in the prefilter housing.

2.3.3 PM 090 PROCEDURE. Perform the PM 090 procedure as follows:

1. Ask the user to prepare the system for PM and to remove the system disk cartridge and store it in a safe place. Also, check with the user to see if any problems have occurred since the last PM was performed.
2. Verify that the user has been performing the user PM procedures. If he has not been doing the user PM or has been doing it incorrectly, demonstrate the correct method to use and explain that any service calls caused by lack of user PM will be billed to the user. Verify that the user has a valid media maintenance program.
3. Power down the unit and visually inspect the wiring and the unit for wear.
4. Check the unit and subassemblies to verify that the latest Field Change Orders (FCOs) have been incorporated. If there are any outstanding FCOs, list them so they can be installed during the next scheduled PM session.
5. Inspect and clean the read/write heads as follows:

CAUTION

- Do not smoke while cleaning heads.
 - Do not touch head face.
 - When cleaning or buffing the heads, always move the tongue depressor perpendicular to the length of the head/arm assembly.
 - Do not leave residue or lint on the head faces.
 - Do not allow the head carriage assembly to advance toward the spindle. The head loading mechanism will force the heads together and damage the surfaces. Heads can be held apart by using rolled-up paper wipes or a block of cork between the head arms.
- a. Inspect heads for dirt on the head face. If dirt is present, clean the head as described in steps b and c.



- b. Use a lint-free cloth or wipes on a tongue depressor to lightly dry-buff the head face.
- c. If dry buffing does not remove dirt, dampen (do not soak) the cloth with 91% isopropyl alcohol, or a media cleaner approved by the disk manufacturer, and wipe the head face. Use a dry cloth to lightly buff the head face.

NOTE

The lower set of heads cannot be inspected so the decision to clean them or not must be based on the results of the diagnostics. If data errors are found on the fixed disk, the media should be inspected and may need to be replaced.

- d. Inspect the user's media for proper storage and a valid media maintenance program. Do not open the disk packs, but look for obvious signs of contamination, dust, and dirt. If packs are contaminated or have no stickers indicating that they have been professionally cleaned within the last six months, inform the user of needed corrections.
6. Clean the prefilter of pedestal mounted drives per this step. For rackmount drives, proceed to step 7.
- a. Remove the front panel by pulling the panel out at the top until the fasteners release and then lift the panel off the tabs until it is clear of the cabinet.
 - b. Remove the prefilter from the cabinet.
 - c. Remove the prefilter element from the aluminum frame and clean by washing in warm water and soap.
 - d. Rinse and dry the prefilter element and reinstall it in the aluminum frame.
 - e. Install the prefilter in the cabinet. Ensure that the expanded metal surface faces upward.
 - f. Reinstall the front panel.
 - g. Proceed to step 8.
7. Clean the prefilter or rackmount drives as follows:
- a. Remove the prefilter assembly. It is held on by magnetic strips.
 - b. Remove the prefilter element and wash it in warm water and soap.
 - c. Rinse and dry the prefilter element and then reinstall it in the prefilter housing.
 - d. Reattach the prefilter assembly to the front of the disk drive.
8. Vacuum the drive thoroughly.
9. Perform the disk cartridge inspection procedure on the system disk cartridge (paragraph 2.3.5) and recommend cleaning if necessary.



10. Power up the drive, insert a scratch disk cartridge, and bring the drive to the READY condition.

CAUTION

Before proceeding to the next step, make sure that the customer has preserved the fixed disk data so that it can be restored to the fixed disk. Verify that the fixed/removable disk logical unit number jumpers (on the cable adapters) are correctly positioned. If it is not possible to safeguard the data offline, place the fixed disk in the write protect mode via the W/PROT-FIXED switch.

11. Run diagnostic tests E1 through E4. E5 may be performed to verify the media.
12. Remove the scratch cartridge and have the user reinstall the data on the fixed disk, if the fixed disk was tested.
13. If no other equipment is scheduled for PM, go to the final system integrity check, paragraph 2.3.6.

2.3.4 PM 180 PROCEDURE. PM 180 should be performed in accordance with the following procedure. Refer to figure 2-1 when changing the absolute filter.

1. Perform steps 1 through 5 of PM 090.
2. For pedestal mounted drives, perform PM 090 steps 6a through 6d, replace the absolute filter (see note), and then perform steps 6e, 6f, 8, and 9 of PM 090.
3. For rackmounted drives, perform PM 090 steps 7a through 7c, replace the absolute filter (see note), and perform steps 7d, 8, and 9 of PM 090.

NOTE

If the drive is a rackmounted unit with no external prefilter, the absolute filter must be replaced at 12-month intervals for computer room environments and at 6-month intervals for office environments. If the drive is pedestal mounted or has an external prefilter, the absolute filter replacement interval may be extended to 18 months for computer room environments and 12 months for office environments. Harsh environments require accelerating the filter replacement schedule at the user's expense.

4. If diagnostic results indicate a possible problem with the lower heads of the fixed-disk platter, inspect the fixed-disk platter and heads per PM 090 steps 5a through 5c.
5. Insert the CE alignment cartridge and perform a head alignment check on all heads as described in paragraph 3.5.4 (alignment and adjustment procedures). Adjust if required. Remove the CE alignment cartridge upon completion.
6. Perform steps 10 through 12 of PM 090.

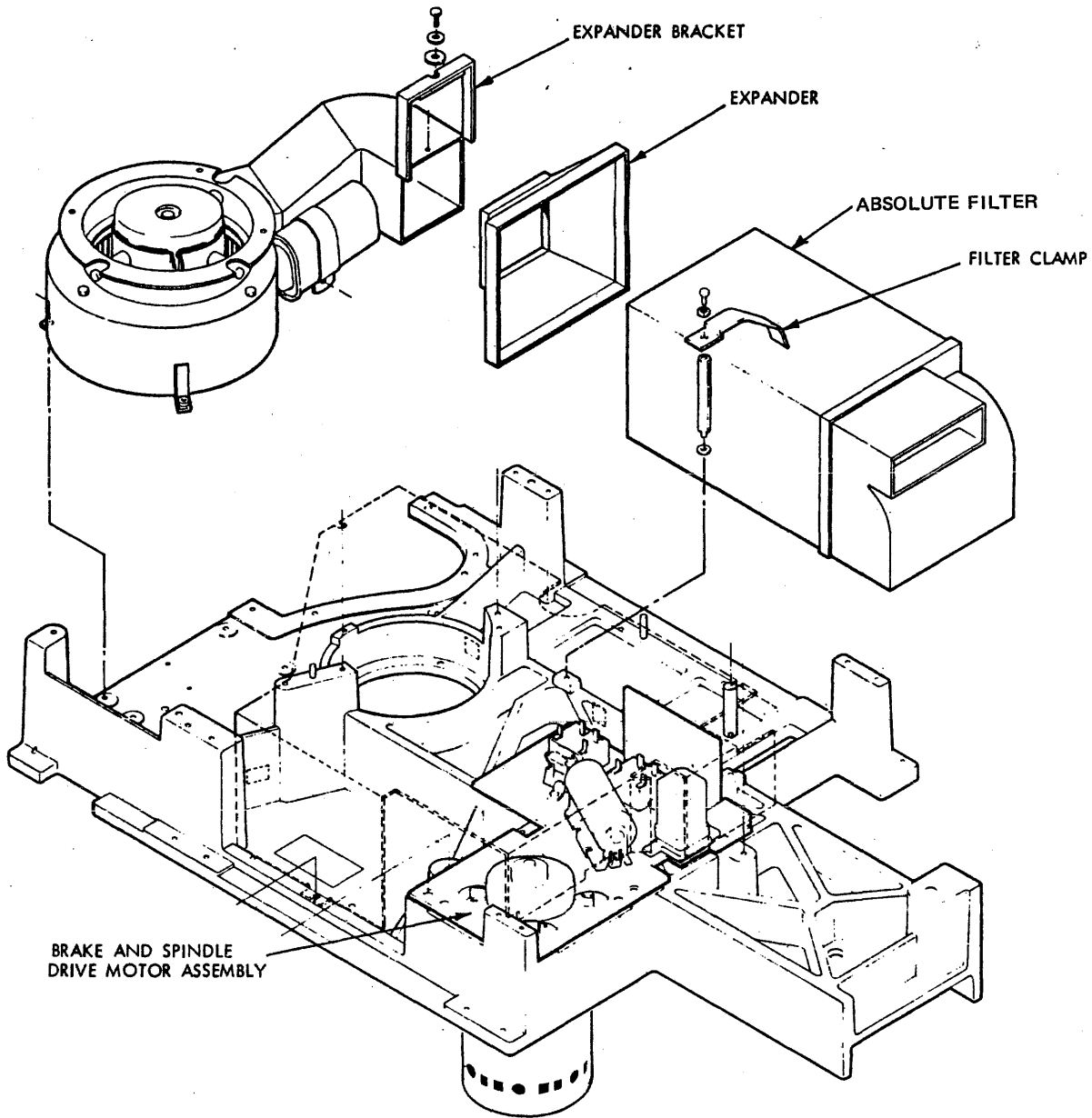


Figure 2-1. DS10 Disk Drive Filter Mounting



2.3.5 DISK INSPECTION AND CLEANING. Disk inspection is required as scheduled, when it is suspected that head-to-disk interference has occurred, or when read errors occur that appear to result from contaminated disk surfaces.

The user is responsible for maintaining his own disk packs. All disk media should be inspected and cleaned on a semiannual schedule. If the environment around the disk drive tends to be dusty, inspection and cleaning should be performed more often. The use of a professional media maintenance service is highly recommended.

2.3.5.1 Disk Inspection General Notes. Head-to-disk interference (HDI) is caused by the presence of a foreign particle in the airstream between the head face and the disk surface, or a protrusion on the head or disk which interferes with the air bearing as the head glides over the disk. If the problem is not corrected, it can cause cartridge-to-cartridge or drive-to-drive damage. The propagated damage results when the operator does not recognize or understand head-crash symptoms so as to hold HDI damage propagation to a minimum. Never reinstall a disk which is suspected to be defective.

A tinkling, zinging or scratching sound, audible with the disk cartridge installed and the heads loaded (disk drive READY), is an indication of HDI. This may be an initial symptom and may not continue, or the noise may become louder and the damage more serious.

The presence of fingerprints, films, or stains on the surface of either the disk or the heads leaves a deposit which may build up to a height greater than the gliding height of the head, causing HDI. At a minimum, suspected HDI calls for an immediate inspection of the disk and head surfaces. Depending upon the results of the inspection, a thorough head cleaning, disk surface cleaning, and spindle area cleanup may be sufficient to clear the problem. In more serious cases, replacement of the heads and the cartridge or fixed disk platter may be necessary.

The user and/or engineer should enter any observed problems in the Field Service System Log Book. Identify the disk cartridge by serial number.

2.3.5.2 Disk Cartridge or Fixed Disk Inspection Procedure. This procedure may be used by field service personnel to inspect 5440-type disk cartridges. Inspection of the fixed disk platter should only be made when diagnostics indicate the possibility of a problem (i.e., data errors). Inspection of the fixed-disk platter requires partial drive disassembly and is limited to qualified field service personnel. The same inspection procedure may be used once access is gained to the fixed-disk platter. This procedure assumes familiarity with the disk inspection notes of the previous paragraph.

CAUTION

Never reinstall a disk cartridge which is suspected to be defective. Reuse of a defective cartridge can cause additional damage to the drive and to the cartridge. Such problems can propagate from cartridge to cartridge and from drive to drive.

CAUTION

Do not touch head or disk surfaces.

1. Use a high intensity directional light source to illuminate each disk surface. (Mount cartridge on an inspection fixture if available.)



2. Manually rotate the disk platter (do not touch disk surfaces) while searching for the following damage indications:
 - a. Scratches in oxide which show the aluminum substrate. Aluminum visible on disk edge is not serious and is acceptable. Note: Scratches in oxide forming concentric rings indicate that a head with an embedded particle or other protrusion has been used on the disk. This requires replacement of the disk pack by the user and inspection of the head by a qualified Field Service Customer Engineer.
 - b. Embedded particle with a trailing scratch (comet trail). This requires replacement of the disk cartridge by the user.
 - c. Unacceptable bands: a circular ring, concentric rings or a strip which is 1/32 inch in length or longer. Bands may be identified by color, texture or reflective variations from the other disk surfaces. Note: Bands which are not black in color and possess a high degree of reflectivity (appear polished) or which shine more than remaining disk surfaces are acceptable for use.

Unacceptable bands are black in color and may be shiny or dull in comparison to other disk surfaces. Such areas have been damaged by HDI and could result in further HDI if pack is reused. Therefore, the disk pack must be replaced by the user and inspection of the head performed by a qualified Field Service Customer Engineer.

- d. Deposits, smears or discolorations usually are the result of residue buildup and are the cause of most intermittent read errors. HDI will eventually occur if the disk pack is used in this condition. Only small areas of light-colored stains or other discolorations which remain after the disk pack has been thoroughly cleaned are acceptable. During normal read/write operations the disk surfaces may become slightly scratched. This type of scratch looks similar to a polishing scratch and is insignificant as long as data can be properly recovered.

CAUTION

If HDI is verified by inspection of the disk pack, do not continue use of the disk drive unit until the heads on the unit have been checked and verified by a qualified Customer Service Engineer. Continued use of the unit or pack could result in serious damage to the unit. The cost incurred in repairing the unit under these circumstances will be the user's responsibility.

2.3.5.3 Qualified Vendor or Manufacturer Disk Pack Preventive Maintenance. Preventive maintenance is necessary for mass memory disk system disk packs on a regularly scheduled basis. The following subparagraphs explain the basis for this requirement and the procedures for scheduling the preventive maintenance.

NOTE

Regular preventive maintenance (PM) procedures must be performed on all disk packs and disk cartridges every six months.



The disk pack is one of today's most advanced mass information storage systems. However, this seemingly ideal system requires special care to maintain optimum performance. Manufacturers originally considered disk packs and disk cartridges to be maintenance free. However, they have come to realize that regular cleaning and inspection are necessary to prevent costly system crashes, rerun time, and loss of valuable data. Regular PM is necessary on disk packs to alleviate costly problems that can arise to degrade the quality of data storage, render the disk packs unusable, or damage disk drives.

The need for PM arises in the following manner: Read/write heads fly over disk surfaces on an air bearing of 20 to 135 microinches, depending on the type of disk pack. Contamination in the form of dust, grease, metal filings, smoke particles, etc., build up on disk recording surfaces, decreasing the separation between read/write heads and disk surfaces, figure 2-2.

CAUTION

Damaged or questionable-quality disk packs must never be installed in a disk drive. Disk drives must not be used without a clean and serviceable air filter. To prevent damage to the disk packs, the filter must be checked at least twice a year, and monthly in dusty or nontemperature-controlled locations.

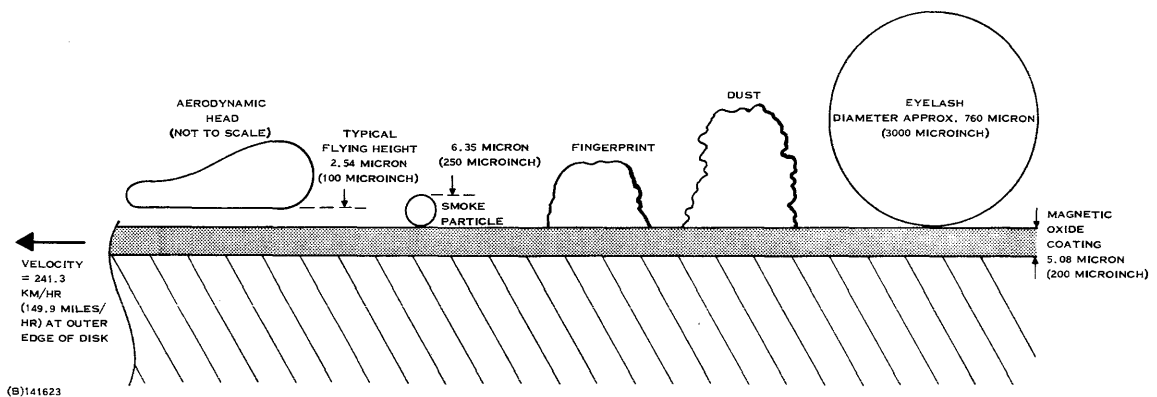


Figure 2-2. Disk Contaminants



Disk contaminants cause temporary errors, retries, and data checks. At this stage, most data should be recoverable by thorough cleaning of the disk surfaces. If foreign particles are allowed to build up, head crashes and other permanent damage to heads and disk surfaces are inevitable.

For these reasons, all disk packs should be removed from service and PM performed by a qualified vendor or manufacturer every six months. Contact the local TI sales and service office for help in locating a qualified, convenient vendor. Normally the PM is performed at the customer's location.

During the PM procedures, the vendor should clean and inspect the following areas in the disk pack:

- Top and bottom for cracks, chips, dirt, wear
- Spindle retainer for condition and wear
- Trim shield retaining screws for condition and tightness
- Spindle lock for wear, dirt, binding
- Thrust bearing, races, washers for damage and wear
- Hub and cone area for dirt, film, nicks, burrs
- Index (bottom protective) disk for bends, damage, axial runout
- Recording disks inspected, cleaned, and checked for surface damage and axial runout.

The vendor performing PM on disk packs will indicate the status of each pack cleaned and inspected. This will detail whether the pack is good, requires repair, or is nonrepairable. Many problems can be corrected by cleaning, but if a pack is found to be damaged, it must not be used again and should be scrapped or repaired before returning to service. Replacing disk packs can be costly, but quite inexpensive compared to system downtime due to disk drive crash or loss of data on a pack. Some packs may be repairable, in which case the repairs are usually done at the PM vendor's office.

Other than those periodic inspections and cleanings, disk cartridges should be cleaned in the field only when inspection reveals contamination or when excessive read/write errors are associated with the specific cartridge.

If HDI damage is suspected, evaluate the disk pack condition by referring to paragraphs 2.3.5.1 and 2.3.5.2. If inspection reveals that disk pack cleaning is required, the following procedure represents a generalized method which is acceptable for use by qualified personnel.



CAUTION

Disk pack *cleaning* should be accomplished only by a qualified person using methods and materials approved by disk pack manufacturers.

1. Install disk on inspection fixture (this may require removal of the disk platter from the plastic cartridge assembly).
2. Slightly dampen a lint-free cloth with 91 % isopropyl alcohol or approved media cleaning solution.

CAUTION

Excessive alcohol can be detrimental to disk surfaces and will leave a residue which would cause head-to-disk interference. Alcohol must not be allowed to dry by evaporation on disk surface.

3. Place cloth against platter surface and rotate platter one full revolution.
4. Repeat previous step with dry end of cloth.

Clean disk pack cartridge protective covers with a lint-free cloth dampened with 90% isopropyl alcohol. Wipe inside surfaces first and then outside surfaces to prevent bringing additional dust into the cartridge interior).

2.3.6 FINAL SYSTEM INTEGRITY CHECK. The final step after any PM is to perform a final system check to assure that no problems have been induced by PM and that the customer's equipment is up and running satisfactorily.

1. All equipment taken off-line for PM should be brought back to on-line status. Then have user verify the system is operating normally.
2. Update the system problem log (in the Field Service System Log Book) indicating that all scheduled PM has been done and have user initial the entry.



SECTION 3

CORRECTIVE MAINTENANCE

3.1 CORRECTIVE MAINTENANCE INTRODUCTION

Corrective maintenance procedures are divided into three categories: troubleshooting, part removal/replacement, and alignment/adjustment. In all cases, corrective maintenance should be followed by a system verification (paragraph 2.3.4) to assure that the original problem has been corrected and that no new problems have been induced.

Corrective maintenance for the DS10 Cartridge Disk System is based on replacement of defective controller boards and repair by subassembly/part replacement or adjustment of defective disk drives. The DS10 disk controller is a sophisticated, highly complex device. The controller is spared at the field level and repaired at the depot level. Built-in self-tests and on-board indicators help speed up fault isolation to the board level.

The DS10 Disk Drive (CDC 9427H "Hawk") includes a large number of individually replaceable, repairable, and/or adjustable subassemblies and parts. It represents a considerable capital investment to the customer and is not "swapped out" with a replacement drive except under very unusual circumstances. On particularly stubborn problems, backup to the field service engineer is provided by disk-drive technical specialists.

3.2 CORRECTIVE MAINTENANCE SUPPLIES

The special tools, test equipment and other supplies which may be required during corrective maintenance are listed in table 3-1. This table does not include spare parts, which are listed in table 1-3.

3.3 TROUBLESHOOTING

The disk system and its interfaces with the remainder of the computer system are key supporting elements for a disk-based software operating system. Retry capability in the software provides tolerance for "soft" or transient errors in the disk equipment. However, a "hard" failure in the disk equipment will usually cause a software system "crash." Corrective maintenance is required before the system can be restored to reliable operation.

The service engineer must first make a step-by-step analysis of the available information surrounding the system crash to aid in isolating the faulty subsystem. A flowchart of these initial steps is shown in figure 3-1.

The disk system interfaces with other elements of the overall computer system. A failure in one of these other systems can appear to be a disk problem. Assuming that thoroughly-debugged software was operating at the time of the crash, the cause of the crash could be one of the following:

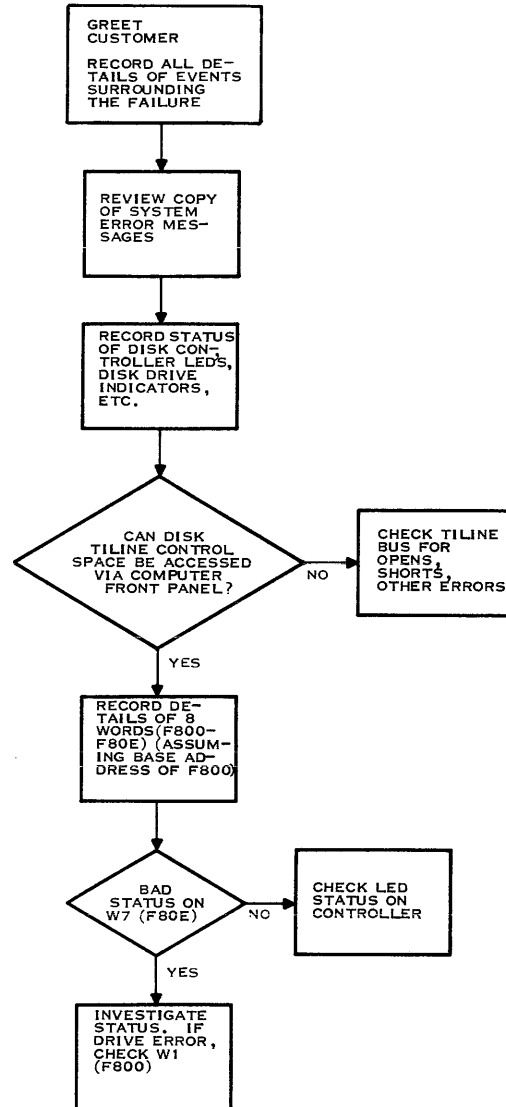
- Central processor unit (CPU). The CPU could make the failure appear as a disk fault by sending improper commands to the disk controller or by failing to recognize and respond to an interrupt.
- TILINE memory. The TILINE memory can mimic a disk fault by failing to store or fetch correct data during controller master cycles.

**Table 3-1. Special Tools and Test Equipment for Corrective Maintenance**

Item	Vendor Part Number	TI Part No.
Control Data Cartridge Disk Drive, Model 9427H, Hardware Maintenance Manual	Control Data Corp 77834675	937517
CE Alignment Disk Pack (Same as DS44)	CDC 89296000	943849-0201
Scratch Disk Pack		943849-0203
Oscilloscope	Tektronix 475 or equivalent	
Card Extender	CDC 74861504	943849-0204
Torque screwdriver, Phillips/hex (1 to 30 in-lbs)	Commercially available	943849-0209
Head Alignment Tool	CDC 75797900	943849-0206
Armature Plate Simulator	CDC 83455500	943849-0207
Plastic Shim Stock	Commercially available	943849-0208

- TILINE bus wiring, or TILINE couplers if an expansion chassis is installed. Physical bus lines could be open or shorted, and a bad connector could be preventing the correct exchange of control/data signals. The TILINE coupler, if used, could be incorrectly mapping address spaces or garbling inter-chassis data. The TILINE hold could have failed in an active state.
- Disk controller. Switch and jumper settings may be incorrect, or an internal failure may have occurred.
- Disk controller to disk cabling. A damaged cable or connector, misplaced jumper on the cable adapter, or broken etch in the cable adapter may cause the problem.
- Disk drive. Drive may be out of adjustment, read/write heads may be dirty or damaged, one of many option switches may be mis-positioned, or a physical or electronic failure may have occurred.
- Media. Disk cartridge may be substandard “off-branch”, may be damaged or dirty, may have bad tracks, or may have been formatted and/or recorded on a drive which was misaligned.

Troubleshooting procedures are described by flowcharts in this section. These flowcharts are intended to assist in isolating problems to successively smaller areas of circuitry or electromechanical subassemblies and parts. These flowcharts are guidelines only and cannot substitute fully for the judgement of the field service engineer. Also, flowcharts cannot be comprehensive enough to fully isolate all problems. However, use of the flowcharts should speed up troubleshooting in most cases.



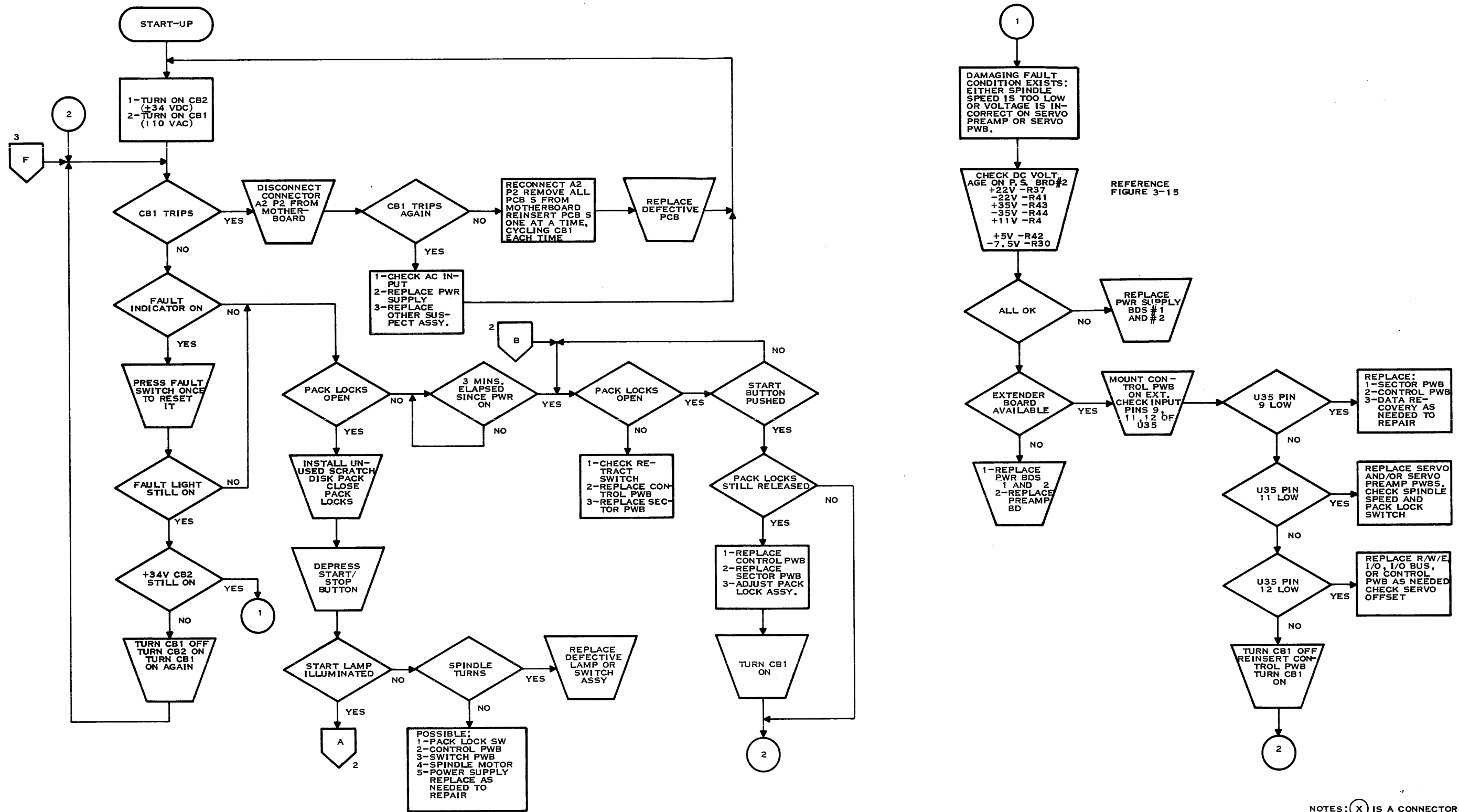
(A) 141087

Figure 3-1. Initial Troubleshooting

Figure 3-2 is a flowchart for off-line troubleshooting of the DS10 disk drive. The steps on this flowchart may be followed whether or not the controller and drive are cabled together. Refer to this flowchart if the disk drive will not come to the READY state (READY indicator lit). This flowchart refers to probe locations on power supply board No. 2, figure 3-15.

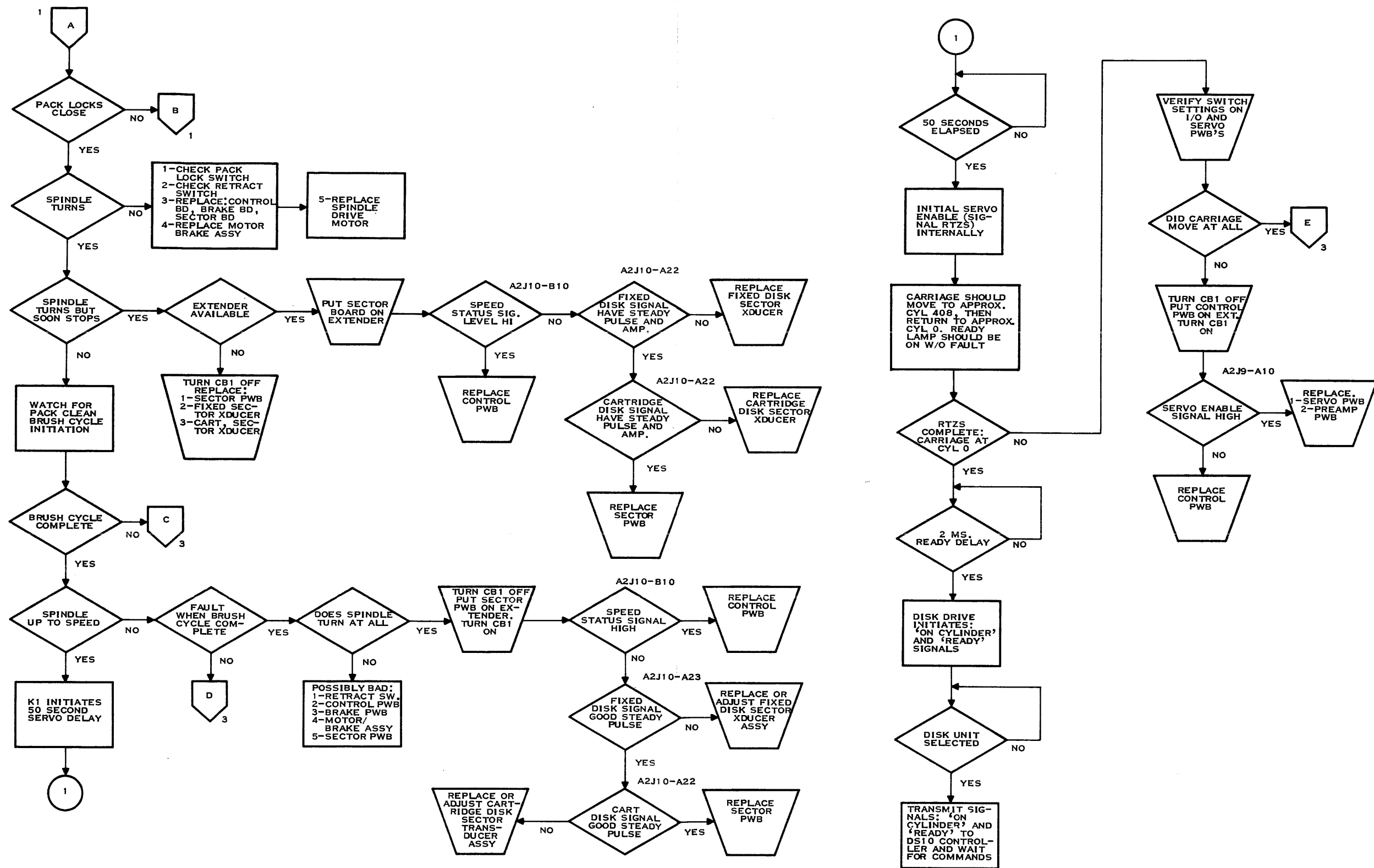
If the drive can be brought to the READY state and if the controller and drive are both under suspicion, proceed to the DOCS diagnostic flowchart, figure 3-3. This flowchart requires that the controller be installed in a 990 computer chassis and cabled to the disk drive. It also requires a means to enter the Diagnostic Operation Control System (DOCS) software and the DS10PD diagnostic which operates under DOCS.

If the drive cannot be brought to the READY state, or if the DOCS diagnostic flowchart steps do not cure the problem, go on to figure 3-4, Disk Operational Faults. Note that parts of this test require a working controller. If previous testing has not cleared the controller of suspicion, replace it



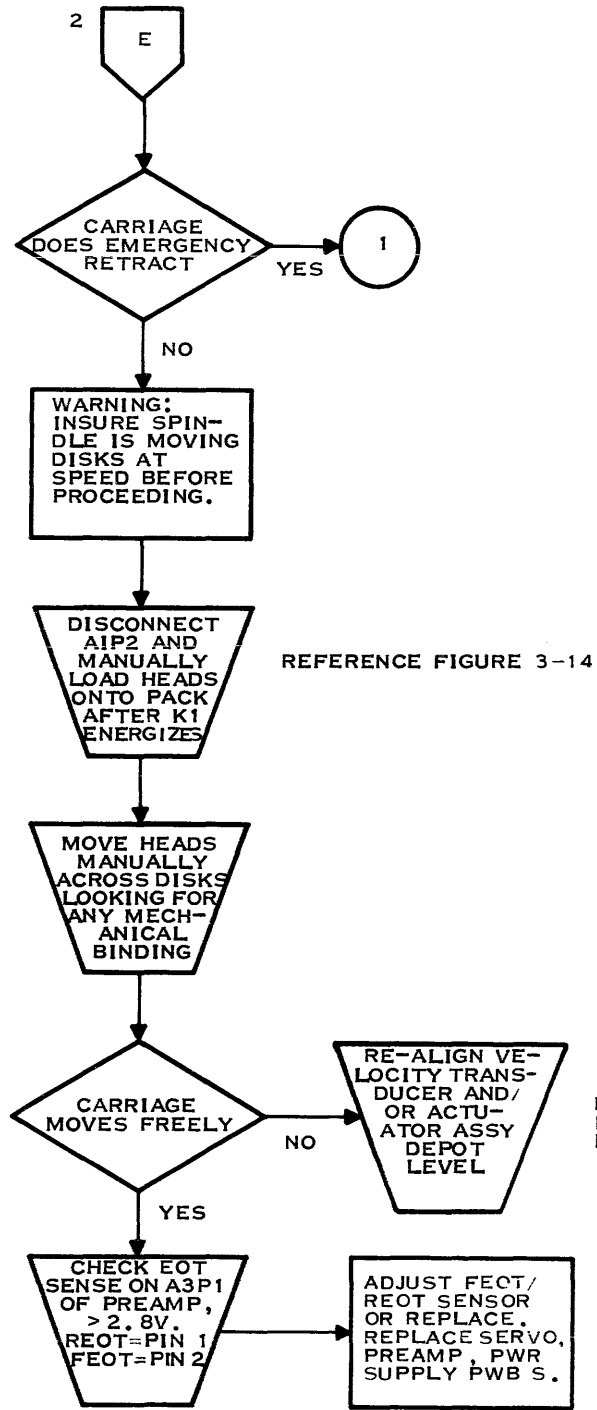
NOTES: (X) IS A CONNECTOR TO A POINT ON THE SAME PAGE
 (X) IS A CONNECTOR TO A POINT ON ANOTHER PAGE

Figure 3-2. Off-line Troubleshooting (Sheet 1 of 3)



(C) 141088 (2/3)

Figure 3-2. Off-line Troubleshooting (Sheet 2 of 3)



REFERENCE FIGURE 3-14

NOT IN CURRENT MAINTENANCE PHILOSOPHY

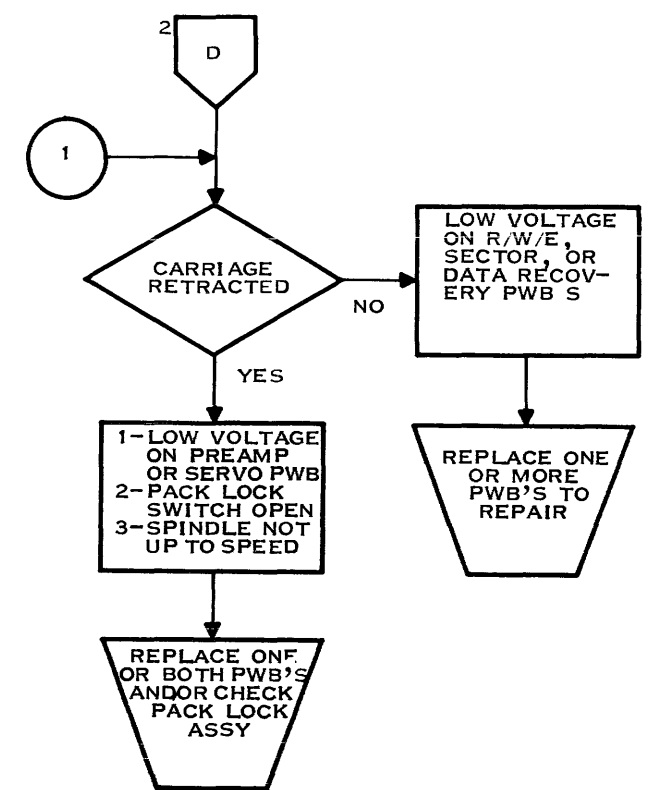
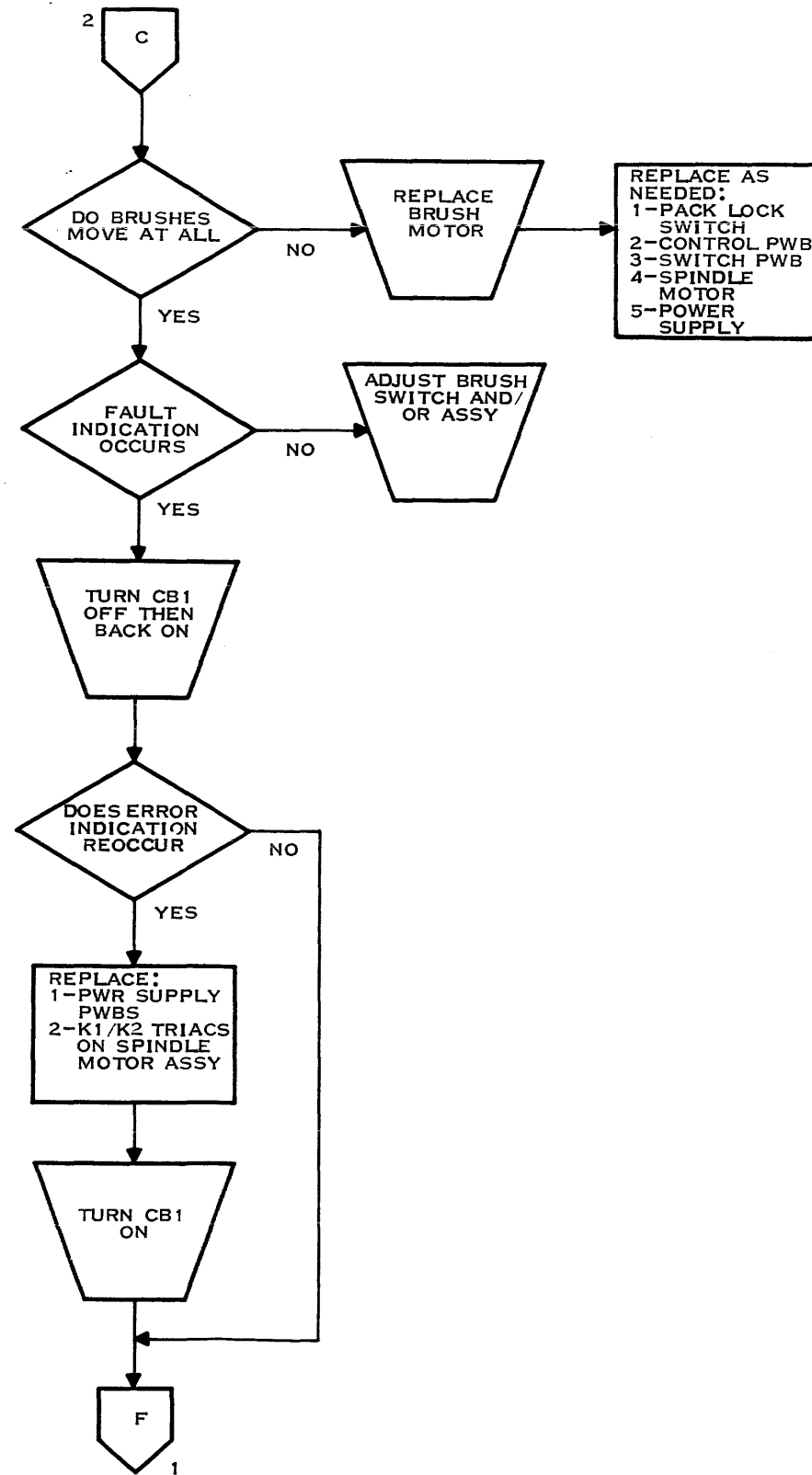
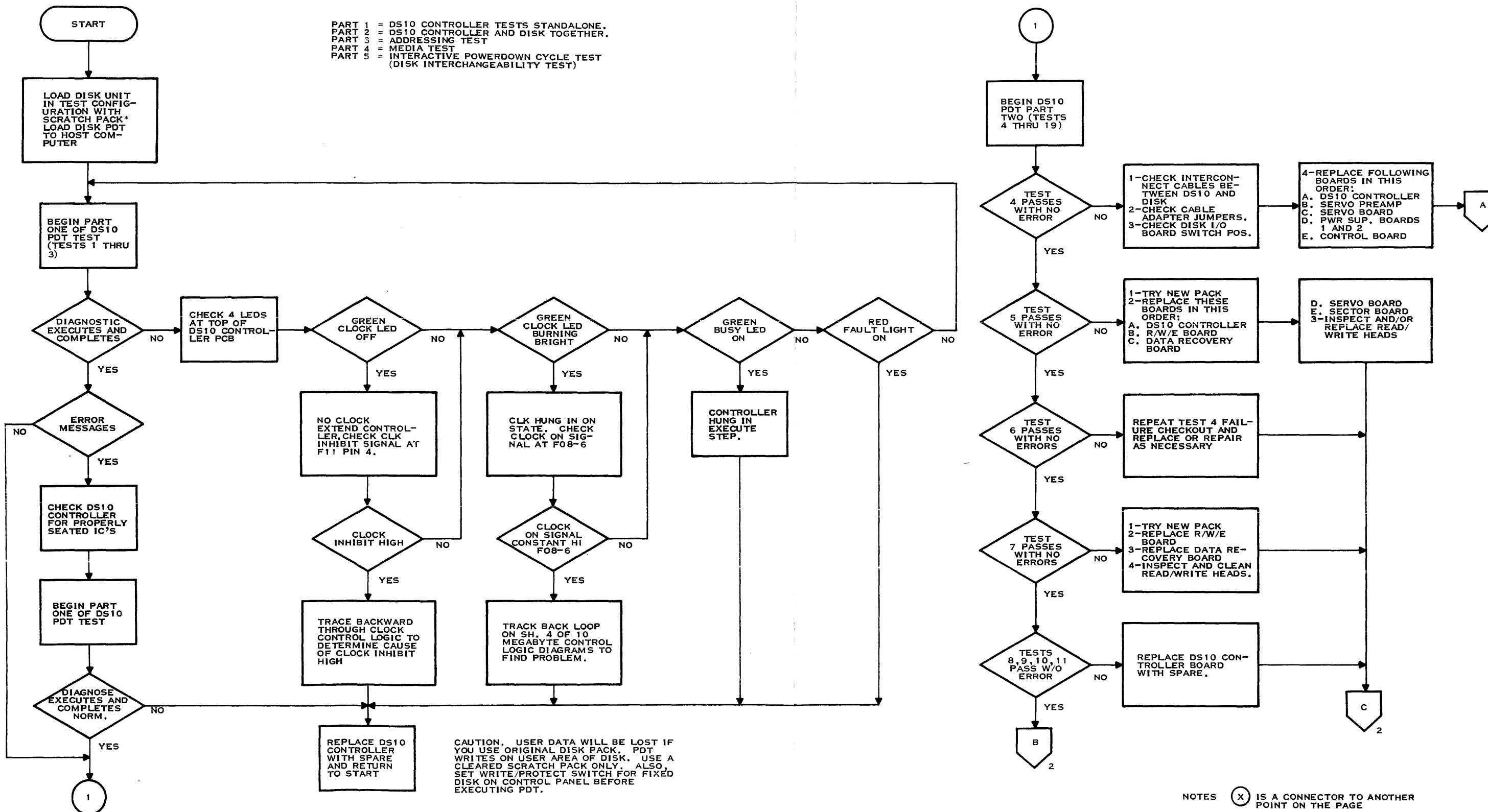


Figure 3-2. Off-line Troubleshooting (Sheet 3 of 3)



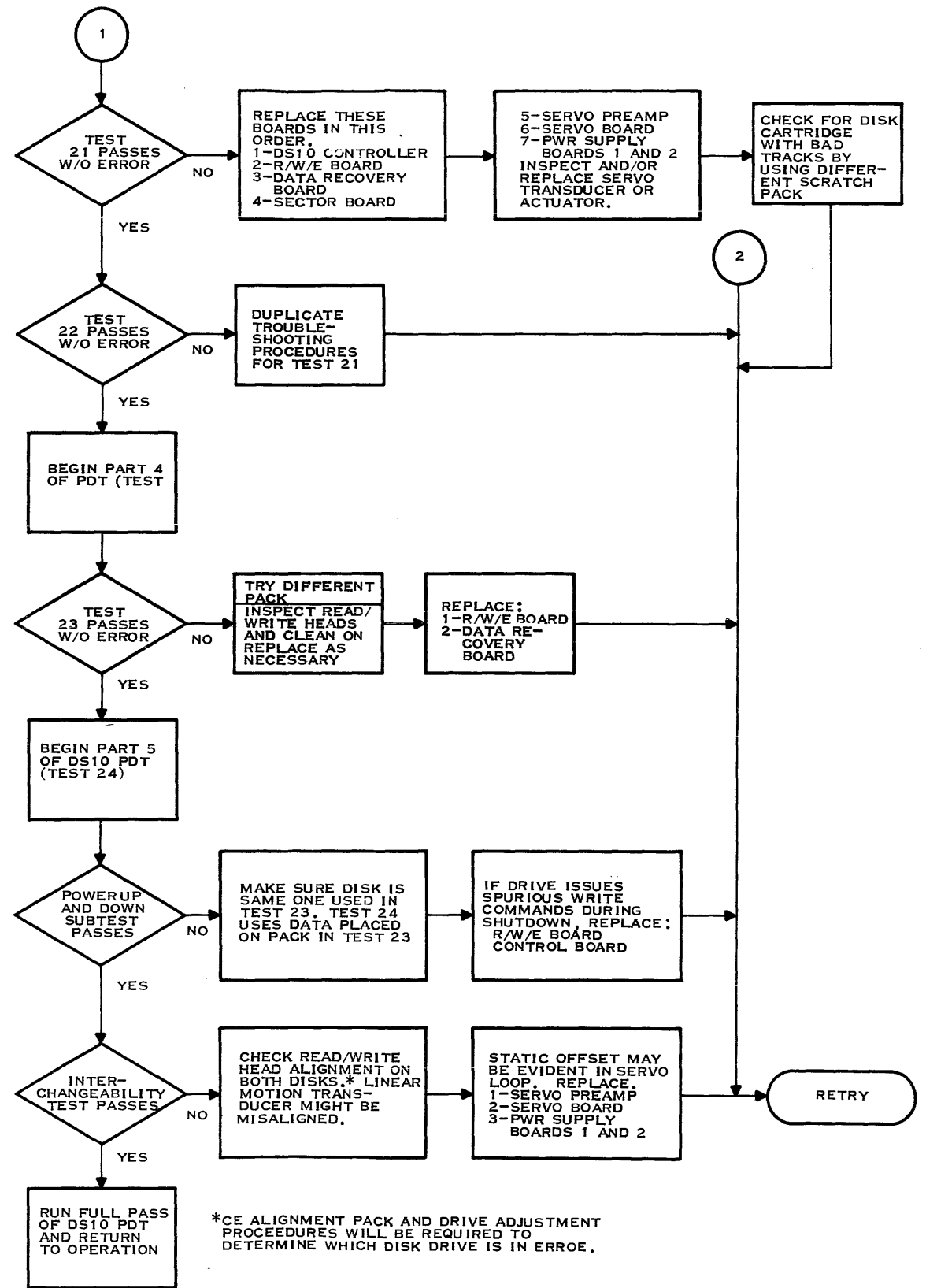
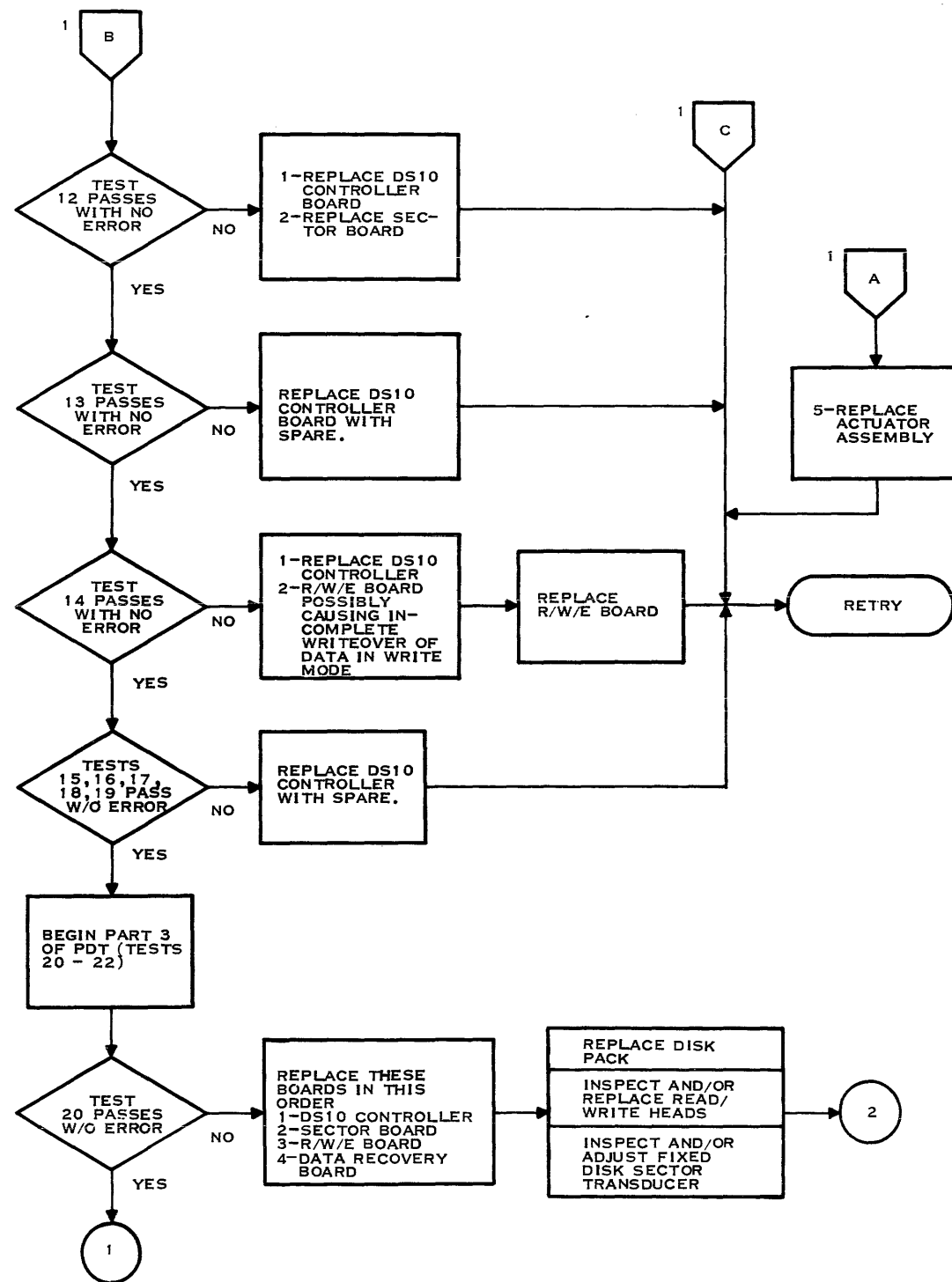
PART 1 = DS10 CONTROLLER TESTS STANDALONE.
 PART 2 = DS10 CONTROLLER AND DISK TOGETHER.
 PART 3 = ADDRESSING TEST
 PART 4 = MEDIA TEST
 PART 5 = INTERACTIVE POWERDOWN CYCLE TEST
 (DISK INTERCHANGEABILITY TEST)



CAUTION. USER DATA WILL BE LOST IF YOU USE ORIGINAL DISK PACK. PDT WRITES ON USER AREA OF DISK. USE A CLEARED SCRATCH PACK ONLY. ALSO, SET WRITE/PROTECT SWITCH FOR FIXED DISK ON CONTROL PANEL BEFORE EXECUTING PDT.

NOTES (X) IS A CONNECTOR TO ANOTHER POINT ON THE PAGE
 (X) IS A CONNECTOR TO A POINT ON ANOTHER PAGE

Figure 3-3. DOCS Diagnostic (Sheet 1 of 2)

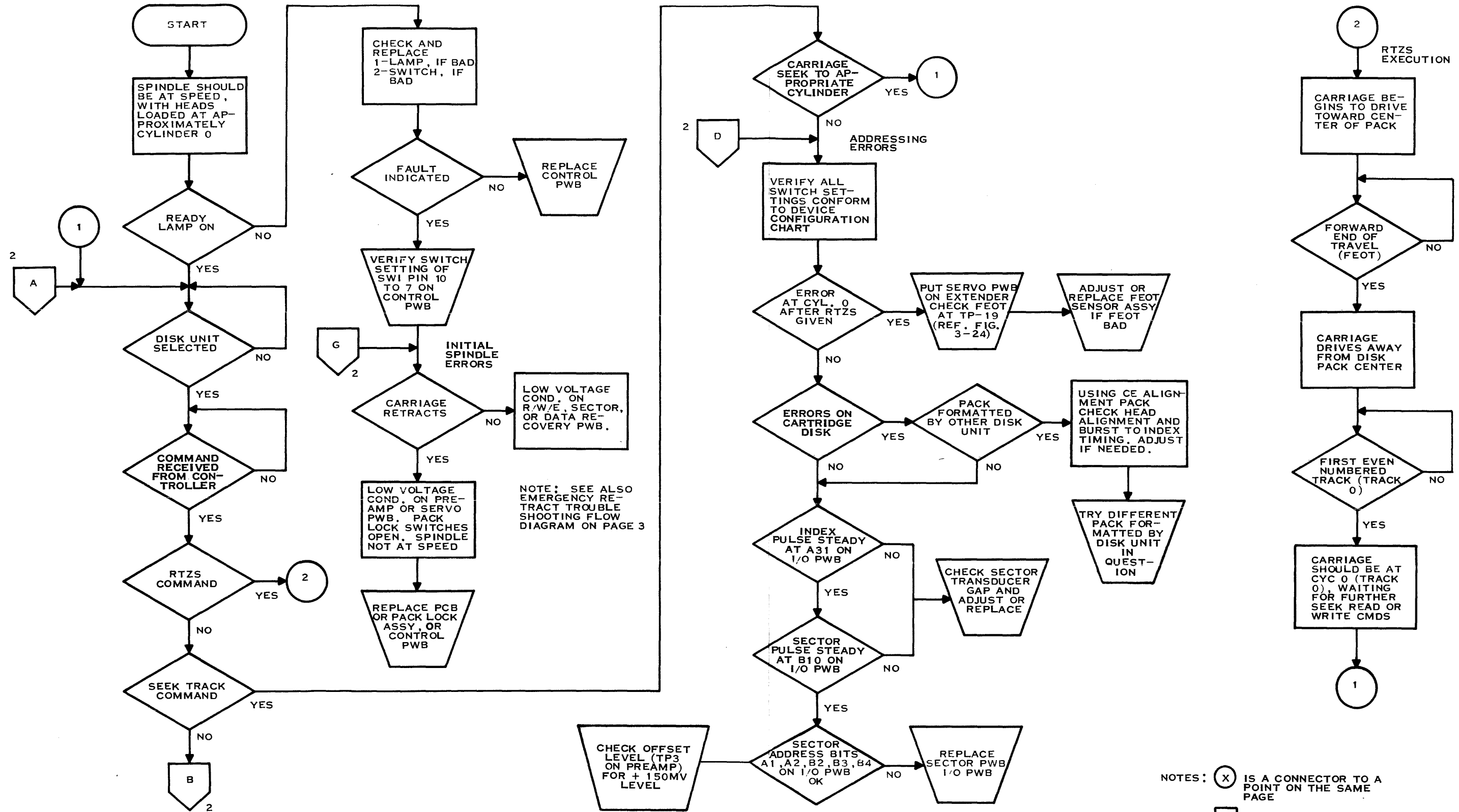


*CE ALIGNMENT PACK AND DRIVE ADJUSTMENT PROCEDURES WILL BE REQUIRED TO DETERMINE WHICH DISK DRIVE IS IN ERROE.

Figure 3-3. DOCS Diagnostic (Sheet 2 of 2)



DISK OPERATIONAL FAULTS

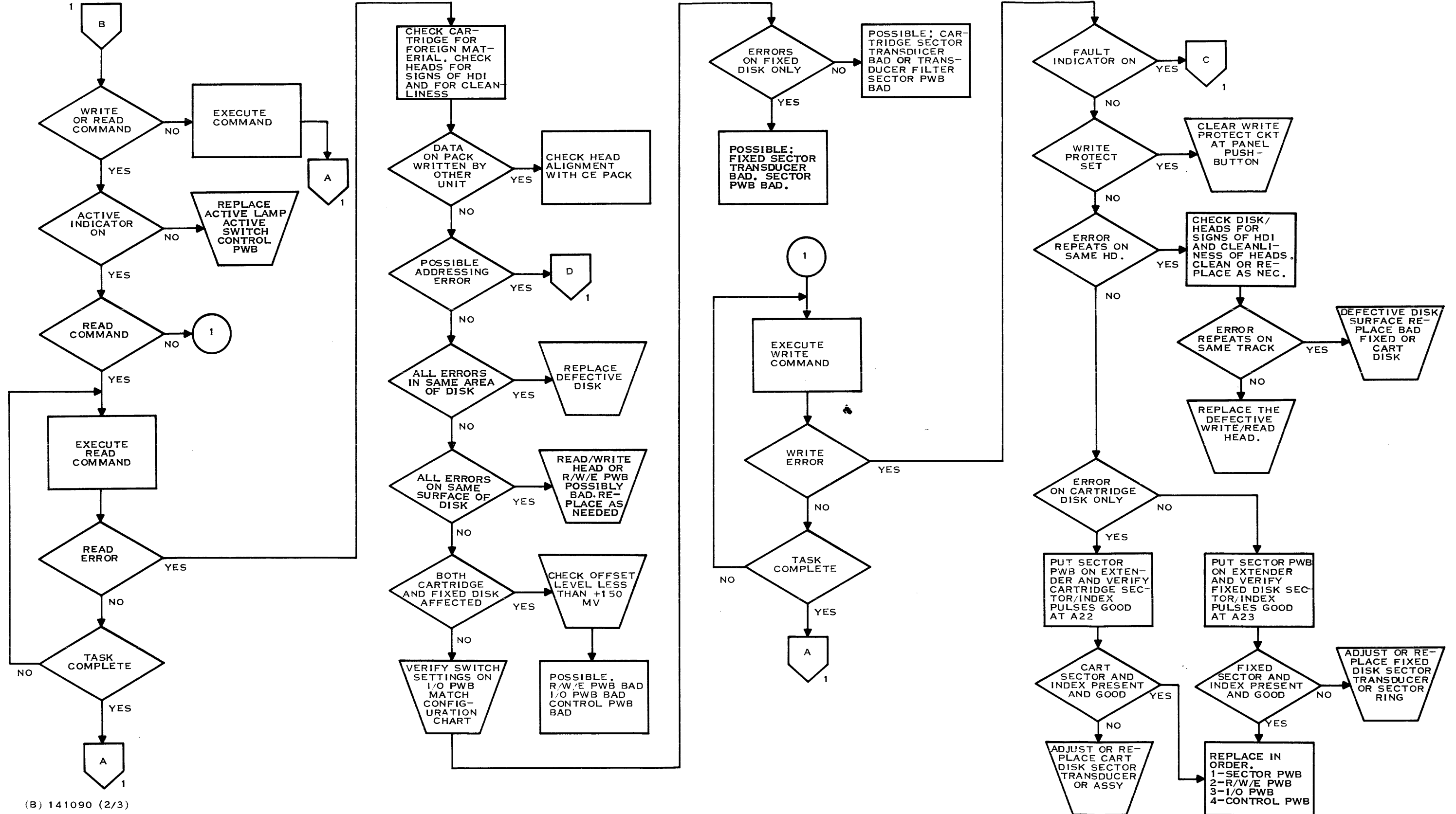


NOTES: (X) IS A CONNECTOR TO A POINT ON THE SAME PAGE
 [X] IS A CONNECTOR TO A POINT ON ANOTHER PAGE

Figure 3-4. Disk Operational Fault Troubleshooting (Sheet 1 of 3)

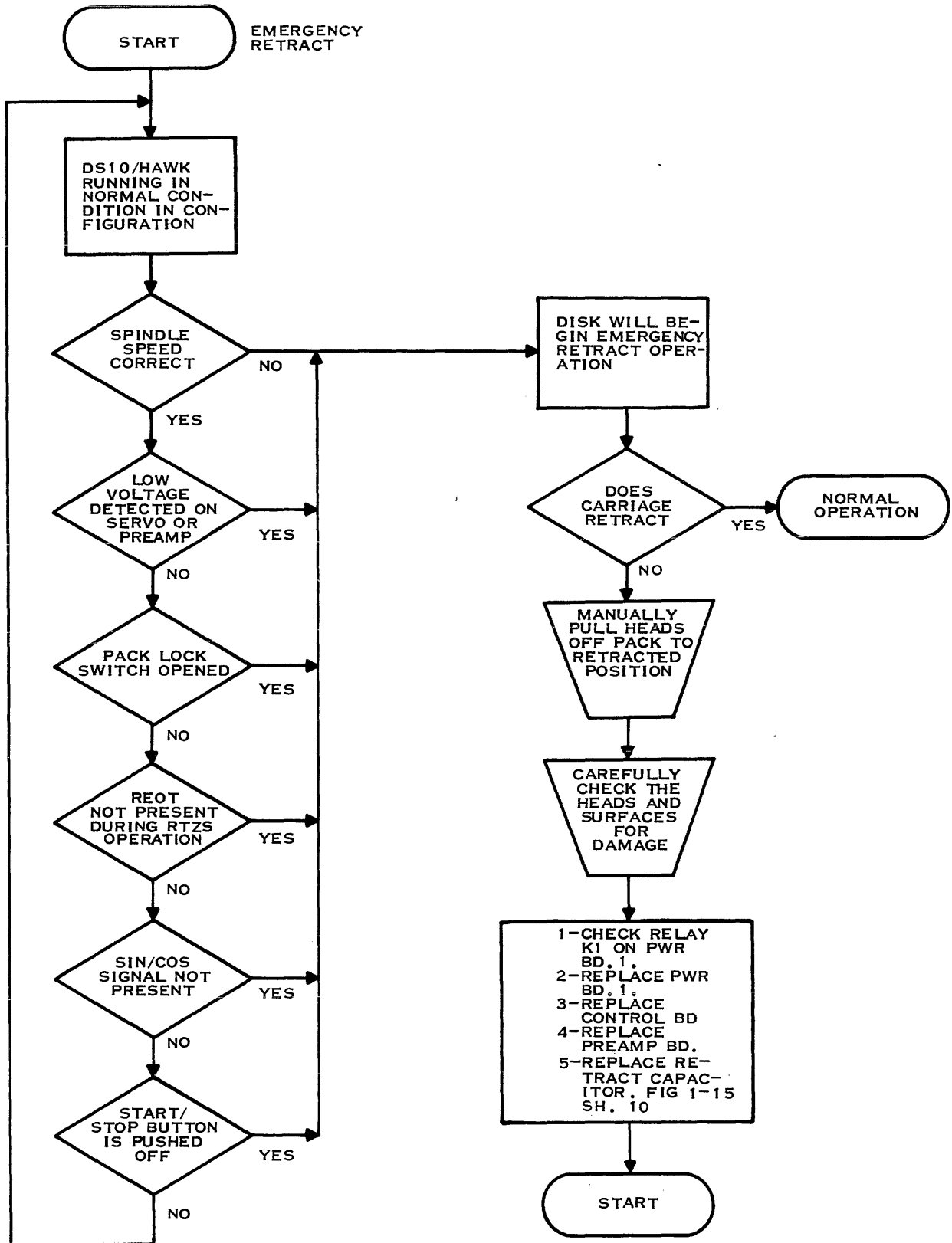


CDC 9427H DISK OPERATIONAL FAULTS



(B) 141090 (2/3)

Figure 3-4. Disk Operational Fault Troubleshooting (Sheet 2 of 3)



(A) 141090 (3/3)

Figure 3-4. Disk Operational Fault Troubleshooting (Sheet 3 of 3)



before going on to the operational fault procedure. This procedure calls for initiation of various commands, such as reading or seeking to a specific track. The easiest way to initiate these commands is to use the DOCS verbs, without execution of the diagnostic tests. Refer to the programming information in paragraph 1.2.2, and to sample commands included in the alignment and adjustment procedures.

3.4 REMOVAL AND REPLACEMENT PROCEDURES

These removal and replacement procedures should be followed when replacing components of the disk system. Refer also to the exploded views of figure 1-15. Table 3-2 is an index to the removal and replacement procedures.

CAUTION

The replacement of a disk drive component may affect one or more adjustments. There is also interaction between adjustments. The following precautions should be observed:

- a. Replace only one component/assembly at a time.
- b. Perform all the specified adjustments and checks in the order given.

Multiple component/assembly/circuit board replacement without intervening checks and adjustments has been observed to set up very complex interactions which are most time-consuming to resolve.

3.4.1 DS10 CARTRIDGE DISK CONTROLLER REMOVAL AND REPLACEMENT. This procedure is used when swapping controller boards.

3.4.1.1 Removal:

1. Place disk drive START/STOP switch in the STOP position.
2. After drive slows down and heads retract, set MAIN (ac) breaker on rear of drive to OFF. This removes +5V terminator power from the cables.
3. Turn keylock switch on 990 chassis front panel to the OFF position, and remove key to prevent accidental power turn-on.
4. Disconnect 50-pin and 40-pin flat cables from connectors at outer edge of controller board. This step is not necessary if the controller is being pulled for a check (such as TILINE base address switch setting) rather than for replacement. Do not allow strain on the connectors.
5. Free the board from the back panel connectors by gently rocking with the ejector tabs.
6. Remove the board from the chassis and immediately tag the board with information such as symptom, chassis and slot from which the board was removed, and which drive units were connected at time of failure. If the site includes multiple systems, record system identifier.
7. Note all switch settings and jumper options. These settings and options must be set up on the replacement board.



Table 3-2. Index to Removal and Replacement Procedures

Paragraph	Procedure	Page
3.4.1	DS10 Cartridge Disk Controller Removal and Replacement	3-14
3.4.2	Actuator Assembly Removal and Replacement	3-15
3.4.3	Head Removal and Replacement	3-21
3.4.4	EOT Assembly Removal and Replacement	3-23
3.4.5	Fixed Disk Removal and Replacement	3-24
3.4.6	Position Transducer Scale Removal and Replacement	3-26
3.4.7	Velocity Transducer Removal and Replacement	3-31
3.4.8	Velocity Transducer Magnet Removal and Replacement	3-33
3.4.9	Spindle Assembly Removal and Replacement	3-36
3.4.10	Cartridge Disk Index/Sector Transducer Removal and Replacement	3-39
3.4.11	Fixed Disk Index/Sector Transducer Removal and Replacement	3-40
3.4.12	Sector Ring Removal and Replacement	3-42
3.4.13	Cartridge-on Switch Removal and Replacement	3-42
3.4.14	Disk Brush Assembly Removal and Replacement	3-45
3.4.15	Spindle Drive Motor Assembly Removal and Replacement	3-47
3.4.16	Card Cage Printed Circuit Board Removal and Replacement	3-48
3.4.17	Power Supply Removal and Replacement	3-49
3.4.18	Piggyback Power Board Removal and Replacement	3-51
3.4.19	Card Cage/Motherboard Removal and Replacement	3-52
3.4.20	Blower Motor Assembly Removal and Replacement (Base Cabinet)	3-54
3.4.21	Blower Motor Assembly Removal and Replacement (Rackmount)	3-55

3.4.1.2 Replacement:

1. Verify that all switch settings and jumper options correspond to removed board.
2. Record new board serial number and options and transfer to the system configuration chart.
3. Slide new board into card guides and align connector pins with backpanel connectors. Press in until connector pins and connectors are fully mated.
4. Reconnect 50-pin and 40-pin flat cables, being careful to observe polarity of embossed arrowheads on connector bodies.
5. Restore power to disk drive and 990 computer.

3.4.2 ACTUATOR ASSEMBLY REMOVAL AND REPLACEMENT. The actuator assembly must be removed to clean or replace lower read/write heads.

3.4.2.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove disk cartridge.
3. Remove top cover by lifting cover straight up (base cabinet only).



4. Set main circuit breaker to OFF position.
5. Remove electronics cover from card cage.
6. Remove rear door (base cabinet only).
7. Remove power supply cover and disconnect A1P5.
8. Disconnect A3P1, A3P2, A3P3, A3P4, A3P5, and A3P6 from AGC preamplifier.
9. Remove the four screws securing the AGC preamplifier to the magnet and remove preamplifier.
10. Between the two sets of upper and lower heads and approximately halfway along the length of the head arm assembly, insert a piece of paper 1.6 mm (1/16-inch) thick, 12.7 mm (1/2-inch) wide rolled up paper (or similar spacer) to prevent the head pads from touching when actuator is removed.
11. Remove card cage by performing removal steps 1 through 13 of card cage removal and replacement procedure.
12. Remove velocity transducer end cap and velocity transducer (see figure 3-5 and sheet 14 of figure 1-15).
13. Remove two screws that fasten the magnet to the main deck. Screws are located underneath the base casting, one screw in back of magnet and one in front (see figure 3-6).
14. Move carriage and voice coil assembly forward.
15. Lift magnet slightly and very carefully slide the magnet assembly out from the voice coil. Extreme care must be taken to avoid any bending stress to the velocity transducer magnet.
16. Unplug A1P2 (see figure 3-14) connecting the voice coil flexible lead to the power supply.
17. Unlace A3P6 located on top of actuator frame.
18. Remove head harness clip for heads 3 and 4 located on front of voice coil.
19. Using 9/64 ball allen driver, remove the three mounting bolts from the actuator frame securing the actuator to the deck (see figure 3-6).
20. Lift rear of actuator frame to clear guide pin and then pull actuator frame slightly back from eccentric screw which is located at front of actuator frame. Then lift actuator clear of unit.

CAUTION

Extreme care must be exercised to avoid damage to fixed disk, position transducer scale and position transducer slider.

21. Heads, velocity transducer magnet and EOT assembly can be replaced at this time, if required. When actuator is removed, the heads should be cleaned.

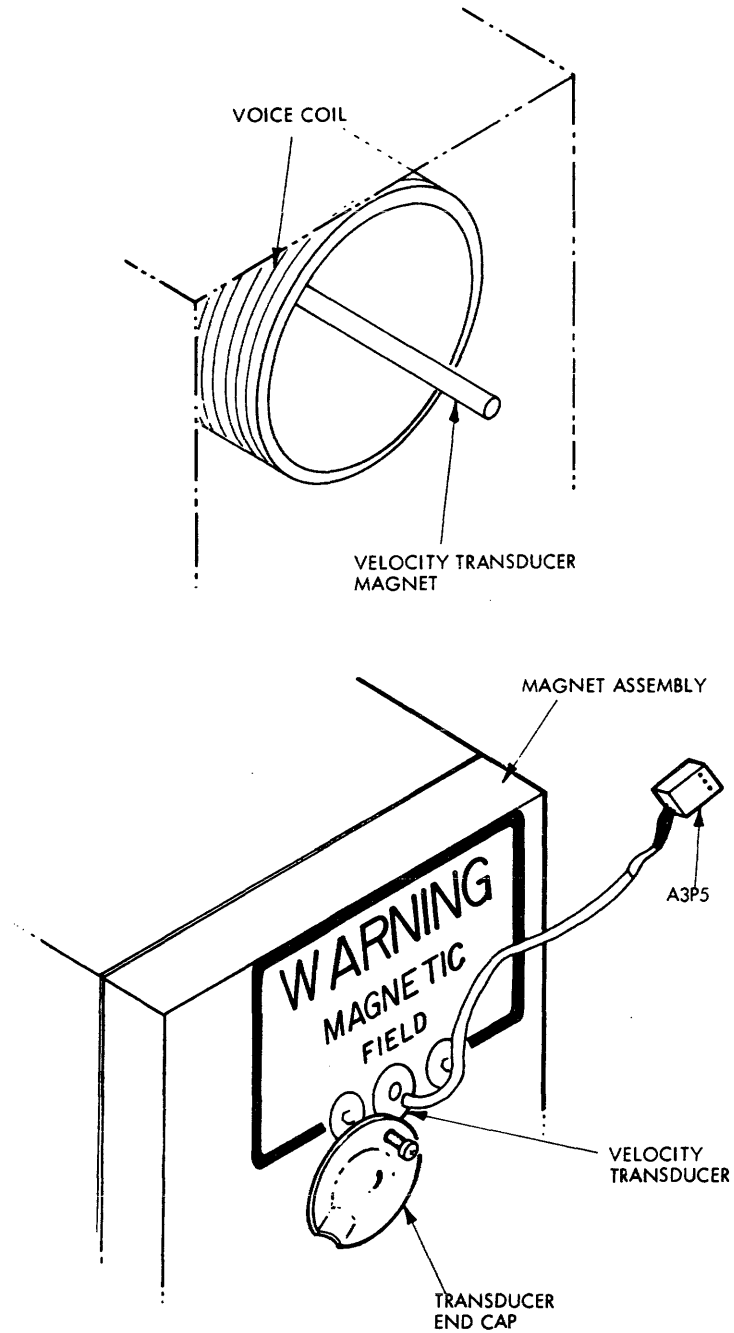


Figure 3-5. Velocity Transducer Location

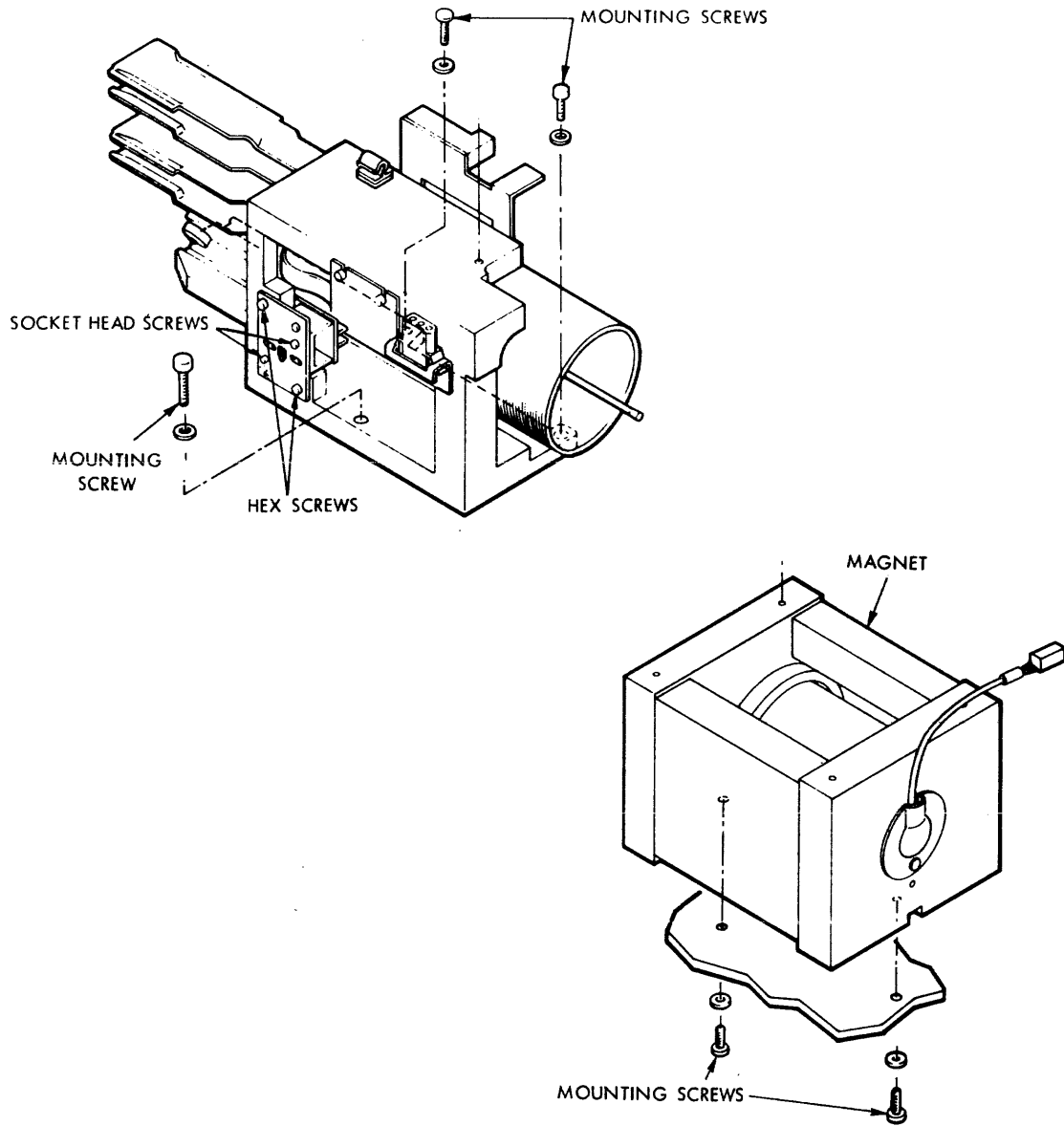


Figure 3-6. Actuator, Magnet and EOT Sensor Mounting



3.4.2.2 Replacement:

1. To install actuator assembly, align slot at front of actuator frame with eccentric screw and slide frame forward while clearing guide pin until holes for mounting screws are aligned.

CAUTION

Extreme care must be exercised to avoid damage to fixed disk, position transducer scale and position transducer slider.

2. Using 9/64 ball allen drive, install the three mounting bolts securing the actuator to the drive (see figure 3-6).
3. Install head harness clip for heads 3 and 4.
4. Replace A3P6 across top of actuator frame.
5. Connect A1P2 (see figure 3-14) connecting the voice coil flexible head to the power supply.
6. Very carefully slide magnet assembly onto the two guide pins. Extreme care must be taken to avoid any bending stress to the velocity transducer magnet.
7. Fasten magnet to the main deck with the two mounting screws (see figure 3-6).
8. Install velocity transducer and velocity transducer end cap (see figure 3-5).
9. Install card cage by performing replacement steps 3 through 9 of card cage removal and replacement procedure.
10. Remove spacers from between heads.
11. Install AGC servo preamplifier to the top of magnet with the four mounting screws.
12. Connect A3P1, A3P2, A3P3, A3P4, A3P5.
13. Connect A1P5 and install power supply cover.
14. Install rear door.
15. Perform AGC servo preamplifier and inductosyn check and adjustment.
16. Perform FEOT check and adjustment.
17. Perform head alignment check and adjustment.
18. Perform index-to-burst check and adjustment.
19. Perform track indicator check and adjustment.
20. Install electronics cover.
21. Install top cover (base cabinet only).

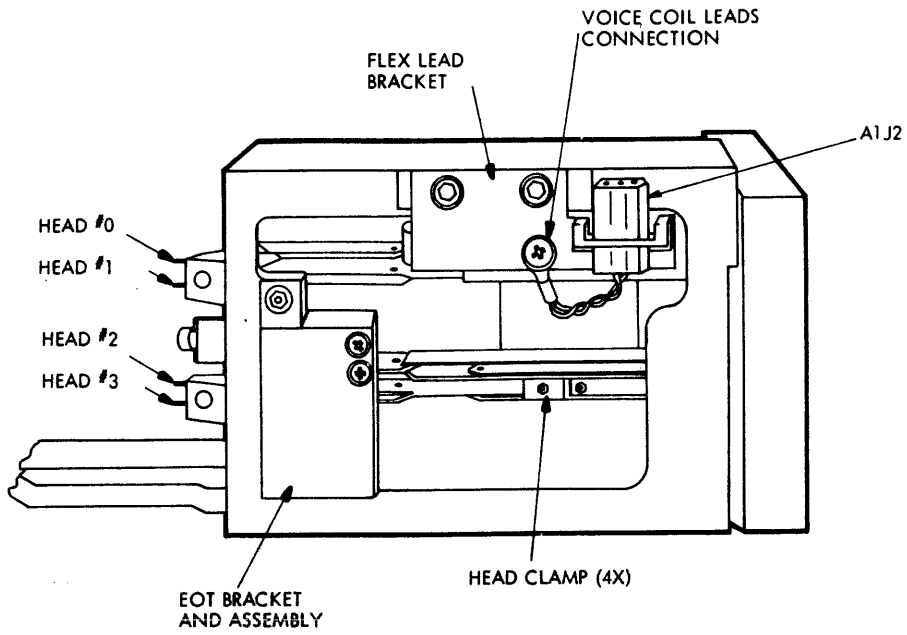


Figure 3-7. Actuator Assembly — Heads Installed

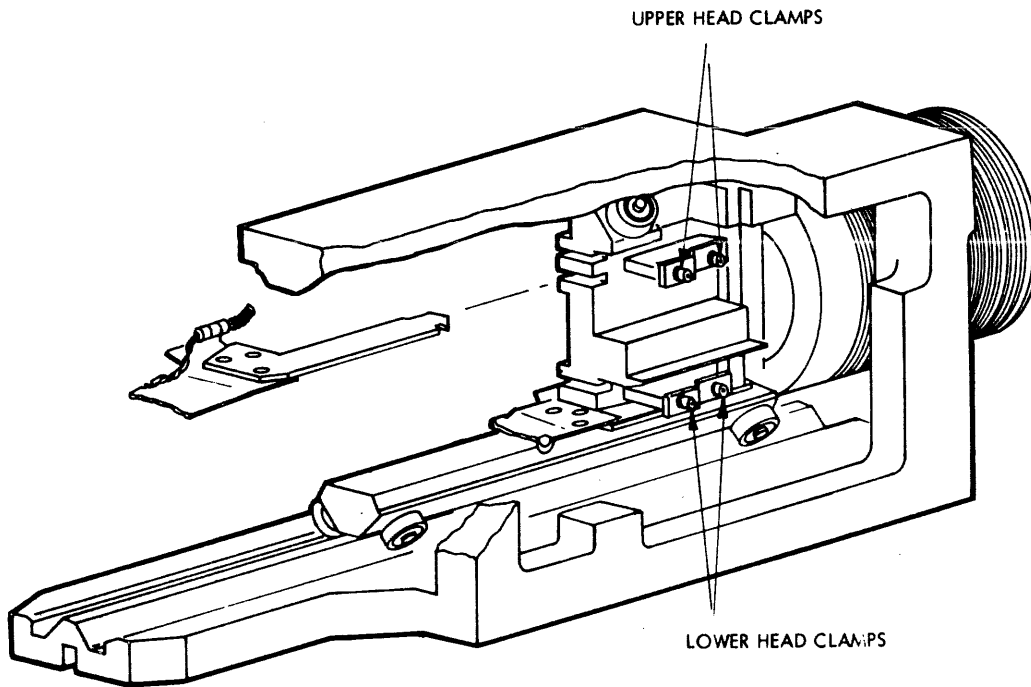


Figure 3-8. Head Removal and Replacement



3.4.3 HEAD REMOVAL AND REPLACEMENT.

3.4.3.1 Cartridge Disk Head Removal (#0 or #1):

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).
3. Remove disk cartridge.
4. Set main circuit breaker to OFF position.
5. Remove electronics cover. Remove cover from card cage.
6. Remove head harness clamp (figure 1-15, sheet 1).
7. Remove quadraclip between head plugs and card cage.
8. Remove clip holding head lead springs to carriage assembly.
9. Remove power supply cover assembly.
10. Loosen upper head clamps (figures 3-7 and 3-8).

CAUTION

Extreme care should be exercised when removing heads. Do not touch head face with fingers. Do not allow head to bang against anything.

11. Remove Head #0 or #1.

3.4.3.2 Cartridge Disk Head Replacement (#0 or #1):

CAUTION

The standard head supplied by Texas Instruments is a straddle erase type identified by the following CDC part numbers:

75037505-0	upper head (#0, #2)
75037504-0	lower head (#1, #3)

Some drives may have preerase heads supplied directly by CDC. Preerase heads are identified by the following part numbers:

70590209-6	upper head (#0, #2)
70590208-8	lower head (#1, #3)

Straddle and preerase heads may not be mixed in the same drive unit. Do not replace a removed head by a different type unless all four heads are to be changed.



1. Install replacement head.
2. Tighten head clamps. (Note torque requirement during head alignment.)
3. Install power supply cover assembly.
4. Install clip holding head lead springs to carriage assembly.
5. Install quadraclip.

CAUTION

Insure head cables are dressed such that the voice coil does not touch any cable when heads are loaded and extended to cylinder 405. This can be verified when doing head alignment check and adjustment.

6. Install head harness clamp.
7. Install card cage cover.
8. Install CE disk cartridge.
9. Perform head alignment check and adjustment.
10. Perform index-to-burst check and adjustment.
11. Install electronics cover.

3.4.3.3 Fixed Disk Head Removal (#2 or #3):

1. Perform removal steps 1 through 21 of actuator assembly removal and replacement procedure.
2. Loosen lower head clamps (figures 3-7 and 3-8).

CAUTION

Extreme care should be exercised when removing heads. Do not touch head face with fingers. Do not allow head to bang against anything.

3. Remove Head #2 or #3.



3.4.3.4 Fixed Disk Head Replacement (#2 or #3):

CAUTION

The standard head supplied by Texas Instruments is a straddle erase type identified by the following CDC part numbers:

75037505-0	upper head (#0, #2)
75037504-0	lower head (#1, #3)

Some drives may have preerase heads supplied directly by Control Data Corporation. Preerase heads are identified by the following part numbers:

70590209-6	upper head (#0, #2)
70590208-8	lower head (#1, #3)

Straddle and preerase heads may not be mixed in the same drive unit. Do not replace a removed head by a different type unless all four heads are to be changed.

1. Install replacement head.
2. Tighten head clamps. (Note torque requirement during head alignment.)
3. Install spacer between heads.
4. Perform replacement steps 1 through 21 of actuator assembly removal and replacement procedure, paragraph 3.4.2.2.

3.4.4 EOT ASSEMBLY REMOVAL AND REPLACEMENT.

3.4.4.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished). Remove cartridge.
2. Open top cover (base cabinet only).
3. Set MAIN circuit breaker to OFF position.
4. Remove electronics cover.
5. Remove power supply cover and disconnect A1P5.
6. Remove Relay K1 from power supply board.
7. On EOT assembly bracket, remove top and bottom mounting hex screws (see figure 3-6).
8. Remove EOT assembly.



3.4.4.2 Replacement:

1. Install EOT assembly.

CAUTION

Insure the EOT scale on carriage assembly does not rub against EOT assembly.

2. Install relay K1.
3. Install power supply cover and connect A1P5.
4. Perform FEOT check and adjustment.
5. Perform head alignment check and adjustment.
6. Perform index-to-burst period check and adjustment.
7. Perform track indicator check and adjustment.
8. Install electronics cover.
9. Close top cover (base cabinet only).

3.4.5 FIXED DISK REMOVAL AND REPLACEMENT.

3.4.5.1 Removal:

1. Depress START/STOP pushbutton to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).
3. Remove disk cartridge.
4. Set MAIN circuit breaker to OFF position.
5. Remove electronics cover.
6. Remove power supply cover and disconnect A1P5.
7. On rackmounted units with Accuride slides, remove coupling screw securing latch knob to latch mechanism (see figure 3-9). On rackmounted units with Grant slides, remove latch knob by turning it counterclockwise.
8. Disconnect ground straps from front panel (one on rackmounted units, two on base cabinet units).
9. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-9).
10. Remove the three screws from inside cartridge receiver.

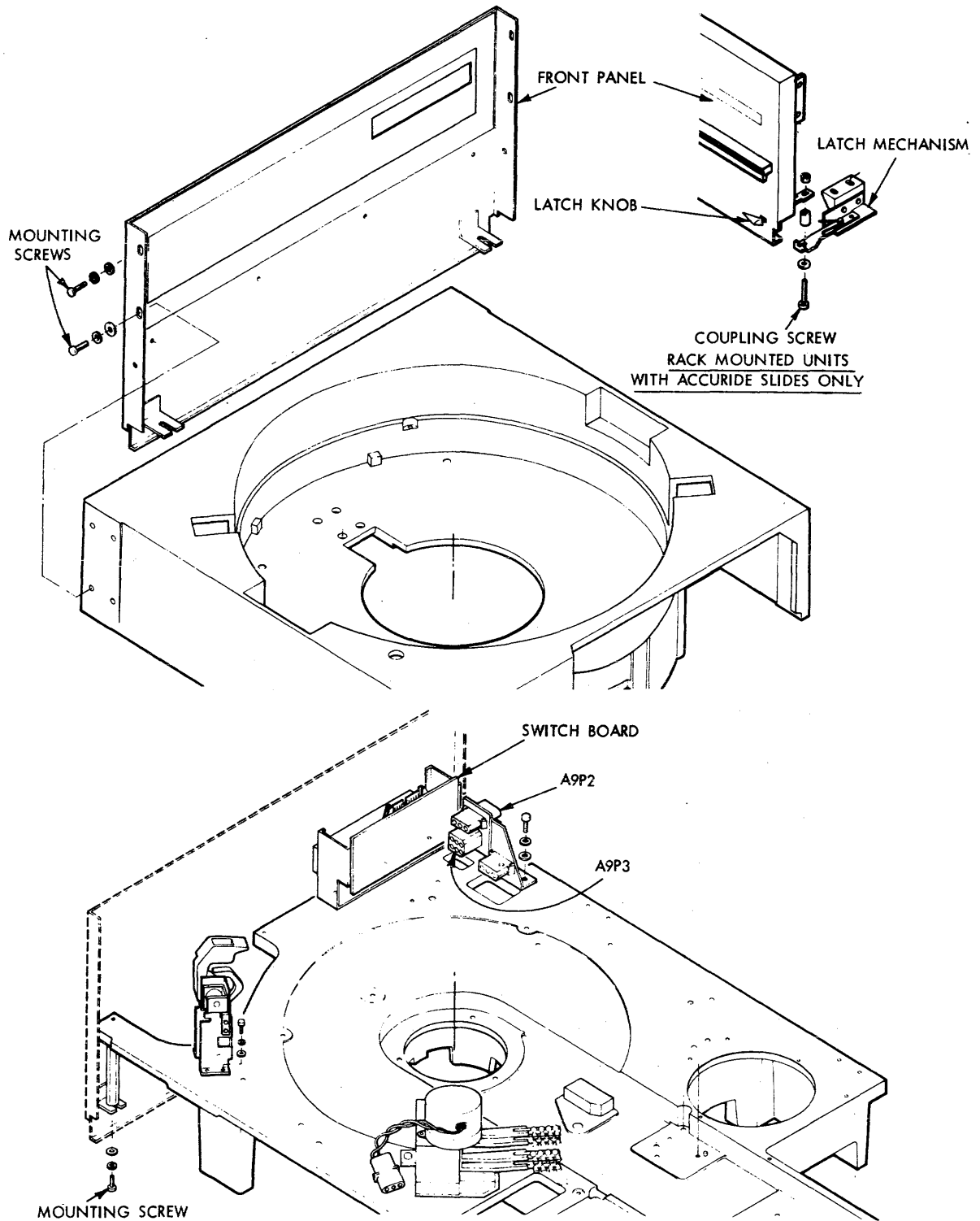


Figure 3-9. Front Panel Removal



11. Lift the cartridge receiver up until connector A9P2 can be unplugged (see figure 3-9). After A9P2 is unplugged, further remove cartridge receiver.

CAUTION

While lifting cartridge receiver, be extremely careful to avoid damage to the fixed disk.

12. Remove fixed disk clamp (see figure 3-10).
13. Remove fixed disk.

3.4.5.2 Replacement:

1. Inspect replacement disk for defects; replace if required.
2. Install fixed disk and insure proper seating.
3. Install disk clamp. Torque screws to 12 in-lbs.
4. Install cartridge receiver by aligning it on the two small pins on the deck and connecting A9P2.

CAUTION

While installing cartridge receiver, be extremely careful to avoid damage to fixed disk.

5. Fasten cartridge receiver with three screws.
6. Install front panel and ground straps.
7. Install latch assembly or knob as required.
8. Perform index-to-burst period check and adjustment.
9. Install electronics cover.
10. Install top cover (base cabinet only).

3.4.6 POSITION TRANSDUCER SCALE REMOVAL AND REPLACEMENT.

3.4.6.1 Removal:

1. Depress START/STOP pushbutton to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).
3. Remove disk cartridge.
4. Set MAIN circuit breaker to OFF position.
5. Remove electronics cover.

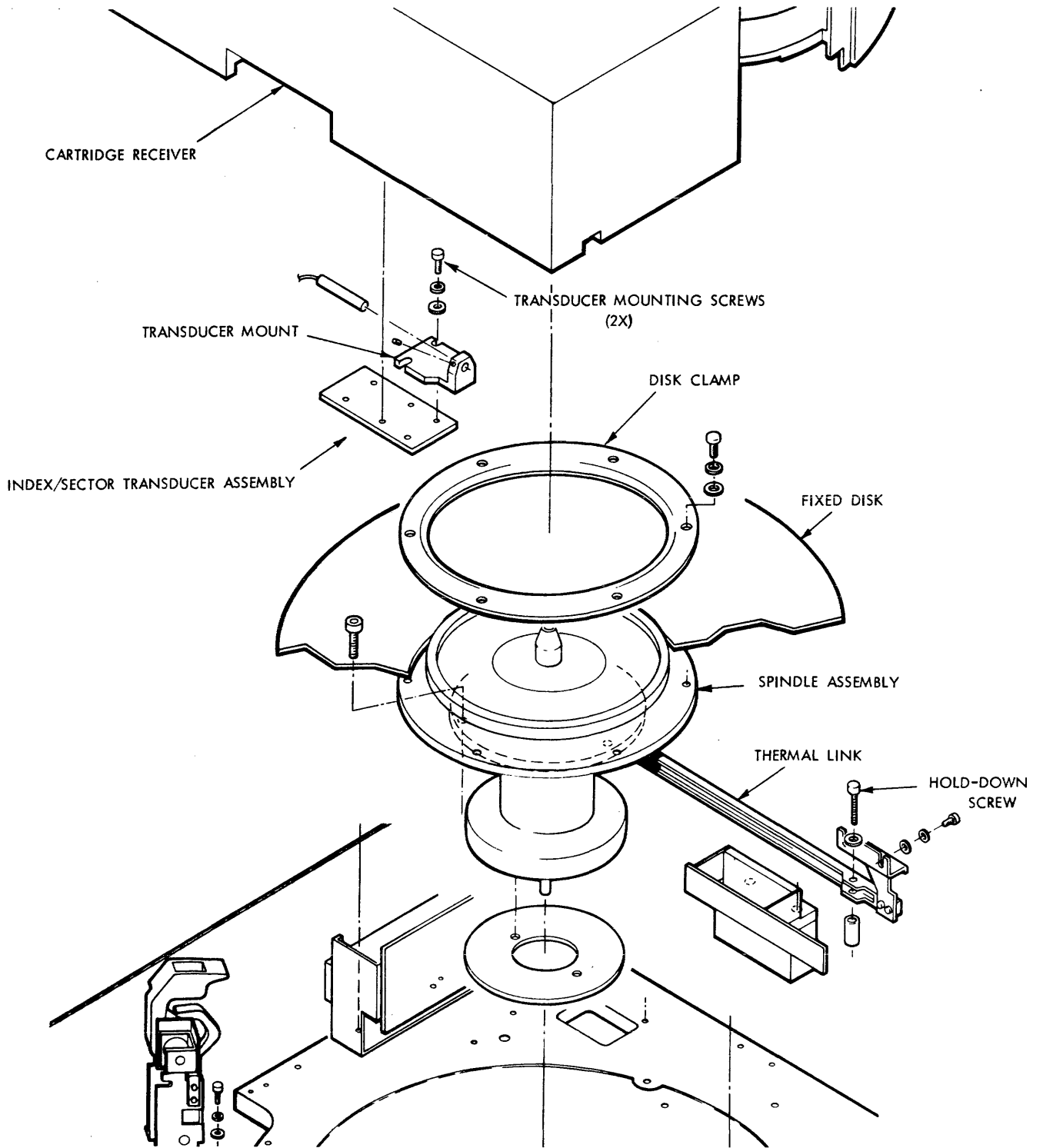


Figure 3-10. Fixed Disk Removal



6. Remove power supply cover and disconnect A1P5.
7. On rackmounted units with Accuride slides, remove coupling screw securing latch knob to latch mechanism (see figure 3-4). On rackmounted units with Grant slides, remove latch knob by turning it counterclockwise.
8. Disconnect ground straps from front panel (one on rackmounted units, two on base cabinet units).
9. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-4).
10. Remove the three screws from inside cartridge receiver.
11. Lift the cartridge receiver up until connector A9P2 can be unplugged (see figure 3-9). After A9P2 is unplugged, remove cartridge receiver.

CAUTION

While lifting cartridge receiver, be extremely careful to avoid damage to the fixed disk.

12. Perform removal steps 1 through 11 of upper head removal and replacement procedure.
13. Loosen two screws in thermal link bracket (figure 3-11).
14. Disconnect A3P6 from AGC preamp board and unlace from actuator frame.
15. Remove transducer scale assembly by removing the two mounting screws (item 3, figure 3-12), which hold position transducer mount block to deck.

CAUTION

Extreme care must be exercised in preventing face of transducer from coming in contact with other parts.

3.4.6.2 Replacement:

1. Install replacement transducer scale assembly.
2. Verify that thermal link bracket is flush with top of transducer scale. If not, adjust thermal link hold-down screw (figure 3-11).
3. Tighten screws in thermal link bracket.
4. Lace A3P6 over top of actuator frame and connect AGC preamp board.
5. Perform steps 1 through 8 of upper heads replacement procedure.
6. Install cartridge receiver by aligning it on the two small pins on the deck and connecting A9P2.

CAUTION

While installing cartridge receiver, be extremely careful to avoid damage to fixed disk.

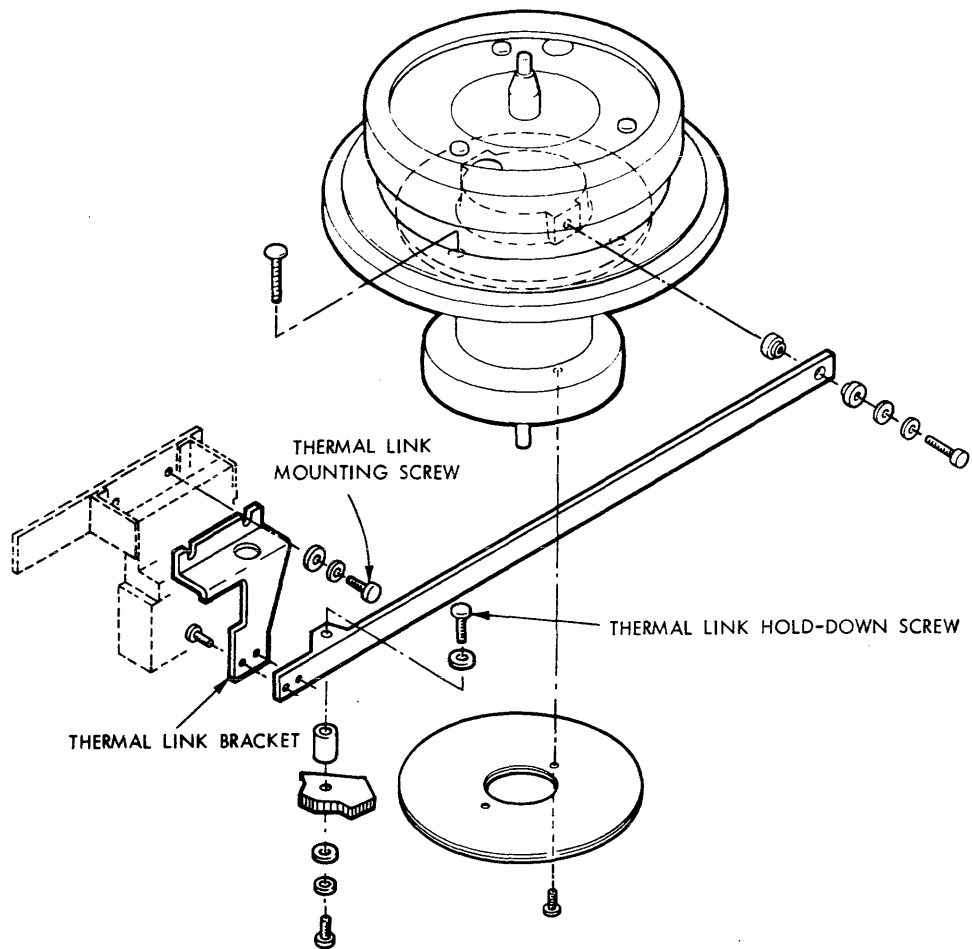


Figure 3-11. Thermal Link Removal and Replacement

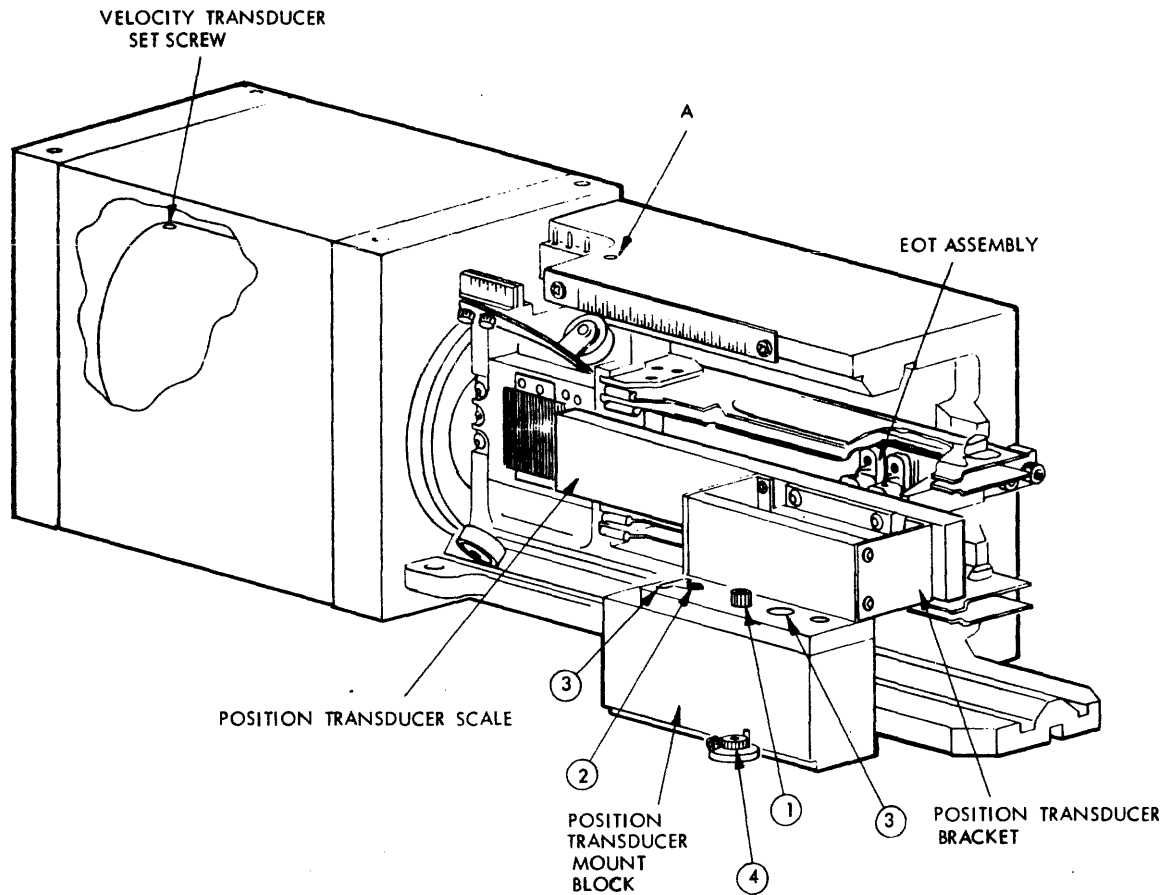
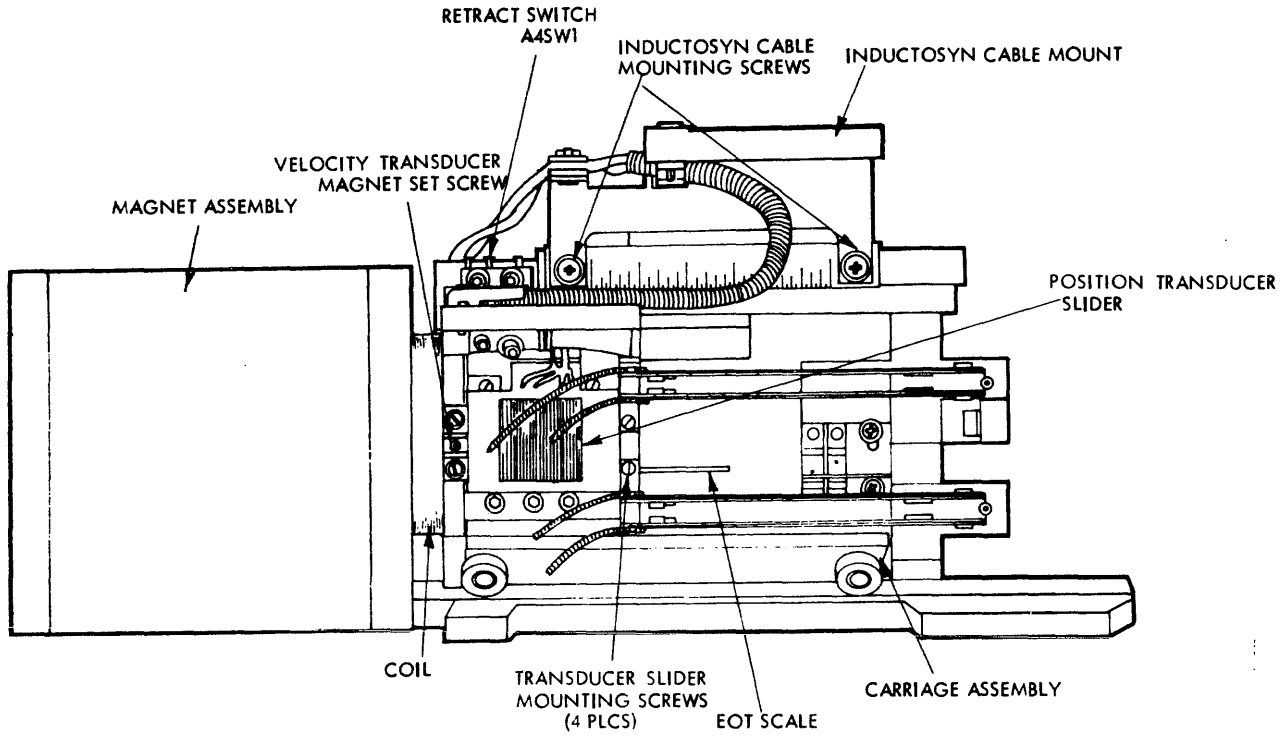


Figure 3-12. Actuator Assembly



7. Fasten cartridge receiver with three screws.
8. Install front panel and ground straps.
9. Install latch assembly or knob as required.
10. Perform track indicator check and adjustment.
11. Perform AGC servo preamplifier and inductosyn check and adjustment.
12. Perform FEOT check and adjustment.
13. Perform head alignment check and adjustment.
14. Perform index-to-burst check and adjustment.
15. Install electronics cover.
16. Install top cover (base cabinet only).

3.4.7 VELOCITY TRANSDUCER REMOVAL AND REPLACEMENT.

3.4.7.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Open top cover (base cabinet).
3. Set main circuit breaker to OFF.
4. Remove electronics cover.
5. Disconnect connector A3P5 from preamp board.
6. Remove transducer and end cap from magnet assembly (figure 3-5).
7. Loosen velocity transducer set screw (figure 3-12) through hole in preamp and magnet assembly.
8. Remove transducer through rear of magnet assembly.

3.4.7.2 Replacement:

1. Insert replacement transducer into magnet assembly until flush with end of magnet.
2. Tighten set screw through hole in preamp board.



3. Install velocity transducer and cap.
4. Connector A3P5 to preamp board.
5. Connect DS10 disk controller to unit.
6. Install disk cartridge.
7. Remove A1P2 from the actuator and power up drive for normal operation. Insure that K1 has energized.
8. Manually load heads.
9. Move carriage by hand, insuring that the velocity transducer magnet is not rubbing against velocity transducer. If rubbing occurs, unload heads, power down unit, and reposition transducer or transducer magnet.
10. Push carriage forward so that carriage is at forward stop position.

CAUTION

While performing steps 11 and 12, keep hands clear of carriage.

11. Reconnect A1P2.
12. Using the verb capabilities of the Diagnostic Operation Control System (DOCS) software, execute a Restore command to the disk to get the heads back at a known position. This can be done by setting up a Restore command in memory and then issuing that command to the drive via the "IC" verb. To put this command in memory, use the "modify memory" (.MM) verb and enter the following information:

Memory Address	Data
8000	0000
8002	0700
8004	0100
8006	0000
8008	0002
800A	8100
800C	0400
800E	0000

Once this data is entered, issue the command to the disk drive by entering "IC" after VERB. The command should be issued to the drive, causing the heads to move to track 0.

13. Perform temperature stabilization procedure.



14. Perform an alternate seek between cylinders 293_{10} (125_{16}) and 405_{10} (195_{16}). This may be done by using either of the two methods that follow:
- a. Use the “.MM” verb to enter the following in memory:

Address	Data
8010	0000
8012	0400
8014	0100
8016	0125
8018	0002
801A	8100
801C	0400
801E	0000
8020	0000
8022	0400
8024	0100
8026	0195
8028	0002
802A	8100
802C	0400
802E	0000

This operation can be continually repeated by executing a “LO” command at address 8010 for two commands with status ignored, as follows:

```
VERB? LO ADRS 8010 COMMANDS 2 STATUS 0
```

- b. Use the “AL” verb to issue alternate seeks. Answer the prompts as follows:

```
VERB ? -AL
```

```
NUMBER OF DIFFERENT SEEKS? 1 OR 2? -2
```

```
CHECK STATUS? -0
```

```
SEEK TO CYLINDER NUMBER? -125
```

```
SURFACE NUMBER? -0
```

```
SEEK TO CYLINDER NUMBER? -195
```

```
SURFACE NUMBER? -0
```

15. Monitor “on cylinder” signal at I/O board pin B9 and adjust velocity gain potentiometer for a seek time of 35 ± 1 milliseconds, as described in step 20 of the servo preamplifier and transducer check and adjustment procedure.
16. Install electronics cover.
17. Close top cover.



3.4.8 VELOCITY TRANSDUCER MAGNET REMOVAL AND REPLACEMENT.

3.4.8.1 Removal

CAUTION

Keep replacement transducer magnet in its shipping container until ready for installation since contact between magnet and metal objects is harmful to magnet.



1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove disk cartridge.
3. Open top cover.
4. Set main circuit breaker to off position.
5. Remove electronics cover.
6. Remove rear door (base cabinet only).
7. Remove power supply cover and disconnect A1P5.
8. Disconnect A3P1, A3P2, A3P3, A3P4, A3P5, and A3P6 from AGC servo preamplifier.
9. Remove AGC servo preamplifier.
10. Remove velocity transducer end cap and velocity transducer (see figure 3-5).
11. Remove two screws that fasten the magnet to the main deck. Screws are located underneath the base casting (see figure 3-6).
12. Lift the magnet slightly and very carefully slide the magnet assembly out from the voice coil. Extreme care must be taken to avoid any bending stress to the velocity transducer magnet.
13. Remove card cage by performing removal steps 1 through 13 of card cage removal and replacement procedure.
14. Loosen velocity transducer magnet set screw (figure 3-12) and remove magnet.

3.4.8.2 Replacement

1. Install replacement velocity transducer magnet and tighten set screw.
2. Very carefully slide magnet assembly onto the two guide pins. Extreme care must be taken to avoid any bending stress to the velocity transducer magnet.
3. Fasten magnet to the main deck with the two mounting screws (see figure 3-6).
4. Install card cage by performing steps 3 through 9 of card cage removal and replacement procedure.
5. Install velocity transducer and velocity transducer end cap.
6. Install AGC servo preamplifier.
7. Connect A3P1, A3P2, A3P3, A3P4, A3P5 and A3P6 to AGC servo preamplifier.
8. Install power supply cover and connect A1P5.



9. Install rear door.
10. Install disk cartridge.
11. Remove A1P2 from the actuator and power up drive for normal operation. Insure that K1 has energized.
12. Manually load heads.
13. Move carriage by hand insuring that the velocity transducer magnet is not rubbing against velocity transducer. If rubbing occurs, unload heads, power down unit and reposition transducer or transducer magnet.
14. Push carriage forward so that carriage is at forward stop position.

CAUTION

While performing steps 15 and 16 keep hands clear of carriage.

15. Reconnect A1P2.
16. Execute a Restore command to the disk to get the heads back at a known position. This can be done by setting up a Restore command in memory and then issuing that command to the drive via the "IC" verb. To put this command in memory use the "modify memory" (.MM) verb and enter the following information:

Memory Address	Data
8000	0000
8002	0700
8004	0100
8006	0000
8008	0002
800A	8100
800C	0400
800E	0000

Once this data is entered, issue the command to disk by entering "IC" after VERB. The command should be issued to the drive, causing the heads to move to track 0.

17. Perform temperature stabilization procedure.
18. Perform an alternate seek between cylinders 293_{10} (125_{16}) and 405_{10} (195_{16}). This is done by entering the following data in memory by using the ".MM" verb.



Address	Data
8010	0000
8012	0400
8014	0100
8016	0125
8018	0002
801A	8100
801C	0400
801E	0000
8020	0000
8022	0400
8024	0100
8026	0195
8028	0002
802A	8100
802C	8400
802E	0000

This operation can be continually repeated by executing a “LO” command at address 8010 for two commands with status ignored, as follows:

VERB? LO ADRS 8010 COMMANDS 2 STATUS 0

19. Monitor RDYSRW- on the interface line to the controller (Winchester pin F or 40-pin connector pin 6) and adjust velocity gain potentiometer for a seek time of 35 ± 1 milliseconds as described in step 20 of the servo preamplifier and transducer check and adjustment procedure.
20. Install electronics cover.
21. Close top cover.

3.4.9 SPINDLE ASSEMBLY REMOVAL AND REPLACEMENT.

3.4.9.1 Removal

1. Depress START/STOP pushbutton to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).
3. Remove disk cartridge.
4. Set main circuit breaker to OFF position.



5. Remove electronics cover.
6. Remove power supply cover and disconnect A1P5.
7. On rackmounted units with Accuride slides, remove coupling screw securing latch knob to latch mechanism (see figure 3-9). On rackmounted units with Grant slides, remove latch knob by turning it counterclockwise.
8. Disconnect ground straps from front panel (one on rackmounted units, two on base cabinet units).
9. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-9).
10. Remove the three screws from inside cartridge receiver.
11. Lift the cartridge receiver up until connector A9P2 can be unplugged (see figure 3-4). After A9P2 is unplugged, remove cartridge receiver.

CAUTION

While lifting cartridge receiver, be extremely careful to avoid damage to the fixed disk.

12. Remove fixed disk clamp.
13. Remove fixed disk, carefully avoiding contact with recording surfaces. Place disk on soft clean surface.
14. Remove mounting screws from thermal link bracket (figure 3-11).

CAUTION

Do not perform step 15 until step 14 has been performed.

15. Remove thermal link hold-down screw (figure 3-11).
16. Remove cabinet skins from both sides (base cabinet only).
17. Remove module bottom cover.
18. Unplug connector A9P1.
19. Perform removal steps 1 through 6 of the sector ring removal and replacement procedure.
20. Remove spindle drive belt.
21. Rotate spindle to positions where spindle-mounting bolts are visible through access hole and remove bolts through access hole.
22. Carefully lift spindle slightly.



23. Detach thermal link from spindle. Note sequence of fiber washers on mounting bolt (figure 3-11). Swing thermal link out of the way.
24. Remove spindle assembly.

3.4.9.2 Replacement:

1. Attach thermal link to replacement spindle.
2. Install spindle with the mounting bolts.
3. Rotate spindle and verify that thermal link is not contacting spindle flange.
4. Install thermal link hold-down screw and tighten until thermal link bracket is flush with top of transducer scale (figure 3-11).

CAUTION

Do not perform step 5 until step 4 has been performed.

5. Install thermal link bracket screws.
6. Install drive belt.
7. Install sector ring.
8. Install transducer mount assembly by performing replacement steps 7 through 12 of the sector ring removal and replacement procedure.
9. Reconnect A9P1.
10. Clean spindle rim area with media cleaning solution.
11. Prior to installing fixed disk, inspect disk for scratches or defects. If disk is unacceptable, replace with new one.
12. Clean disk surface with lint-free gauze, dampened (not soaked) with media cleaning solution.
13. Install fixed disk and insure proper seating.
14. Install disk clamp. Torque screws to 12 in-lbs.
15. Install cartridge receiver by aligning it on the two small pins on the deck and connecting A9P2.

CAUTION

While installing cartridge receiver, be extremely careful to avoid damage to fixed disk.

16. Fasten cartridge receiver with three screws.
17. Install front panel and ground straps.



18. Install latch assembly or knob as required.
19. Perform fixed disk index/sector transducer check and adjustment.
20. Perform static eliminator check.
21. Perform cartridge index/sector transducer check and adjustment.
22. Perform AGC servo preamplifier and inductosyn check and adjustment.
23. Perform EOT check and adjustment.
24. Perform head alignment check and adjustment.
25. Perform index-to-burst period check and adjustment procedure.
26. Install module bottom cover.
27. Install side skins (base cabinet only).
28. Install electronics cover.
29. Install top cover (base cabinet only).

3.4.10 CARTRIDGE DISK INDEX/SECTOR TRANSDUCER REMOVAL AND REPLACEMENT.

3.4.10.1 Removal:

1. Depress START/STOP pushbutton to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).
3. Remove disk cartridge.
4. Set main circuit breaker to OFF position.
5. Remove electronics cover.
6. Remove power supply cover and disconnect A1P5.
7. On rackmounted units with Accuride slides, remove coupling screw securing latch knob to latch mechanism (see figure 3-9). On rackmounted units with Grant slides, remove latch knob by turning it counterclockwise.
8. Disconnect ground straps from front panel (one on rackmounted units, two on base cabinet units).
9. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-9).
10. Remove the three screws from inside cartridge receiver.



11. Lift the cartridge receiver up until connector A9P2 can be unplugged (see figure 3-9). After A9P2 is unplugged, remove cartridge receiver.

CAUTION

While lifting cartridge receiver, be extremely careful to avoid damage to the fixed disk.

12. Remove transducer assembly from receiver by removing four screws (figure 3-10).
13. Remove transducer from mount by loosening clamp Allen set screw.

3.4.10.2 Replacement:

1. Install new transducer into mount. Tighten Allen screw.
2. Install transducer assembly on receiver with four mounting screws making sure harness lies in groove.
3. Install cartridge receiver by aligning it on the two small pins on the deck and connecting A9P2.

CAUTION

While installing cartridge receiver, be extremely careful to avoid damage to fixed disk.

4. Fasten cartridge receiver with three screws.
5. Install front panel and ground straps.
6. Install latch assembly or knob as required.
7. Perform cartridge index/sector transducer check and adjustment.
8. Perform index-to-burst period check and adjustment.
9. Install electronics cover.
10. Install top cover (base cabinet only).

3.4.11 FIXED DISK INDEX/SECTOR TRANSDUCER REMOVAL AND REPLACEMENT.

3.4.11.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).
3. Remove disk cartridge.
4. Set main circuit breaker to OFF position.



5. Remove left-hand side skin (base cabinet only).
6. Remove module under cover.
7. On rackmounted units with Accuride slides, remove coupling screw securing latch knob to latch mechanism (see figure 3-9). On rackmounted units with Grant slides, remove latch button by turning it counterclockwise.
8. Disconnect ground straps from front panel (one on rackmounted units, two on base cabinet units).
9. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-9).
10. Remove electronics cover.
11. Remove the three screws from inside cartridge receiver.
12. Lift the cartridge receiver up until connector A9P2 can be unplugged (see figure 3-9). After A9P2 is unplugged, remove cartridge receiver.

CAUTION

While lifting cartridge receiver, be extremely careful to avoid damage to the fixed disk.

13. Disconnect A9P1 and unlace harness from around blower motor assembly.
14. Loosen index sector transducer clamp screw.
15. Remove transducer from mount.

3.4.11.2 Replacement:

1. Install new transducer in mount.
2. Connect A9P1 and lace harness around blower motor assembly.
3. Perform fixed disk index/sector transducer check and adjustment procedure.
4. Replace cartridge receiver by aligning it on the two small pins on the deck and connecting A9P2.

CAUTION

While installing cartridge receiver, be extremely careful to avoid damage to fixed disk.

5. Fasten cartridge receiver with three screws.
6. Install front panel and ground straps.
7. Install latch assembly or knob as required.



8. Install electronics cover.
9. Install module under cover.
10. Install cabinet side skin.
11. Install top cover.

3.4.12 SECTOR RING REMOVAL AND REPLACEMENT.

3.4.12.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Set MAIN circuit breaker to OFF position.
3. Remove left-hand side skin (base cabinet only), and remove module under cover.
4. Remove transducer assembly mount (see figure 1-15, sheet 2) by removing one screw (note orientation of sector option).
5. Remove static eliminator and its mounting bracket.
6. Remove sector ring by removing two screws.

3.4.12.2 Replacement:

1. Install replacement sector ring.
2. Install static eliminator and bracket.
3. Install transducer and mount.
4. Perform fixed disk index/sector transducer adjustment procedure.
5. Adjust static eliminator for contact with spindle shaft.
6. Perform static eliminator check.
7. Install module under cover.
8. Install cabinet side skin.

3.4.13 CARTRIDGE-ON SWITCH REMOVAL AND REPLACEMENT.

3.4.13.1 Removal:

1. Depress START/STOP pushbutton to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).



3. Remove disk cartridge.
4. Set MAIN circuit breaker to OFF position.
5. Remove electronics cover.
6. Remove power supply cover and disconnect A1P5.
7. On rackmounted units with Accuride slides, remove coupling screw securing latch knob to latch mechanism (see figure 3-4). On rackmounted units with Grant slides, remove latch knob by turning it counterclockwise.
8. Disconnect ground straps from front panel (one on rackmounted units, two on base cabinet units).
9. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-9).
10. Remove the three screws from inside cartridge receiver.
11. Lift the cartridge receiver up until connector A9P2 can be unplugged (see figure 3-9). After A9P2 is unplugged, remove cartridge receiver.

CAUTION

While lifting cartridge receiver, be extremely careful to avoid damage to the fixed disk.

12. Disconnect wires from cartridge on switch.
13. Remove two screws, washers and nuts securing switch assembly to hold-down arm and remove switch. (Refer to figure 3-13.)

3.4.13.2 Replacement:

1. Install replacement switch.
2. Close hold-down arms.
3. Check switch status with multimeter set on RX1 scale. Indication should be zero ohms.
4. With disk cartridge installed, check switch status with multimeter set to RX1 scale. Meter should indicate zero ohms.
5. If switch does not read zero ohms, adjust as follows:
 - a. Loosen hold-down arm adjustment screws (figure 3-13).
 - b. Adjust hold-down arm for contact with cartridge disk cover.
 - c. Tighten adjustment screws.

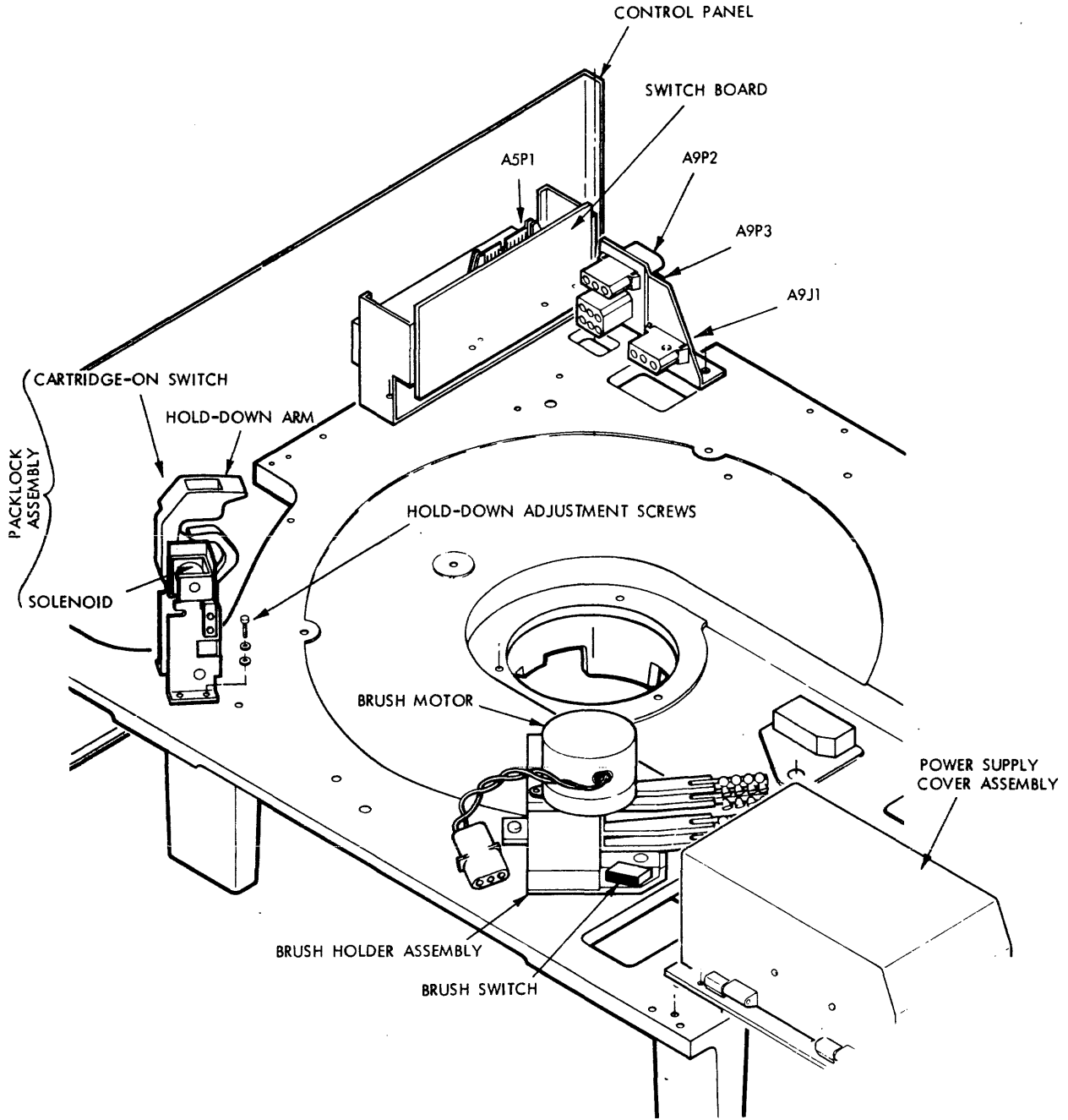


Figure 3-13. Packlock and Brush Assemblies



6. Check switch status with multimeter for zero ohms. If switch does not indicate zero ohms, replace switch.
7. Connect wires to switch.
8. Override solenoid (see figure 1-23) and open hold-down arms.
9. Install cartridge receiver by aligning it on the two small pins on the deck and connecting A9P2.

CAUTION

While installing cartridge receiver, be extremely careful to avoid damage to fixed disk.

10. Fasten cartridge receiver with three screws.
11. Install front panel and ground straps.
12. Install latch assembly or knob as required.
13. Install electronics cover.
14. Install top cover (base cabinet only).

3.4.14 DISK BRUSH ASSEMBLY REMOVAL AND REPLACEMENT.

3.4.14.1 Removal:

1. Depress START/STOP pushbutton to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove top cover by lifting cover straight up (base cabinet only).
3. Remove disk cartridge.
4. Set Main circuit breaker to OFF position.
5. Remove electronics cover.
6. Remove power supply cover and disconnect A1P5.
7. On rackmounted units with Accuride slides, remove coupling screw securing latch knob to latch mechanism (see figure 3-9). On rackmounted units with Grant slides, remove latch knob by turning it counterclockwise.
8. Disconnect ground straps from front panel (one on rackmounted units, two on base cabinet units).
9. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-9).
10. Remove the three screws from inside cartridge receiver.



11. Lift the cartridge receiver up until connector A9P2 can be unplugged (see figure 3-9). After A9P2 is unplugged, remove cartridge receiver.

CAUTION

While lifting cartridge receiver, be extremely careful to avoid damage to the fixed disk.

12. Disconnect A1P3 and A1P7.
13. Disconnect wires from brush retract switch (see figure 3-13).
14. Remove three mounting screws from the brush assembly. One screw is countersunk.
15. Remove brush assembly.

3.4.14.2 Replacement:

1. Install new brush assembly with the three mounting screws.

NOTE

Verify that brushes are fully retracted for the following check.

2. With a multimeter set on RX1 scale, check that switch actuates when brushes are clear of disk area.
3. If switch actuation does not occur as indicated in previous step, replace switch.
4. Reconnect wires to brush retract switch.
5. Install cartridge receiver by aligning it on the two small pins on the deck and connecting A9P2.

CAUTION

While installing cartridge receiver, be extremely careful to avoid damage to fixed disk.

6. Fasten cartridge receiver with three screws.
7. Install front panel and ground straps.
8. Install latch assembly or knob as required.
9. Connect A1P3 and A1P7.
10. Install power supply cover and reconnect A1P5.
11. Install electronics cover.



12. If necessary, mark up label on cartridge receiver showing brush alignment when fully retracted.
13. Install top cover (base cabinet only).

3.4.15 SPINDLE DRIVE MOTOR ASSEMBLY REMOVAL AND REPLACEMENT.

3.4.15.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Set main circuit breaker to OFF position.
3. Disconnect unit from main power source.

CAUTION

Live voltages are present in the area of the drive motor even when main circuit breaker is off. Failure to disconnect or turn off main power source may result in injury to service personnel.

4. Remove both cabinet side skins (base cabinet only).
5. Remove module under cover.
6. Disconnect A2P5, A1P13 and A1P14 (figure 1-15, sheet 2) from power supply.
7. Remove plastic slide stabilizer (rackmount unit only).
8. Remove drive belt.

CAUTION

Do not lose rubber isolation washers between motor deck and plate.

9. Support motor assembly to prevent it from falling and remove four mounting screws (see figure 1-15, sheets 3 and 4).
10. Carefully lower drive motor assembly out of unit.
11. Loosen motor pulley set screw and remove pulley from shaft.

3.4.15.2 Replacement:

1. Install pulley on replacement drive motor assembly. Apply Loctite Grade C, to pulley set screw and torque to 20 in-lbs. Pulley must be 1.6 mm (1/16 inch) above motor plate.
2. Install replacement drive motor assembly. Insure that rubber isolation washers are on all mounting screws on both sides of motor plate.
3. Install drive belt.



4. Connect A2P5, A1P13 and A1P14.
5. Check resistance between drive motor plate and module casting. If dc ground is connected to ac ground, resistance should be less than 1 ohm. If dc ground is isolated from ac ground, resistance should be greater than 1000 ohms.
6. Install module under cover.
7. Install cabinet side skins.
8. Connect unit to main power source.

3.4.16 CARD CAGE PRINTED CIRCUIT BOARD REMOVAL AND REPLACEMENT.

3.4.16.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Set Main circuit breaker to OFF position.
3. Open top cover (base cabinet only).
4. Remove electronics cover.
5. Remove clamp from card cage cover.
6. Remove card cage cover.
7. Remove required circuit board. Note setting of any option switches (I/O control, sector and data recovery board). Set option switches on replacement board to same setting.

NOTE

If I/O board is to be replaced, remove four board mounting screws. Also terminator modules, if required, must be removed from old board and installed in new one.

If R/W/E board is replaced, head connectors must be disconnected and two resistor modules must be removed from old board and installed in new one.

CAUTION

Insure head cables are dressed such that the voice coil does not touch any cable when heads are loaded and extended to cylinder 405.

8. If the following circuit boards are removed, the designated checks and adjustments must be performed.
 - A. Servo Preamp:
 1. AGC servo preamplifier and transducer check and adjustment.



2. FEOT check and adjustment.
3. Head alignment.
4. Index-to-burst period check and adjustment.

B. Servo Board:

1. Perform temperature stabilization.
2. Perform steps 19 through 29 of AGC servo preamplifier and transducer check and adjustment.

C. Sector Board:

1. Index-to-burst period check and adjustment.

3.4.16.2 Replacement:

1. Carefully install replacement board, insuring that all pins are engaged before completely installing board.
2. Install card cage cover and clamp.
3. Install electronics cover.

3.4.17 POWER SUPPLY REMOVAL AND REPLACEMENT.

3.4.17.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Set MAIN current breaker to OFF position.
3. Open top cover (base cabinet only).
4. Remove electronics cover.
5. Open power supply cover assembly.

CAUTION

Live voltages are present in the area of the drive motor even when MAIN circuit breaker is OFF. Failure to disconnect or turn off main power source may result in injury to service personnel.

6. Remove ac line cord from power source.
7. Disconnect A1P5 and remove power supply cover.
8. Disconnect A1P2, A1P13 and A1P14.
9. Disconnect A1P2, A1P3 and A1P7 (see figure 3-14).

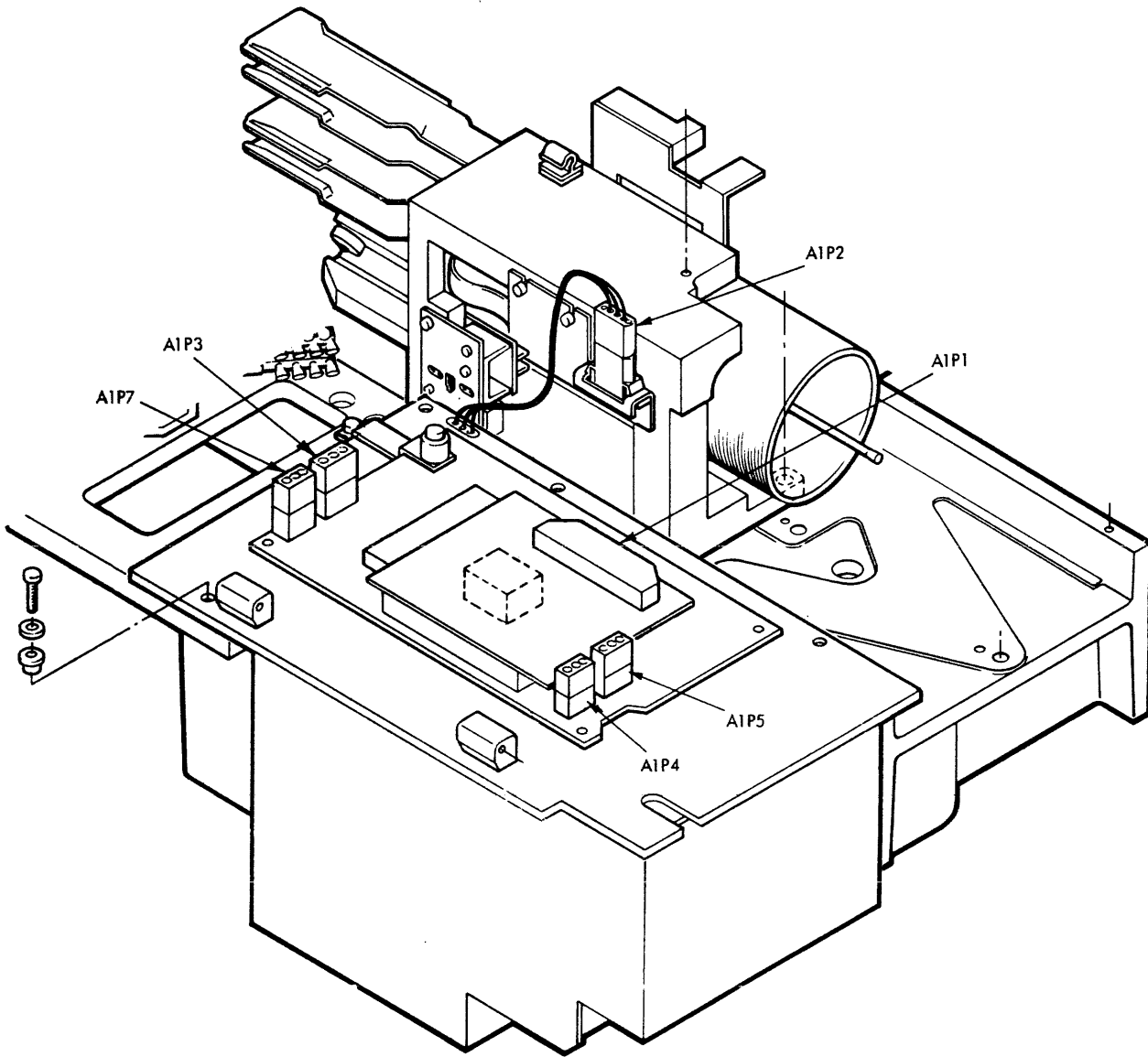


Figure 3-14. Power Supply Assembly



10. Disconnect ribbon cable A2P2 from motherboard.
11. Disconnect ground strap to frame.
12. Remove four screws holding power supply in place.
13. Remove power supply.

3.4.17.2 Replacement:

1. Install new power supply so that mounting holes are aligned.

CAUTION

Insure gasket between power supply and absolute filter is properly aligned. If not properly aligned, air flow can be restricted causing damage to power supply.

2. Reverse removal procedure to complete installation.
3. Perform steps 17-26 of the servo preamplifier and transducer check and adjustment, paragraph 3.5.2. This procedure checks the velocity offset and gain.

3.4.18 PIGGYBACK POWER BOARD REMOVAL AND REPLACEMENT.

3.4.18.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Open top cover (base cabinet only).
3. Set MAIN current breaker to OFF position.
4. Remove electronics cover.
5. Disconnect ac line cord from power source.
6. Open power supply cover assembly.

WARNING

Live voltages are present in the area of the drive motor even when MAIN circuit break is OFF. Failure to disconnect or turn off main power source may result in injury to service personnel.

7. Disconnect A1P5 and remove power supply cover.
8. Disconnect A1P1, A1P2, A1P3, A1P4, A1P7 (see figure 3-14).
9. Remove dc grounding screw noting assembly configuration.



10. Remove screw and insulating washer from wind tunnel located between relay K1 and power board #2.
11. Remove board assembly being careful not to lose spacers located under ground option (corner of board assembly).

3.4.18.2 Replacement:

1. Install new board assembly (figure 3-15).
2. Reverse removal procedure to complete installation.
3. Make sure that power supply-to-chassis ground strap is tight.
4. Perform steps 17 through 26 of the servo preamplifier and transducer check and adjustment, paragraph 3.5.2.

3.4.19 CARD CAGE/MOTHERBOARD REMOVAL AND REPLACEMENT.

3.4.19.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Open top cover (base cabinet only).
3. Set MAIN circuit breaker to OFF position.
4. Disconnect unit from main power source.

WARNING

Live voltages are present near the underside of the card cage area. Failure to disconnect or turn off main power source may result in injury to service personnel.

5. Remove electronics cover.
6. Disconnect I/O connector ribbon cables.
7. Remove four screws holding I/O board to card cage and remove board. Disregard this step if card cage is only removed to facilitate other removal and replacement procedures.
8. Remove card cage cover and clamp and quadraclip from head connectors on R/W/E board.
9. Disconnect head connectors.
10. Remove rear cabinet skin (base cabinet only).
11. Disconnect A2P2, A2P4, A2P5, and A2P6 from motherboard.
12. Disconnect ground strap from deck plate.

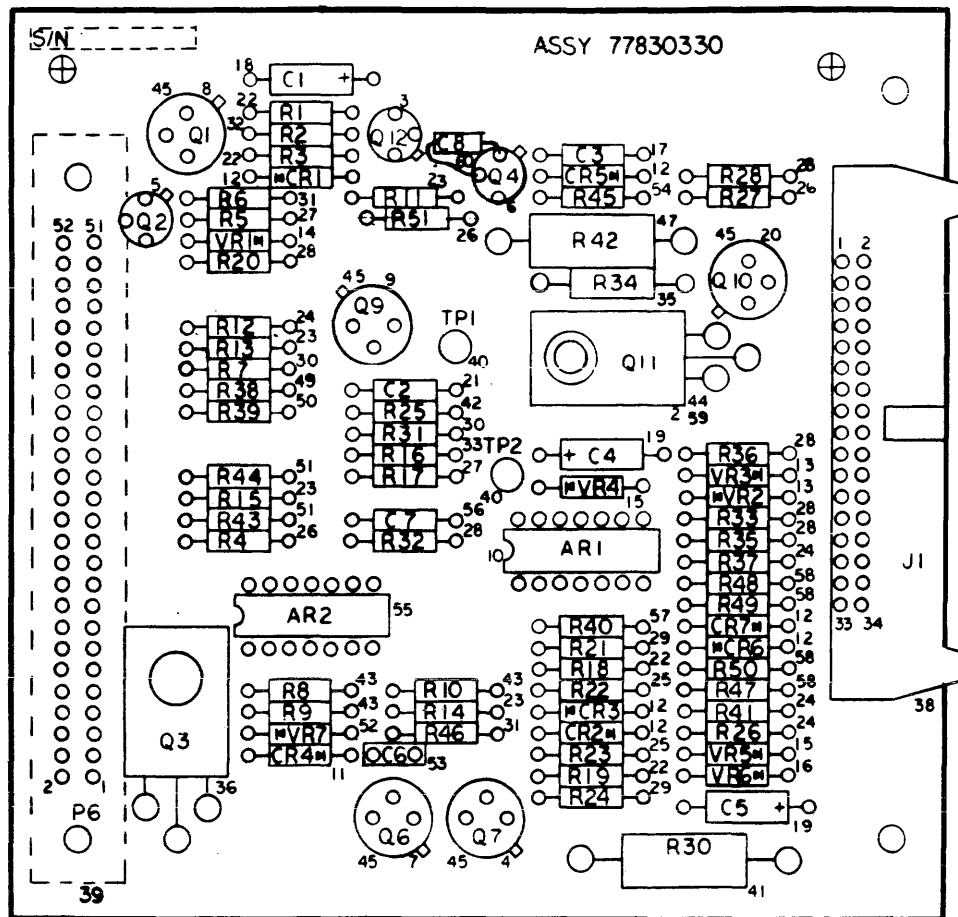


Figure 3-15. Power Supply Board No. 2

13. Remove three screws securing card cage and remove card cage.
14. Using card extractor, remove all boards.
15. Remove the five screws holding the mother cover and board together. Watch for fiber washer.
16. Separate mother cover and board from card cage. Do not lose star washers.

3.4.19.2 Replacement:

1. Attach mother cover and board to card cage assembly. Be careful not to overtighten, plastic bracket strips out easily.
2. Install all circuit boards.
3. Install card cage with three mounting screws.



4. Install connectors removed in steps 9 and 11.

CAUTION

Insure head cables are dressed such that the voice coil does not touch any cable when heads are loaded and extended to cylinder 405.

5. Install quadraclip and head cable clamp.
6. Replace I/O board if removed in step 7 (Removal procedures).
7. Reconnect I/O ribbon cables.
8. Install ground strap.
9. Install card cover and clamp.
10. Install electronics cover.
11. Connect unit to main power source.
12. Close top cover (base cabinet only).

3.4.20 BLOWER MOTOR ASSEMBLY REMOVAL AND REPLACEMENT (BASE CABINET).

3.4.20.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Set MAIN circuit breaker to OFF position.
3. Remove top cover by lifting cover straight up (base cabinet only).
4. Remove front door and both side cabinet skins (base cabinet only).
5. Disconnect ground straps from front panel.
6. Remove front panel by loosening two screws at bottom of panel and removing two screws on each side of panel (see figure 3-9).
7. Remove the pre-filter and disconnect A1P13 from power supply assembly.
8. Remove filter expander bracket and absolute filter.
9. Remove nuts from studs that secure module to base frame (two nuts are in pre-filter area and one nut is below actuator magnet).
10. Unlace motor harness.
11. Support blower assembly to prevent it from falling and remove three screws securing blower assembly.
12. Remove blower assembly.



3.4.20.2 Replacement:

1. Install replacement blower motor assembly.
2. Reverse the removal procedure to complete the installation.

NOTE

Slightly tighten the three screws securing the blower motor and then align the air chute with the absolute filter. Finish tightening the blower motor screws (do not overcompress rubber washers on the three screws).

3.4.21 BLOWER MOTOR ASSEMBLY REMOVAL AND REPLACEMENT (RACKMOUNT).

3.4.21.1 Removal:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Set MAIN circuit breaker to OFF position.
3. Unlatch the latch assembly securing the unit in the cabinet.
4. Remove the front panel by loosening two screws at the bottom of the panel and removing two screws on each side of the panel.
5. Disconnect plug A1P13 from power supply.
6. Remove filter, expander, bracket and absolute filter.
7. Unlace the motor harness from side of main deck.
8. Remove the air inlet cover (held in place by three screws).
9. Remove the three screws holding the blower motor in place and remove blower motor.

3.4.21.2 Replacement:

1. Install blower motor assembly.
2. Reverse the removal procedure to complete the installation.

NOTE

Slightly tighten the three screws securing the blower motor and then align the air chute with the absolute filter. Finish tightening the blower motor screws (do not overcompress rubber washers on the three screws).

3.5 DISK DRIVE ALIGNMENTS AND ADJUSTMENTS

These checks and adjustments are based on the recommendations of the disk drive vendor, Control Data Corporation. They are modified where necessary to accommodate use of the Texas



Instruments disk controller and diagnostic software. The disk controller has no field-level adjustments. Table 3-3 is an index to alignments and adjustments.

CAUTION

There is a degree of interactivity between adjustments and component replacements in the disk drive. Do not omit the adjustment rechecks specified in these procedures.

The temperature stabilization process described in the next paragraph is a mandatory prerequisite for all alignments/adjustments.

Table 3-3. Index to Alignments of Adjustments

Paragraph	Title	Page
3.5.1	Temperature Stabilization	3-56
3.5.2	Servo Preamplifier and Transducer Check and Adjustment	3-56
3.5.3	FEOT Check and Adjustment	3-62
3.5.4	Head Alignment Check and Adjustment	3-66
3.5.5	Index-to-Burst Period Check and Adjustment	3-68
3.5.6	Track Indicator Check and Adjustment	3-72
3.5.7	Static Eliminator Check and Adjustment	3-72
3.5.8	Cartridge Index/Sector Transducer Check and Adjustment	3-73
3.5.9	Fixed Disk Index/Sector Transducer Check and Adjustment	3-74
3.5.10	Cartridge On Switch Check and Adjustment	3-74

3.5.1 TEMPERATURE STABILIZATION. If disk unit has not been operating or if a CE disk cartridge has been installed, allow unit to exercise for twenty minutes. For an additional ten minutes, allow unit to sit in a heads-loaded, unit-ready condition. Perform this with electronic cover on. Perform needed checks and adjustments; or if a disk unit has been operating, allow unit to sit in a heads-loaded, unit-ready condition, for ten minutes (with electronic cover on) before proceeding with checks and adjustments.

3.5.2 SERVO PREAMPLIFIER AND TRANSDUCER CHECK AND ADJUSTMENT.

CAUTION

In performing this procedure, care must be exercised to prevent severe and extended contact between position transducer and slider.

1. If position transducer, AGC preamp, or Servo Board has been replaced, insure that all connectors are plugged into their respective receptacles.
2. Connect the disk controller to the drive and replace the disk cartridge with a scratch pack. Load the PDT into memory.
3. Remove AIP2 from the actuator and power up drive for normal operation. It is necessary that a disk cartridge is installed in the drive and relay K1 on power board #1 has energized.
4. Install a jumper from TP1 to -5V supply (TP9). See figure 3-16.
5. Connect oscilloscope to C24 (point A of figure 3-16). Set scope for internal trigger and auto sync.

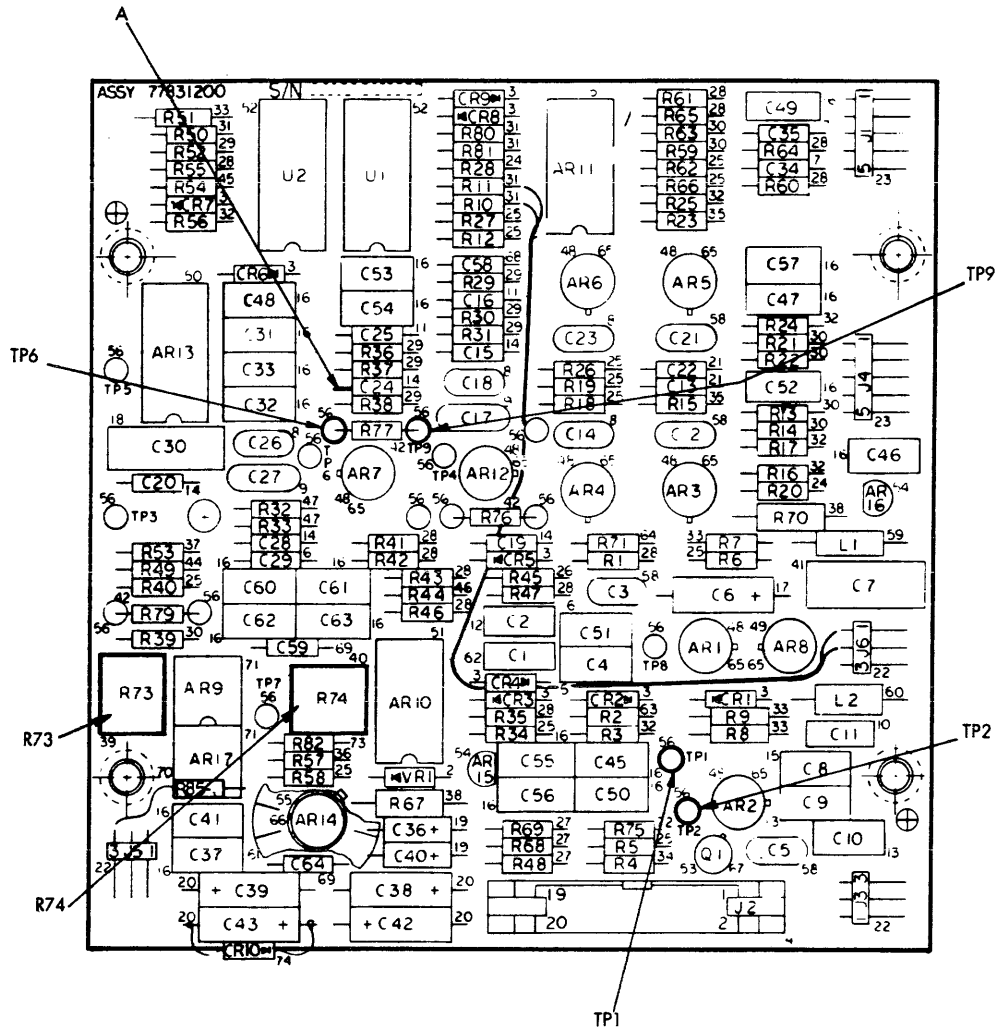


Figure 3-16. Servo Preamp Board Adjustment Location

6. Move carriage by hand, back and forth between cylinders 000₁₀ and 405₁₀ (0000₁₆ and 195₁₆) and observe waveform on oscilloscope.
7. If amplitude of waveform is $1.0 \pm .05$ volts peak to peak (see figure 3-17), do not make any adjustment and proceed to step 9, if not, proceed to step 8.

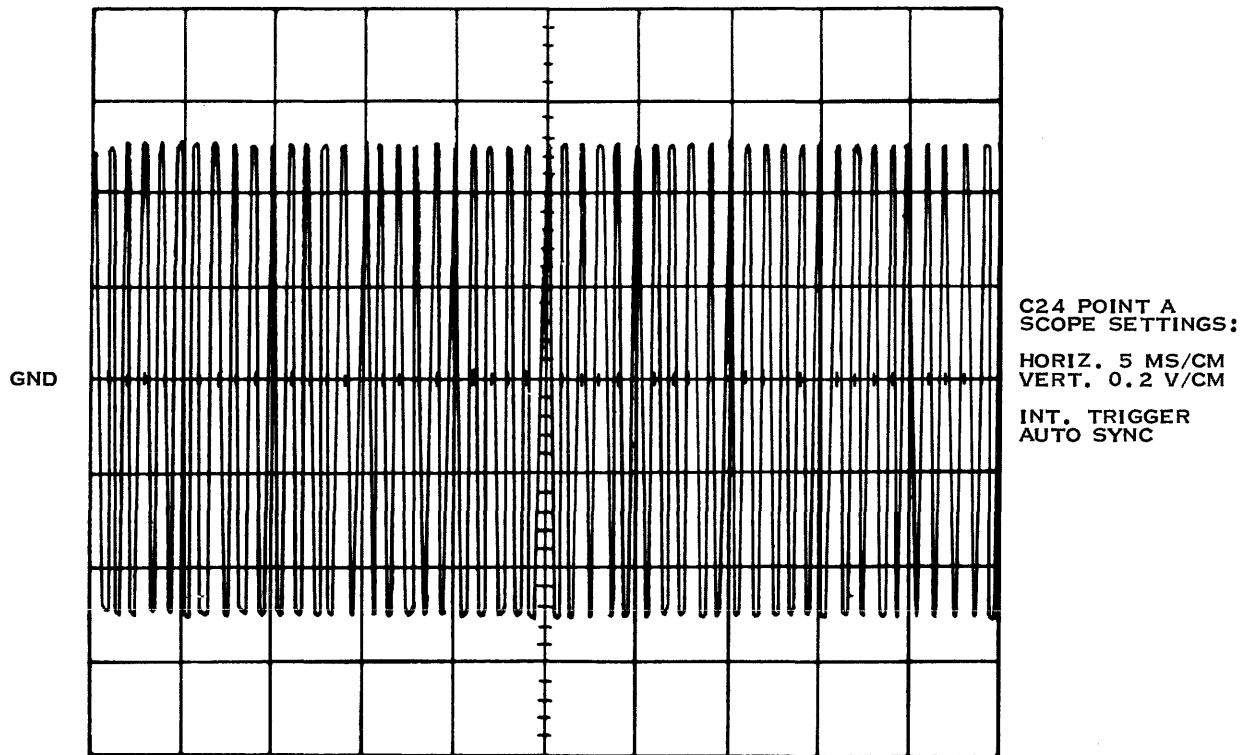


Figure 3-17. Position Transducer Waveform

8. If waveform is not within the tolerances stated in step 7, loosen transducer mount block forward-most screw (figure 3-18, item 3), and adjust cam (figure 3-18, item 4) for proper amplitude. If this adjustment is not sufficient, loosen transducer scale mounting screw (figure 3-18, item 1). It may be necessary to make sequential adjustments of the cam and eccentric screw to obtain proper amplitude tolerances.
9. Tighten transducer scale mounting screw (figure 3-18, item 1) to 20 in/lb.
10. Verify the waveform amplitude is still $1.0 \pm .05$ volts peak to peak between cylinders 000_{10} and 405_{10} (000_{16} and 195_{16}).
11. Remove jumper from TP1 and TP9.
12. Connect oscilloscope to TP3.
13. Move carriage by hand back and forth between cylinders 000_{10} and 405_{10} and observe waveform on oscilloscope.
14. Amplitude of waveform must be $5(+.4, -.2)$ volts peak to peak. If not, repeat steps 4 through 10 again. If adjustment cannot be performed, replace AGC preamp. Waveform will be similar to figure 3-17 except for difference in amplitude.

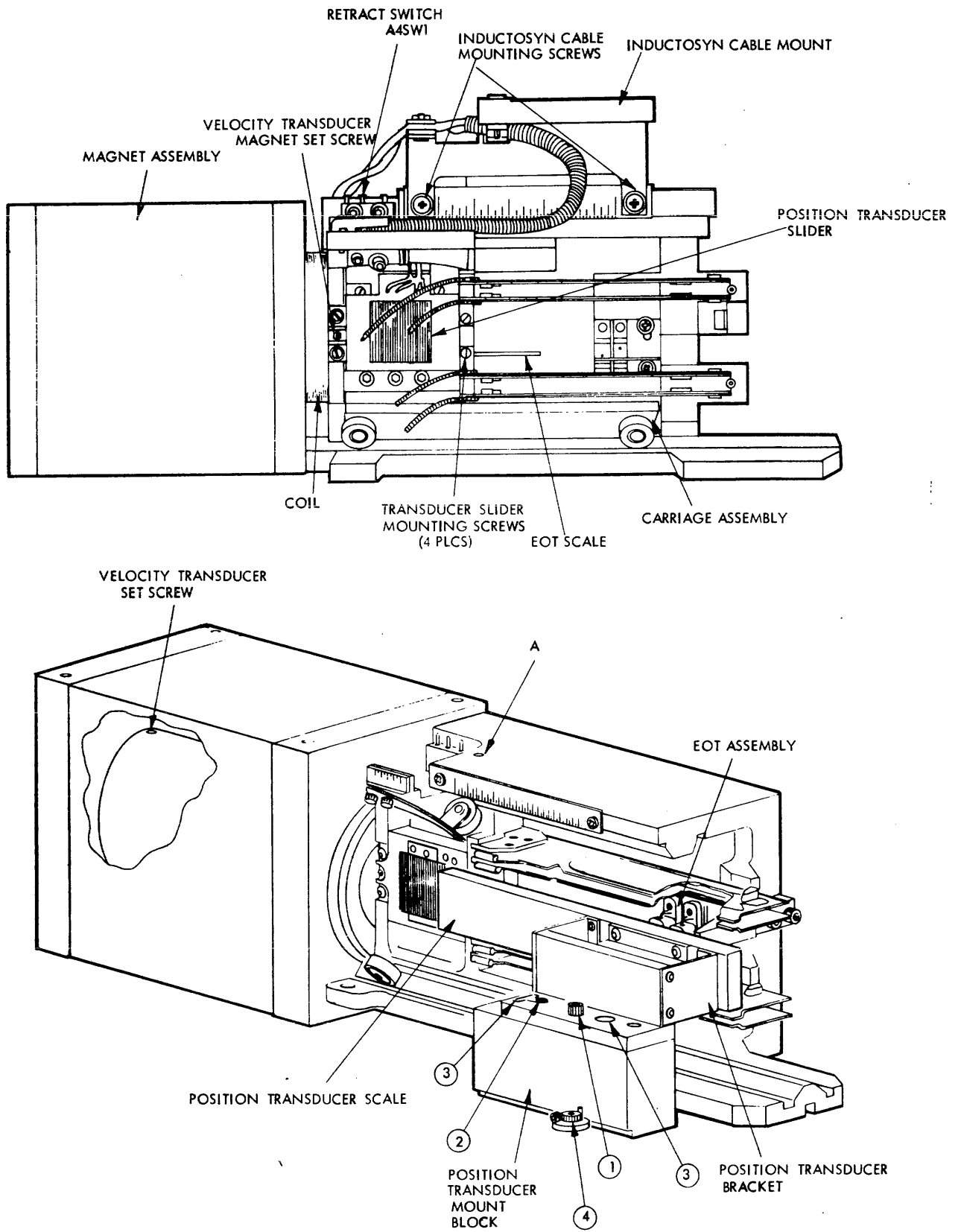


Figure 3-18. Actuator Assembly



15. Push carriage forward so that carriage is at forward stop position.

CAUTION

While performing steps 16 and 17, keep hands clear of carriage.

16. Reconnect AIP2.
17. Execute a Restore command to the disk to get the heads back at a known position. This can be done by setting up a Restore command in memory and then issuing that command to the drive via the "IC" verb. To put this command in memory, use the "modify memory" (.MM) verb and enter the following information:

Address	Data
8000	0000
8002	0700
8004	0100
8006	0000
8008	0002
800A	8100
800C	0400
800E	0000

Once this data is entered, issue the command to disk by entering "IC" after VERB. The command should be issued to the drive, causing the heads to move to track 0.

18. Perform temperature stabilization procedure.
19. Perform an alternate seek between cylinder 200_{10} ($C8_{16}$) and 201_{10} ($C9_{16}$). This is done by changing the value at 8016 to 00C8 and at 8026 to 00C9. Once this has been done, the command should be executed by issuing the following command to the disk drive:

VERB? LO ADRS 8010 COMMANDS 2 STATUS 0

Sync the scope on "RDYSRW-" and monitor TP3 and adjust offset potentiometer R74 on the preamp board so that the amplitudes are balanced within ± 100 MV of logic ground. Refer to figures 3-19 and 3-20.

20. This adjustment (step 19) should be repeated whenever the drive exceeds ± 150 MV from logic ground.
21. Verify the adjustment by seeking from cylinder 000 to 0001 and from cylinder 400_{10} (190_{16}) to 401_{10} (191_{16}). This is done by changing the data at memory address location 8016 and 8026 to the appropriate cylinder address. The command should then be repeatedly executed by issuing an "LO" command. It may be necessary to adjust R74 to bring all three locations into adjustment.



22. Verify the adjustments again by changing memory location 8016 and 8026 to 0000 and 0002 and again for cylinders 400_{10} (190_{16}) and 402_{10} (192_{16}). Again it may be necessary to adjust R74 to bring both locations into adjustment. Refer to figure 3-21.
23. Perform an alternate seek between cylinders 293_{10} (125_{16}) and 405_{10} (195_{16}). This may be done by using either of the two methods that follow:
- a . Use the “.MM” verb to enter the following in memory:

Address	Data
8010	0000
8012	0400
8014	0100
8016	0125
8018	0002
801A	8100
801C	0400
801E	0000
8020	0000
8022	0400
8024	0100
8026	0195
8028	0002
802A	8100
802C	0400
802E	0000

This operation can be continually repeated by executing a “LO” command at address 8010 for two commands with status ignored, as follows:

```
VERB? LO ADRS 8010 COMMANDS 2 STATUS 0
```

- b . Use the “AL” verb to issue the alternate seeks. Answer the prompts as follows:

```
VERB ? -AL
```

```
NUMBER OF DIFFERENT SEEKS? 1 or 2? -2
```

```
CHECK STATUS? -0
```

```
SEEK TO CYLINDER NUMBER? -125
```

```
SURFACE NUMBER? -0
```

```
SEEK TO CYLINDER NUMBER& -195
```

```
SURFACE NUMBER? -0
```

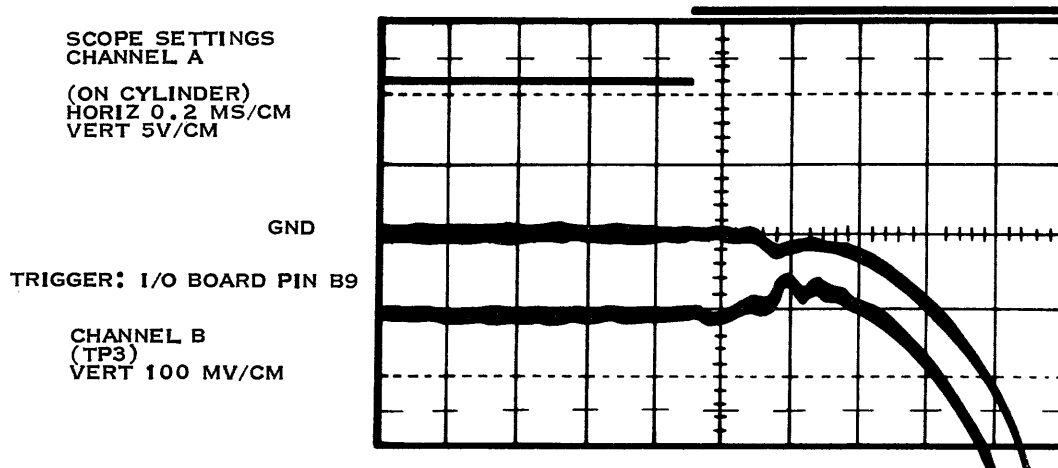


Figure 3-19. One Track Seek Unbalanced

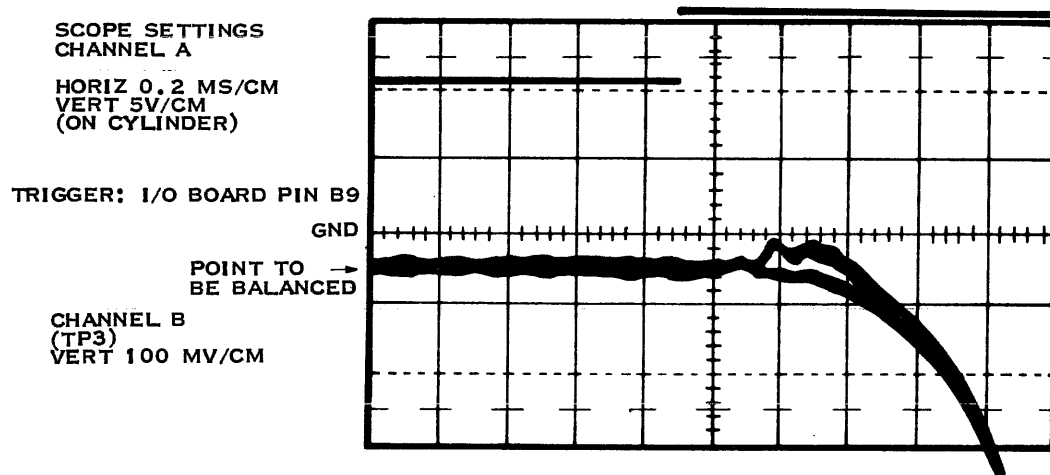


Figure 3-20. One Track Seek Balanced

24. Monitor RDYSRW- (same as on cylinder) on the disk interface line to the controller. This signal can be monitored at Pin B9 on the I/O board. This signal should be a positive pulse of 35 ± 1 millisecond (figure 3-23). Adjust velocity gain potentiometer R73 (figure 3-16) to get the desired seek time.
25. Monitor the waveform at TP3. The peak-to-peak amplitude of the last full sinewave before "On-cylinder" goes positive must be 5 ± 0.5 volts. (See figure 3-22 for the proper waveform for forward movement. Figure 3-23 shows the corresponding waveform for reverse movement as described in step 20.)
26. In addition to the above adjustments, the EOT check and adjustment, head alignment check and index-to-burst adjustments should be checked.



3.5.3 FEOT CHECK AND ADJUSTMENT.

1. Set up two read commands and one restore command in memory by using the “.MM” verb to enter the following:

Address	Data	
8000	0000	
8002	0200	Read
8004	0100	1 S/R
8006	0198	Cyl Add = 408
8008	0000	Byte Cnt = 0
800A	9000	
800C	0800	Unit 0
800E	0000	
8010	0000	
8012	0200	Read
8014	0100	1 S/R
8016	019A	Cyl Add = 410
8018	0000	Byte Cnt = 0
801A	9000	
801C	0800	Unit 0
801E	0000	
8020	0000	
8022	0700	Restore (RTZS)
8024	0000	
8026	0000	
8028	0000	
802A	0000	
802C	0800	Unit 0
802E	0000	

2. Set MAIN (ac) breaker to the OFF position. Remove the electronics cover and the card cage cover to gain access to the control board and the servo board.
3. Install servo board on card extender. The extender board may require a 0.0047 microfarad capacitor between pin B17 (RTZS line) and ground.



SCOPE SETTINGS
CHANNEL A

HORIZ 0.2 MS/CM
VERT 5V/CM
(ON CYLINDER)

TRIGGER: I/O BOARD PIN B9

CHANNEL B
TP3
VERT 100 MV/CM

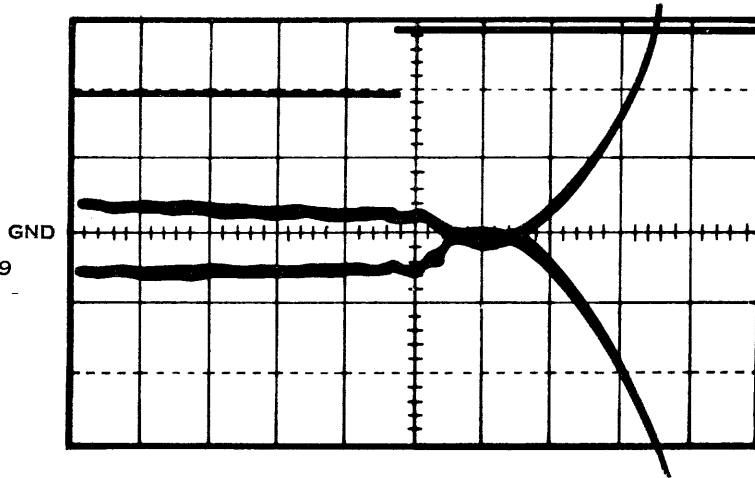


Figure 3-21. Two Track Seek Within Tolerance

SCOPE SETTINGS
CHANNEL A
ON CYLINDER

HORIZ 5MS/CM
VERT 5V/CM

CHANNEL B
TP3
VERT 1V/VM

TRIGGER: I/O BOARD PIN B9

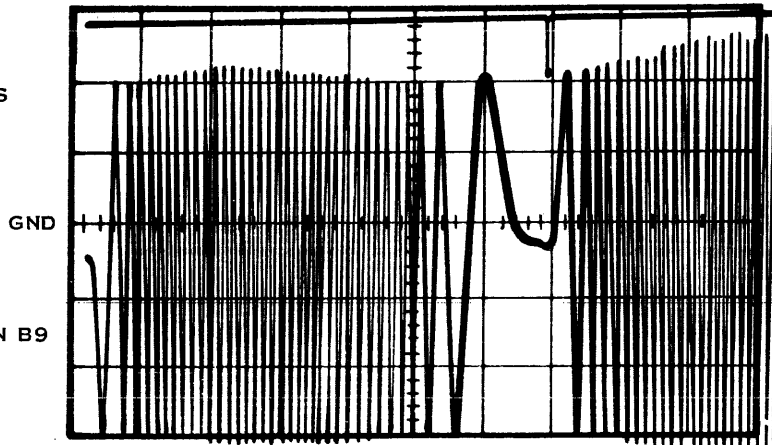


Figure 3-22. Forward Seek

SCOPE SETTINGS
CHANNEL A
ON CYLINDER

HORIZ 5MS/CM
VERT 1V/CM

CHANNEL B
TP3
VERT 1V/CM

TRIGGER: I/O BOARD PIN B9

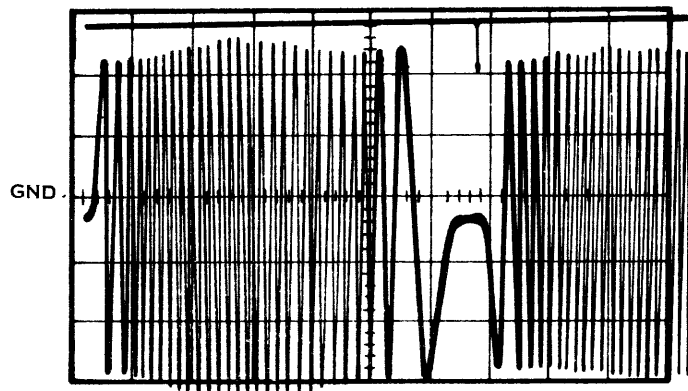


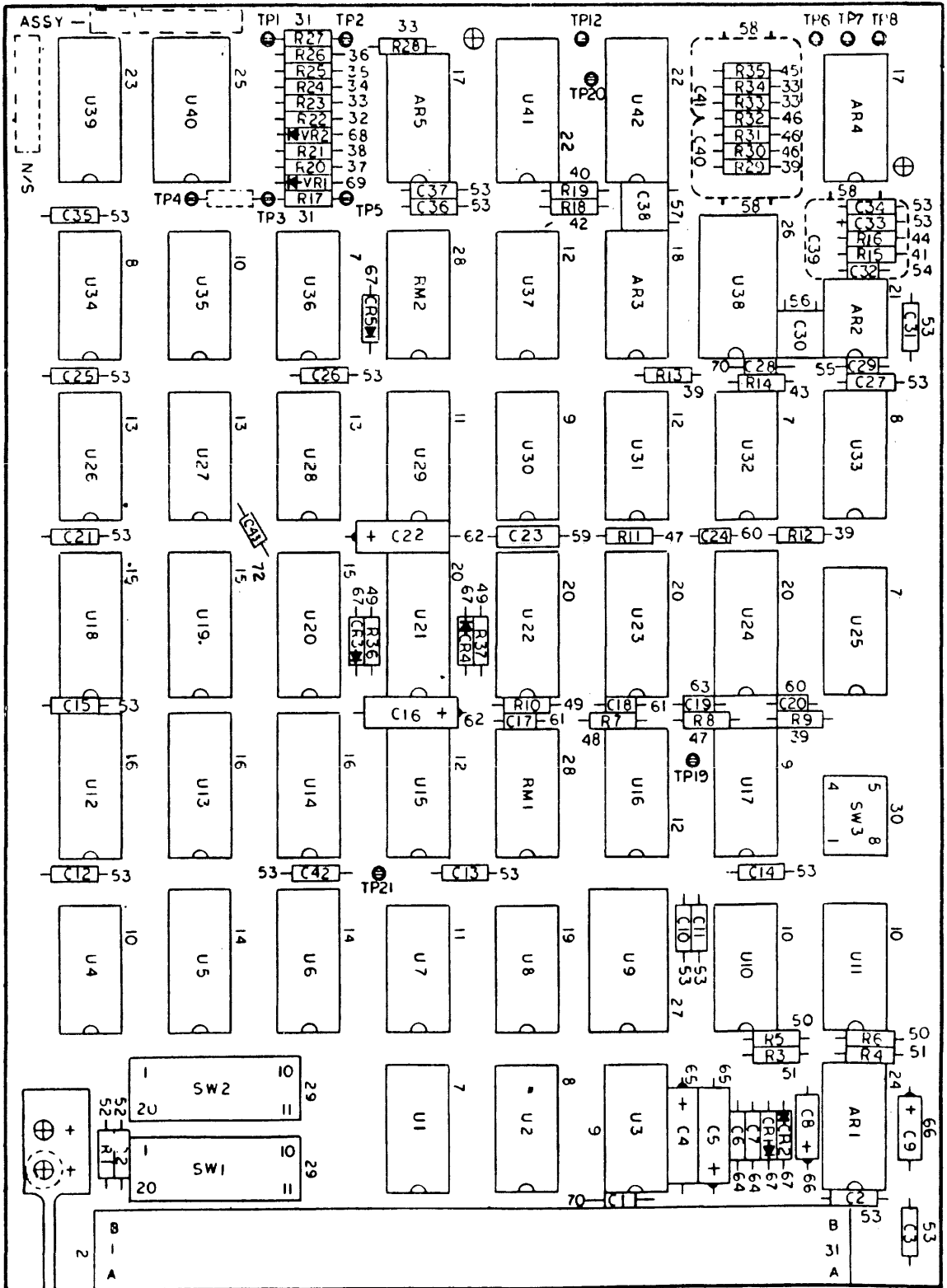
Figure 3-23. Reverse Seek



4. Connect disk controller to drive and load PDT. Initialize PDT, but do not execute.
5. Set MAIN circuit breaker to ON position.
6. Depress START/STOP switch to START (on) and wait for completion of first seek.
7. Perform temperature stabilization procedure.
8. Change switch settings as follows:

Control board	S1-7 to OFF	
Servo board	S2-10 to OFF	FEOT adjustment switches
9. Unplug A1P2 on actuator.
10. On servo board (figure 3-24), ground TP20.
11. Set actuator at forward stop and reconnect A1P2.
12. Issue Restore command from 990 computer to disk drive. Use the "IC" verb to initiate the Restore command at address 8020.
13. Sync internal negative on channel A. Use variable sweep if necessary and monitor TP19 on servo board with channel A of oscilloscope and monitor TP3 (figure 3-16) on preamp board with channel B of oscilloscope.
14. Perform an alternate seek between cylinders 408_{10} (198_{16}) and 410_{10} ($19A_{16}$). This may be done by using the "LO" verb to loop on the two read commands set up in step 1. Enter 0 to respond to the STATUS prompt.
15. If waveform is not within limits as shown in figure 3-25, slightly loosen two socket-head screws (Phillips on early units) on EOT Detector (figure 3-6). Place screwdriver in slot and adjust detector horizontally to limits shown in figure 3-25.
16. Tighten screws and verify that adjustment has not changed.
17. Unplug A1P2 on actuator.
18. On servo board, remove grounds from TP20.
19. Set actuator at forward stop and reconnect A1P2.
20. Reissue RESTORE command, as in step 11.
21. Perform head alignment check and adjustment.
22. Perform index-to-burst period check and adjustment.
23. Depress START/STOP to stop the drive.
24. Turn off MAIN (ac) circuit breaker.
25. Refer to step 3 and change the switch settings back to normal.

Figure 3-24. Servo Board Assembly



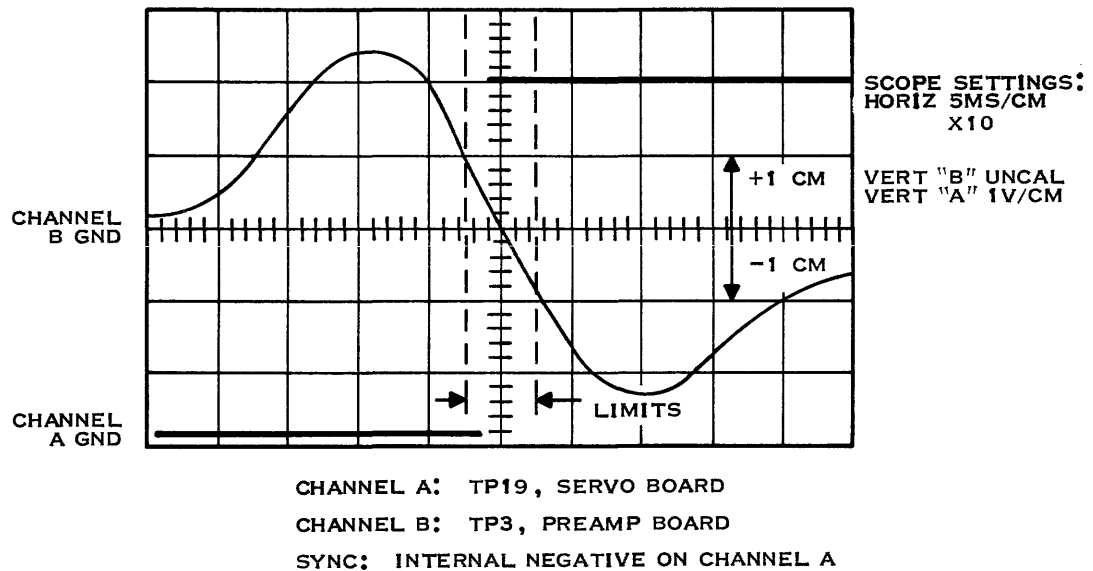


Figure 3-25. FEOT Waveform

3.5.4 HEAD ALIGNMENT CHECK AND ADJUSTMENT.

1. Depress START/STOP switch to STOP and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove disk cartridge and install CE disk cartridge.
3. Set MAIN circuit breaker to OFF position.
4. Remove electronics cover.
5. Record setting of all switches on I/O board.
6. Verify that resistive terminators are installed in XRM1-XRM12 on the I/O board.
7. Connect the disk controller to the drive and load and initialize the PDT, but do not execute.

CAUTION

K1 should not be removed until MAIN circuit breaker is in the OFF position. With K1 removed, emergency retract is disabled. Consequently, heads must be manually retracted if spindle slows down below tolerance limit.



8. Open power supply cover and remove relay K1 to provide access to heads.
9. Disconnect A1P2 (Note orientation).
10. Set MAIN circuit breaker to ON position.
11. Depress W/PROT CART and W/PROT FIXED switches to ON (in).
12. Depress START/STOP switch to START (in) and allow spindle to attain operating speed.
13. Reconnect A1P2, but reverse orientation (as noted in step 4) immediately upon completion of brush cycle.
14. Perform temperature stabilization procedure.
15. Enter and execute a command to seek to cylinder 146₁₀ (92₁₆). This may be done by using either of the following two methods:

- a. Use the “.MM” verb to enter the following data in memory:

Address	Data
8010	0000
8012	0400
8014	0100
8016	0092
8018	0002
801A	8100
801C	0400
801E	0000

Issue the command at 8010 using an “IC” verb.

- b. Use the “AL” verb to issue the alternate seeks. Answer the prompts as follows:

VERB ? -AL

NUMBER OF DIFFERENT SEEKS? 1 or 2? -1
CHECK STATUS? -0
SEEK TO CYLINDER NUMBER? -92
SURFACE NUMBER? -0

16. Place oscilloscope external sync on sector (P1-B10 on I/O board).



17. Monitor this signal and set up oscilloscope trace to indicate one complete revolution (20 sector pulses). Use horizontal range of 2 milliseconds/cm, and use uncalibrated sweep control for final adjustment (see top of figure 3-26).
18. Monitor TP1 and TP2 on I/O board with channels A and B of the oscilloscope.
19. Set oscilloscope to add signals and invert one channel.

NOTE

Head alignment waveform should be indicated in figure 3-26. If center crossover for both #0 and #1 are within ± 0.8 cm of horizontal center, heads need not be adjusted. If alignment is outside this tolerance, adjust heads so that center crossover is within ± 0.5 cm of horizontal center. Using the horizontal position control, move the display so that these crossovers are displayed within the 10-cm scope graticule as shown in figure 3-26. Do not change the time base established in step 17 for the remainder of the adjustment procedure.

20. Loosen head #0 clamp if adjustment required (figure 3-8).
21. Using head alignment tool, adjust head for signal shown in figure 3-26.
22. Tighten head #0 clamp and torque to 6.0 ± 0.5 inch/pounds.
23. Select head #1 by repeating step 15 with data 0401 at address 8012, replacing 0400.
24. Loosen head #1 clamp if adjustment required (figure 3-8).
25. Using head alignment tool, adjust head for signal shown in figure 3-26.
26. Tighten head #1 clamp and torque to 6.0 ± 0.5 inch pounds.
27. If new heads have been installed or actuator has been removed, proceed to step 17 of index-to-burst period check and adjustment. Otherwise, continue procedure.
28. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
29. Remove CE disk cartridge.
30. Set MAIN circuit breaker to OFF position.
31. Disconnect AIP2, reverse plug, and reconnect.
32. Install K1 and close power supply cover.
33. If a manual or field test procedure was used to position the actuator, set all I/O board switches back to the normal positions.
34. Disconnect oscilloscope.
35. Install electronics cover.

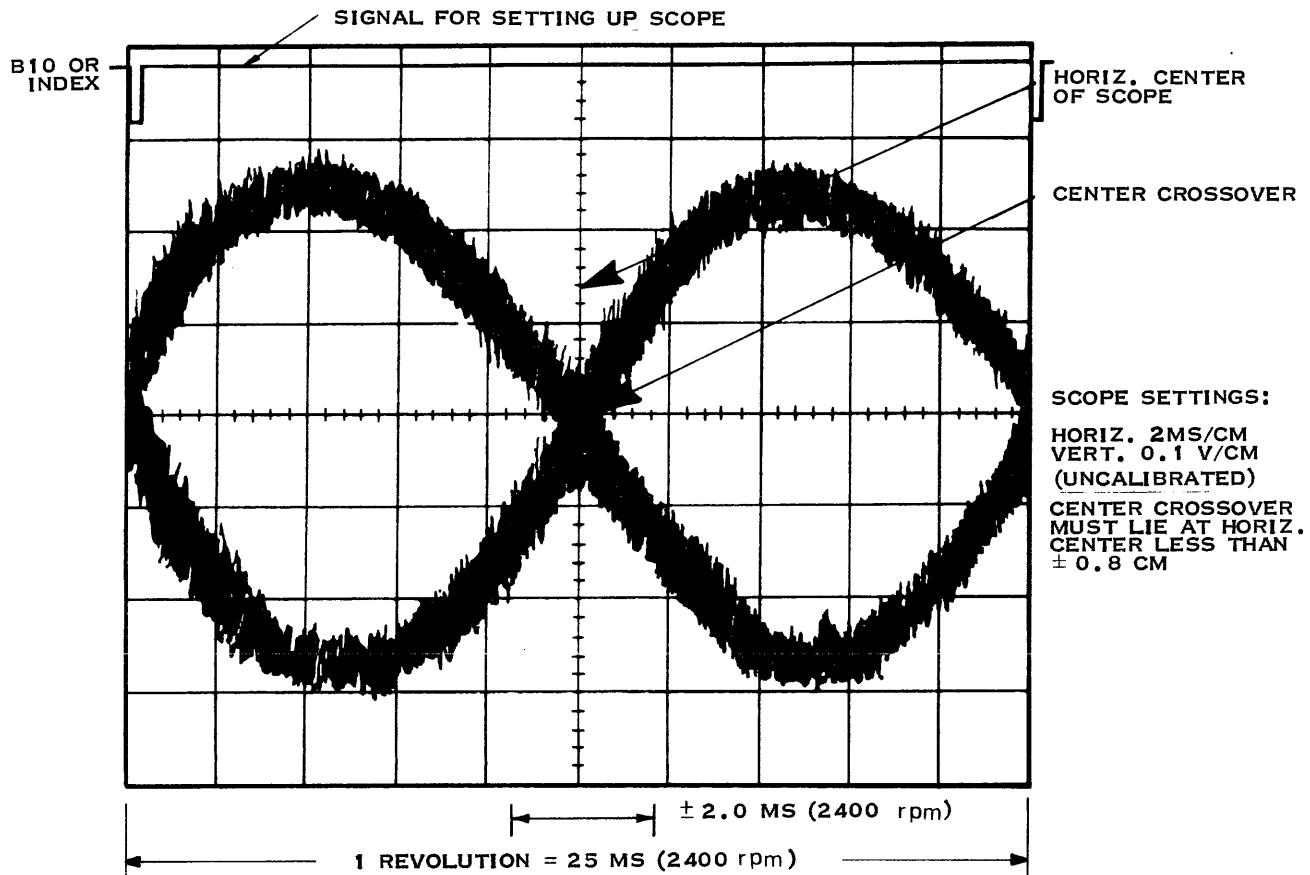


Figure 3-26. Head Alignment Waveform

3.5.5 HEAD SKEW AND INDEX-TO-BURST PERIOD CHECK AND ADJUSTMENT.

1. Depress START/STOP switch to STOP and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove disk cartridge and install CE disk cartridge.
3. Set MAIN circuit breaker to OFF position.
4. Open top cover.
5. Remove electronics cover.
6. Record settings of all switches on I/O board.
7. Verify that resistor modules are installed on I/O board.
8. Connect the disk controller to the drive and load but do not execute the diagnostic.

**CAUTION**

K1 should not be removed until MAIN circuit breaker is in OFF position. With K1 removed, emergency retract is disabled. Consequently, heads must be manually retracted if spindle slows down below tolerance limit.

9. Open power supply cover and remove relay K1 to provide access to heads.
10. Disconnect A1P2 (note orientation).
11. Set MAIN circuit breaker to ON position.
12. Depress W/PROT CART and W/PROT FIXED switches to ON (in).
13. Depress START/STOP switch to START (in) and allow spindle to attain operating speed.
14. Reconnect A1P2 but reverse orientation (as noted in step 10) immediately upon completion of brush cycle.
15. Perform temperature stabilization procedure (see paragraph 3.5.1).
16. Select head 0 and command unit to seek to cylinder 10_{10} (A_{16}) using either of the two methods that follow:
 - a. Enter the following data using the “.MM” verb:

Address	Data
8010	0000
8012	0400
8014	0100
8016	000A
8018	0002
801A	8008
801C	0400
801E	0000

Issue the command at 8010 using an “IC” verb.

- b. Use the “AL” verb and answer the prompts as follows:

VERB? -AL

NUMBER OF DIFFERENT SEEKS? 1 or 2? -1

CHECK STATUS? -0

SEEK TO CYLINDER NUMBER? -A

SURFACE NUMBER? -0

17. Actuator should move to cylinder 10_{10} .



18. Place oscilloscope channel A on sector (P1-B10 on I/O board), sync negative, internal on channel A. See figure 3-27A.
19. Connect oscilloscope channel B to TPI on I/O board.

NOTE

Head-skew check (steps 20 through 22) should only be performed if a head has been replaced. If the check fails specification, keep replacing that head until the check passes specification. All measurements are to be made on the peak of the leading pulse derived by the CE pack regardless of polarity. To measure head-skew with reliable accuracy, the index-to-data burst should be observed on a delayed sweep having a time base of 1 microsecond per division for straddle-erase heads and 5 microseconds per division for pre-erase heads. An alternate procedure is to change the index-to-burst timing so the pulse can be centered on the scope screen having the horizontal time base just mentioned. See figure 3-27B.

20. With head 0 selected, place the burst pulse in the center of the scope (figure 3-27B).
21. Next, select head 1. Head 1 may be selected by using the “.MM” verb to change the contents of memory address 0812 from 0400 to 0401 and using the “IC” verb to issue the command at 8010 (see step 16).
22. With head 1 selected, measure the difference between the burst point of the upper head to the burst point of the lower head. The head-to-head difference must be within the following limits:

3 microseconds maximum for straddle-erase heads (2400 RPM)
4 microseconds maximum for pre-erase heads (2400 RPM)

CAUTION

The standard head supplied by Texas Instruments is a straddle-erase type identified by the following CDC part numbers:

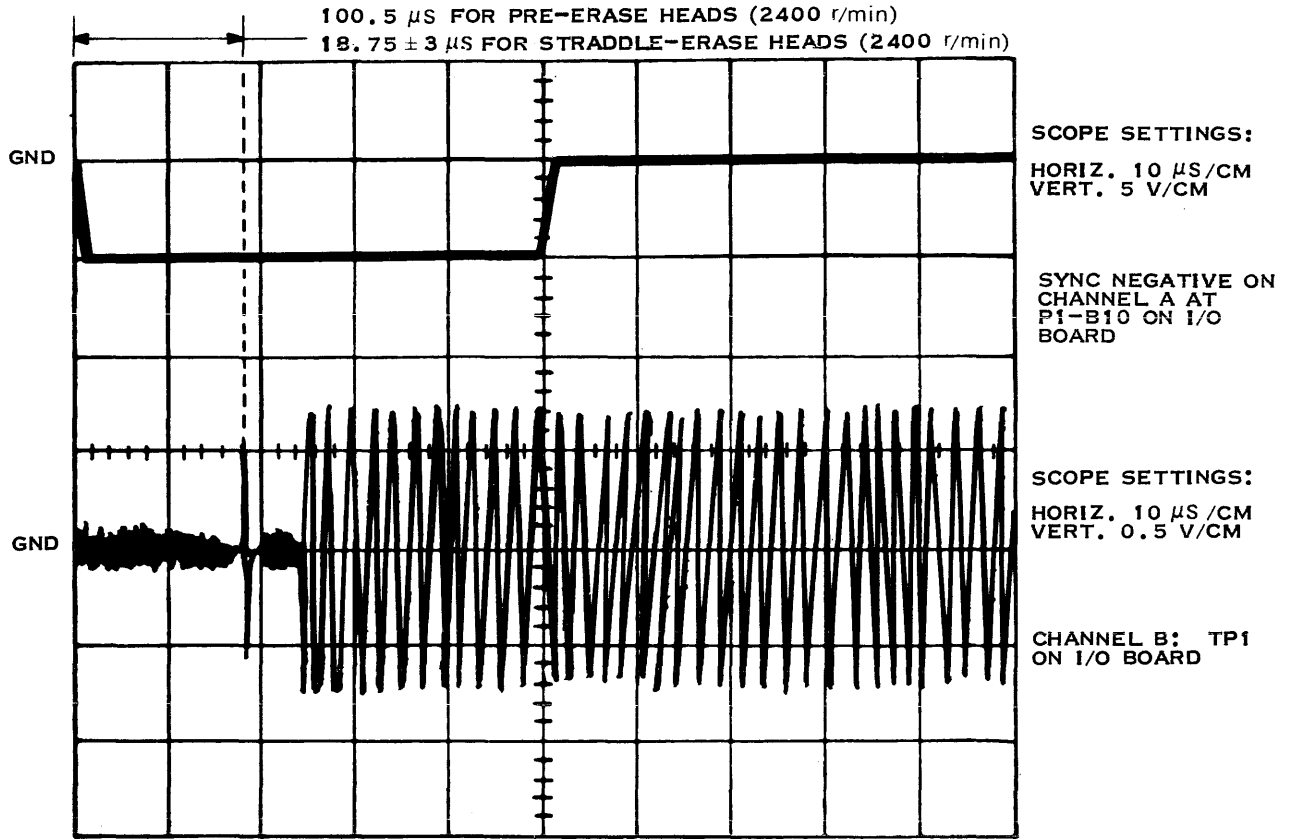
75037504-0	lower head (#1, #3)
75037505-0	upper head (#0, #2)

Some drives may have pre-erase heads supplied directly by Control Data Corporation. Pre-erase heads are identified by the following CDC part numbers:

70590208-8	lower head (#1, #3)
70590209-6	upper head (#0, #2)

The part number is stamped on the head assembly. Check the part number before performing the adjustment. All heads in the drive must be of the same type.

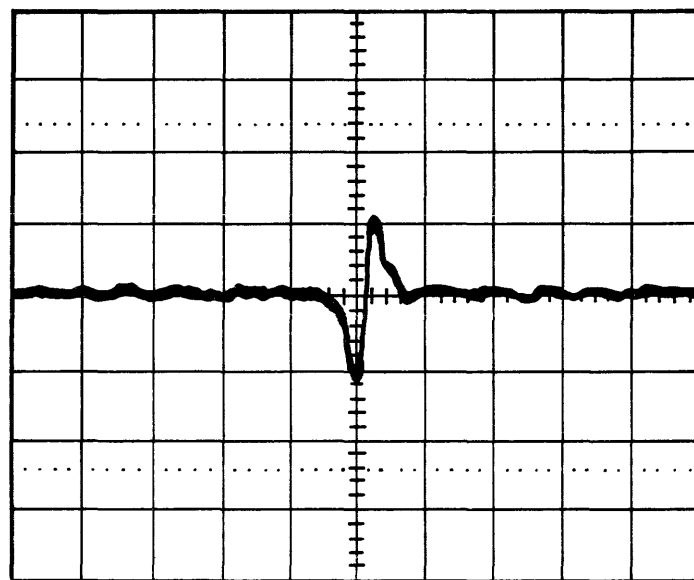
23. Select head 0. Use the “.MM” verb to change the data at memory address 0812 back to 0400 and use the “IC” verb to issue the command at memory address 0810 (see step 16).



NOTE:

MEASUREMENT TO BE MADE AT THE PEAK OF THE LEADING PULSE REGARDLESS OF POLARITY. SOME CR PACKS PRODUCE PULSES INVERTED TO PULSE SHOWN IN FIGURE.

Figure 3-27A. Index-To-Burst Period Waveform



HEAD 0

Figure 3-27B. Index-To-Burst Waveforms



24. Check and record the index-to-burst period as shown in figure 3-27A.
25. Select head 1. Follow instructions in step 21 to select head 1.
26. Check and record the index-to-burst period as shown in figure 3-27A.
27. Determine which head has the lowest index-to-burst period and verify that it meets the following limits:

100 ± 5 microseconds for pre-erase heads (2400 RPM)
 18.8 ± 3 microseconds for straddle-erase heads (2400 RPM)

If the head with the lowest index-to-burst period meets these limits, go to step 29, if not, continue with next step.

28. If the head with the lowest index-to-burst period does not fall within the limits in step 27, select that head and adjust potentiometer R29 on the sector board to the following:

100 ± 1 microseconds for pre-erase (2400 RPM)
 18.8 ± 0.1 microseconds for straddle-erase heads (2400 RPM)

If the potentiometer is not present or if the adjustment range of the potentiometer does not reach far enough, depress the START/STOP pushbutton to STOP and perform the cartridge index/sector transducer check and adjustment, then repeat steps 24 through 28.

29. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
30. Remove CE disk cartridge.
31. Set MAIN circuit breaker to OFF position.
32. Disconnect A1P2, reverse plug, and reconnect.
33. Install K1 and close power supply cover.
34. Set all switches on I/O board back to original positions if altered by manual procedure.
35. Disconnect oscilloscope.
36. Install electronics cover.
37. Close top cover (base cabinet only).

3.5.6 TRACK INDICATOR CHECK AND ADJUSTMENT. Check and, if necessary, adjust the track indicator as follows:

1. Open top cover (base cabinet only).
2. Remove electronics cover.
3. Set MAIN circuit breaker to ON position.



4. Install disk cartridge.
5. Depress START/STOP switch to START (in) and wait for unit to complete FIRST SEEK.
6. Check that zero marks on fixed and movable sections of track indicators (figure 3-28) are aligned.
7. If marks are not aligned, loosen fixed section of track indicator and position for alignment with moveable section.
8. Check that gap between the fixed and moveable sections of track indicator is 0.1 to 0.3 inches.
9. Install electronics cover.

3.5.7 STATIC ELIMINATOR CHECK. Check the static eliminator as follows:

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Remove disk cartridge.
3. Open top cover (base cabinet only).
4. Set MAIN circuit breaker to OFF position.
5. Using multimeter, check for one ohm or less between module ground and side or rotating spindle cone while turning spindle by hand.
6. If resistance is above one ohm, clean static eliminator and perform step 5 again.
7. If multimeter indicates no continuity or high resistance after cleaning, replace static eliminator.

3.5.8 CARTRIDGE INDEX/SECTOR TRANSDUCER CHECK AND ADJUSTMENT.

1. Depress START/STOP switch to STOP (out) and wait for spindle to stop rotating (START/STOP lamp extinguished).
2. Open top cover (base cabinet only).
3. Remove disk cartridge.
4. Set MAIN circuit breaker to OFF position.
5. Install armature plate simulator onto spindle as shown in figure 3-29.
6. Using plastic shim stock, adjust clearance A to 0.76 ± 0.13 mm (0.030 ± 0.005 inches). The adjustment is made by loosening the clamp screw and sliding the transducer in or out for proper clearance.
7. After the transducer is properly adjusted, perform the index-to-burst period check and adjustment procedure.

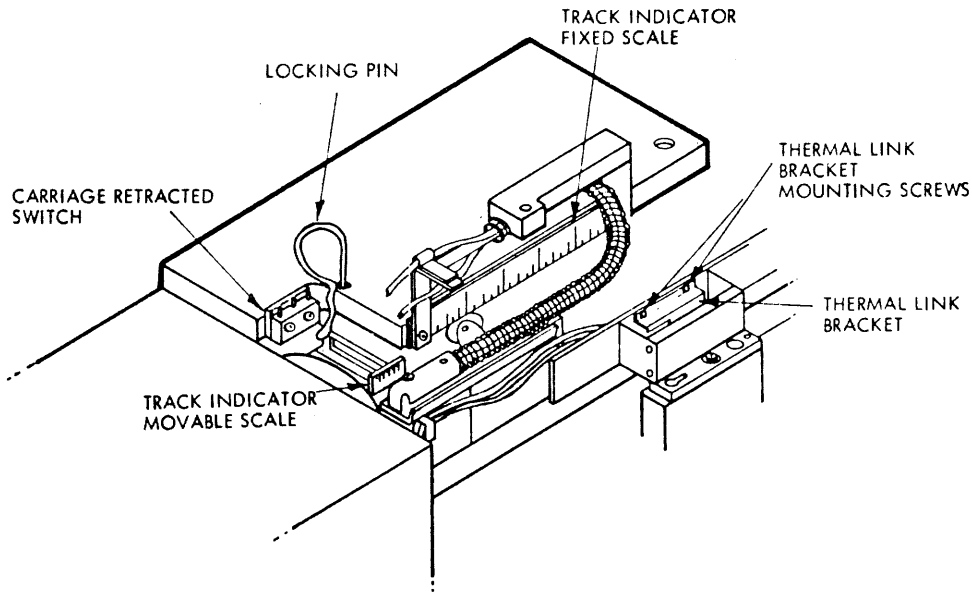


Figure 3-28. Track Indicator

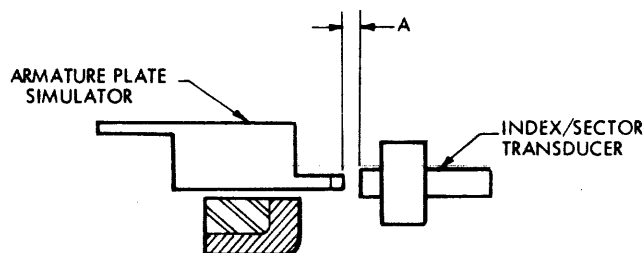


Figure 3-29. Index/Sector Transducer Adjustment

3.5.9 FIXED DISK INDEX/SECTOR TRANSDUCER CHECK AND ADJUSTMENT.

1. Set MAIN circuit breaker to OFF position.
2. Remove cabinet skin from left side (base cabinet only).
3. Remove module bottom cover.
4. Using plastic shim stock, check clearance A (figure 3-30). Clearance should be $0.25 + 0.076, -0.000$ mm ($0.010 + 0.003, -0.003, -0.000$ inches). If clearance is out of tolerance, loosen transducer clamp and slide transducer in or out to adjust for proper clearance.
5. Tighten transducer clamp.
6. Install side skin removed in step 2.

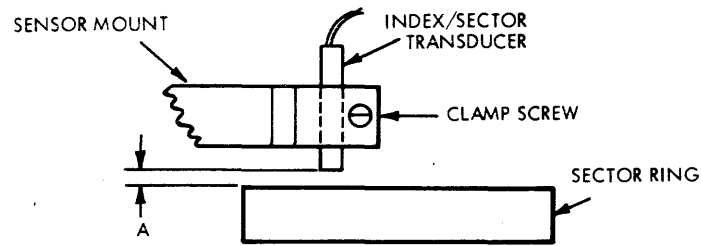


Figure 3-30. Fixed Disk Index/Sector Transducer Adjustment

3.5.10 CARTRIDGE-ON SWITCH CHECK AND ADJUSTMENT.

1. Insert a disk cartridge in the drive and load the heads by depressing the START/STOP switch. Once the heads are loaded (READY indicator lighted) the hold-down arms should be gently pulled away from the disk cartridge. They should not pull away; otherwise, they have not locked properly and may be defective.
2. The interlock switches should be checked by placing the hand on the disk cartridge cover and then "wiggling" it back and forth. If the drives heads are unloaded and the spindle starts slowing down (READY light goes out), then the switches may be faulty or the hold-down arms may be out of alignment. This problem may be corrected by moving the hold-down arms closer toward the cartridge to give a firmer fit. If this is not the problem, then the sensor switch should be replaced.



APPENDIX A

DISK CONTROLLER AND DISK-DRIVE INTERFACE SIGNALS

Table A-1. Disk Controller and Disk-Drive Interface Signals

Signal Name	Controller Pin No.	Drive (Winchester) Connector Pin	Description
Controller-to-Disk Signals:			(Active in the low voltage state unless otherwise specified)
ADD001-	P4-8	N	Cylinder address. Valid when cylinder address strobe, ADDSTB-, is low. A read or write operation need not load a new cylinder address unless the heads must seek to a new track.
002-	P4-30	s	
004-	P4-10	J	
008-	P3-42	X	
016-	P4-22	f	
032-	P3-16	T	
064-	P3-24	b	
128-	P3-46	BB	
ADD256- (MSB)	P3-30	m	
ADDSTB-	P3-36	i	Cylinder address strobe. Loads cylinder address into disk drive electronics when low. For read or write seeks, ADDSTB- remains active until Address Acknowledge (ADDACK-) is issued. For Restore-, strobe remains active for at least one microsecond.
SELECTA-	P3-14	L	Select disk-drive A. When low, selects the dual disk drive which is designated "A". The select line must be active (low) to allow the drive unit to accept data or any other control signals and to generate any control status signals except seek error and unit ready. This line selects a drive which contains two independent logic units. The select line and disk select signal are both required to uniquely specify logical unit 0 or 1.
SELECTB-	P4-12	R	Select disk-drive B. When low, selects the disk drive which is designated "B". The select line and the disk select signal are both required to uniquely specify logical unit 2 or 3. See SELECTA-, above.



Table A-1. Disk Controller and Disk-Drive Interface Signals (Continued)

Signal Name	Controller Pin No.	Drive (Winchester) Connector Pin	Description
DISKSEL-	P4-36	AA	Disk select. Selects one of the two platters within a disk drive. When low, DISKSEL- selects the fixed disk, and when high, selects the removable disk. The controller must check the position of the fixed/removable logical unit reversing jumper (SWAIN- or SWBIN-) before setting the polarity of DISKSEL-. This signal is called HS/1 within the disk drive.
HDSEL-	P3-22	a	Head Select. Selects the read/write head on the upper surface (HDSEL- low) or the lower surface (HDSEL- high) of the selected fixed or removable disk platter. HDSEL- is stable for at least 10 microseconds before the leading edge of a write gate and remains stable for the duration of a read or write operation. This signal is called HS/0 within the disk drive.
RG-	P3-6	E	Read gate. Enables read data and clock through the disk-drive electronics to the controller. Leading edge of read gate enables phase-lock circuitry in disk-drive data recovery board.
WG-	P3-26	e	Write gate. Enables write current during a write operation.
EG-	P3-12	K	Erase gate. Enables erase current during a write operation, so the erase heads can “shear” flux splatter at the outer track edges (straddle erase).
WDNCLK-	P3-8	B	Double-frequency encoded write data and clock to the disk unit. Minimum pulse width is 100 nanoseconds, with a rise/fall time less than 50 nanoseconds.
RESTORE-	P3-38	w	Restore to Track Zero, also known as “Return to Zero Seek” (RTZS-). Causes the head carriage to advance to the forward limit of travel and then return to the home (track 000) position. Also clears disk cylinder address registers and counters, and clears disk unit fault latches. Essentially a master clear to the selected disk drive. Cylinder Address Strobe (ADDSTB) must be low for the disk to accept the Restore command.



Table A-1. Disk Controller and Disk-Drive Interface Signals (Continued)

Signal Name	Controller Pin No.	Drive (Winchester) Connector Pin	Description
Disk-to-Controller Signals:			
ADDACK-	P4-26	P	Address Acknowledge. Acknowledges acceptance and validity of cylinder address loaded into the disk drive electronics. Addresses greater than 407 are considered invalid.
FILERDY-	P3-15	U	Disk File Ready. Active (low) if the disk cartridge is installed, disk spindle is up to speed, heads are loaded, dc voltages are within tolerance, unit selected, no fault latches set, terminator and terminator power present. Inverted within the disk controller as OFFLINE-.
RDYSRW-	P4-06	F	Ready to Start Read/Write (also called "on cylinder"). Indicates that the head carriage has reached the specified cylinder address and the heads are stable. Also incorporates all file-ready conditions. Inverted within the disk controller as NOTRDY-.
SKIC-	P3-34	u	Seek Incomplete (also called seek error, Sker). Indicates that the disk drive failed to properly seek to the desired cylinder address. This condition may be cleared by a Restore operation.
INDMRK-	P4-16	y	Index Mark. A reference pulse which occurs once every disk revolution when sector 0 rotates under the R/W heads. The controller has the logic to monitor INDMRK-, but the controller microprogram makes no use of it. The controller depends instead upon the sector address supplied by the selected disk unit. Generated separately for the fixed and removable disks.
SECMRK-	P4-14	W	Sector Mark. A rotational position pulse (50 microseconds) which identifies the start of each disk sector. Used as the timing reference for starting read or write operations. Generated separately for the fixed and removal disks.



Table A-1. Disk Controller and Disk-Drive Interface Signals (Continued)

Signal Name	Controller Pin No.	Drive (Winchester) Connector Pin	Description
SECTORB01- SECTORB02- SECTORB04- SECTORB08- SECTORB16- (MSB)	P4-20 P3-28 P3-32 P4-28 P4-34	c j h n v	Sector Address. The disk drive electronics has a sector counter which uses the index and sector marks to keep track of the current rotational position of the selected disk. The disk controller compares this current sector address to the desired sector address to determine whether the desired sector is under the read/write heads. The sector address is updated at the end of a sector, about 4 microseconds before the next sector mark. It is stable when the sector mark occurs and remains stable until 4 microseconds before the next sector mark.
RD-	P3-2	C	Read Data. A clock/data separator in the data recovery board uses phase-lock techniques to separate the double-frequency recorded clock and data stream into separate clock and data outputs to the controller. Nominal pulse width is 100 nanoseconds, with variations allowable from 50-150 nanoseconds. Leading edge is the reference.
RCLK-	P3-4	A	Read Clock. Clock recovered from disk which is used as basic disk I/F clock for read operations. Recovered from recorded double-frequency clock data stream by phase-lock techniques. Nominal pulse width is 100 nanoseconds, with allowable variations from 50-150 nanoseconds. Leading (falling) edge is the timing reference.
WP-	P4-10	P	Write Protect. Indicates that data may not be written onto the selected disk because the associated WRITE PROTECT switch on the disk drive control panel is on.
WCHK-	P4-24	h	Write Check (also called Fault). Indicates that the disk-drive electronics has detected a fault condition and inhibited the write and erase currents. Fault conditions which may be cleared by a Restore-signal, if temporary, include: <ol style="list-style-type: none">1. More than one head selected2. Read and write gates simultaneously active (low)3. Read and Erase gates simultaneously active4. Erase gate active without write gate for more than 20 microseconds.



Table A-1. Disk Controller and Disk-Drive Interface Signals (Continued)

Signal Name	Controller Pin No.	Drive (Winchester) Connector Pin	Description
			5. Write or erase gate on when not on cylinder (RDYSRW- high) 6. Low dc voltages in disk drive 7. Emergency retract condition, such as motor under speed
SWAIN-	P4-38	N/C	Position of fixed/removable disk logical unit number reversing jumper for 1st dual disk drive (disk drive A). SWAIN- high means that the reversing jumper is <i>not</i> installed, so that the removable disk cartridge is logical unit 0 and the fixed disk is logical unit 1. This is the normal situation. SWAIN- low means that the reversing jumper is installed, so that the removable disk is changed to logical unit 1 and the fixed disk is changed to logical unit 0.
SWBIN-	P4-40	N/C	Position of fixed/removable disk logical unit number reversing jumper for the second dual disk drive (disk-drive B). SWBIN- high means that the reversing jumper is <i>not</i> installed, so that the removable disk cartridge is logical unit 2 and the fixed disk is logical unit 3. This is the normal situation. SWBIN- low means that the reversing jumper is installed on the cable adapter, so that the removable disk is changed to logical unit 3 and the fixed disk is changed to logical unit 2.



ALPHABETICAL INDEX

INTRODUCTION

HOW TO USE THE INDEX

The index, table of contents, list of illustrations, and list of tables are used in conjunction to obtain the location of the desired subject. Once the subject or topic has been located in the index, use the appropriate paragraph number, figure number, or table number to obtain the corresponding page number from the table of contents, list of illustrations, or list of tables.

INDEX ENTRIES

The following index lists key words and concepts from the subject material of the manual together with the area(s) in the manual that supply major coverage of the listed concept. The numbers along the right side of the listing reference the following manual areas:

- Sections – References to Sections of the manual appear as “Section x” with the symbol x representing any numeric quantity.
- Appendixes – References to Appendixes of the manual appear as “Appendix y” with the symbol y representing any capital letter.
- Paragraphs – References to paragraphs of the manual appear as a series of alphanumeric or numeric characters punctuated with decimal points. Only the first character of the string may be a letter; all subsequent characters are numbers. The first character refers to the section or appendix of the manual in which the paragraph is found.
- Tables – References to tables in the manual are represented by the capital letter T followed immediately by another alphanumeric character (representing the section or appendix of the manual containing the table). The second character is followed by a dash (-) and a number:

Tx-yy

- Figures – References to figures in the manual are represented by the capital letter F followed immediately by another alphanumeric character (representing the section or appendix of the manual containing the figure). The second character is followed by a dash (-) and a number:

Fx-yy

- Other entries in the Index – References to other entries in the index are preceded by the word “See” followed by the referenced entry.



AA Model DS10 Cartridge Disk
 System FMITitle
 ActuatorF3-7
 Actuator:
 AssemblyF3-18
 Removal/Replacement3.4.2
 Head Carriage1.1.4.2
 MountingF3-6
 Removal/ReplacementF3-12
 Adapter Jumpers, CableF1-21
 Address Switch Settings, TILINEF1-9
 Adjustment:
 Fixed Disk:
 Index/Sector TransducerF3-30
 Sector TransducerF3-30
 Index/Sector TransducerF3-29
 Servo PreamplifierF3-16
 Adjustments, Drive Alignments and3.5
 AGC Servo Preamplifier Board1.1.4.3
 Alignment Waveform, HeadF3-26
 Alignment/Adjustment:
 Cartridge Index/Sector Transducer ... 3.5.8
 Cartridge-On Switch3.5.10
 FEOT3.5.3
 Fixed Disk Index/Sector Transducer .. 3.5.9
 Alignments and Adjustments, Drive3.5
 Forward-End-of-Travel Transducer ... 3.5.3
 Head3.5.4
 Index-to-Burst Period3.5.5
 Pack Lock3.5.10
 Procedure IndexT3-3
 Servo Preamplifier3.5.2
 Static Eliminator3.5.7
 Temperature Stabilization3.5.1
 Track Indicator3.5.6
 Armature Plate SimulatorF3-29
 Assemblies, Field Replaceable Parts and ..T1-3
 Block Diagram:
 Data Recovery BoardF1-17
 Disk SystemF1-2
 Read/Write/Erase BoardF1-16
 System DetailedF1-7
 Blower Motor, Removal/
 Replacement3.4.20, 3.4.21
 Board:
 AGC Servo Preamplifier1.1.4.3
 Block Diagram:
 Data RecoveryF1-17
 Read/Write/EraseF1-16
 Data Recovery1.1.4.9
 I/O1.1.4.1
 Power Supply No. 11.1.4.6
 Power Supply No. 21.1.4.5
 Read/Write/Erase R/W/E1.1.4.8
 Removal/Replacement:
 Circuit3.4.16
 Power Supply Piggyback3.4.18
 Sector1.1.4.7
 Servo1.1.4.4, F3-24
 Board No. 2, Removal/
 Replacement Power SupplyF3-15

BrushF3-13
 Brush:
 Assembly, Removal/ReplacementF3-13
 IndicatorF1-19
 Removal/Replacement3.4.14
 Cable Adapter JumpersF1-21
 Cabling:
 Configurations1.1.3
 Interconnect (Pedestal)F1-5
 Interconnect (Single Drive)F1-3
 Interconnect (Two Drives)F1-4
 Card Cage, Removal/Replacement3.4.19
 Carriage:
 Actuator, Head1.1.4.2
 Lock Pin1.2.1.2
 LocationF1-20
 Cartridge:
 Index/Sector Transducer, Alignment/
 Adjustment3.5.8
 Index/Sector Transducer, Removal/
 Replacement3.4.10
 Installation, Disk1.2.1.5, F1-22
 LockF1-23
 Removal, Emergency Disk1.2.1.7
 Removal (Normal), Disk1.2.1.6
 Cartridge-On:
 Switch:
 Alignment/Adjustment3.5.10
 Removal/Replacement3.4.13
 Circuit Board, Removal/
 Replacement3.4.16
 Cleaning, Disk2.3.3
 Components, Disk SystemT1-2
 Configurations, Cabling1.1.3
 Control and Indicator Location,
 Disk DriveF1-18
 Control Words1.2.2
 Controller:
 Jumpers, DiskF1-10
 LED Indicators, DiskF1-11
 Photograph, DiskF1-8
 Physical Description1.1.3.2
 Programming, Disk1.2.2
 Removal/Replacement3.4.1
 Controls and Indicators, DriveT1-4
 Corrective Maintenance:
 Introduction3.1
 Supplies and ToolsT3-1
 Test EquipmentT3-1
 Daily User PM Procedures2.3.1
 Data Recovery:
 Board1.1.4.9
 Block DiagramF1-17
 Description:
 Controller Physical1.1.3.2
 Drive Physical1.1.3.2
 General1.1.1
 Interface Signal PinoutAppendix A
 Replaceable Parts1.1.4
 Detailed Block Diagram, SystemF1-7
 Diagnostic Flowchart, DOCSF3-3



Disk:

- Cartridge:
 - Installation 1.2.1.5, F1-22
 - Removal, Emergency 1.2.1.7
 - Removal (Normal) 1.2.1.6
- Cleaning 2.3.5
- Controller:
 - Jumpers F1-10
 - LED Indicators F1-11
 - Photograph F1-8
 - Programming 1.2.2
- Drive:
 - Control and Indicator Location F1-18
 - Filter Mounting F2-1
 - Photograph F1-12, F1-13
 - Replaceable Part Location F1-15
 - Switch Settings F1-14
- Inspection 2.3.5
- Operational Fault Troubleshooting
 - Flowchart F3-4
- Removal/Replacement Fixed F3-10
- System:
 - Block Diagram F1-2
 - Components T1-2
 - Photograph F1-1
 - Specifications T1-1
- DOCS Diagnostic Flowchart F3-3
- Documents, Related Preface
- Drive:
 - Alignments and Adjustments 3.5
 - Control and Indicator Location,
 - Disk F1-18
 - Controls and Indicators T1-4
 - Filter Mounting, Disk F2-1
 - Motor, Removal/Replacement
 - Spindle 3.4.15
 - Photograph, Disk F1-12, F1-13
 - Physical Description 1.1.3.2
 - Replaceable Part Location, Disk F1-15
 - Switch Settings, Disk F1-14
- Emergency:
 - Disk Cartridge Removal 1.2.1.7
 - Power Down 1.2.1.11
 - Retract Relay 1.1.4.6
- End of Travel Assembly, Removal/Replacement 3.4.4
- EOT:
 - Mounting F3-6
 - Removal/Replacement 3.4.4
- Fault:
 - Operation 1.2.1.9
 - Troubleshooting Flowchart,
 - Disk Operational F3-4
- FEOT:
 - Alignment/Adjustment 3.5.3
 - Waveform F3-25
- Field Replaceable Parts and Assemblies . . T1-3
- Filter Mounting, Disk Drive F2-1
- Fixed Disk:
 - Index/Sector Transducer Adjustment . . F3-30
 - Index/Sector Transducer, Alignment/Adjustment 3.5.9
 - Index/Sector Transducer, Removal/Replacement 3.4.11
 - Removal/Replacement 3.4.5, F3-10
 - Sector Transducer Adjustment F3-30
- Flowchart:
 - Disk Operational Fault
 - Troubleshooting F3-4
 - DOCS Diagnostic F3-3
 - Initial Troubleshooting F3-1
 - Off-line Troubleshooting F3-2
- Forward-End-of-Travel Transducer,
 - Alignment/Adjustment 3.5.3
- Forward-End-of-Travel Waveform F3-25
- Forward Seek Waveform F3-22
- Front Panel, Removal/Replacement F3-9
- General Description 1.1.1
- HDI 2.3.5
- Head:
 - Alignment/Adjustment 3.5.4
 - Alignment Waveform F3-26
 - Carriage Actuator 1.1.4.2
 - Removal/Replacement 3.4.3, F3-8
- Head-to-Disk Interference 2.3.5
- Illustrated Parts List F1-15
- Index:
 - Alignment/Adjustment Procedure T3-3
 - Removal/Replacement Procedure T3-2
- Index-to-Burst Period:
 - Alignment/Adjustment 3.5.5
 - Waveform F3-27
- Index/Sector Transducer:
 - Adjustment F3-29
 - Adjustment, Fixed Disk F3-30
 - Alignment/Adjustment:
 - Cartridge 3.5.8
 - Fixed Disk 3.5.9
 - Removal/Replacement Cartridge 3.4.10
 - Removal/Replacement Fixed Disk 3.4.11
- Indicator:
 - Assembly, Track F3-28
 - Brush F1-19
 - Location, Disk Drive Control and . . . F1-18
- Indicators:
 - Disk Controller LED F1-11
 - Drive Controls and T1-4
- Inductosyn:
 - Removal/Replacement 3.4.6
 - Waveform F3-17
- Initial Troubleshooting Flowchart F3-1
- Inspection, Disk 2.3.5
- Installation, Disk Cartridge 1.2.1.5, F1-22
- Integrity Check, System 2.3.6
- Interconnect (Pedestal), Cabling F1-5
- Interconnect (Single Drive), Cabling . . . F1-3
- Interconnect (Two Drives), Cabling . . . F1-4



Interface:
 Signal Pinout and Description Appendix A
 Signals 1.1.3.1, F1-6

Interference, Head-to-Disk 2.3.5

Introduction:
 Corrective Maintenance 3.1
 Preventive Maintenance 2.1

I/O Board 1.1.4.1

Jumper Settings, Switch and 1.2.1.3

Jumpers:
 Cable Adapter F1-21
 Disk Controller F1-10
 Unit Number F1-21

LED Indicators, Disk Controller F1-11

Loading the Disk Cartridge F1-22

Location:
 Carriage Lock Pin F1-20

Disk:
 Drive Control and Indicator F1-18
 Drive Replaceable Part F1-15
 Velocity Transducer F3-5

Lock, Cartridge F1-23

Lock Pin:
 Carriage 1.2.1.2
 Location, Carriage F1-20

Magnet, Removal/Replacement
 Velocity Transducer 3.4.8

Maintenance:
 Introduction:
 Corrective 3.1
 Preventive 2.1
 Schedule, Preventive T2-2

Supplies and:
 Tools, Corrective T3-1
 Tools, Preventive T2-1

Test Equipment, Corrective T3-1

Motherboard, Removal/Replacement . . . 3.4.19

Mounting:
 Actuator F3-6
 EOT F3-6

Numbers, Part T1-2

Off-line Troubleshooting Flowchart F3-2

One-Track Seek Waveform F3-19, F3-20

Operating Precautions 1.2.1.1

Operation, Fault 1.2.1.9

Operational Fault Troubleshooting
 Flowchart, Disk F3-4

Pack Lock F1-23
 Alignment/Adjustment 3.5.10
 Removal/Replacement F3-13
 Switch, Removal/Replacement 3.4.13

Part:
 Location, Disk Drive Replaceable F1-15
 Numbers T1-2

Parts and Assemblies, Field Replaceable . . T1-3

Parts Description, Replaceable 1.1.4

Parts List, Illustrated F1-15

Photograph:
 Disk:
 Controller F1-8
 Drive F1-12, F1-13
 System F1-1

Physical Description:
 Controller 1.1.3.2
 Drive 1.1.3.2

Piggyback Board, Removal/
 Replacement Power Supply 3.4.18

Pinout and Description, Interface
 Signal Appendix A

PM090, Preventive Maintenance 2.3.1

PM180, Preventive Maintenance 2.3.2

Position Transducer, Removal/
 Replacement 3.4.6

Position Transducer Waveform F3-17

Power Down 1.2.1.10
 Emergency 1.2.1.11

Power Supply:
 Board No. 2, Removal/Replacement . . . F3-15
 No. 1 Board 1.1.4.6
 No. 2 Board 1.1.4.5

Piggyback Board, Removal/
 Replacement 3.4.18
 Removal/Replacement 3.4.17, F3-14

Power Up Procedure 1.2.1.4

Preamplifier:
 Adjustment, Servo F3-16
 Board, AGC Servo 1.1.4.3

Precautions, Operating 1.2.1.1

Preventive Maintenance:
 Introduction 2.1
 PM090 2.3.3
 PM180 2.3.4
 Schedule 2.3, T2-2
 Supplies and Tools T2-1
 User Procedures 2.3.1, 2.3.2

Procedure:
 Index:
 Alignment/Adjustment T3-3
 Removal/Replacement T3-2
 Power Up 1.2.1.4

Procedures:
 Removal and Replacement 3.4
 Startup and Shutdown 1.2.1
 Programming, Disk Controller 1.2.2
 Protect, Write 1.2.1.8

Read/Write/Erase:
 Board Block Diagram F1-16
 R/W/E Board 1.1.4.8

Related Documents Preface

Removal and Replacement Procedures 3.4

Removal, Emergency Disk Cartridge . . . 1.2.1.7

Removal (Normal), Disk Cartridge 1.2.1.6

Removal/Replacement:
 Actuator F3-12
 Actuator Assembly 3.4.2
 Blower Motor 3.4.20, 3.4.21
 Brush 3.4.14
 Brush Assembly F3-13
 Card Case 3.4.19
 Cartridge Index/Sector Transducer . . . 3.4.10
 Cartridge-On Switch 3.4.13



Circuit Board	3.4.16	Spindle Drive Motor, Removal/ Replacement	3.4.15
Controller	3.4.1	Startup and Shutdown Procedures	1.2.1
End of Travel Assembly	3.4.4	Static Eliminator, Alignment/ Adjustment	3.5.7
EOT	3.4.4	Supplies and Tools: Corrective Maintenance	T3-1
Fixed Disk	3.4.5, F3-10	Preventive Maintenance	T2-1
Index/Sector Transducer	3.4.11	Switch and Jumper Settings	1.2.1.3
Front Panel	F3-9	Switch: Alignment/Adjustment Cartridge-On . .	3.5.10
Head	3.4.3, F3-8	Removal/Replacement: Cartridge-On	3.4.13
Inductosyn	3.4.6	Pack Lock	3.4.13
Motherboard	3.4.19	Settings, Disk Drive	F1-14
Pack Lock	F3-13	Settings, TILINE Address	F1-9
Switch	3.4.13	System: Block Diagram, Disk	F1-2
Position Transducer	3.4.6	Components, Disk	T1-2
Power Supply	3.4.17, F3-14	Detailed Block Diagram	F1-7
Board No. 2	F3-15	Integrity Check	2.3.6
Piggyback Board	3.4.18	Photograph, Disk	F1-1
Procedure Index	T3-2	Specifications	1.1.2
Sector Ring	3.4.12	Disk	T1-1
Spindle Assembly	3.4.9	Temperature Stabilization, Alignment/ Adjustment	3.5.1
Spindle Drive Motor	3.4.15	Test Equipment, Corrective Maintenance . .	T3-1
Thermal Link	F3-11	Thermal Link, Removal/Replacement . . .	F3-11
Velocity: Transducer	3.4.7	TILINE Address Switch Settings	F1-9
Transducer Magnet	3.4.8	Tools: Corrective Maintenance Supplies and . . .	T3-1
Replaceable: Part Location, Disk Drive	F1-15	Preventive Maintenance Supplies and . .	T2-1
Parts and Assemblies, Field	T1-3	Track Indicator: Alignment/Adjustment	3.5.6
Parts Description	1.1.4	Assembly	F3-28
Retract Relay, Emergency	1.1.4.6	Transducer; Adjustment: Fixed Disk Index/Sector	F3-30
Reverse Seek Waveform	F3-23	Fixed Disk Sector	F3-30
R/W/E Board, Read/Write/Erase	1.1.4.8	Index/Sector	F3-29
		Magnet, Removal/Replacement Velocity	3.4.8
		Removal/Replacement: Cartridge Index/Sector	3.4.10
Schedule, Preventive Maintenance	2.3, T2-2	Fixed Disk Index/Sector	3.4.11
Sector Board	1.1.4.7	Position	3.4.6
Sector Ring, Removal/Replacement	3.4.12	Velocity	3.4.7
Sector Transducer Adjustment	F3-29	Troubleshooting	3.3
Sector Transducer Adjustment, Fixed Disk	F3-30	Flowchart: Disk Operational Fault	F3-4
Sector Transducer-See Index/Sector Transducer	N/A	Initial	F3-1
Seek Waveform: Forward	F3-22	Off-line	F3-2
One-Track	F3-19, F3-20	Two-Track Seek Waveform	F3-21
Reverse	F3-23	Unit Number Jumpers	F1-21
Two-Track	F3-21	User PM Procedures: Daily	2.3.1
Servo: Board	1.1.4.4, F3-24	Monthly	2.3.2
Preamplifier Adjustment	F3-16	Velocity Transducer: Location	F3-5
Preamplifier, Alignment/Adjustment . . .	3.5.2	Magnet, Removal/Replacement	3.4.8
Preamplifier Board, AGC	1.1.4.3	Removal/Replacement	3.4.7
Settings, Disk Drive Switch	F1-14		
Shutdown Procedures, Startup and	1.2.1		
Signal Pinout and Description, Interface	Appendix A		
Signals, Interface	1.1.3.1, F1-6		
Simulator, Armature Plate	F3-29		
Specifications: Disk System	T1-1		
System	1.1.2		
Spindle Assembly, Removal/ Replacement	3.4.9		



Waveform:

FEOT	F3-25	One-Track Seek	F3-19, F3-20
Forward End-of-Travel	F3-25	Position Transducer	F3-17
Forward Seek	F3-22	Reverse Seek	F3-23
Head Alignment	F3-26	Two-Track Seek	F3-21
Index-to-Burst Period	F3-27	Words, Control	1.2.2
Inductosyn	F3-17	Write Protect	1.2.1.8

FOLD



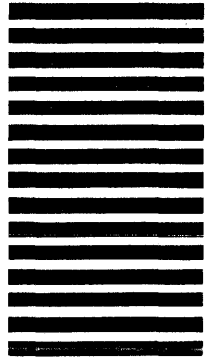
NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 7284 DALLAS, TX

POSTAGE WILL BE PAID BY ADDRESSEE

TEXAS INSTRUMENTS INCORPORATED
DIGITAL SYSTEMS GROUP

ATTN: TECHNICAL PUBLICATIONS
P.O. Box 2909 M/S 2146
Austin, Texas 78769



FOLD



TEXAS INSTRUMENTS

INCORPORATED

DIGITAL SYSTEMS GROUP

POST OFFICE BOX 2909

AUSTIN, TEXAS
