

Trident

Trident Disk Drives Models T202/T302 Maintenance Manual

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April 1982



WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the technical manuals, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

RECORD OF REVISIONS	
REVISION	NOTES
0	ORIGINAL ISSUE
1	New Covers and Title Page & Incorporate TMC $1 - 8/79$.
2	Updates manual to include Model T202 and latest engineering changes.
3	Incorporate Errata Change 1 and Change 3, Add TMC1. $-5/81$.
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SECTION 1 GENERAL INFORMATION

This manual contains preventive maintenance, operational checks and adjustments, removal and replacement procedures, and other related maintenance information for Models T202/T302 Trident Disk Drives (Figure 1-1).

With the exception of the data recording frequency (and those specifications thereby affected) these disk drives are essentially the same. All maintenance procedures described in this manual are applicable to both disk drives unless otherwise stated.



Figure 1-1. Model T202/T302 Trident Disk Drive

This manual is intended as a guide for field engineers and other technical personnel who are involved in maintaining the disk drives. The information in the manual is divided into four basic sections, with each subsection relating to task-oriented objectives.

- General Information Equipment Specifications Major Assemblies Basic Operating Procedures
- Preventive Maintenance Head Inspection and Cleaning

Pack Area Maintenance Periodic Maintenance Schedules

- Corrective Maintenance Alignment Procedures Head Replacement and Adjustment Assembly Removal and Replacement
- Troubleshooting Aids

Before performing preventive or corrective maintenance on the disk drive, maintenance personnel should become familiar with the electrical characteristics and principals of operation of the drive.

RELATED DOCUMENTS

Century Data Systems provides the following related documents to support the T202/T302 Disk Drives:

76206-2XX
76206-4XX
76206-5XX
76206-7XX
76245-1XX

DESCRIPTION

The Model T202/T302 Trident Disk Drives are high speed, random-access memory devices that are used for mass data storage in data processing systems. Each unit is a single, self-contained disk drive mounted in a low-profile cabinet.

The disk drive uses a removable disk pack that is installed or removed by means of a pack area lid at the top front of the unit. Removable covers allow access to the upper and lower interior of the unit for maintenance purposes.

Physical and electrical characteristics for the T202/T302 disk drive are listed in Table 1-1.

TOOLS AND TEST EQUIPMENT

Tools and test equipment recommended for maintaining T202/T302 disk drives are listed in Table 1-2.

LOCATIONS OF MAJOR COMPONENTS

Figure 1-2 shows the locations of major components of the disk drive for the benefit of maintenance technicians unfamiliar with this unit. A brief description of each component shown in the figure follows.

TABLE 1-1. PHYSICAL ANDELECTRICAL CHARACTERISTICS

T

Physical Characteristics	
Height	36 inches
Width	19.5 inches
Depth	33 inches
Weight (shipping)	525 pounds
Weight (operating)	480 pounds
Service Clearance	40 inches,
Power Requirements	
Input Voltage	208 or 240
	-15%,
	± 0.5 Hz
	optional)
Starting Current	25 amperes
	seconds (
Running Current	5 amperes
Operating Environment	
Temperature	60°F to 90°
	15°F cha
Relative Humidity	10% to 80%
	sation)
Heat Dissipation	3500 Btu/h
	(nominal
Specifications	
Disk Pack	CDS P/N 1
	(T202/T
	CDS P/N 2
	(T202RN
	CDS P/N 2
	(T302RN
Disk Pack Capacity	208.1 Mega
	210.1 Mega
	(T202RN
	312.1 Mega
	315.2 Mega
	(T302RN
Recording Format	Fixed or va
Recording Method	Triple freq
Interface Data Transfer	NR7 hit se
Data Transfer Rate	806 kilobyt
Data Hansiel Rate	megabits
	1200 kiloh
	megabits
Data Bit Cell Time	155 nanose
Duta Dit Con Time	103.3 nano
Dotational Snood	2600 mm -
Rotational Speed	Soon thur :
Rotational Latency	0.05
Average	8.35 millise
Maximum	1/.5 millise
Head Positioning	
Method	Servo-contr
and the second	motor

36 inches	
19.5 incres	
33 inches	
525 pounds	
480 pounds	
40 in the found of the	
40 inches, front and rear	
	1
208 or 240 vac, $+10\%$,	
-15% single-phase 60	
$\pm 0.5 \text{ Hz} (50 \pm 1.0 \text{ Hz})$	
± 0.3 Hz (30 ± 1.0 Hz	
optional)	
25 amperes rms for 10	
seconds (nominal)	
5 amperes (nominal)	
60°F to 90°F (max. rate of	
15°F change per hour)	
10% to 80% (no conden-	
sation)	
sation/	
3500 Btu/hour/drive	
(nominal)	
CDS P/N 16988-301	
(T202 (T202)	
(1202/1302)	
CDS P/N 23003-202	
(T202RM)	
CDS P/N 23003-302	
(T302RM)	
208 1 Megabytes (T202)	
210.1 Magabutas	
210.1 Megabytes	
(1202RM)	
312.1 Megabytes (T302)	
315.2 Megabytes	
(T302RM)	
Fixed or variable longth	
rixed of variable length	
Triple frequency, bit serial	
NRZ bit serial	
806 kilohytes/sec (6.45	
$\frac{1}{100}$ knobytes/sec (0.45	
megabits/sec) for 1202;	
1209 kilobytes/sec (9.68	
megabits/sec) for T302	
155 nanoseconds (T202)	
103.3 nanoseconds (T302)	l
200	
3600 rpm ±3%	
8.35 milliseconds	1
17.5 milliseconds	
A	
Servo-controlled linear	
5 A A	

TABLE 1-1. PHYSICAL AND ELECTRICAL CHARACTERISTICS (Continued)

Recording Surfaces	19 data and 1 servo surface
Recording Cylinders	815 (823, RM Pack)
Cylinder Spacing	0.0027 inch (nominal)
Bit Density	4040 bits/inch (nominal) inner track (T202) 6060 bits/inch (nominal) inner track (T302)
Track Density	370/384 tracks/inch
Tracks Per Pack	15352 (plus spares)*
Access Time Minimum	7.5 milliseconds/cylinder to cylinder
Average	30 milliseconds/average seek length
Maximum	55 milliseconds/815-cylin- der seek
Start/Stop Time	
Start	20 seconds (drive ready, nominal)
Stop	30 seconds (nominal)
*Customer dependent	

TABLE 1-2. RECOMMENDED TOOLS AND
TEST EQUIPMENT

Category	Description
Test	Tektronix Scope, Model 465 (equiva-
Equipment	lent or better)
1 1	Digital Multimeter (accuracy of 0.5%
	or better)
	Model T2002B Exerciser (22865-001)
	and Model T2001B Head Alignment
	Meter (23510-001)
	Scratch Disk Pack (16988-301) or
	(23003-302)
	CE Alignment Disk Pack (14975-002)
	Extender Card (12427-001)
Special	Lid Installation Tool (18699-001)
Tools	Head Mounting Torque Wrench
	(11521-001)
	Hex Bit (Head Alignment) 11521-003)
	Head Camming Tool (96803-001)
	Head Alignment Pliers (17209-001)
	Head Alignment Tool Gauge
	(17201-001)
	Head Support Tool (10076-001)
	Head Positioning Tool (97769-001)
	Pin Extractor (T7835-200)
	Safety Pin (97722-001)
	Tach Rod Tool (13445-001)
	Carriage and Way Alignment Fixture
	(17585-001, with case)
	Way Torque Driver (91516-001)
	Bit Way Screw (99129-001)







DECK PLATE GROUND

Figure 1-2. Location of Major Components

11561

- Control Panel Location of all switches and indicators normally used by the operator.
- Blower Assembly Generates air pressure for the disk air system. Major system components include the blower assembly, absolute filter, air system boot, air shrouds, intake filter, and muffler assembly.
- Pack Area Lid Covers disk pack and seals pack area for positive air pressure. Lid is raised for unloading and loading of pack.
- Air Shrouds Front air shroud surrounds disk pack to contain and direct air flow to the pack from the blower assembly. Also mounts pack area lid. Rear air shroud covers carriage and way assembly to contain pressurized air.
- Spindle Rotating assembly on which disk pack is mounted. The spindle is turned by the spindle drive motor through a belt drive system and includes the eddy current brake disk.
- Head Carriage and Way
 Assembly
 Mounts one servo head and 19 read/write data heads in precise alignment with the disk pack. Carriage moves the heads in and out of the disk pack under control of the head-positioning linear motor.
- Power Amplifier Provides drive current to the linear motor bobbin to cause head carriage motion. Provides +50 and -50V supply for spindle brake.
- Logic Card Cage
 Contains disk drive control logic, read/write logic, and servo circuits mounted on seven plug-in circuit boards. System I/O cables also plug into this assembly.
- Read/Write Matrix Boards Contains the logic that is directly associated with enabling a selected head and determining the correct write current; and circuits involved

in the actual writing data onto or reading data from the disk pack.

- Power Supply Provides all necessary dc power to operate the disk drive except ± 50 Vdc.
- Ac Distribution Assembly Contains the distribution network that feeds dc power to the cooling fans, blower motor, and dc power supply. Also mounts the main circuit breaker and contains the relay that controls the spindle drive motor.
- Front, Rear, Dress covers that are removable Top, and Side for maintenance. Covers

CONTROLS AND INDICATORS

Model T202/T302 Trident Disk Drives are designed to be sequenced on and off by the system disk drive controller. However, operating controls are provided to power up and power down the disk drive manually for disk pack changes and for offline maintenance operation. Indicators are provided to show Ready and Device Check status. Except for five maintenance switches, the controls and indicators are located on the operator control panel at the front of each disk drive.

Operator Control Panel

Figure 1-3 shows the controls and indicators on the operator control panel. Their functions are described in Table 1-3.

Maintenance Switches

Figure 1-4 shows the locations of the maintenance switches not normally used by operators. A functional description of each is contained in Table 1-4.

Power Amplifier Circuit Breakers

There are two circuit breakers mounted on the Power Amplifier PCB: +50V CB1 and -50V CB2 (Figure 1-4). These components are not actually maintenance



Figure 1-3. Operator Control Panel

Control/Indicator	Description/Function	
READ ONLY- READ/WRITE Switch	READ ONLY position disables write logic for read-only pack protection. READ/WRITE position enables all data operations (Note 1).	
FAULT Pushbutton Switch/Indicator (Red)	Indicates that an unsafe operating condition has been detected and that corrective action is required. Pressing the pushbutton will clear any fault condition that no longer exists.	
Ready Indicator/ Logical Address Plug (White)	Indicates that the drive is powered up and the heads are loaded. Logical address of the drive is stamped on the indi- cator lens. Flashes during power up until the drive is ready and during power down until the disk pack has stopped.	
START-STOP Switch	START position turns on spindle drive motor, and loads the heads when a pack is present and an unsafe condition does not exist. STOP position retracts the heads, turns off spindle drive motor, and activates the eddy current brake to stop the disk pack.	
Access A and Access B Switches (Note 2)	A or B position enables re- spective interface for access by the controller(s) (Notes 1 and 2).	
 Note 1. An electrical interlock prevents switch actuation from disrupting an operation in progress. Note 2. Applies only to units with dual-access canability 		

TABLE 1-3. CONTROLS AND INDICATORS

switches, since they are normally left on. If either breaker trips, troubleshooting of the servo system is indicated. It will be necessary to reset the circuit breaker to do so.

MAINTENANCE OPERATING PROCEDURES

Normal online operating procedures for operators are given in the Model T202/T302 Trident Disk Drive Installation and Operation Manual. Offline operating procedures, also included in that manual, are recapped below for the benefit of maintenance technicians.

- 1. To place the disk drive offline of the system for maintenance, first power down the drive by setting the START/STOP switch to STOP. The heads should retract, the spindle should slow to a stop in approximately 20 seconds, and the white Ready indicator should flash on and off until the disk pack has stopped turning.
- 2. Remove the rear cover from the drive. Refer to the paragraph titled Removing the Disk Drive Covers.
- 3. Open the swing frame by pulling the two spring latches (top and bottom) to the left and pulling out the swing frame.
- 4. Set the ONLINE/DEGATE switch to DEGATE. Set LOCAL/REMOTE switch to LOCAL. Set the ON-LINE/OFFLINE switch to OFFLINE. The drive is now offline to the system. (See Figure 1-4).

Note

Ensure that all exerciser toggle switches are off (down position) before connecting the exerciser.

5. If the Model T2002B exerciser is to be used, connect the exerciser cable paddleboard to card cage connector J01 on the logic door (top connector, mounted horizontally).

Note

Steps 4 and 5 can be performed while the disk drive is powered up. However, a pack change is usually necessary to protect the customer pack during maintenance, requiring powerdown sequencing before or after the drive is taken offline.

6. Power the drive back up by setting the START/ STOP switch to START. The spindle and pack should start turning and build to full speed in 22 seconds. The heads should load after speed is attained, and the flashing white Ready Indicator should light steadily after 22 seconds.

The unit is now in the Drive Ready condition and offline. Disk drive checkout can now proceed by using the exerciser for control. Device check errors can be cleared through the exerciser or by powerdown/power-up sequencing. To power down while offline, set the START/STOP switch to STOP.





Figure 1-4. Maintenance Switch and Servo Circuit Breaker Locations

Switch	Description/Function	Location
Circuit Breaker CB1	The OFF (down) position removes ac and dc power from all loads within the drive.	AC Distribution Box
ONLINE/OFFLINE Switch	When this switch is in the OFFLINE position, dc ground and chas- sis ground are connected together for the protection of mainte- nance personnel. The ONLINE position allows normal, online operation.	Ac Distribution Box
ONLINE/DEGATE Switch	When this switch is in the down (DEGATE) position, the disk drive is electrically disconnected from the controller and accepts commands from the T2002B Exerciser. The up (ONLINE) position allows the disk drive to be selected by the controller for normal, on- line operation.	Driver/Receiver Card, (Single access) or (dual access); card cage location 1C/D

TABLE 1-4. MAINTENANCE SWITCHES

Switch	Description/Function	Location		
SERVO ENABLE/ SERVO DISABLE Switch	When this switch is in the SERVO ENABLE position, the head- positioning system is enabled for normal operation; the SERVO DISABLE position prevents positioning system operation.	Logic Control II Card, Card cage location 4A/B		
LOCAL/REMOTE Switch*	When this switch is in the REMOTE position, the power sequenc- ing function is assigned to the controller.	Driver card (single-access) or (dual-access); card cage loca- tion 1C/D		
*Not installed on early production units.				

TABLE 1-4. MAINTENANCE SWITCHES (Continued)

CAUTION

Printed-circuit boards and all other electrical components should be removed and replaced only when circuit breaker CB1 is OFF. Further, this switch should be turned ON or OFF only while the disk drive is offline to an operating system. This prevents power transients from reaching the drive interface lines.

7. Make sure that circuit breaker CB1 is ON.

Note

Steps 8 and 9 need not be performed with the disk drive powered down. However, a pack change is usually normal after maintenance and before returning the disk drive to the system.

- 8. Disconnect the exerciser cable from the disk drive connector if applicable.
- 9. Set the ONLINE/DEGATE switch to ONLINE. Set the ONLINE/OFFLINE switch to ONLINE. Set LOCAL/REMOTE switch to REMOTE. The disk drive is now online to the system.
- 10. Set the START/STOP switch to START. If the controller has selected the drive for sequencing, the disk drive will go through a normal power-up sequence.

REMOVING THE DISK DRIVE COVERS

Access to the assemblies contained within the disk drive cabinet for maintenance requires removal of the front cover, rear cover, top cover, or side covers, or a combination of these. When extensive checkout or repair is anticipated, it is easier to remove at least the front and rear covers and the top cover before proceeding.

- 1. Remove the front and back covers from the drive by pulling forward at the top of the cover and lifting the covers straight up out of the retaining trough.
- 2. Remove the top cover by pulling the cover straight up and off the ball stud retainers.
- 3. Remove the side covers by removing two bolts from the upper inside of each cover.

STANDALONE GROUNDING PRECAUTIONS

WARNING

A potentially hazardous voltage difference, as high as 60 volts, may develop between the unit ac ground (chassis frame) and the dc ground (base casting and card cage) when this unit is operating with system cabling disconnected. Read and observe the following precautions. For normal system operation, the ac and dc grounds are isolated from one another at the disk drive, and the dc grounds of all drives are connected together radially at the controller. When operating a disk drive as a standalone unit, physically disconnect it from the operating system; set the ONLINE/OFFLINE switch on the ac distribution box to OFFLINE. This shorts the ac and dc grounds together and eliminates the potential hazard referred to in the Warning above.

When reinstalling a disk drive in the operating system after standalone operation, make sure that the ONLINE/OFFLINE switch is set to ONLINE.

Note

Many system noise problems occur because ac and dc ground isolation is not maintained or because of excessive resistance in the dc ground system.

If a noise problem is experienced, make power-off resistance measurements between the chassis frame (ac ground) and the base casting or card cage terminal E1 (dc ground). Resistance should be at least 1 megohm. If shorted, check the position of the ONLINE/OFFLINE switch first. Another possibility is that one of the shipping bolts that locks the base casting to the frame during shipment is still in place. This should have been removed and discarded prior to initial installation.

PRIORITY SELECT OPERATING MODES

When two controllers are sharing a disk drive, drive usage is determined by the system operating mode. There are two basic ways of operating in a priority select environment (normal priority or override priority) as determined by the setting of priority select DIP switches S1 thru S8 on the driver card in card slot 1C/D. On some machines, the switches may be replaced by jumper sockets and wires, but the effect is the same in either case. Refer to Table 1-5 for switch positions.

As shipped, units arrive at the customer site with the switches configured for normal priority operation. In a normal priority operating mode the act of selecting, the drive also reserves the unit and inhibits the alternate controller from reserving that drive. The controller awaiting drive access will receive a Busy Signal until the drive is available. Driver card in card slot 1C/D contains six LED's which when illuminated display which channel "A" or "B" is selected and reserved.

TABLE 1-5. PRIORITY SELECT SWITCH SETTINGS

Switch Number	S1	S2	S 3	S4	S 5	S 6	S 7	S8*
Normal Priority	On	On	On	Off	Off	Off	Off	Off
Override Priority	Off	Off	Off	On	On	On	On	Off
*Used for factory test only								

DRIVER CARD 1C/D

LED	DS1 = A SELECT TRY
LED	DS2 = A RESERVED
LED	DS3 = B SELECT TRY
IFD	DS4 = B RESERVED

- LED DS5 = A PRIORITY
- LED DS6 = B PRIORITY

In the event that both controller "A" and "B" attempt to select a unit simulatneously, controller "A" will be allowed access. However, when the switches are configured for override priority, a requesting controller can capture the drive *unless* the partner controller has priority reserved the drive.

Override priority allows either controller to cancel the operation of the other controller under any operating condition other than priority reserve operation. For example, assume that controller A has selected and reserved the drive and is using the reserve timer; controller B can cancel that operation, capture the drive, and lock out controller A in the middle of its operation if the switches are configured for override priority. This type of operation allows more flexibility of operation, but places more of the burden of control on the software system.

SECTION 2 PREVENTIVE MAINTENANCE

The purpose of preventive maintenance is to reduce equipment downtime to the lowest possible figure. Every maintenance operation should be performed with this single objective in mind.

The most important part of any preventive maintenance program is periodic inspection. Many potential problems can be discovered visually and corrected before they become serious. Cleanliness is of particular importance in maintaining a disk drive.

Visual inspection should be made for the following conditions:

- Dirt Because of the small air gap between a flying head and a disk surface, dust and dirt can be particularly destructive. The disk drive and disk pack filters prevent serious damage if they are changed regularly and if the disk drive is operated in an office type environment.
- Wear A certain amount of wear is inevitable where mechanical elements are involved. Metal particles and excessive clearances between adjacent moving mechanical parts are indicative of excessive wear.
- Corrosion Corrosion may occur if the disk drive is subjected to temperature and humidity conditions that produce condensation. If corrosion takes place, it generally occurs at the junction of dissimilar metals.
- Defective wiring Wiring insulation may become cracked or frayed, or the wires themselves may become kinked because of improper wire dress or carelessness during maintenance. Wiring attached to the swing frame or cables that run through access holes should be inspected closely.
- Loose electrical connections Loose electrical connections can cause intermittent troubles, usually the most difficult type to remedy. Loose wirewrap connections are unusual; push-on and screw-lug types connections are more likely to be troublesome in this respect.
- Dirty, burned, or pitted contacts Particular attention should be given in contacts that carry high currents. Dirty contacts can be cleaned with a business

card dampened with alcohol; components that have burned or pitted contacts should be replaced.

• Loose mechanical connections — Because of disk drive vibration, mechanical and electrical parts should be inspected periodically to ensure that they are mounted securely.

CLEANING

Cleanliness is probably the single most important element in the maintenance program for the disk drive. With the exception of the read/write heads, cleaning operations are normally limited to the use of lint-free cloths dampened with a solution of 91 percent isopropyl alcohol. The disk pack area and the mechanical assemblies are cleaned with this solution and then wiped dry with the lint-free cloth. The exterior covers of the drive and the pack area lid may be cleaned with a mild detergent, wiped with a damp cloth, and then wiped dry.

CAUTION

Do not use abrasive cleaners and chemical cleaning agents that contain acetone, toluene, xylene, or benzene. These cleaners may cause equipment damage that requires major repair.

PREVENTIVE MAINTENANCE ROUTINES

Preventive maintenance operations and schedules are listed in Tables 2-1 through 2-3. The schedules are based on a normal office type environment and usage. Under different environments or usage the requirements could vary.

READ/WRITE HEAD CONFIGURATION

Each disk drive contains 19 read/write heads and one servo head in the configuration shown in Figure 2-1. These heads differ physically from one another depending upon whether they face up or face down and whether they are mounted on the right- or left-hand side of the head mounting tower. Table 2-4 identifies the servo head and the four types of read/write heads used and their locations by head position.

Component	Procedure	Remarks
External cabinet surfaces	Clean	Use soft cloth and commercial (mild) detergent.
Read/write heads	Inspect	Refer to text for details.
Air shroud	Clean	Refer to text for details.
Spindle surface	Inspect, clean, and lubricate	Refer to text for details.
Spindle drive belt	Inspect	Refer to text for details.
Intake air filter	Clean	Refer to text for details.
Air system boot	Inspect/replace	See ozone note.

TABLE 2-1. BIMONTHLY (60 DAY) PREVENTIVE MAINTENANCE SCHEDULE

TABLE 2-2. SEMIANNUAL PREVENTIVE MAINTENANCE SCHEDULE

Component	Procedure	Remarks			
Perform all Bimonthly Preventive Maintenance Procedures					
Internal cabinet surfaces	Clean	Use a soft brush or vacuum cleaner or both.			
Carriage and way system	Inspect and clean	Refer to procedures given in Section 3.			
Spindle grounding brush	Check resistance	Refer to text for details.			
Power supply	Check voltages	Refer to text for deails.			
Read/write system	Check alignment	Refer to procedures given in Section 3.			
Positioning system	Check adjustment	Refer to procedures given in Section 3.			
Spindle drive system	Check operation	Refer to procedures given in Section 3.			
Air system boot	Inspect/replace	See ozone note.			

TABLE 2-3. ANNUAL PREVENTIVE MAINTENANCE SCHEDULE

Component	Procedure	Remarks				
Perform all Bimonthly Preventive Maintenance Procedures						
Perform all Semiannual Preventive Maintenance Schedules						
Absolute air filter	Replace	Refer to text for details.				
Air system boot	Inspect/replace	See ozone note.				
Lid gasket	Inspect/replace	See ozone note.				

Note

If the disk drive is operating in high ozone environments, the air system boot inspection procedure should be included in the bimonthly preventative maintenance cycle. In areas of normal or low ozone environment levels, the inspection procedure should be performed during the semi-annual and/or annual preventative maintenance cycle. Examples of low, normal and high environmenal ozone levels are as follows:

LOW — Ozone concentration of less than 5 PPHM*.

NORMAL or AVERAGE — Ozone concentration of between 5 to 5 PPHM.

HIGH — Ozone concentration of 12 or more PPHM.

*PPHM — Parts Per Hundred Million

Head Locations	Part Number
0, 4, 8, 12, 16	18507-004
2, 6, 10, 14, 18	18507-003
1, 5, 11, 15	18507-002
3, 7, 9, 13, 17	18507-001
Servo	13500-001

TABLE 2-4. HEAD LOCATIONS AND PART NUMBERS



Figure 2-1. Head/Disk Surface Configuration

Heads are partially identified by color coding of their connectors. Viewed from the rear of the drive, heads with red/brown connectors are installed on the left, and heads with yellow connectors are installed on the right of the head-mounting tower. Color coding of the connectors only simplifies identification; the heads cannot be interchanged from left to right because of physical mounting differences.

READ/WRITE HEAD PROBLEMS

The read/write heads fly on a cushion of air about 30 millionths of an inch from the surface of the disk pack. An exception is during the head loading, while the air bearing that the head is to fly on is being established. As long as this minute separation between the disk and the head is maintained, the heads will operate properly and cause no damage to the disk or to themselves. However, if the heads contact the disk for any reason, damage to the disk or heads usually occurs.

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 recovered properly. However, there are types of head-to-disk interference that can cause significant damage to the disk surfaces and heads. Dirt, dust, oxide, or residue buildups on either the disk pack surfaces or the heads are some of the most common types of head-to-disk interference.

Use soft cloth and commercial (mild) detergent.

Dirt or dust particle damage occurs when a foreign particle becomes wedged between the flying head and the spinning disk. The particle may become embedded in the surface of the disk or in the epoxy of the heads and is likely to leave a deep groove at the point of entry. If the particle remains embedded in the surface of the disk, it will damage the head and render it useless. If the particle remains embedded in the head, it will damage the entire disk surface. If the particle is not detected during preventive maintenance procedures, the particle may eventually be dislodged and become wedged between another head and disk surface.

Residue may also build up on the disk surfaces or on the heads. Residue buildup is usually the result of contamination introduced into the disk pack or head area. The contamination is usually alcohol residue left after cleaning either the disk pack area or the heads, fingerprints that contain oil and salt, or a contaminated environmental atmosphere such as smoke. The results of residue buildup, if not detected, are the same as particle and oxide buildup — a useless head or heads and a damaged disk pack.

An early indication of head-to-disk interference is an excessive number of intermittent read errors. Therefore, the importance of preventive maintenance cannot be overemphasized.

Figure 2-2 shows examples of contamination experienced with the heads and the corrective action to be taken.

ROUTINE HEAD MAINTENANCE

Only in-place inspection and cleaning of the servo and read/write heads are considered routine head maintenance and treated in this section. Head removal, bench type cleaning, installation, and alignment are corrective maintenance procedures and will be found in Section 3.



Figure 2-2. Examples of Head Contamination

Inspecting Installed Heads

To inspect the read/write heads while they are in place, proceed as follows:

- 1. Make sure that the disk drive is powered down. Open the pack area lid, and remove the disk pack.
- 2. Remove the rear cover and rear air shroud from the unit.
- 3. Move the head carriage outward by hand no more than 3/8-inch to separate the heads for easier inspection. Hold the carriage in this position.

CAUTION

The head spring arms that are against the cam surfaces tend to pull the carriage further outward if not restrained and cause the heads to crash together. In step 4, do not touch the head surfaces with the inspecting tools.

- 4. Using a pen flashlight or other light source and a dental mirror, inspect each head for possible damage and for contamination.
- 5. If a head has been damaged, it must be replaced. Refer to Section 3 for the head removal procedure. Dirty heads can usually be cleaned in place by following the head cleaning procedure given in this section. If a head or heads are dirty, remove and clean the disk pack according to the disk pack manufacturer's cleaning procedures. If a head or heads are damanged, return the disk pack to the manufacturer for inspection and repair.

6. After inspection is complete, return the head carriage to the fully retracted position.

Head Cleaning Materials

The only solvents factory approved for cleaning head surfaces are uncontaminated isopropyl alcohol (at least 90 percent) and Freon TF. Under no circumstances should other solutions be used. This applies particularly to acetone, carbon tetrachloride, MEK, trichlorethylene, or even distilled water.

Before each use of the solutions, test them for contamination by allowing a small amount of solution to evaporate on a clean glass. Discard the solution if any residue or dust particles are present on the glass after the solution has evaporated.

Cleaning Installed Heads

CAUTION

Do not clean the heads unnecessarily. Clean only those heads that routine inspection shows to be dirty. Also, never blow on the heads. Moisture in your breath may cause the heads to pick up more contaminants than are dislodged.

- 1. Dampen a lint-free cloth with Freon TF, and clean the contaminated surface of the head pad.
- 2. Dry the head pad with a lint-free cloth.
- 3. Reinspect the head pad to make sure that the head is clean and free of residue. Also check adjacent heads

to be sure that they have not been contaminated by the cleaning operation.

4. If oxide cannot be removed in this way, the head will have to be removed for more thorough cleaning or for replacement. Refer to Section 3 for these procedures.

HEAD CRASH RECOVERY

If a head crash is recognized and corrected immediately, propagation to the heads can be prevented. Oxide can sometimes be removed from the head that has crashed simply by cleaning it in place. If all oxide is removed by the in-place cleaning procedure, the head can be put back into service. The damaged pack, however, must be taken out of service.

With another disk pack installed and up to speed, listen for unusual noises while the heads are flying. If noises are heard that suggest head-to-disk interference, powerdown immediately. The affected head or heads will have to be replaced. If no noises are heard, exercise the unit for at least an hour and then reexamine the heads to make sure they are not picking up more oxide.

DRY LOAD RECOVERY

A dry load occurs when the heads are extended without a pack on the spindle or when the pack is not turning. In either case, the heads usually slam together or slam into the pack with such force that they are damaged beyond repair and must be replaced, since they will not fly properly.

Note

Certain procedures in this book call for manually extending the heads without a pack. When this is done, the head support tool (P/N 10076-001) should be used.

CLEANING THE DISK PACK AREA

- 1. Open the pack area lid and remove the disk pack.
- 2. Wipe the inside of the air shroud (Figure 2-3) with a lint-free cloth dampened with alcohol. Wipe it dry and remove all residue.
- 3. Clean the inside of the pack area lid with the alcohol-dampened cloth. Wipe it dry and remove all residue.
- 4. Inspect the lid gasket for evidence of deterioration and wipe the gasket clean, if necessary. Do not clean the gasket with anything except an alcohol-dampened cloth.



SPINDLE THREADS

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Figure 2-3. Disk Pack Area and Components

CLEANING AND LUBRICATING THE SPINDLE

- 1. Open the pack area lid, and remove the pack.
- 2. Inspect the spindle (Figure 2-3) for dirt or other contamination and for wear.

CAUTION

Do not saturate the spindle surface with alcohol. Alcohol runoff into the spindle bearing will cause damage.

- 3. Clean the spindle surface with alcohol and a lint-free cloth, and wipe the surface dry.
- 4. Use an alcohol-moistened Q-tip swab to remove contamination and grease from the threads of the spindle hole. Use a dry swab to soak up any remaining alcohol.

- 5. Apply a light coat of Sta-Lube Molybdenum Grease, Part No. 3141, to a Q-tip swab, and lubricate the threads of the spindle hole. Do not allow lubricant to get on the surface of the spindle.
- 6. Place a disk pack on the spindle to make sure that it can be installed and removed easily.
- 7. Operate the spindle lock by hand to verify that it engages and disengages freely.

SPINDLE GROUNDING BRUSH CHECK

1. Remove both side covers and the belt drive guards (Figure 2-4).



Figure 2-4. Spindle Grounding Brush and Drive Belt

- 2. Check the resistance between the spindle contact arm and the spindle. Resistance must be at less than 0.5 ohm. If the resistance is too high, the brush must be serviced and readjusted. Refer to Section 3.
- 3. Proceed to the Spindle Drive Belth Check.

SPINDLE DRIVE BELT CHECK

- 1. Inspect the spindle drive belt (Figure 2-4) for fraying or other damage. If damage or belt stretching is apparent, replace the drive belt.
- 2. Replace the side covers and belt guards.

INTAKE FILTER CLEANING AND REPLACEMENT

- 1. Lift the muffler door (Figure 1-2) and tilt the door forward to expose the intake air filter.
- 2. Remove the filter by pulling it straight forward away from the disk drive.
- 3. Inspect the filter. It may be cleaned with a vacuum cleaner if a new filter is not available. Badly clogged filters should be replaced.
- 4. Install the filter by reversing the removal procedure.
- 5. Close the muffler door.

ABSOLUTE FILTER REPLACEMENT

- 1. Remove the front cover.
- 2. Unhook the springs that retain the plenum outlet to the blower cover (Figure 2-5). Leave the springs hooked to the plenum outlet.
- 3. Remove the air system boot from the plenum outlet.



Figure 2-5. Blower Air System, Partial View

Note

The air system boot that connects the output of the abosolute filter to the air shroud intake plenum is susceptible to ozone deterioration. Test results indicate that the rubber boot material has a life expectancy of two years or more when exposed to normal ozone levels. The rubber boot material life expectancy is reduced when exposed to higher ozone levels.

Extended deterioration of the air system boot results in cracking and splitting which could allow rubber or dirt particles to enter the air shroud assembly.

To determine if the rubber boot is beginning to deterioriate, perform the following maintenance steps during regular preventive maintenance cycles and whenever the absolute filter is replaced.

- a. Remove the rubber boot from the asbolute filter assembly and the air shroud intake plenum.
- b. Inspect the outside of the air system boot for cracks in the rubber, especially at the corners and folds.
- c. Turn air system boot completely inside out and inspect the inside for cracks in corners and folds.
- d. If no cracks are found, turn back right side out and reinstall.

- e. If cracks are found, replace the air system boot, part number 16434-001.
- 4. Raise the plenum outlet slightly, tilt it outward on the right side, and withdraw the outlet from the front of the machine.
- 5. Lift the absolute filter and withdraw it from the machine.
- 6. Install the absolute filter by reversing the removal procedure.
- 7. Install the plenum outlet with springs attached by reversing the removal procedure. *Check carefully* to ensure that the rubber boot is positioned correctly.
- 8. Clean the pack area and air shroud assembly after assembly is complete.

POWER SUPPLY CHECKS AND ADJUSTMENTS

The following procedure may be used to check and adjust the power supply dc voltages. All voltage checks should be measured using a DMV and should be within 3 percent accuracy. Adjustment potentiometers are located on the power supply pcb (see Figure 2-6) except the -50 Vdc which is not field adjustable. Refer to Figure 2-7 for location of card cage test points. The +50V is



Figure 2-6. Power Supply Adjustments and Fuse Locations



Figure 2-7. Card Cage Voltage Test Points

measured on the Power Amplifier pcb, J21, pin 4 (see Figure 2-8) and is also not field adjustable. The rear cover must be removed for accessibility. Head loading must be inhibited during this procedure.



Figure 2-8 Power Amplifier +50V Test Point Location

Note

The power supply should not normally require field adjustment. Adjustment of the +5v supply requires a check and possible readjustment of the read/write VFO frequency. Refer to Section 3 for this procedure.

- 1. Ensure that the SERVO ENABLE/SERVO DIS-ABLE switch is set to SERVO DISABLE (down position).
- 2. Set ONLINE/OFFLINE switch to OFFLINE, set ONLINE/DEGATE switch to DEGATE and set LOCAL/REMOTE switch to LOCAL.
- 3. Set circuit breaker CB1 to ON. Observe that the equipment cooling fans and blower motor commence operation. Refer to Table 2-5 for dc voltage.

Output Voltage	Minimum Voltage	Maximum Voltage	Test Point	Adjustment Potentiometer
— 5v	– 4.75v	— 5.25v	Card Cage	R50
+12v	11.50v	12.50v	Card Cage	R23
-12v	-11.50v	-12.50v	Card Cage	R40
+24v	23.0v	25.0v	Card Cage	R29
+ 5v	4.75v	5.25v	Card Cage	R11
-50v	-34v	-42v	Card Cage	Not Adj.

TABLE 2-5. DC POWER SUPPLY VOLTAGES

INDICATOR LAMP REPLACEMENT

To change an indicator lamp, grasp the indicator tile and pull it straight out. The lamp can then be removed from the back side of the tile. After a new lamp has been installed in the tile, press the tile firmly back into the socket.

SECTION 3 CHECKS, ADJUSTMENTS, AND REPLACEMENTS

This section contains instructions for checking, adjusting, aligning, and replacing disk drive components. Additional information including preparation for maintenance, notes and precautions and use of the special tools is also contained herein.

Preparation for Maintenance

Prior to beginning any maintenance, the disk drive is usually removed from online operation. To place the disk drive offline of the system for maintenance perform the following steps.

- 1. Power down the disk drive by setting the START/ STOP switch located on the operator control panel to STOP (down).
- 2. Remove customer data pack.

Note

A scratch disk pack (or CE pack, as the case may be) should always be installed before attempting to perform maintenance operations. Customer or job packs should only be used to verify error-free operation.

- 3. Remove rear cover and open swing frame.
- 4. On card location 1C/D set ONLINE/DEGATE switch to DEGATE. Set LOCAL/REMOTE switch to LOCAL.
- 5. On the ac distribution box, set ONLINE/OFFLINE switch to OFFLINE. Set circuit breaker CB1 to OFF (down position). The disk drive is now offline to the system.

Restoring Disk Drive to Online Operation

- 1. On the ac distribution box, set circuit breaker CB1 to ON (up position). Set ONLINE/OFFLINE switch to ONLINE.
- 2. On card location 1C/D set LOCAL/REMOTE switch to REMOTE. Set ONLINE/DEGATE switch to ONLINE.
- 3. Close swing frame and install rear cover.

- 4. Install customer data pack.
- 5. Set START/STOP switch on the operator control panel to START. The disk drive is now online and the drive control has been returned to the system.

MAINTENANCE NOTES AND PRECAUTIONS

Circuit breaker CB1 on the ac distribution box should always be off when mechanical adjustments or replacements are being performed unless otherwise noted. It should also be off while removing or replacing circuit cards.

The air shroud area can easily become contaminated by dust and dirt if the pack area lid is left open. This area can also be contaminated by metal particles if the disk pack rubs against loose screws in the bottom of the shroud area. Also, the disk drive should not be operated except for maintenance purposes with the rear air shroud removed. Operating the unit with the shroud removed increases the chance of contamination.

Note

It is recommended that maintenance personnel read through an entire procedure before attempting to perform it.

If maintenance procedure includes manual load of R/W heads, SERVO ENABLE/SERVO DISABLE switch on card location 4A/B must be placed in SERVO DISABLE position.

Note

Certain maintenance procedures require that the read/write heads be extended manually into the spinning disk pack while the linear motor is inoperative. Ensure that power to the drive motor is not removed while the heads are under manual control (i.e., with the servo disabled); a power shutdown will invariably cause a "head crash" and result in extensive damage. Before loading the heads manually, make certain that the disk pack is up to speed. This normally requires approximately 20 seconds after the START/STOP switch on the control panel is activated.

Other maintenance procedures require that the head carriage be extended manually into the air shroud area with the disk pack removed. This must always be done with power off, and the head support tool installed.

SPECIAL TOOLS

A number of special tools are required to service the disk drive adequately. These tools are described and their use is discussed in this section at the time each is used. Refer to Section 1 for complete list of tools.

LOGIC CARD CAGE ASSEMBLY

The logic card cage assembly is mounted on the swing frame at the rear of the machine. All the electronics for the machine with the exception of the read/write matrix boards, servo head preamp, speed transducer, and emergency retract assembly are contained on seven plug-in circuit cards housed within the card cage.

Card Locations

Figure 3-1 shows the card cage layout, and Table 3-1 lists the correct card locations for the plug-in circuit cards.

Logic Test Points

Most card connector test points are located on the wired side of the connector panel wired assembly. The test points are accessible when the swing frame assembly is opened.

Test points are identified by card slot, connector, and pin number. For example, test point 6B35 designates card location 6, connector row B, pin 35. There are two connectors per card; each card in location 1 occupies either rows A and B or C and D. Refer to Figure 3-1 for clarification.

Card Removal and Replacement

1. Perform Preparation for Maintenance, page 3-1.

CAUTION

Circuit breaker CB1 must be turned off before a circuit card is removed or replaced. Also, some cards can be damaged if they are installed in the wrong slot.

Plug-in circuit cards are best replaced with the swing frame latched in the closed position. Circuit cards can be removed by hand. Grasp the card at each corner with your fingers and pull the card out with a slight rocking motion. When reinstalling a circuit

card, make sure that it is placed in the correct slot with the component side facing the linear motor. Guide the card evenly until it meets the connectors; then press it home with equal pressure at both corners.

2. Perform Restoring Disk Drive to Online Operation, page 3-1.



Figure 3-1. Card Cage Layout, Card Side View

TABLE 3-1. CARD LOCATIONS

Location	Row	Card Designation
1	A/B	Servo Control I, P/N 21822-001 (T302)
1	A/B	Servo Control I, P/N 21511-001 (T202)
2	A/B	Servo Control II, P/N 16461-001
3	A/B	Logic Control I, P/N 17732-001
3	A/B	Logic Control I, P/N 22928-001 (T202RM/T302RM)
4	A/B	Logic Control II, P/N 17735-001
4	A/B	Logic Control II, P/N 22931-002 (T202RM/T302RM)
5	A/B	Read Limiter, P/N 16458-001 (T302)
5	A/B	Read Limiter, P/N 17686-001 (T202)
1	C/D	Driver • P/N 19573-001 (Single-access) • P/N 19831-001 (Dual-access)
2	C/D	Receiver • P/N 19576-001 (Single-access) • P/N 17726-001 (Dual-access)
5	C/D	Data Separator, P/N 17963-001 (T302)
5	C/D	Data Separator, P/N 20899-001 (T202)

POSITIONING SYSTEM

Electrical and mechanical checks and adjustments for the positioning system are contained in the following paragraphs. If electrical adjustment is required, all electrical adjustments should be performed, and they should be performed in the sequence given.

Special Tools and Test Equipment for the Positioning System

Special tools and test equipment required for servicing the positioning system are as follows:

- Tach Rod Tool, P/N 13445-001
- Head Mounting Torque Wrench, P/N 11521-001 with HEX BIT P/N 11521-003
- Carriage and Way Alignment Fixture, P/N 96840-001, (P/N 17585-001 includes case)
- Head Support Tool, P/N 10076-001

- Bit, Way Screw, P/N 99129-001
- Way Torque Driver, P/N 91516-001
- Model T2002B Exerciser, P/N 22865-001
- Scratch Disk Pack, P/N 16988-301

Perform the electrical preadjustment procedure given in the next paragraph before attempting the Positioning System adjustment procedures.

Electrical Preadjustment Procedure

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove top rear cover and air shroud.
- 3. Set SERVO ENABLE/SERVO DISABLE on the Control Logic II card in location 4A/B to SERVO DISABLE.
- 4. Install the Model T2002B exerciser.
- 5. Set circuit breaker CB1 to ON.
- 6. Mount a scratch pack.
- 7. Ensure that the head carriage is fully retracted. Set the START/STOP switch to START and note that the SPEED lamp on the exerciser lights with the DISPLAY SELECT switch set to SEQUENCE.

POSITIONING SYSTEM ADJUSTMENTS

Phase Lock Oscillator (PLO) Frequency Check and Adjustment.

- 1. Set up the scope as follows:
 - SYNC: Int, pos, 0.5 μ sec/div, CHAN 1.
 - CHAN 1: TP3 at card location 1A/B (Figure 3-2A).
 - MODE: CHAN 1
- Verify that the observed 403 kHz signal period is 2.5 microseconds + or 100 nanoseconds at the signal 50% point. Adjust R35 as necessary to meet this requirement. Refer to Figure 3-2A for location.
- 3. Change the sweep speed to $1 \mu \text{sec/div}$. Set the scope display so that three cycles are displayed. Set the third positive transition in the center of the display and set the X10 magnifier on.

CAUTION

When manually loading or unloading the heads, do so in a positive and deliberate manner, without hesitation. If the heads are moved into the pack too slowly, they could crash.



Figure 3-2. Positioning System Adjustment Locations, Test Points, and Position Signal

- 4. Manually load the heads and move them back and forth between the head load zone and the outer guard band of the pack. Notice that this type of back and forth movement causes a phase shift in the scope display as the oscillator alternates between its locked and free-run states. Readjust R35 to eliminate this phase shift when the heads are moved back and forth between the head load zone and outer guard band. Recheck frequency to insure you have not locked up on a harmonic.
- 5. Retract the head carriage manually.

Servo AGC Adjustment

- 1. Set up the scope as follows:
 - SYNC: Int, pos, 1 μ sec/div, CHAN 1

• CHAN 1: Dc 2v/div, TP2 at card location 1A/B (Figure 3-2A)

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- MODE: CHAN 1
- 2. Load the heads manually.
- 3. Manually position the head carriage over the outer guard band and observe the display amplitude. Adjust potentiometer R136 (Figure 3-2A) for a peakto-peak amplitude of 9 \pm 0.2 volts.

Note

Heads must be maintained in the outer guard band or adjustment will be incorrect.

4. Retract the head carriage manually.

Position Gain Adjustment

- 1. Set up the scope as follows:
 - SYNC: Int, pos, 5 msec/div, CHAN 1
 - CHAN 1: Dc, 1v/div, TP4 at card location 1A/B (Figure 3-2A)
 - MODE: CHAN 1
- 2. Load the heads manually.
- 3. Move the head carriage back and forth manually over the data area of the pack and note that the scope display corresponds to that shown in Figure 3-2B. Adjust R93 (Figure 3-2A) to achieve the desired result.
- 4. Retract the head carriage manually.
- 5. Perform Restoring Disk Drive to Online Operation, page 3-1.

Power Amplifier Null Check

Note

This is not normally a field adjustment. Do not attempt this adjustment procedure unless a DVM is available.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Install exerciser, power up disk drive and place heads at cylinder 496.
- 3. Connect the DVM between TP4 on card 1A/B and logic ground.
- 4. Reading on DVM should be 0.000 \pm 0.500 millivolts at cylinder 496.
- 5. Rezero the drive several times and observe the meter reading after each operation. Verify the reading at cylinders 000 and 800. The reading should be repeatable with ± 15 millivolts.
- 6. If adjustment is required, R7 (Figure 3-3) may be altered. This is a very critical adjustment.
- 7. Proceed to Velocity Adjustment.

Velocity Adjustment

- 1. Set up the exerciser switches for an 814-cylinder, alternate-seek operation. The position rate switch should be set to the three-quarter full position.
- 2. Set up the scope as follows:
 - SYNC: Int, pos, 10 msec/div, CHAN 1
 - CHAN 1: Dc, 2v/div, 4B19 (FWD)
 - CHAN 2: Dc, 2v/div, 4A40 (RDY)
 - MODE: CHOPPED
- 3. Press the CONT switch on the exerciser. Monitor the channel 2 display and record the access time for a forward seek.
- 4. Change the scope trigger from positive to negative.



Figure 3-3. Power Amplifier Adjustment Location

- 5. Monitor the channel 2 display and record the access time for a reverse seek.
- 6. Compare the forward and reverse access times. The longer seek should not exceed 51 ± 1 milliseconds, and the shorter seek should be within 3 milliseconds of the longer one. Adjust potentiometer R140 (only potentiometer at card location 2A/B) for the desired result.

Note

Initial adjustment shall be made with a cold motor. A cold motor is defined as a motor in a $72^{\circ}F \pm 5^{\circ}F$ room with 15% or less duty cycle on the servo during the previous hour.

7. Perform Restoring Disk Drive to Online Operation, page 3-1.

Heads-Extended Microswitch Check and Adjustment

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Ensure that the head carriage is fully retracted.
- 3. Remove top rear cover and air shroud.

CAUTION

Do not extend the heads past the cam tower, as head crash will result.

- 4. Manually extend the head carriage forward approximately 1/4 inch. The microswitch contact should transfer approximately 0.060-inch from the fully retracted position.
- 5. While the heads are still extended, measure the resistance across the normally closed contacts. Resistance should be less than 1 ohm.
- 6. Retract the head carriage. If the check above indicates that adjustment is required, proceed as follows:
 - Loosen the switch-mounting screws.
 - Position the head carriage approximately 0.060inch from the fully retracted position.
 - Adjust the microswitch until its contacts transfer at the point indicated in step 4. Tighten the mounting screws.
- 7. Power the drive up and down. Check the clearance between the linear motor softstop and carriage. It

should be 0.010 inch when the switch is correctly adjusted.

8. Proceed to Heads-Extended Microswitch Replacement if necessary. If replacement is not required proceed to End-of-Travel Microswitch Check and Adjustment.

Heads-Extended Microswitch Replacement

- 1. Remove the microswitch plug.
- 2. Remove the two screws that attach the microswitch to the mounting bracket. Remove the microswitch.
- 3. Install the replacement microswitch. Install but do not tighten the screws.
- 4. Perform the microswitch adjustment procedure above.

End-of-Travel Microswitch Check and Adjustment

- 1. Install the scratch disk pack.
- 2. Unplug connector P/J42 on the emergency retract board.
- 3. Set the START/STOP switch to START.
- 4. Manually load the heads and extend the head carriage to the forward endstop.

Note

The transfer of the end-of-travel microswitch can be monitored by observing emergency retract relay K1. When the microswitch transfers, K1 deenergizes.

5. Exert a slight pressure (5 ± 2 lbs.) on the carriage against the forward endstop and observe that K1 deenergizes.

If the microswitch adjustment is correct, unload the heads manually and connect P/J42. Otherwise, continue the procedure.

- 6. Adjust the microswitch so that a slight pressure on the carriage against the forward endstop causes K1 to deenergize.
- 7. After the adjustment is performed and rechecked, manually unload the heads and power the drive down.
- 8. Connect P/J42. Proceed to End-of-Travel Microswitch Replacement if necessary.

End-of-Travel Microswitch Replacement

- 1. Remove the plug from the microswitch.
- 2. Remove the two screws that fasten the microswitch to the mounting bracket. Remove the microswitch.
- 3. Install the replacement microswitch. Install but do not tighten the screws.
- 4. Adjust the microswitch as described above.
- 5. Replace rear air shroud and rear top cover.
- 6. Perform Restoring Disk Drive to Online Operation, page 3-1.

Tach Rod and Velocity Transducer Replacement

The velocity transducer is composed of a transducer housing and a tach rod. A special tool, the tach rod tool, is required to remove and insert the tach rod in the housing. The use of this tool is described below. The head alignment torque wrench (P/N 11521-001) is used to torque the tach rod in place. The tach rod tool is required for removing and installing tach rods because the rod is not otherwise accessible. When the velocity transducer housing (Figure 3-4) is removed from the linear motor, the tach rod remains inside the motor with one end screwed into the head block.

Note

Ensure that the head carriage is secured in the retracted position to allow the tach rod tool to mate with the tach rod and to eliminate the possibility of dry loading the heads.

The tach rod tool is inserted into the rear of the motor and over the tach rod in place of the housing. The two holes in the tach rod end flange (Figure 3-5) are mated with two corresponding dowel pins on the tool, and the tool is then turned to unscrew the tach rod. A springloaded ball within the tool bore provides tension to hold the rod so that it may be withdrawn from the motor. Installing the tach rod is done in a like manner. The tach rod should be torqued with the head alignment torque wrench only.

Note

Use care that the tach rod tool is fully inserted in the motor housing during installation. When fully inserted, the head carriage will move out approximately one inch from the fully retracted position. If the tool is not fully inserted, the tach rod will not be centered in the floating nut on the head block and may cause positioning errors after installation.

Replace the Tach Rod as follows:

- 1. Perform Preparation for Maintenance page 3-1.
- 2. Remove top rear cover and air shroud.
- 3. Ensure that the bobbin is fully retracted, then remove the two screws that fasten the housing retainer to the rear of the linear motor.
- 4. Remove the housing and housing tension spring from the motor.
- 5. Remove the velocity transducer housing.
- 6. Use the tach rod tool to remove the tach rod.
- 7. Install the replacement tack rod and torque with 80 ± 6 inch ounce setting.
- 8. Install the velocity transducer housing, the housing retainer and the spring.
- 9. Install a scratch pack.
- Set SERVO ENABLE/SERVO DISABLE switch on Control Logic II card in location 4A/B to SERVO DISABLE.
- 11. Set circuit breaker CB1 to ON, and power up the drive. Ensure that the disk is rotating, and load the heads manually.
- 12. Verify that the tach rod has complete freedom of movement within the tach rod housing by moving the carriage slowly back and forth.
- 13. Set up the scope as follows:
 - SYNC: Int, pos 1 ms/div, AUTO
 - CHAN 1: Dc, 1v/div, 2A49 (VELIN:S)
 - MODE: CHAN 1
- 14. Check the output of the transducer while moving the carriage back and forth. Observe that the output is negative while the carriage is moving forward and positive while moving in reverse. If the opposite is true, interchange the two pins in connector PA2 attached to the card slot 2A/B at pins A49 and A47 using pin extractor tool P/N T7835-200.





Linear Motor Bobbin Check and Adjustment

Head support tool P/N 10076-001 must be used for the following procedure.

The head support tool fits over the heads in their cammed positions and screws onto the head block. With this tool in place, the carriage can be extended safely into the shroud area without a pack installed to facilitate certain maintenance procedures such as bobbin or motor replacement. Figure 3-6 shows the head support tool installed.



Figure 3-6. Head Support Tool Installed

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the top rear cover and air shroud.
- 3. Install the head support tool.
- 4. Load the heads manually.
- 5. Check for a shorted condition from each bobbin terminal (heavy uninsulated wires are bobbin leads) to logic ground while moving the carriage back and forth along the entire carriage way. See Figure 3-7.

- 6. While moving the carriage back and forth, verify that the conductor bands are not being distorted and that the bobbin moves freely within the motor block. If the bobbin checks indicate that mechanical adjustment is necessary, continue with the following procedure; otherwise proceed to step 12.
- 7. Loosen the seven screws that secure the bobbin to the head tower.
- 8. Extend the carriage and insert four pieces of card or heavy paper stock around the outer bobbin flange (Figure 3-8). Slide the bobbin carefully to the fully retracted position.
- Torque the bobbin screws to the proper value (No. 6's 100 ±5 inch ounces, No. 4's 64 ±5 inch ounces).
- 10. Extend the carriage and remove the paper shims.



Figure 3-7. Bobbin and Related Components



Figure 3-8. Bobbin Shims In Place

- 11. Ensure that the bobbin has complete freedom of movement within the motor block by repeating step 6 above.
- 12. Measure the bobbin for a shorted or open condition. The actual resistance is marked on the bobbin and it normally ranges between 1.36 and 1.50 ohms.

Note

The carriage will normally move in one direction or the other while the measurement is being made. Reversing the leads causes the carriage to move in the opposite direction. The additional weight of the head support tool may prevent this movement from taking place.

- 13. If the preceding check indicates that the bobbin is defective, replace the bobbin. Instructions for replacing the bobbin are contained in the Linear Motor/Bobbin Replacement procedure that follows. Otherwise remove the head support tool and continue.
- 14. Perform Restoring Disk Drive to Online Operation, page 3-1.

Linear Motor/Bobbin Replacement

The majority of problems with the linear motor are caused by a defective motor bobbin. Because of the restricted space available, the motor bobbin is not accessible with the linear motor in place; the motor must be removed from the cabinet in order to remove the bobbin. The following procedure provides instructions for replacing both the motor and the motor bobbin.

CAUTION

Do not remove the head tower from the carriage. The head tower is factory aligned to the carriage and way assembly.

- 1. Perform Preparation for Maintenance page 3-1.
- 2. Remove top rear cover and air shroud.
- 3. Tag and disconnect the four wires from the bobbin and temperature-sensing thermistor at the motor terminal mount. (See Figure 3-7.)
- 4. Loosen the two screws that secure the motor terminal mount to the head tower. Restrain the terminal mount while removing the screws to keep it from snapping forward.

- 5. Install the head support tool, and extend the head tower into the shroud area.
- 6. Remove the screw that fastens the crash bar to the linear motor. (See Figure 3-8.) Do not lose the shims

 they must be installed with the replacement motor.

Note

On some units it may also be necessary to remove the bar from the cam tower.

- 7. Remove the velocity transducer.
- 8. Remove the seven screws that fasten the bobbin to the head tower. Note the position of the ground lead so that it may be connected correctly during installation.
- 9. Remove the four screws that fasten the linear motor to the deck plate.
- 10. Remove four screws that retain the top rear crossmember, and remove the crossmember.

WARNING

The linear motor weighs approximately 90 lbs. Exercise correct lifting procedure when removing the motor to avoid injury.

11. Grasp the motor securely, lift it straight up off the dowel pins, and remove it from the deck plate. If motor repair is to be effected by bobbin replacement, study the motor block carefully to determine which type motor has been removed. The complete motor assembly is interchangeable, but the motor bobbins are not. Motor types are identified by their physical appearance. (See Figure 3-9.) Motor blocks with rough castings are SLI motors, and those with smooth castings are Infomag motors. There are two different types of SLI motors, but one bobbin fits both.



Figure 3-9. Motor Bobbin Identification (Front View)

- 12. Remove the bobbin and install the replacement unit.
- 13. Clean the surface of the deck plate, and install the replacement motor by reversing the removal procedure. When replacing the motor, observe the following requirements:
 - Clearance between the head block and the crash bar should be $0.003 \pm .002$ inch (T302) (0.003 $\pm .002$ T202) throughout the carriage travel.
 - Torque the motor-mounting screws to 240 inchpounds.
- 14. Perform the Linear Motor Bobbin Check and Adjustment procedure.
- 15. Install the velocity transducer.
- 15A. Manually extend head carriage to about cylinder 200. Check linear motor bobbin polarity using a 9-Volt VOM set at X1 scale ohms. Place meter positive lead to connector P42-3 (grey wire) on emergency retract PWB (Figure 3-33) and negative lead to P42-1 (blue wire). Head carriage should drive forward (toward spindle), reverse the meter leads and observe that the head carriage moves in reverse. Depending on meter used, and/or the added weight of the head support tool this movement may be very slight. If correct movement is not observed, check bobbin leads for reverse installation.
- 16. Perform the Electrical Preadjustment Procedure, steps 3 through 7.

CAUTION

During the next step, listen carefully for a tinging noise, which indicates that one or more heads are contacting the pack. Retract the heads immediately if head contact occurs.

17. Load the heads manually. Then move the heads slowly and carefully in (no more than 2 inches) and out of the disk pack area by hand; listen for head-todisk interference. Also be aware of any feeling of mechanical interference or roughness in carriage travel.

Note

If head contact was made with the disk pack, power down the drive, remove the pack, and clean the heads in place. Replace any head that cannot be cleaned, and correct the interference problem before proceeding. Also check the pack carefully for evidence of damage. If in doubt, do not reuse the pack.

- 18. Retract the heads fully from the disk pack, and set the START/STOP switch to STOP.
- 19. Install the rear air shroud, and cover, then set the SERVO ENABLE/SERVO DISABLE switch to SERVO ENABLE.
- 20. With a scratch pack still installed, set the START/ STOP switch to START. The disk drive should sequence up, and the heads should load automatically within 25 seconds. The Ready Indicator/Logical Address Plug should flash at a 1-second rate during power up and should remain lit after the heads load.
- 21. Perform Restoring Disk Drive to Online Operation, page 3-1.

Servo Preamp Replacement

- 1. Perform Preparation for Maintenance page 3-1.
- 2. Remove top rear cover and air shroud.
- 3. Disconnect P/J43 at the servo preamp board (Figure 3-10).
- 4. Disconnect the servo head connector plug from the servo preamp.



Figure 3-10. Servo Preamp Attachment and Related Components

- 5. Remove the two screws and their associated spacers that fasten the plastic cover to the servo preamp board.
- 6. Remove the two screws that fasten the servo preamp board to the deck plate. Note the dressing of the ground wires.
- 7. Install the servo preamp by reversing the removal procedure.
- 8. Replace rear air shroud and top rear cover.
- 9. Perform Restoring Disk Drive to Online Operation, page 3-1.

Carriage and Way Alignment

Carriage and way alignment is set at the factory and realignment is not normally required unless the carriage and way is replaced. Spindle replacement can necessitate realignment, but this is the exception rather than the rule.

Carriage and way alignment is normally indicated if read/write heads 00 and 18 cannot be adjusted to within ± 250 microinches of track center at cylinders 008 and 800.. This assumes that the heads and disk pack are within specification, and that the servo is positioning correctly.

Carriage and way alignment problems normally manifest themselves as a pattern of intermittent data checks at the lower- and higher-numbered cylinders. Occasionally, a bearing in the carriage and way assembly will fail; this failure usually results in a positioning fault such as a seek incomplete or wrong cylinder selection.

The alignment procedure itself requires considerable time and jugement on the part of the person performing the task. Alignment should not be attempted by anyone who has not actually seen or assisted in the performance of the procdure.

The following special tools are required for aligning the carriage and way assembly:

• Alignment Fixture P/N 96840-001 (Rev J or later must be used)

Note

The carriage and way fixture is a multipiece alignment jig that is used to verify the roll, and yaw axis alignment of the head carriage in relation to the spindle. Bit, Way Screw, P/N 99129-001

Way Torque Driver, P/N 91516-001

Note

Use the carriage and way carrying case, P/N 12032-001, to protect the alignment tools when they are not in use.

Perform the alignment procedure as follows:

- 1. Perform Preparation for Maintenance page 3-1.
- 2. Ensure that the head carriage is fully retracted.
- 3. Remove the front air shroud and rear top cover and air shroud.
- 4. Remove all read/write heads from the head tower and set them aside in a safe place.
- 5. Using a standard allen wrench, loosen carriage and way screws No. 1, No. 2, and No. 3 (Figure 3-11); then torque screws No. 1 and No. 3 to 18 ± 2 inchpounds.
- 6. Clean all mating and measuring surfaces of the alignment tool parts with alcohol and lint-free tissues. Clean the affected drive components (carriage bearings, way surfaces, and spindle surfaces) in the same manner.
- 7. With the tilt dial indicator installed on the alignment fixture (Figure 3-12), place the alignment fixture on its side on a flat surface. Mate the alignment plate with the fixture so that the three inline pads and the button on the alignment plate mate with the two spherical buttons, the tilt indicator, and the runout pad on the alignment fixture as shown in Figure 3-12.
- 8. Position the tilt dial indicator horizontally about its mounting screw until the small hand on the dial indicator is between 4 and 6, and then tighten the mounting scew enough to hold the adjustment.
- 9. Loosen the dial face locking screw and rotate the dial face so that the big hand on the dial indicator indicates 0; then lock the dial face. Ensure that the alignment plate and fixture are properly mated while zeroing the dial face.

Note

The top thumbscrew on the alignment plate threads into the third head-mounting screw hole from the top. Servo head alignment pins must be visable through the two holes in the center back of the alignment plate.



Alignment Fixture

10. Using the two thumbscrews, fasten the alignment plate to the head tower as shown in Figure 3-13. Ensure that the place is seated firmly against the head tower and that no gap exists.

Note

The correct shoulder bolt has a hole approximately 3/16-inch in diameter in the threaded end.

- 11. Screw the knurled shoulder bolt finger tight into the center of the spindle.
- 12. Seat the alignment fixture on the spindle with the springs on the spring retainer connected to the fixture holddown screws, and hook the spring-loaded retainer under the shoulder bolt in the spindle.
- 13. Install the runout dial indicator on the cam tower indicator clamp with the compression spring over the barrel of the dial indicator. Secure the clamp on the cam tower so that the dial indicator mates with the pad on the side of the alignment fixture.
- 14. Position the runout dial indicator horizontally about its mounting screw until the small hand on the dial indicator is between 4 and 6, then tighten the mounting screw enough to hold the adjustment.

- 15. Position the carriage so that the alignment plate is in relation to the alignment fixture as shown in Figure 3-14. Loosen the dial face locking screw and rotate the dial face so that the big hand on the dial indicator is at 0, then relock the dial face.
- 16. Move the carriage as close as possible toward the spindle.

Note

The carriage must remain against the forward stop until step 19 has been completed.

17. If the tilt indicator does not indicate 0, determine which pad is out of contact with its spherical button by observing the gap between the pad and the button or, if a gap is not visible, apply light finger pressure at the top or bottom of the alignment plate and fixture.

Note

If a large gap exists, and excessive pressure is applied, the fixture could shift on the spindle and cause erroneous readings. Eliminate any obvious gaps by adjusting the jackscrew before testing with finger pressure.



Figure 3-13. Carriage and Way Alignment Fixture Details



Figure 3-14. Carriage and Way Alignment Fixture Component Parts

- 18. If a gap exists at the top pad, turn the leveling jack (Figure 3-13) clockwise; if a gap is at the bottom pad, turn the leveling jack counterclockwise. Do not turn the leveling jack excessively. Loosening screw No. 2 is necessary to turn the leveling jack clockwise; tighten screw No. 2 when the leveling jack is turned counterclockwise to follow the jack adjustment.
- 19. Continue the adjustment until the indicator reads 0 ± 0.002 inch (two small marks on the dial face).
- 20. Torque screw No. 2 to 18 ± 2 inch-pounds.
- 21. Move the carriage away from the spindle until the spherical button on the alignment plate rests on the rearward end of the long pad on the alignment fix-ture approximately as shown in Figure 3-14.
- 22. Reset the runout dial indicator to 0, if necessary, and verify that the indicator is still in its working range and not bottoming.
- 23. Move the carriage toward the spindle; stop the carriage just before the center pad of the three inline pads contacts the tilt indicator.
- 24. If the runout dial indicator reads greater than 0 ± 0.0002 inch (two small marks on the dial face), adjust the position of the way by tapping the side of the way with a plastic mallet and brass punch at the point indicated in Figure 3-13 until the dial indicator does read 0 ± 0.0001 inch.

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- 25. Repeat steps 21 thru 24 until no further adjustment is necessary. Rezero the dial indicator as required during the procedure.
- 26. Recheck the tilt adjustment by repeating steps 16 thru 20.
- 27. If tilt readjustment was necessary, recheck the runout adjustment by repeating steps 21 thru 25.
- 28. Repeat step 26 and 27 until neither tilt nor runout requires further adjustment.
- 29. Gradually torque the way screws, in numerical sequence; first to 30 inch-pounds, then to 40 inch-pounds, and finally to 50 \pm 3 inch-pounds (T302) (\pm 5 T202). After each tightening, recheck the tilt and runout adjustments, and correct them as necessary. The final tilt and runout reading should be 0 \pm 0.0001 inch.

Note

As the way screws are tightened, the play in the leveling jack is taken up, thereby changing the tilt. Also, the way tends to move during the tightening procedure and this affects runout alignment.

30. Extend the carriage manually; verify that the tach rod has complete clearance within the velocity transducer and that the bobbin has complete clearance

- 33. Align heads 00 and 18.
- 34. Use the exerciser to seek cylinders 008 and 800, and check the alignment of heads 00 and 18 at these cylinders. If the heads are more than ± 250 microinches out of alignment on the cylinders, the carriage and way alignment is not correct.
- 35. Remove the read/write heads and reinstall the alignment tool.
- 36. Recheck the tilt and runout adjustments by performing steps 26 thru 28.
- 37. If any tilt or runout readjustment is necessary, repeat steps 30 thru 34.
- 38. When the tilt and runout adjustments measure correctly and the alignment of heads 00 and 18 at cylinders 008 and 800 after step 37 is performed, this fact should be recorded along with the readings for heads 00 and 18 on cylinders 008 and 800, and then the remainder of the read/write heads should be installed and aligned. Restore the drive to operational status (step 40).
- 39. If heads 00 and 18 do not read within ± 250 microinches on cylinders 008 and 800 after step 37 has been performed, replace the carriage and way assembly.
- 40. Perform Restoring Disk Drive to Online Operation, page 3-1.

Carriage and Way Assembly, Inspection and Cleaning

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove top rear cover and linear motor air shroud.
- 3. Open pack area lid and install the Head Support Tool P/N 10076-001.
- 4. Remove pack area access cover (3 screws). Refer to Figure 3-28.
- 5. Inspect way on three top surfaces and two front under side surfaces using pen light and mirror.
- 6. Use an alcohol-moistened cloth to clean the way rails exposed under the access cover. Use a lint-free cloth to dry same.
- 7. Move the heads forward and into the pack area, hold heads forward and clean way rear bearing surfaces. Carefully clean outer bearing races while moving carriage in and out. Wipe dry with a clean lint-free cloth.

CAUTION

Light application of alcohol to lint-free cloth may be used to clean outer bearing races, but care must be taken as excessive amounts may get inside bearings and cause premature failure.

- 8. Re-inspect way surfaces, again, using pen light and mirror. Inspect all areas of way for damage with carriage moved in different positions, i.e., anodized surface worn, aluminum surface visible through anodized coating, etc. Move carriage back and forth and check for smooth operation. If damage is noted, refer to Carriage and Way Replacement in this section.
- 9. After inspection and cleaning is completed, retract heads and remove head support tool.
- 10. Replace access cover. Insure that mounting screws are firmly in place.
- 11. Replace linear motor air shroud and rear cover.
- 12. Perform Restoring Disk Drive to Online Operation, page 3-1.

Carriage and Way Replacement

- 1. Perform Preparation for Maintaince, page 3-1.
- 2. Remove the rear top cover and all covers from the machine.
- 3. Remove rear air shroud and read/write heads.
- 4. Remove the matrix boards and front air shroud.
- 5. Remove the velocity tach rod.
- 6. Remove the seven screws that secure the bobbin to the head tower.
- 7. Tag and disconnect the wires from the linear motor mount terminal block
- 8. Remove the two screws that secure the terminal block to the carriage and way. Restrain the block while removing the screws to keep it from snapping forward.
- 9. Remove the carriage and way assembly by removing the three bolts that fasten it to the deck plate.
- 10. Clean deck plate surfaces and remove the old Loctite from the three bolts.

Note

The carriage and carriage way are matched units and must be replaced as an assembly.

- 11. Install the replacement assembly on the deck plate.
- 12. Apply Loctite Grade C to the bolts.
- 13. Install the bolts.
- 14. Install the bobbin and perform the Linear Motor and Bobbin Check and Adjustment procedure.
- 15. Mount the motor terminal block on the carriage and way.
- 16. Connect the wires removed in step 7.
- 17. Perform the Carriage and Way Alignment procedure.
- 18. Perform Linear Motor Bobbin Check and Adjustment.
- 19. Install the velocity tach rod.
- 20. Install the front air shroud.
- 21. Install the matrix boards.
- 22. Install the read/write heads.
- 23. Perform the Positioning System adjustments.
- 24. Perform the Heads-Extended Microswitch Check and Adjustment procedure.
- 25. Perform the End-of-Travel Microswitch Check and Adjustment procedure.
- 26. Perform the head alignment procedure.
- 27. Install the rear air shroud, and all dress covers.
- 28. Perform Restoring Disk Drive to Online Operation, page 3-1.

Special Tools for the R/W Heads

The special tools required for servicing the R/W heads are as follows:

- Model T2001B Head Alignment Meter, P/N 23510-001
- Head Camming Tool, P/N 96803-001
- Head Positioning Tool, P/N 97769-001
- Head Mounting Torque Wrench, P/N 11521-001 with HEX BIT, P/N 11521-003

- Head Alignment Pliers, P/N 17209-001
- Safety (Grenade) Pin, P/N 97722-001
- Head Alignment Tool Gauge, P/N 17201-001

The R/W heads have a single mounting screw (Figure 3-15) that must be torqued to a predetermined value to hold the head in alignment. With this type arrangement, a reference point for the head tools is required. This reference point is established by the tool recesses milled into the head tower to which the heads are secured.

The head camming tool is used to install or remove a head. Unrestrained heads exhibit a certain amount of bend at the head arm/loading ramp junction. This characteristic makes removing or installing the head extremely difficult unless the bend can be removed temporarily. When the head camming tool is installed, it introduces a tension that straightens out this bend and allows the head to be removed or installed easily. Figure 3-16 shows the tool.

The head positioning tool (Figure 3-17) is used to establish coarse head positioning when installing a head. After a head has been fitted into place, the positioning tool is pressed into the tool recesses to establish the coarse head position.

A calibrated torque wrench must be used to ensure that all heads are not overtorqued and that they are all torqued to the same value. The tool is precalibrated, and



Figure 3-15. Head Positioning Tool Recesses and Related Components



Figure 3-16. Head Camming Tool Installation



Figure 3-17. Head Positioning Tool and Torque Wrench

no attempt should be made to recalibrate it. Figure 3-17 shows the tool in use.

The head alignment pliers (Figure 3-18) is used in conjunction with the torque wrench, scope, exerciser, and head alignment meter to position the heads exactly over the alignment track. The tool (commonly referred to as



Figure 3-18. Head Alignment Tool and Safety Pin Slot

the **head pliers**) resembles and operates much like an ordinary pair of pliers; however, the action is reversed; squeezing the handles opens the tool ends rather than closing them. A micrometer adjustment thumbscrew is incorporated to limit the tool travel, and a safety feature is incorporated to prevent a head from being dislodged from its mounting and pushed into the pack area.

The design intent of the tool is based on the snap-action principle of the tool operation. In order to take advantage of this principle, the head should first be pulled back away from the spindle. The thumbscrew should then be adjusted so that slight pressure is exerted by the tip of the thumbscrew against the tool handle *at the nominal alignment position* of the head. Proficiency in using the tool results from practice as the user develops a feel for the tool's operation.

Head alignment is normally done as follows:

- Head mounting screw is loosened enough to pull the head back against the mounting block. The head pliers may be used for this purpose by opening the handles.
- Head positioning tool is used to course align the head.

- Head mounting screw is tightened until it is just snug.
- Head pliers are inserted into the milled tool recess on the mounting block and the adjustment slot in the head.
- Pliers are squeezed to move the head into the pack area. The micrometer thumbscrew is adjusted before each squeeze so that the final squeeze positions the head exactly over the alignment track.
- Head mounting screws should be torqued with the Head Mounting Torque Wrench.

A calibration setscrew prevents the tool from pushing the heads out of the mounting block and into the pack area. *Calibration should be checked periodically*, using Head Alignment Tool Gauge P/N 17201. The calibration check procedure is performed as follows:

- 1. Place the gauge on the tool ends.
- 2. Squeeze the handles together to force the tool ends against the cavity in the gauge.
- 3. While squeezing the handles firmly, observe that the setscrew is barely snug against the opposite handle. If the setscrew is not touching, calibration is indicated.

Calibration of the alignment tool should be performed in the following manner:

- 1. Temporarily remove the thumbscrew and the setscrew. Clean all threads, both internal and external, with alcohol and reinsert the setscrew.
- 2. Hold the plier assembly in one hand and spread the handles to close the jaws. Do not exert excessive force.
- 3. Place the gauge on the tool ends. Ensure that the tool ends touch the gauge cavity bottom and remain there during the procedure. Only surfaces of the round end of the rectangular tooth ends should make contact with the gauge.
- 4. Squeeze the handles together forcing the tool ends against the ends of the gauge cavity. Adjust the setscrew until it is barely snug against the opposite handle while this force is applied.
- 5. Spread the handles slightly and remove the gauge.

Note

This screw setting must not be altered except during a subsequent recalibration.

6. Apply a drop of Loctite (purple) to the internal threads of the handle where the setscrew is inserted, and reinstall the setscrew.

A safety (sometimes called a *grenade*) pin inserted through the crash bar (Figure 3-18) and into the head tower prevents possible injury in case an emergency retract condition occurs while the heads are being aligned. This precaution provides excellent results in preventing injury but can result in extensive damage to the machine. All tools not in use should be kept away from the head area so that the safety pin can be pulled immediately if the machine attempts an emergency retract. The safety pin should never be installed when the unit is unattended.

READ/WRITE HEAD HANDLING

Handle the head assembly with care. The head is very fragile; do not hold the head assembly by the head pad or touch the gimbal spring that holds the head pad in place.

If the gimbal spring is touched near the welds, the pitch and roll attitude of the head may change such that it will not be positioned above the disk surface at the proper angle and it may crash after several head loads. If the head assembly is dropped or mishandled, replace the assembly.

CAUTION

Never blow on the heads. Moisture from your breath will accumulate on the surface and contaminate the head. R/W errors and head crash may eventually result.

Always lay the head assembly with the back side of the head assembly resting on a clean surface. *Do not touch the surface of the head*. The oil from your fingers can cause a head crash. If it is touched, clean the head with Freon TF or an alcohol solution and a lint-free cloth.

Head Removal

To remove a read/write head or the servo head, proceed in the following manner:

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the top rear cover, remove two screws and remove the rear air shroud.
- 3. Set SERVO/ENABLE/SERVO DISABLE switch to SERVO DISABLE.
- 4. Pivot the head connector retainer.

5. Remove the cable plug of the head to be replaced from the matrix board.

CAUTION

Do not overflex the read/write arm when installing the camming tool, or damage may result to the read/write arm.

- 6. Install the head camming tool on the head assembly as shown in Figure 3-16.
- 7. Loosen the screw that fastens the head assembly to the head tower.
- 8. Remove the head. Insure the head does not contact any surface.

Head Cleaning and Inspection

Recommended head-cleaning materials and descriptions of the types of head contamination that are experienced can be found in Section 2. If a head has been flown and has brownish oxide streaks from the disk, the head must be cleaned before being reinstalled. A head-cleaning brush can be used to scrub the head pad, although generally a cotton-tipped swab will be adequate. Saturate the brush or swab with 91 percent isopropyl alcohol solution, shake off the surplus, and lightly scrub the face of the pad with a circular motion.

After cleaning the head pad with alcohol solution, wipe the face of the pad dry with a lint-free, nontreated tissue. Silicon-treated tissue leaves an oily film and must never be used. Finish the cleaning process by polishing the head pad with a cotton swab moistened with Freon TF followed by using a dry swab. This removes any solid or moisture contaminants left by the alcohol solution.

If the oxide on the head is black or has tinges of black, the head has rubbed the disk hard enough to generate heat and burn the oxide. High temperatures usually change the core characteristics of the head, making it unreliable. Burned heads should be replaced.

Visually inspect all heads, whether new or just cleaned, prior to installation by reflecting light off the polished surface of the head pad. The pad must be scrupulously clean and free of all dust particles.

CAUTION

Do not blow dust from the heads with your breath. Use a lint-free tissue or soft camel hair brush to remove dust.

Read/Write Head Installation

To install a read/write head after bench cleaning and inspection (or to replace a head), proceed as follows:

CAUTION

Do not overflex the head arm when installing the head camming tool during the first step, or permanent damage to the head will result.

- 1. Install the head camming tool on the head assembly to be replaced, as shown in Figure 3-16.
- 2. Insert the head assembly with the camming tool installed in the correct position by setting the arm on the proper cam and then sliding the head to the rear so that both front and rear tangs on the head mount mate with the proper head tower slots on the carriage assembly. See Figure 3-15.

CAUTION

If the arm is allowed to slide forward toward the spindle during any of the following steps, the rear tang may disengage from the head tower slot. If this occurs, the head can rotate and slam into the opposing head, resulting in damage to both heads.

- 3. Install head mounting screw into head tower and tighten lightly.
- 4. While holding the head firmly against the head tower, remove the head camming tool.
- 5. Install the head positioning tool (two-prong prepositioning tool) in the hole in the head tower and the slot in the head mount (see Figure 3-17) and torque the head mounting screw. Remove the tool.
- 6. Connect the head cable plug to the appropriate head receptacle on the Read/Write Matrix board, and secure it with the cable plug retainer after all heads have been installed.
- 7. After all heads to be installed have been prepositioned according to steps 1 thru 6, perform a manual head load as follows:
- 8. Mount a scratch pack on the drive, close and latch the lid.
- 9. Set circuit breaker CB1 to ON.
- 10. Set the START/STOP switch to START. The white, Ready Indicator/Logical Address Plug should flash

on and off and remain off after approximately 20 seconds.

CAUTION

During the next step, listen carefully for a tinging noice, which indicates that one or more heads are contacting the pack. Retract the heads immediately if head contact occurs.

11. Load the heads manually. Then move the heads slowly and carefully in (no more than 2 inches) and out of the disk pack area by hand; listen for head-todisk interference. Also be aware of any feeling of mechanical interference or roughness in carriage travel.

Note

If head contact was made with the disk pack, power down the drive, remove the pack, and clean the heads in place. Replace any head that cannot be cleaned, and correct the interference problem before proceeding. Also check the pack carefully for evidence of damage. If in doubt, do not reuse the pack.

- 12. Retract the heads smartly and fully from the disk pack, and set the START/STOP switch to STOP.
- 13. Perform the Head Alignment Check and Adjustment procedure given later in this section.

Servo Head Installation

The servo head is installed with the head camming tool in a manner similar to the other read/write heads. However, the head tower has a positioning pin in the servo head location that makes the use of the prepositioning tool unnecessary. When installing the servo head, locate the head mount over the positioning pin, press the head rearward (into the head tower) against the pin, and tighten the securing screw with the head torque wrench. Perform steps 8 through 12 of Read/Write Head Installation before continuing.

When the servo head position has been disturbed by removal and replacement of the head, all other read/ write heads must be realigned to the new servo head position by performing the Head Alignment Check and Adjustment procedure given next.

Head Alignment Check and Adjustment

The read/write heads must be aligned to the servo head whenever one or more heads have been reinstalled or replaced or when the head alignment check indicates that any head is more than 75 microinches or 125 microinches (using a different alignment pack). Also, if the position of the servo head has been changed in any way, all read/write heads must be realigned to the new position of the servo head. Heads are checked and aligned as follows:

Note

Whenever possible, the same alignment pack should be used to check and align the heads on all drives using common customer packs.

- 1. Ground 4A22 (CEDISABLE/) to inhibit write capability.
- 2. Connect the T2002B Exerciser to the disk drive by interconnecting it to the card cage connector J01 with the ribbon cable provided.
- 3. Connect the T2001A Head Alignment Meter box to the connector located at the top of the Read Limiter card in location 5A/B. Set the METER SCALE switch to OFF.
- 4. Set the control panel READ WRITE/READ ONLY switch to READ ONLY, and install the CE Alignment disk pack on the disk drive.
- 5. Power up the disk by setting the START/STOP switch to START. Wait for drive ready (File indicator lamp steady).
- 6. Load head alignment cylinder address 496 by setting exerciser BUS 0-9 switches to hex 1FO (Bits 256, 128, 64, 32 and 16 up).
- 7. Perform a seek to the cylinder by setting the exerciser FUNCTION SELECT switch to SKALT and pressing the LDNAR then the SINGLE switch until the drive seeks to cylinder 496. Verify the seek to the correct cylinder by setting the DISPLAY SELECT switch to CAR. Display indicators should light in hex 1FO pattern.

Note

Head check and alignment must be performed after stabilizing the drive and alignment pack for 15 minutes, provided the drive has been in operation (i.e., ac power applied) for the previous hour. An additional 2 minute stabilization time at cylinder 496 is also required.

8. Set the exerciser DISPLAY SELECT switch to SEQUENCE and the FUNCTION SELECT switch to READ.

- 9. Set the Head Alignment Meter box METER SCALE switch to 1250 μ IN. The R1/R2 switch should be in the R1 position. Activate the read gate by turning on the exerciser CONT switch.
- 10. Check the meter reading, and set the METER SCALE switch to the most sensitive position possible without pinning the meter. Record the meter reading in plus or minus microinches for the head selected.
- 11. Place the R1/R2 switch in the R2 position and record the reading.
- 12. Take the algebraic average of the readings obtained in steps 10 thru 12 using the formula $(\frac{R_1 + R_2}{2})$. Record this figure as the final reading. 2
- 13. Press the exerciser ADVHD switch to step to the next head. The binary head address is displayed by the five low-order bits of the SEQUENCE display. (Pressing the RSTHD switch resets the head address count back to the Head 0 address.)
- 14. Repeat steps 9 thru 12 for each head until the offtrack values for all read/write heads have been recorded. If all heads are in alignment this step ends the Head Alignment Check.

Note

If the original alignment pack is used to realign the heads, all heads must be within ± 75 microinches of track centr. If a different pack is used, the tolerance is ± 125 microinches.

- 15. Begin realignment if necessary by setting up a scope to observe the head alignment dibit signal.
 - SYNC: Int, Pos 0.5 µsec/cm, CHAN 1 only
 - CHAN 1: AC, 1v/cm, E01 (Card Location 5A/B)
 - CHAN 2: AC, 1v/cm, E02 (Card Location 5A/B)

- MODE: Add, Invert CHAN 2
- 16. Remove the rear air shroud and insert the safety pin down through the hole in the cam tower rear extension and into the head tower assembly.

CAUTION

Never place your hands or tools in the carriage and way area without the safety pin being installed. Remove all tools and the safety pin as quickly as possible to prevent a possible head crash if the carriage attempts to retract. Also, never leave the disk drive unattended while the safety pin is installed. Do not power off the drive with the safety pin installed.

- 17. Torque the mounting screw for the head to be aligned and then back off approximately one-eighth turn. (The mounting screw should be just snug.)
- 18. Set the head alignment box METER SCALE to OFF, address the head being aligned with the exerciser RSTHD and ADVHD switches, and turn on the exerciser CONT switch.
- While observing the scope; use the head alignment pliers to adjust the head for a balanced dibit pattern, as shown in (F) of Figure 3-19.
- 20. Set the METER SCALE switch to $\pm 500 \ \mu$ IN, and adjust the head again until the meter shows less than ± 100 microinches off center. Tighten the head approximately 1/16 turn with the torque wrench.

Note

Continue to observe the scope to make sure that the head remains over the dibit pattern. If the dibit pattern is lost, exercise care that the head has not moved so far toward the spindle that the head arm comes out of the head tower.



Figure 3-19. Head Alignment Dibit

- 21. Set the METER SCALE switch to $\pm 100 \mu$ IN, and adjust the head with the head-alignment pliers until the meter shows the head is 25 microinches or less off center. Tighten the head until a click is felt with the torque wrench. The head should now be at full torque.
- 22. Ensure that the algebraic average of the two readings is still less than 25 microinches (i.e., $\frac{R_1 + R_2}{2} \le \frac{R_1 + R_2}{2} \le \frac$

25 μ IN). If not, back off the head screw one-sixteenth turn, and repeat steps 21 and 22.

CAUTION

Do not attempt to position the head while the head screw is torqued to the full torque or damage to the mounting screw and alignment pliers can result.

Note

Head alignment may be impossible because of a bent head retaining screw or a deformation of its associated captive washer. P/N 17282-001 includes both items. Ensure that these parts are in good condition when a problem is encountered in head alignment; replace defective components.

- 23. Repeat steps 17 thru 22 for each head requiring adjustment.
- 24. When all heads requiring adjustment have been adjusted, remove the safety pin, turn off the exerciser CONT switch (down), and power drive down and remove CE pack. Install a scratch pack. Power drive up.
- 25. Press the exerciser REZERO switch to recalibrate to cylinder 000, and initiate random seek operation (FUNCTION SELECT switch to SKRDM) by turning on the CONT switch.
- 26. After at least two minutes of random seek operation, turn off the CONT switch and press the REZERO switch. Power drive down and remove scratch pack. Install CE pack and install rear air shroud. Power drive up.
- 27. Reload cylinder address 496 (refer to step 6), set the FUNCTION SELECT switch to SKALT, and press the SINGLE switch until the heads seek to cylinder 496.
- 28. Set the FUNCTION SELECT switch to READ, and turn on the CONT switch. Address each head, in

turn, and verify that all heads aligned are still within ± 25 microinches (average of R1 and R2). If not, realign all out-of-tolerance heads by repeating steps 16 thru 28.

- 29. Power drive down and remove CE pack. Remove the ground at 4A22.
- 30. Perform Restoring Disk Drive to Online Operation, page 3-1.

READ/WRITE SYSTEM

The following adjustments are factory set using special equipment and procedures. Therefore field adjustment is not recommended. The information that follows will help field personel verify the proper operation of the Read/Write System.

All adjustment points for read/write system alignment are located on the Data Separator card in location 5C/D. All test points are located on the same card. See Figure 3-20. If system alignment is deemed necessary, perform the entire alignment procedure in the order outlined below.

Note

Potentiometer R3 on the Data Separator is not field adjustable. Do not disturb the adjustment of this control.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Install a scratch pack.
- 3. Set SERVO ENABLE/SERVO DISABLE switch on Control Logic II card in location 4A/B to SERVO DISABLE.
- 4. Remove the top rear cover and rear air shroud.
- 5. Power the drive up and wait approximately 20 seconds for the drive to come up to speed.
- 6. Check the PLO free-running frequency as described under the Phase Lock Oscillator (PLO) Frequency Check and Adjustment heading in this section of the manual.
- 7. Connect and adjust scope to display 5C/D card test point waveforms as follows (see Figure 3-20):
 - SYNC: Int, neg. 0.2 μs/div, norm, CHAN 1, X10 MAG ON
 - CHAN 1: dc, 1v/div, TP1 (CLOCK)



Figure 3-20. Read/Write System Adjustment and Test Point Locations

- CHAN 2: dc, 1v/div, TP3 (DATA WINDOW)
- MODE: ALT

Note

Ground both scope probes at TP2 (or TP4).

- 8. Verify that the clock signal period is 103 ns \pm 3 ns (T302) or 155 ns \pm 4 ns (T202), adjust R14 as necessary.
- 9. Make sure that the disk is up to speed, then load the heads manually and position them in the vicinity of cylinder zero.
- 10. Change the scope sweep spread to 0.1 μ s/div with X10 MAG on. Adjust the scope controls to display the last pulse in the channel 1 waveform. Place the trailing edge of this pulse on a vertical line of the scope graticule as shown in Figure 3-21 (i.e., original setting, or reference point).
- 11. Manually move the head carriage in the vicinity of cylinder 800.
- 12. Measure the amount of displacement of the trailing edge from the reference point.



Figure 3-21. VFO Clock Adjustment

- 13. Manually retract the heads.
- 14. Adjust R14 so that the trailing edge of the pulse is centered between the two readings obtained.
- 15. Manually position and maintain the heads in the area between CYL 000 and CYL 800.
- 16. Adjust the scope controls to display the second negative-going pulse in the channel 1 waveform.
- 17. Observe that the window waveform pulse meets the requirements shown in Figure 3-22. Adjust R36 as required to achieve this condition.
- 18. Adjust R31 to position the window so that the trailing edge of the clock pulse is centered in the window ± 1 ns as shown in Figure 3-23.
- 19. Perform Retracting Disk Drive to Online Operation, page 3-1. Check its read/write capability.



Figure 3-22. Data Window Width



Figure 3-23. Data Window/Clock Relationship

Read/Write Matrix Board Replacement

The procedure for removing either matrix board is essentially the same. The boards and their respective covers are not interchangeable.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove top rear cover and rear air shroud.
- 3. Remove the head connector retainer.
- 4. Remove the read/write head connectors. Note their positions so that they may be reinstalled.
- 5. Identify and unplug the push-on connectors on the board.
- 6. Unplug connectors P/J01 and P/J02.
- 7. Remove the transparent protective cover from the matrix board (Figure 3-24).
- 8. Remove the two screws that retain the matrix board to the air shroud assembly.
- 9. Carefully slide the matrix board from the slot in the head tower and remove the board from the drive.
- 10. Replace the matrix board by reversing the removal procedure. Replace rear air shroud and top cover.
- 11. Perform Restoring Disk Drive to Online Operation, page 3-1.

SPINDLE DRIVE SYSTEM

The spindle drive system consists of the spindle drive motor, spindle assembly, drive belt, spindle speed transducer, spindle grounding brush, and spindle lock assem-



Figure 3-24. Attachment of Read/Write Matrix Boards

bly. See Figure 3-25. Checkout, adjustment, and replacement instructions for these components are given in the following paragraphs. All components of the spindle drive system except the spindle lock and the spindle assembly must be serviced or replaced from the underside of the deck plate. Removal of the front cover and absolute filter provides limited access; servicing is much easier if both side covers are removed.

Spindle Grounding Brush Service

The spindle grounding brush should be serviced and adjusted if the brush check indicates a resistance value of more than 0.5 ohm.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Clean the grounding brush and contact arm with fine emery paper. Wipe these parts with a lint-free cloth dampened with alcohol to remove any residue.
- 3. Install a disk pack.
- 4. Use a spring gauge to check contact pressure. Contact pressure should be 150 ± 50 grams. Adjust the contact arm as necessary.
- 5. Check ground brush resistance. If the resistance exceeds 0.5 ohm, replace the grounding brush.
- 6. If resistance value is within tolerance, perform Restoring Disk Drive to Online Operation, page 3-1.



Figure 3-25. Spindle Drive System Components

Spindle Grounding Brush Replacement

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Loosen the two screws that secure the brush contact arm to the deck plate.

- 3. Loosen the brush setscrew; remove the grounding brush from the spindle lock shaft.
- 4. Install a new grounding brush and setscrew.
- 5. Position the contact arm and tighten the retaining screws.
- 6. Perform Spindle Grounding Brush Service.
- 7. Perform Restoring Disk Drive to Online Operation, page 3-1.

Spindle Drive Belt Adjustment

The spindle drive belt adjustment should be performed when there is an indication that the spindle and drive motor pulleys are incorrectly aligned.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Check drive belt position to determine in which direction (up or down) the motor pulley should be moved.
- 3. Loosen the motor pulley setscrew.
- 4. Adjust the pulley up or down to center the drive belt. The pulley may be moved up by tapping it with a plastic mallet or pried down with two screwdrivers.

Note

If the pulley cannot be moved easily, it may be expedient to remove the drive motor for better accessibility.

5. Perform Restoring Disk Drive to Online Operation, page 3-1.

Spindle Drive Belt Replacement

Spindle drive belt replacement may be occassioned by any of the following events:

Broken belt

Stretched belt

Dislodged belt

If the reason for replacement is a broken or stretched belt, no special precautions are necessary; the following procedure will suffice in these cases.

If the reason for replacement is a dislodged belt, the problem may be due to binding of the spindle drive motor caused by a tolerance stackup of the mounting hardware. This may be difficult to check; it may be expedient to simply replace the two nylon washers used in mounting the drive motor, and the belt. The determination must be made by the service technician. Refer to the Spindle Drive Motor Replacement procedure in this section of the manual for detailed information.

CAUTION

Belt replacement is always required after the belt has fallen off during operation because the internal fibers are invariably damaged when it rolls over the edge of the pulley. Fibers may also be damaged when the belt is installed if it is "rolled on" over the edge of the pulley. These damaged fibers will cause the belt to wander on the pulley and contribute to the belt dropping off again. All tension must be removed when drive belts are removed or installed.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Pull the drive motor toward the spindle assembly to loosen the drive belt.
- 3. Remove the belt.
- 4. Install a new belt in the same manner as the old one was removed.
- 5. Position the belt so that it is centered on both pulleys.
- 6. Install a scratch pack and power up the drive; recheck the belt position after 5 to 10 minutes of running time.
- 7. Perform Restoring Disk Drive to Online Operation, page 3-1.

Spindle Lock Adjustment

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Raise the pack area lid and remove the disk access cover.
- 3. Using a ruler graduated in tenths of an inch, check for a measurement of 7.1 inches from the centerline of the spindle to the tip of the actuating button (Figure 2-3). Loosen the two, bracket-adjustment screws and adjust the assembly as necessary.
- 4. Install a scratch pack. Leave the pack cover on the check for correct spindle lock operation. If locking action is not positive (spindle exhibits a ratchet action), proceed to step 6.

- 5. Remove the disk pack cover and check for spindle drag. If the spindle drags on the lock bracket, proceed to step 7.
- 6. Turn the lock adjustment screw clockwise to increase the locking action and repeat step 4.
- 7. Turn the lock adjustment screw counterclockwise to eliminate spindle drag. Repeat step 4 to ensure that spindle locking action is positive.
- 8. Perform Restoring Disk Drive to Online Operation, page 3-1.

Spindle Locking Assembly Replacement

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Raise the pack area lid and remove the disk access cover.
- 3. Remove the two screws that secure the lever mounting bracket to the deck plate.
- 4. Remove the spindle locking assembly.
- 5. To install the assembly, reverse the procedure.
- 6. Perform the Spindle Lock Adjustment.
- 7. Perform Restoring Disk Drive to Online Operation, page 3-1.

Speed Detector (Optical Switch Assembly) Adjustment

The speed detector should not normally require adjustment unless it is replaced. If the speed detector is misadjusted, the SPEED signal will not be detected and the heads will not load. Perform the adjustment procedure as follows:

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove front dress cover.
- 3. Set up the scope as follows:
 - SYNC: Int, neg, 0.2 msec/div, CHAN 1
 - CHAN 1: Dc, 1v/div, 4B28 (ROTSEN/)
 - MODE: CHAN 1
- 4. Power the drive up.
- 5. Observe the waveform display and compare it with Figure 3-26.



Figure 3-26. Speed Detector Waveform Characteristics

Note

If pulse width A in Figure 3-26 is too wide, the SPEED signal will not be generated.

6. Adjust pulse width A by slightly loosening the two screws that retain the speed detector mounting bracket to the deck plate (Figure 3-27) and repositioning the switch assembly.

CAUTION

Ensure that there is adequate clearance between the switch assembly and brake disk after the adjustment has been made.

7. Perform Preparation for Maintenance, page 3-1.





Speed Detector (Optical Switch Assembly) Replacement

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the front dress cover.
- 3. Remove the two screws from the underside of the deck plate; these screws secure the switch board assembly to the mounting bracket (Figure 3-27.)
- 4. Install a new switch board assembly.
- 5. Rotate the spindle manually to verify that the brake disk does not contact the optical sensing device.
- 6. Perform the Speed Detector (Optical Switch Assembly) Adjustment procedure.
- 7. Perform Restoring Disk Drive to Online Operation, page 3-1.

Brake Coil Replacement

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the right-hand side cover (as viewed from the front).
- 3. Disconnect the brake coil leads. Remove the diode.

CAUTION

The spindle brake assembly is heavy enough to require support before removing the retaining bolts. If the assembly is not supported, damage to the brake disk may result.

- 4. Remove the two mounting bolts.
- 5. Remove the coil and the pole piece assembly by sliding the assembly back and away from the disk.
- 6. Install the new brake coil assembly.
- 7. Install the mounting bolts.
- 8. Connect the leads to the brake coil. Install the diode.
- 9. Perform Restoring Disk Drive to Online Operation, page 3-1.

Spindle Drive Motor Replacement

The procedure for replacing a spindle drive motor is given below. If a spindle drive belt has fallen off, it may be due to binding of the motor caused by a tolerance stackup of the mounting hardware. Should this be the case, replace the two nylon washers (motor bushings, Figure 3-25) with new bushings, P/N 90048-073.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the front and left-hand side covers (as viewed from the front) from the drive.
- 3. Remove the absolute filter.
- 4. Unplug connector P/J30 at the ac distribution box.
- 5. Remove the drive belt.
- 6. Push the drive motor toward the rear far enough to remove the motor tension spring (Figure 3-25).
- 7. Remove the nut from the motor pivot. Note the washer and insulator arrangement and remove these parts.
- 8. Loosen but do not remove both the bolts that retain the motor mounting plate to the motor support.
- 9. Block up the motor from the underside to relieve the strain on the loosened bolts.
- 10. Remove the loosened bolts to free the motor. Do not lose the washers or insulators.
- 11. Maneuver the motor out of the drive cabinet and onto a bench or other work area.

Note

Observe the relationship between the drive motor and mounting plate before separating the two parts.

- 12. Remove four screws that secure the mounting plate to the drive motor, and separate the two components.
- 13. Remove the motor pulley. If a gear puller is not available, tap the inside edge of the pulley evenly with a plastic mallet. *Do not use a steel hammer*.
- 14. Ensure that the Woodruff key is in place on the replacement motor shaft, and install the removed pulley. Torque pulley set screws to 50 ± 10 in./lbs.
- 15. Install the motor mounting plate by reversing the removal procedure. Observe the same component relationship as noted prior to step 12.
- 16. Replace drive motor by reversing the removal procedure.
- 17. Replace the absolute filter.
- 18. Connect P30 to J30.

- 19. Mount a scratch pack and verify that the drive is otherwise ready for service.
- 20. Power the drive up and verify that it operates correctly.
- 21. Perform Spindle Drive Belt Adjustment procedure. Install front and side dress covers.
- 22. Perform Restoring Disk Drive to Online Operation, page 3-1.

Spindle Assembly Check

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Verify that the disk pack slides smoothly and tightens firmly onto the drive spindle.
- 3. Verify that the disk pack can be removed smoothly from the drive spindle.
- 4. Power up drive.
- 5. Listen to the rotating spindle to ensure that no unusual noises are emitted. If noise is present replace spindle.
- 6. Perform Restoring Disk Drive to Online Operation, page 3-1.

Spindle Assembly Replacement

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the front dress cover.
- 3. Remove the front air shroud assembly.
- 4. Remove the spindle drive belt.
- 5. Remove the eddy current brake pole piece.
- 6. Remove the eddy current brake disk.
- 7. Remove the spindle stop ring.
- 8. Remove the three bolts that fasten the spindle to the deck plate. Clean old Loctite from the bolts.
- 9. Remove the spindle assembly from the deck plate by pulling the spindle assembly straight up.

CAUTION

The spindle and deck plate are machined to extremely close tolerances. Cocking the spindle will result in binding against the deck plate and may damage the machined surfaces.

- 10. Obtain a new grounding brush and setscrew and install it on the replacement spindle shaft.
- 11. Replace the spindle gasket.
- 12. Replace the drive spindle. Ensure that the notch faces the carriage.
- 13. Apply Loctite Grade C to the spindle mounting bolts.
- 14. Install the mounting bolts and torque them to 132 ± 5 inch-pounds.
- 15. Install the spindle stop ring and the brake disk.
- 16. Install the pole piece of the eddy current brake.
- 17. Install and adjust the drive belt.
- 18. Install the front air shroud.
- 19. Check the head alignment. If the heads cannot be aligned, it may be necessary to perform the Carriage and Way Alignment procedure in this section of the manual. In the majority of cases, alignment of the carriage and way is unaffected by spindle replacement.
- 20. Perform Restoring Disk Drive to Online Operation, page 3-1.

AIR SHROUD ASSEMBLY

The air shroud assembly includes the pack area lid and the lid-closed microswitch. The air shroud proper (commonly referred to throughout this manual as the front air shroud) surrounds the disk pack and forms a chamber of pressurized air during operation.

Air Shroud Assembly Removal

Access to certain parts and assemblies of the disk drive for service purposes requires removal of the air shroud assembly and its attached lid. To remove and reinstall the air shroud assembly, proceed as follows:

Note

The read/write matrix boards must be removed before removing the air shroud.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Ensure that the head carriage is in the fully retracted position.
- 3. Remove the three screws (Figure 3-28) that attach the access cover to the bottom of the air shroud, and remove the cover.



Figure 3-28. Air Shroud Assembly Attachment

- 4. Remove the read/write matrix board guards from each side of the unit by removing two retaining screws and sliding the guard toward the rear of the machine.
- 5. Remove the rubber straps that secure the read/write ribbon cable to the shroud at each side of the machine.
- 6. Tag and remove the leads from the lid switch located behind the controls and indicators.
- 7. Remove five screws that attach the air shroud to the deck plate.
- 8. Ensure that the heads are fully retracted; then carefully lift the air shroud straight up and off the drive.
- 9. Install the air shroud by reversing the removal procedure. Ensure that the heads are fully retracted before starting the installation procedure and that the gasket under the shroud assembly is not damaged or deformed during installation.
- 10. Perform Restoring Disk Drive to Online Operation, page 3-1.

Pack Area Lid Spring Adjustment

The pack area lid is held in the raised position by a torsion spring at the bottom of the lid. This spring, when adjusted properly, will maintain the lid in any position from half open to fully open. To adjust spring tension, proceed as follows:

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Perform Air Shroud Assembly Removal.
- 3. Pull the lid in its half-open position, and using the Lid Instl tool tighten or loosen the self-locking nut on the underside of the right-hand spring keeper.
- 4. Lower the lid then raise it to the half-open position. The lid should remain in this position; if not, repeat step 3.
- 5. Reinstall the air shroud and perform Restoring Disk Drive to Online Operation, page 3-1.

Pack Area Lid Removal

Replacement of the pack area lid is most easily accomplished by removing the air shroud first. Proceed as follows:

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the air shroud assembly.
- 3. Remove the gasket retainer (two slotted screws) from the hinged edge of the lid at the center.
- 4. Remove the six screws that secure the right and left hinge brackets to the lid and lift off the lid.
- 5. Reinstall the pack area lid by following the removal procedure in reverse order. Make sure that the right and left hinge brackets engage their respective pivot pins and the positioning lugs on the lid.
- 6. Check lid-opening spring tension by performing the Pack Area Lid Spring Adjustment procedure, step 3.
- 7. Replace the air shroud assembly.
- 8. Perform Restoring Disk Drive to Online Operation, page 3-1.

Pack Area Lid Gasket Replacement

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Raise the pack area lid and place a protective cover over the air shroud opening to prevent debris from falling into the disk drive.
- 3. Remove the lid-gasket retainer (two slotted screws) from the hinged edge of the lid at the center.
- 4. Peel the old gasket away from the lid carefully so as to prevent leaving patches of old gasket attached to the lid.

If necessary reactive the adhesive that holds the old gasket in place by soaking the edges of the gasket with an activator solution of 92 percent 1.1.1 Trichloroethylene and 8 percent isopropyl alcohol by volume.

- 5. Ensure that the lid surface is free of any gasket residue.
- 6. Install the new gasket and retainer removed in step 3.

Note

Note that the cover gasket is not multipositional but has a slight locating protrusion at the bottom of the cover. The new gasket must be installed in the same position.

- 7. Remove protective cover and close pack area lid. Keep the lid closed for several hours to ensure a good bond.
- 8. Perform Restoring Disk Drive to Online Operation, page 3-1.

Lid-Closed Microswitch Check and Adjustment

The lid-closed microswitch is located beneath the front, right-hand corner of the air shroud (Figure 3-29) and is actuated by a pin on the underside of the pack area lid when the lid is closed. If switch operation is suspect, check and/or adjust the switch as follows:

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. With the swing frame open, locate pins 4B38, 4B35, and 4B03.
- 3. Using an ohmmeter measure as follows:

A. Lid Open

- 1. Short between 4B38 and 4B03
- 2. Open between 4B35 and 4B03



Figure 3-29. Lid-CLosed Microswitch Details

- B. Lid Closed and Latched
 - 1. Short between 4B35 and 4B03.
 - 2. Open between 4B38 and 4B03.
- 4. If adjustment is necessary, loosen the two, bracketmounting screws and slide the bracket down as far as it will go.
- 5. With the lid closed and latched, slide the bracket up until the switch transfers; then slide it up another 1/32-inch and tighten the two bracket screws.
- 6. Repeat step 3 to check the switch adjustment.
- 7. Perform Restoring Disk Drive to Online Operation, page 3-1.

Lid-Closed Microswitch Replacement

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Tag and disconnect the switch leads. See Figure 3-29.
- 3. Remove the two bracket-mounting screws and remove the switch and mounting bracket.
- 4. Note the switch/bracket relationship; then press out the switch, and install the replacement switch in the bracket.
- 5. Install the switch and mounting bracket by reversing the removal procedure.
- 6. Perform the Lid-Closed Microswitch Adjustment.
- 7. Perform Restoring Disk Drive to Online Operation, page 3-1.

POWER AMPLIFIER ADJUSTMENT

The power amplifier adjustment is a part of the overall servo adjustment procedure and *should not be done* separately.

POWER AMPLIFIER REPLACEMENT

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Unplug connectors P/J20 and P/J21 on the power amplifier printed-circuit board (Figure 3-30).
- 3. Loosen the six, quarter-turn fasteners while holding the printed-circuit board in place. Withdraw the



Figure 3-30. Power Amplifier/Power Supply Retention and Connectors

board and attached heat sink far enough to unplug connector P/J18 at the rear of the board, and remove the board from the disk drive.

- 4. Unplug connector P/J16 on the power supply assembly.
- 5. Remove the single, hexhead, retaining bolt that secures the power amplifier chassis bracket to the machine floor pan.
- 6. Using a screw-holding screwdriver, remove the two slot-head screws that retain the chassis to the chassis bracket at the top of the power amplifier. Retrieve any hardware that falls onto the machine floor pan.
- 7. Carefully remove the power amplifier chassis from the disk drive.

- 8. Install the power amplifier by reversing the above procedure.
- 9. Perform Restoring the Disk Drive to Online Operation, page 3-1.

POWER SUPPLY REPLACEMENT

Note

Neither the power supply printed-circuit board nor the power supply assembly can be removed until the power amplifier has been removed.

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the power amplifier.
- 3. Unplug connectors P/J13 and P/J14 from the power supply. (Connector P/J16 is disconnected during removal of the power amplifier).
- 4. Remove the single retaining bolt that secures the power supply chassis bracket to the machine floor pan.

Note

Unless the machine is accessible from the side, the power supply assembly must be removed to service the printed-circuit board. If side access is available, proceed to step 6.

- 5. Using a screw-holding screwdriver, remove two slothead screws that fasten the power supply chassis to the bracket at the top of the power supply. Retrieve any hardware that falls onto the machine floor pan.
- 6. Carefully remove the power supply chassis from the disk drive.

Note

If the power supply assembly is being replaced, remove the chassis attaching bracket from the old supply and attach it to the new unit.

- 7. Loosen the six, quarter-turn fasteners while holding the printed-circuit board in place; then withdraw the board and attach heat sink far enough to unplug connector P/J15, and separate the board from the chassis.
- 8. Install the printed-circuit board by reversing the removal procedure.

- 9. Install the power supply by reversing the removal procedure.
- 10. Verify that all connectors are secured in place.
- 11. Replace the power amplifier.
- 12. Perform the Power Supply Checks and Adjustments outlined in Section 2.
- 13. Perform Restoring the Disk Drive to Online Operation, page 3-1.

EMERGENCY RETRACT ASSEMBLY REPLACEMENT

1. Perform Preparation for Maintenance, page 3-1.

Note

Unless the left side panel can be removed easily from the machine, it may be expedient to remove the ac distribution box before performing the following procedure.

- 2. Disconnect P/J41 and P/J42 on the emergency retract assembly (Figure 3-31).
- 3. Remove the two screws that secure the plastic cover over the pcb components.
- 4. Remove the two spacer nuts that secure the emergency retract assembly to the spacer nuts at the rear of the emergency retract assembly.
- 6. Install the emergency retract assembly by reversing the removal procedure.
- 7. Perform Restoring the Disk Drive to Online Operation, page 3-1.

AC DISTRIBUTION BOX REPLACEMENT

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the ac power cord from the facility receptacle.
- 3. Unplug connectors P/J30, and P/J32 thru P/J35 on the top of the distribution box. See Figure 3-31.
- 4. Unplug connectors P/J41 and P/J42 on the emergency retract assembly.
- 5. Remove the ac distribution cover to expose the ac power input terminals.



Figure 3-31. Emergency Retract Assembly Retention

- 6. Disconnect the two phase wires from the distribution box input terminals.
- 7. Remove the single screw with green AC power wire that secures the box to the machine floor pan.
- 8. Slide the box toward the rear of the machine approximately one-half inch to clear the retention tangs at the rear of the box. Remove the box from the machine.
- 9. Replace the ac distribution box by reversing the removal procedure.

Note

Ensure that the screws that secure the ac input leads to the terminals on the distribution box are tightened securely.

- 10. Replace the ac distribution cover.
- 11. Set circuit breaker CB1 on the distribution box to OFF.

- 12. Install the ac power plug into the facility power receptacle and set CB1 to ON.
- 13 Check the operation of the machine before closing the swing frame assembly and installing the rear cover.
- 14. Perform Restoring the Disk Drive to Online Operation, page 3-1.

BLOWER MOTOR REPLACEMENT

- 1. Perform Preparation for Maintenance, page 3-1.
- 2. Remove the front cover.
- 3. Unplug connector P/J32 at the ac distribution box.
- 4. Remove the absolute filter. Refer to the Absolute Filter Replacement heading in Section 2 of this manual.
- 5. Remove four sockethead screws that fasten the blower housing (Figure 3-32) to the floor pan. Lift the blower assembly up and out the front of the machine.
- 6. Remove eight screws that secure the blower cover to the housing.
- 7. Turn the assembly on its side, remove three screws that secure the blower motor to the housing, and remove the blower motor.
- 8. Install the motor by reversing the removal procedure.
- 9. Install the blower cover by reversing the removal procedure; take care to position the motor lead grommet correctly.
- 10. Install the blower motor assembly by reversing the removal procedure.
- 11. Install the absolute filter. Ensure that the air system boot is positioned correctly.
- 12. Connect P/J32.
- 13. Power up the disk drive and check the operation of the blower motor. Ensure that there are no air leaks. Replace the front cover.
- 14. Perform Restoring the Disk Drive to Online Operation, page 3-1.



Figure 3-32. Blower Assembly, Exploded View

SECTION 4 TROUBLESHOOTING AIDS

This section of the manual contains general troubleshooting information, trouble analysis charts, and technical hints and tips,

GENERAL TROUBLESHOOTING INFORMATION

Since the disk drive logic is modularized, the most expedient and practical method of troubleshooting is changing printed-circuit boards. The procedures contained herein are therefore based on that assumption.

In most cases, maintenance personnel will have enough information at hand to make an educated guess as to the cause of the problem. However, caution is advised if servo problems are indicated; starting up a drive to find problem symptoms can be disasterous under certain conditions. For example, a shorted power amplifier can cause extensive damage. It is wise in any case to check the operation of the servosystem while it is disabled before attempting a dynamic check.

Sometimes a drive problem can be detected visually, but this is the exception rather than the rule. However, the drive should be inspected carefully for evidence of damage before attempting to repair the unit.

Note

Be sure a scratch pack is mounted before attempting to troubleshoot the disk drive.

INITIALIZATION MALFUNCTIONS

Malfunctions that occur during the drive initialization (power-up sequence and first-seek operation) are caused by a failure in one of the following areas:

- Ac power circuits
- Sequencing logic
- Servo control logic
- Servosystem

Ac power circuit problems are identified in Table 4-1. Problems related to the remaining three areas listed above are identified in Table 4-2.

TABLE 4-1. AC POWER TROUBLE ANALYSIS

Symptom	Probable Cause
Circuit breaker CB1 ON — ac loads do not operate	No source voltage Defective circuit breaker Defective filter FL1 or FL2
Circuit breaker CB1 pops out	Shorted ac load Defective relay K1
Circuit breaker CB1 pops out when START/STOP is set to START	Defective drive motor Defective relay K1
Spindle motor does not start	Defective Control Logic II card (location 4A/B) Defective Control Logic I card (location 3 A/B) Defective START/STOP or lid-closed switch Defective Relay K1 in ac distribution box Defective drive motor

TABLE 4-2. POWER UP/FIRST SEEKTROUBLE ANALYSIS

Symptom	Probable Cause
First seek operation does not occur; heads remain in hole	Defective Logic Control II card (location 4A/B) Defective Servo Control II card (location 2A/B) Defective Servo Control I card (location 1A/B) Speed transducer defec- tive or misadjusted Defective power amplifier Defective emergency retract assembly Defective START/STOP or lid-closed switch Defective linear motor

TABLE 4-2. POWER/UP FIRST SEEK TROUBLE ANALYSIS (Continued)

Symptom	Probable Cause
Heads drive out on pack but retract immediately	Defective Servo Control I card (location 1A/B) Defective Servo Control II card (location 2A/B) Defective Logic Control II card (location 4A/B) Defective servo Power Amplifier Defective servo head Defective heads-extended microswitch

INTERFACE CONTROL/RESPONSE MALFUNCTIONS

Diagnostic programs are useful in isolating failure areas in most cases. When interface problems exist, careful inspection of all interconnecting cables and their associated connectors is indicated. Table 4-3 identifies probable causes for common interface problems.

TABLE 4-3. INTERFACE CONTROL/RESPONSETROUBLE ANALYSIS

Symptom	Probable Cause
Drive power up but fails to respond to any command	Defective Receiver card (location 2C/D) Defective Driver card (location 1C/D) Defective Logic Control I card (location 3A/B)
Drive does not sequence up	Defective Logic Control II card (location 4A/B) Defective Logic Control I card (location 3A/B)
Drive fails to provide status information	Defective Driver card (location 1C/D)

COMMAND POSITION MALFUNCTIONS

Table 4-4 identifies probable causes for program seek, rezero, and offset operation failures. It is assumed that the drive will perform a successful first-seek operation.

TABLE 4-4. COMMAND POSITION TROUBLE ANALYSIS

Symptom	Probable Cause
Drive will not rezero or perform program-seek operations	Defective Servo Control II card (location 2A/B)

TABLE 4-4. COMMAND POSITION TROUBLE ANALYSIS (Continued)

Symptom	Probable Cause
Drive will rezero but will not perform program- seek operations	Defective Logic Control II card (location 4A/B) Defective Logic Control I card (location 3A/B) Defective Receiver card (location 2C/D)
Drive fails to access correct cylinder (seek incomplete)	Defective Logic Control I card (location 3A/B) Defective Servo Control II card (location 2A/B) Defective Logic Control II card (location 4A/B) Mechanical interference in positioning system Defective Servo Power amplifier
Drive fails to detent properly or drifts off track after detenting	Defective Servo Control II card (location 3A/B) Defective Servo Control I card (location 3A/B) Defective Servo Power amplifier
Drive will not offset properly	Defective Servo Control II card (location 2A/B) Defective Logic Control II card (location 2A/B) Defective Logic Control I card (location 3A/B) Defective Receiver card (location 1C/D)
Heads do not retract automatically	Defective Logic Control II card (location 4A/B) Defective Servo Control II card (location 2A/B)

READ/WRITE MALFUNCTIONS

Read errors are symptomized by temporary read errors or data checks. Write failures are usually discovered as read errors during a read verify or record update. Once the error type has been defined, systematic trouble analysis will determine the defective component. Table 4-5 lists some common read/write failures and their probable causes.

TECHNICAL HINTS AND TIPS

Information given in the following paragraphs has been provided by engineers in the field and by the National Tech Support group.

TABLE 4-5. READ/WRITE TROUBLE ANALYSIS

Symptom	Probable Cause
Read errors on all heads	Positioning system misadjusted Signal ground floating or shorted to chassis Defective Data Separator card (location 5C/D) Defective Read Limiter card (location 5A/B)
Read errors on even- numbered heads	Defective Read/Write Matrix card (right)
Read errors on odd- numbered heads	Defective Read/Write Matrix card (left)
Read/write heads can- not be selected	Defective Logic Control I card (location 3A/B)
Drive will not read or write on any one head	Dirty or defective head Loose head plug
Drive will read but will not write	Defective Data Separator card (location 5C/D) Defective matrix card
Drive will write but will not read	Defective Read Limiter card (location 5A/B) Defective matrix card Defective Data Separator card (location 5C/D)

Handling Printed-Circuit Boards

Spare printed-circuit boards sometimes fail due to mishandling. Touching the contact pins should be avoided, since one's hands may have an invisible layer of grease or oil on them, and this can be transferred to the contacts. Cleaning the pcb contacts with alcohol before installing them is advisable. In some cases, intermittent machine errors have been cured by swabbing the card sockets with alcohol.

Unusual Problems Caused by Ground Loop

Some unusual and sometimes baffling problems arise because of ground loops in the system. These problems may be intermittent data checks, interface control checks, or even seek errors.

In peripheral equipment, the dc and chassis ground should only be connected to one point; this point may be in the control unit or in the CPU. If the grounds are connected in other places in the system, excessive noise will be generated, resulting in the problems noted above.

CE Alignment Disk Packs

In the past, there has been some confusion regarding CE alignment packs for the Trident disk drives. The only approved alignment pack for the Model T202/T302 as of this writing is CDS P/N 14975-002.

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