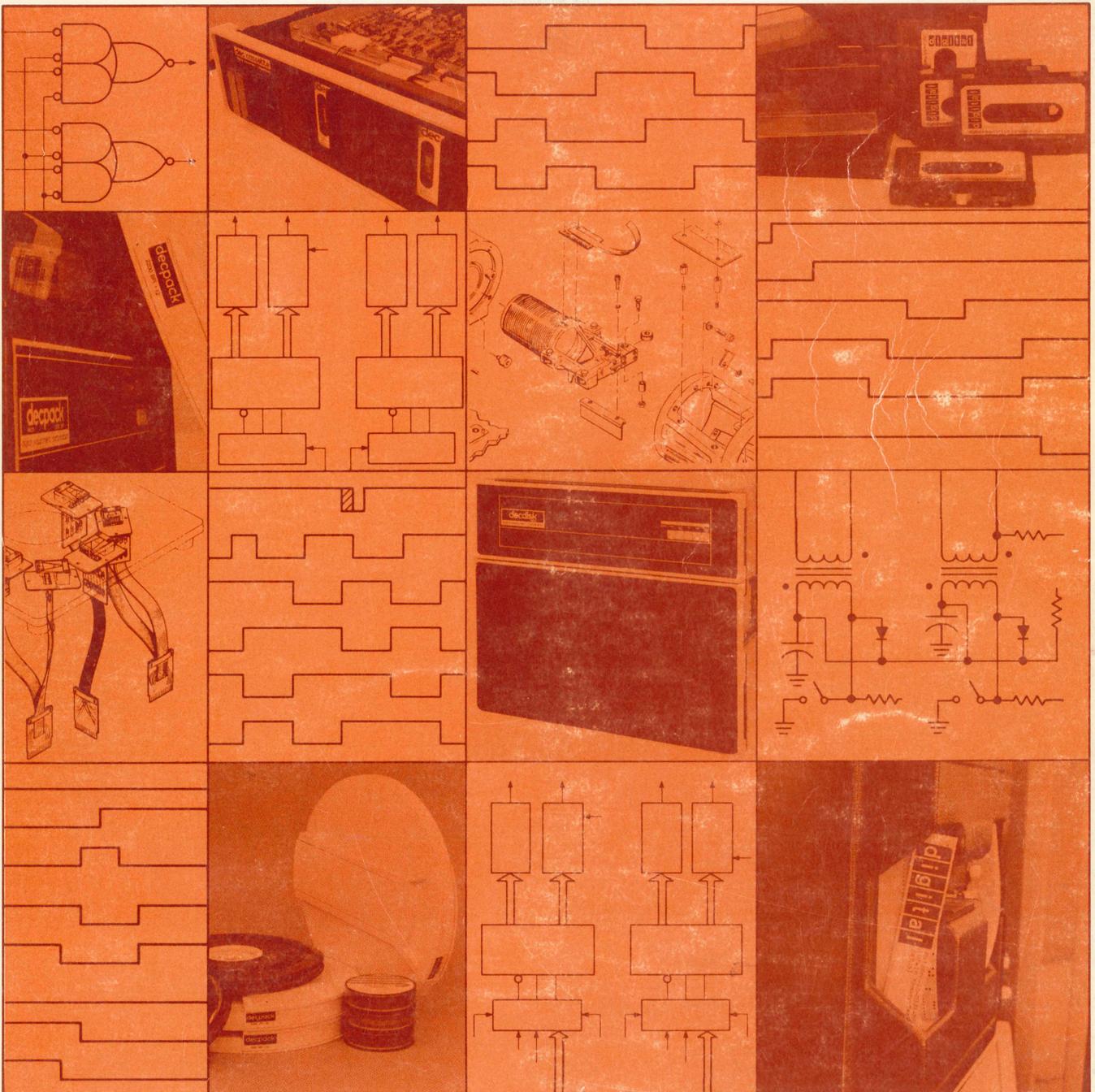
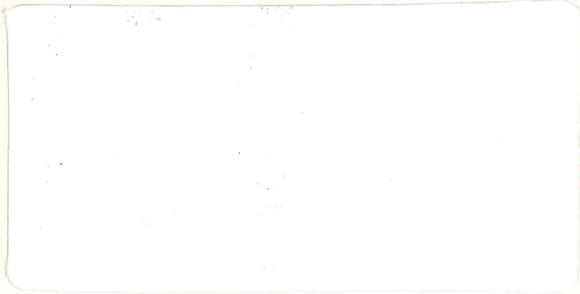


digital

RK05 disk drive maintenance manual





**RK05
disk drive
maintenance manual**

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CHAPTER 1

GENERAL INFORMATION

1.1 INTRODUCTION

The RK05 Disk Drive is a self-contained, random-access, data storage device that is especially well suited for use in small or medium size computer systems, data acquisition systems, terminals, and other storage applications. Operational power for this device is provided by a power supply located within the drive cabinet. The RK05, designed and manufactured by DEC, can be obtained in four different power models.

This compact, light weight drive uses a high density single disk cartridge, similar to the IBM 2315 disk cartridge, as its storage medium. Two movable heads, which fly above and below the rotating disk surface, can read or record up to 406 data tracks at 1500 rpm. The double frequency, nonreturn-to-zero (NRZ) recording method used in this drive can store 25 million bits of on-line data. Data formatting is governed entirely by the operating system.

With the address select logic contained in each drive, up to eight (depending on the system type) RK05 Disk Drives can be "daisy-chained" and operated from a single controller bus.

1.2 SPECIFICATIONS

Table 1-1 lists the performance specifications of the RK05 Disk Drive. Wherever applicable, a second specification, which pertains to a 16 sector cartridge, is also listed.

**Table 1-1
Performance Specifications**

Characteristic	Specification
Storage Medium	
Type	Single disk magnetic cartridge
Disk Diameter	14 in.
Magnetic Heads	
Number	Two
Recording Density and Format	
Density	2200 bpi max.
Tracks	406 (200 plus 3 spares on each side of the disk)
Cylinders	203 (two tracks each)
Sectors (records)	4872 (12 per revolution)/6496 (16 per revolution)

Table 1-1 (Cont)
Performance Specifications

Characteristic	Specification
Bit Capacities (unformatted)*	
Per Disk	25 million
Per Inch	2040 (max. at inner track)
Per Cylinder	115,200
Per Track	57,600
Per Sector	4,800/3,844
Access Times	
Disk Rotation	1500 ± 30 rpm
Average Latency	20 ms (half rotation)
Head Positioning	10 ms – for adjacent tracks
(including settling time)	50 ms – average
	85 ms – for 200 track movement
Bit Transfer*	
Transfer Code	Double frequency, nonreturn-to-zero recording
Transfer Rate	1.44M bits per sec
Electrical Requirements	
Voltage	115/230 Vac @ 50/60 Hz
Power	250 VA
Starting Current	Power only: 1.8A Start spindle: 10A (for 2 sec)
Model Designation	
RK05-AA	95 to 130 Vac @ 60 ± 0.5 Hz
RK05-AB	190 to 260 Vac @ 60 ± 0.5 Hz
RK05-BA	95 to 130 Vac @ 50 ± 0.5 Hz
RK05-BB	190 to 260 Vac @ 50 ± 0.5 Hz
Environment	
Ambient Temperature	50° to 110°F (67° to 73°C nominal)
Relative Humidity	8% to 80% (no condensation)
Barometric Pressure	30 ± 3 mm hg
Dimensions and Weight	
Width	19 in.
Depth	26-1/2 in.
Height	10-1/2 in.
Weight	110 lb

* Some RK11D systems record at 1.54M bits/sec which increases the bit density and capacity accordingly.

1.3 50/60 Hz POWER OPTION

The RK05 Disk Drive is available in the following four power models:

- RK05-AA 95 to 130 Vac @ 60 Hz
- RK05-AB 190 to 260 Vac @ 60 Hz
- RK05-BA 95 to 130 Vac @ 50 Hz
- RK05-BB 190 to 260 Vac @ 50 Hz

Each model is shipped with a complete set of drawings. To change from 50 to 60 Hz operation requires a different spindle drive pulley. To change from 115 to 230V operation requires that the power connector (P2) be reconfigured (Paragraph 4.6).

1.4 MAJOR ASSEMBLIES AND SYSTEMS

The RK05 Disk Drive is composed of the following major assemblies and systems:

- Controls and Indicators
- Spindle and Drive System
- Linear Positioner
- Cartridge Handling System
- Electronic Module
- Air System
- Power Supply

Figure 1-1 illustrates the locations, and the subsequent paragraphs describe the functions of each of the major assemblies and systems.

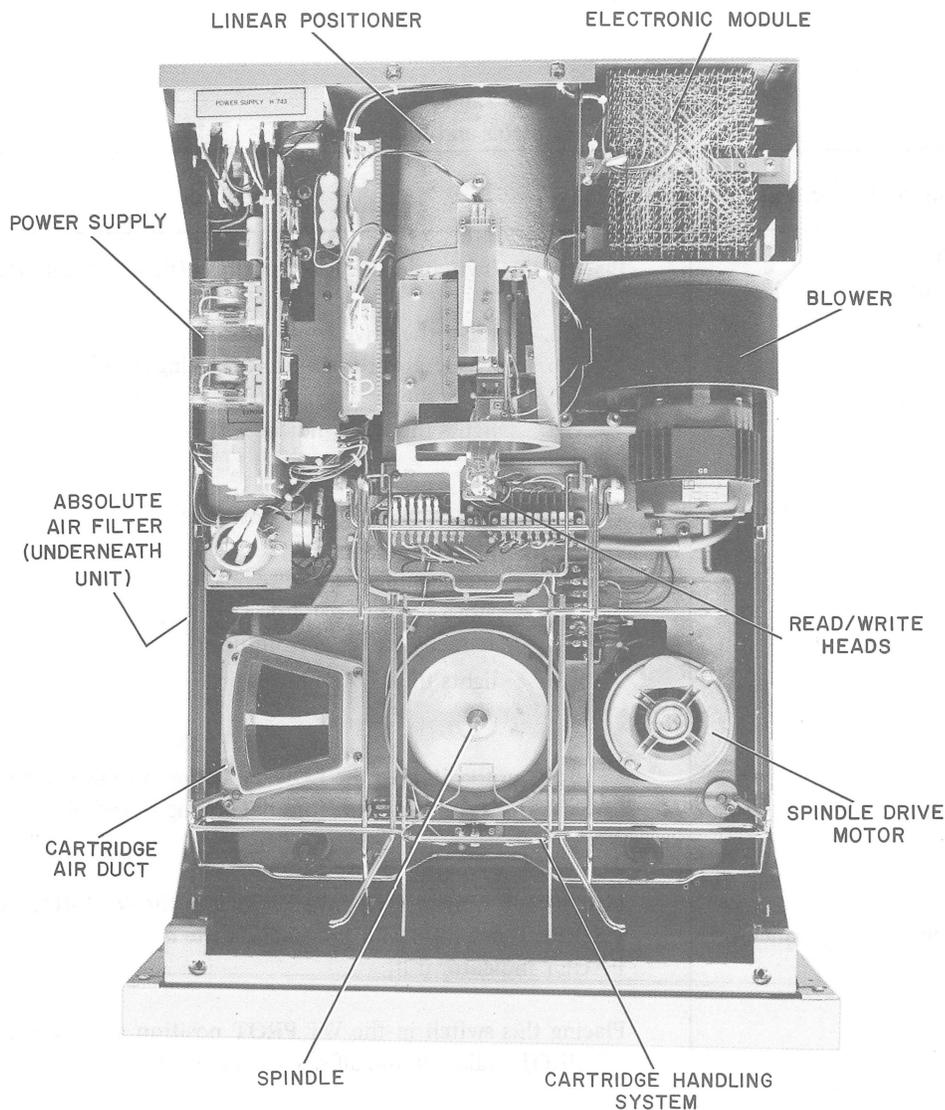


Figure 1-1 Location of Major Assemblies and Systems

1.4.1 Controls and Indicators

The controls and indicators (Figure 1-2) required for normal operation are located on the front of the drive cabinet. Table 1-2 describes the function of each control or indicator.

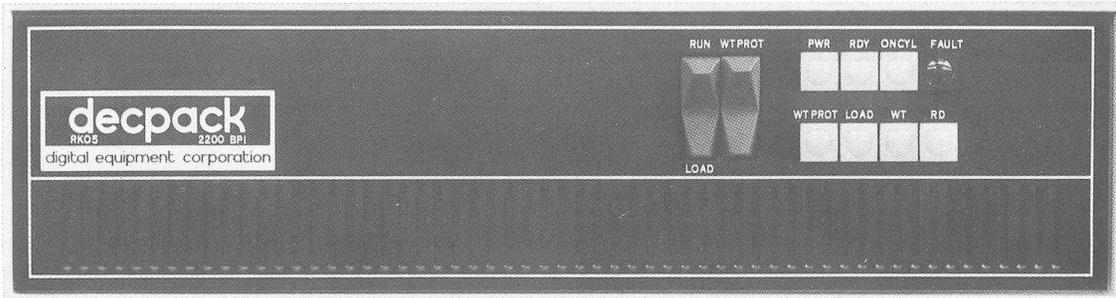


Figure 1-2 Controls and Indicators

Table 1-2
Controls and Indicators

Controls and Indicators	Description
<p>RUN/LOAD (rocker switch)</p>	<p>Placing this switch in the RUN position (providing all interlocks are safe):</p> <ol style="list-style-type: none"> locks the drive front door accelerates the disk to operating speed loads the read/write heads lights the RDY indicator. <p>Placing this switch in the LOAD position:</p> <ol style="list-style-type: none"> unloads the read/write heads stops the disk rotation unlocks the drive front door lights the LOAD indicator. <p style="text-align: center;">CAUTION</p> <p>Do not switch to the LOAD position during a write operation, as this results in erroneous data being recorded.</p>
<p>WT PROT (rocker switch – spring-loaded off)</p>	<p>Placing this momentary contact switch in the WT PROT position lights the WT PROT indicator and prevents a write operation as well as turns off the FAULT indicator if lit.</p> <p>Placing this switch in the WT PROT position a second time turns off the WT PROT indicator and allows a write operation.</p>
<p>PWR (indicator)</p>	<p>Lights when operating power is present. Goes off when operating power is removed.</p>

**Table 1-2 (Cont)
Controls and Indicators**

Controls and Indicators	Description
<p>RDY (indicator)</p>	<p>Lights when:</p> <ul style="list-style-type: none"> a. the disk is rotating at the correct operating speed b. the heads are loaded c. no other conditions are present (all interlocks safe) to prevent a seek, read, or write operation. <p>Goes off when the RUN/LOAD switch is set to the LOAD position.</p>
<p>ON CYL (indicator)</p>	<p>Lights when:</p> <ul style="list-style-type: none"> a. the drive is in the Ready condition b. a seek or restore operation is not being performed c. the read/write heads are positioned and settled. <p>Goes off during a seek or restore operation.</p>
<p>FAULT (indicator)</p>	<p>Lights when:</p> <ul style="list-style-type: none"> a. erase or write current is present without a WRITE GATE or, b. the linear positioner transducer lamp is inoperative. <p>Goes off when the WT PROT switch is pressed or when the drive is recycled through a RUN/LOAD sequence.</p>
<p>WT PROT (indicator)</p>	<p>Lights when:</p> <ul style="list-style-type: none"> a. the WT PROT switch is pressed or, b. the operating system sends a Write Protect command. <p>Goes off when the WT PROT switch is pressed a second time or when the drive is recycled through a RUN/LOAD sequence.</p>
<p>LOAD (indicator)</p>	<p>Lights when the read/write heads are fully retracted and the spindle has stopped rotating.</p> <p>Goes off when the RUN/LOAD switch is set to the RUN position.</p>
<p>WT (indicator)</p>	<p>Lights when a write operation occurs. Goes off when the write operation terminates.</p>
<p>RD (indicator)</p>	<p>Lights when a read operation occurs. Goes off when the read operation terminates.</p>

1.4.2 Spindle and Drive

The spindle and drive system (Figure 1-3) is composed of the spindle, spindle drive motor, and the recording disk. A 50/60 Hz, single-phase ac motor transfers torque (via the drive belt) to the spindle drive pulley. Belt tension is maintained by a tension spring anchored to the baseplate.

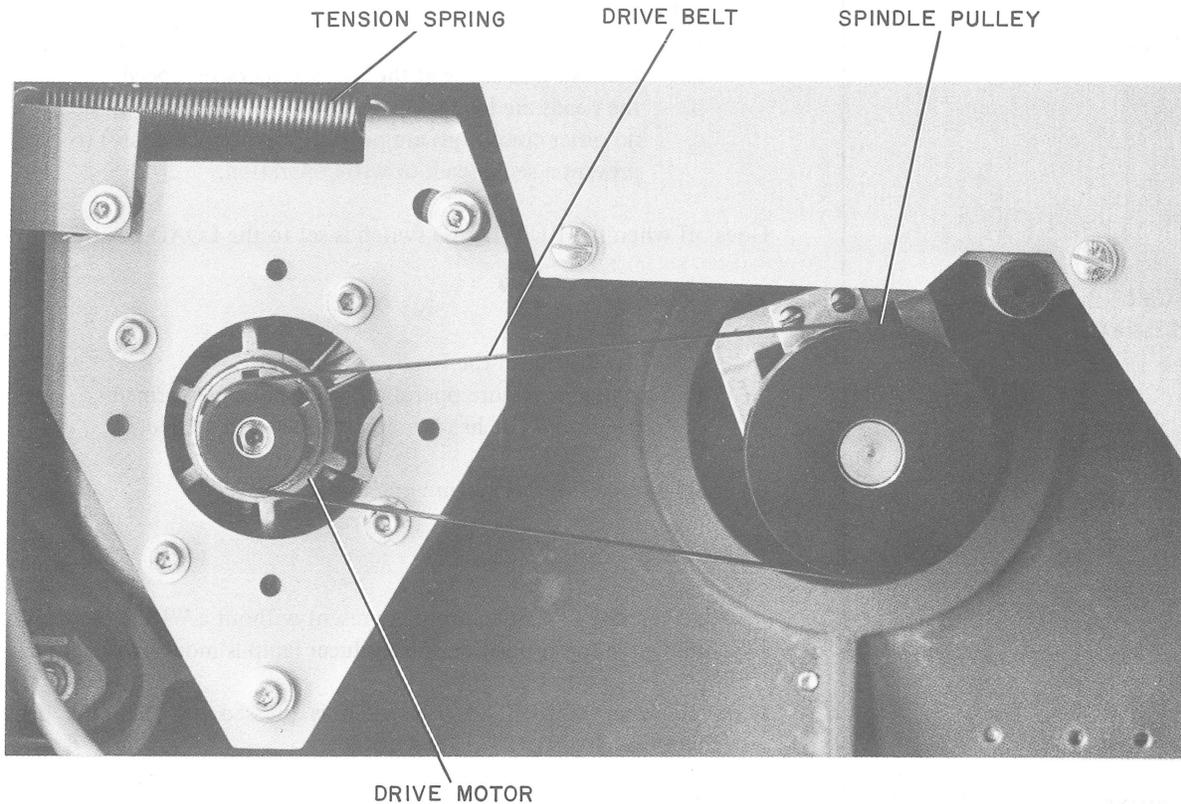


Figure 1-3 Spindle and Drive System

The spindle speed is electronically tested by a circuit that measures the INDEX PULSE interval. When the interval increases to approximately 45 ms, indicating an unsafe speed, the drive is cycled down. If the RUN/LOAD switch is placed in the LOAD position, ac power is removed from the motor and the spindle coasts to a halt.

1.4.3 Linear Positioner

The linear positioner (Figure 1-1) consists of the linear motor, the carriage, the read/write heads, and the linear positioner transducer. To move the read/write heads across the recording disk, dc current is applied to the bobbin-wound armature (Figure 1-4) of the linear motor. The resulting magnetic field reacts with a permanent magnet in the motor housing to either pull the armature into or force it out of the permanent magnetic field, depending upon the polarity of the current applied to the armature. This motion is transferred to the carriage, which is fastened to the armature. As a result, the read/write heads, which are attached to the carriage, move across the surface of the disk.

Any carriage movement is detected by the linear positioner transducer, which is located on the underside of the carriage. The transducer output is used with the control logic to determine the cylinder position of the heads, and in the servo logic to govern the speed of carriage travel.

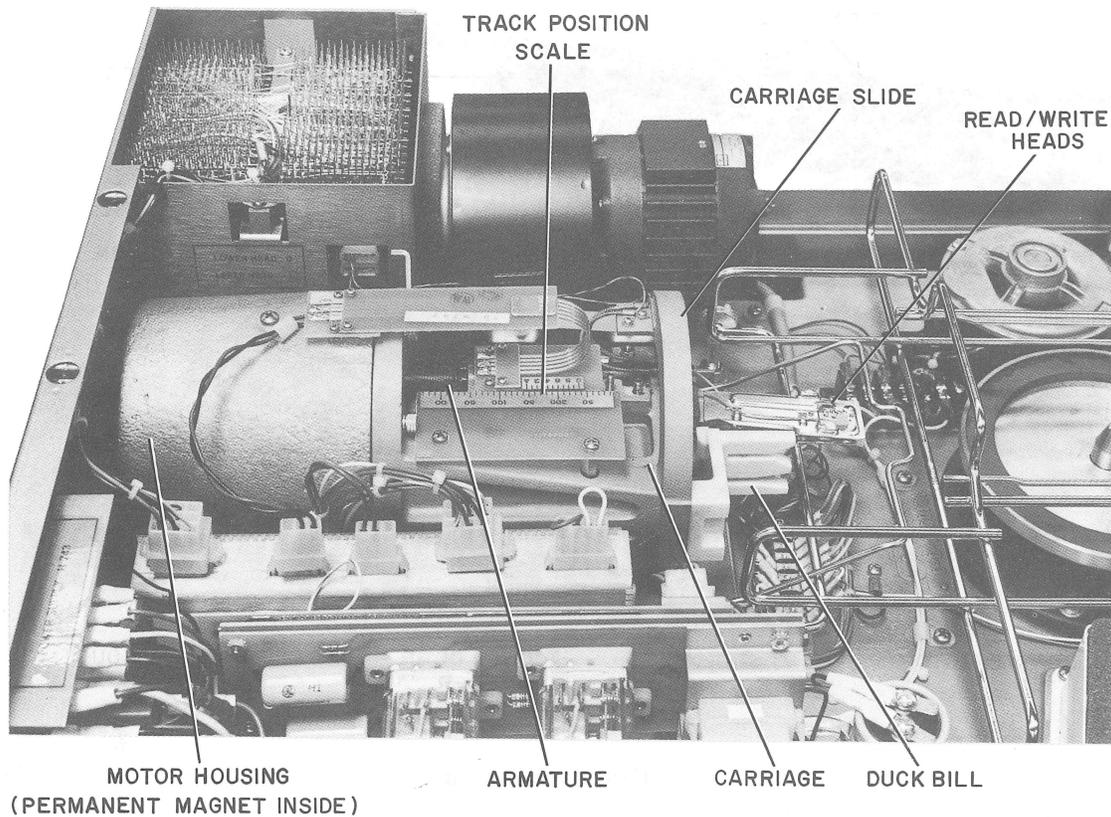


Figure 1-4 Linear Positioner

1.4.4 Cartridge Handling System

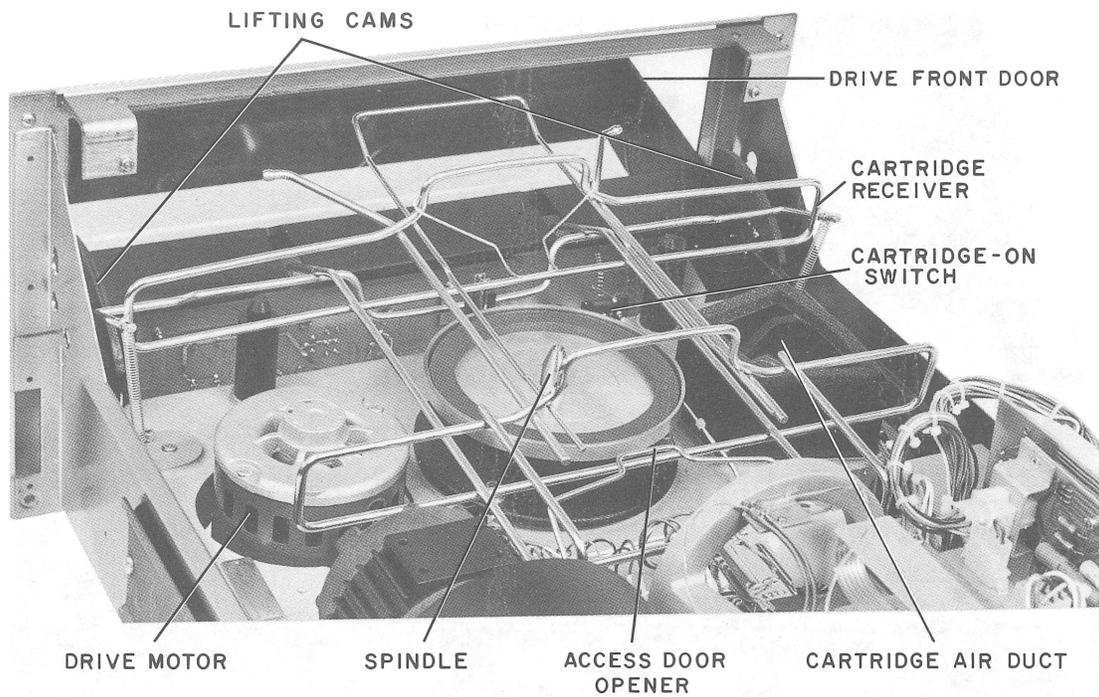
The cartridge handling system (Figure 1-5a) consists of a cartridge receiver, two receiver lifting cams, and an access door opener. During normal operation, the receiver supports the plastic cartridge case, allowing the recording disk to rotate freely on the spindle. The rotating spindle drives the disk by magnetic coupling at the disk hub.

As the drive front door is opened, the magnetic coupling at the disk hub is released and the lifting cams rotate to elevate the receiver to a slanted position. When the disk cartridge is inserted into the receiver (Figure 1-5b), the access door opener contacts the rear of the top cover, opening the access door to allow entry of the read/write heads.

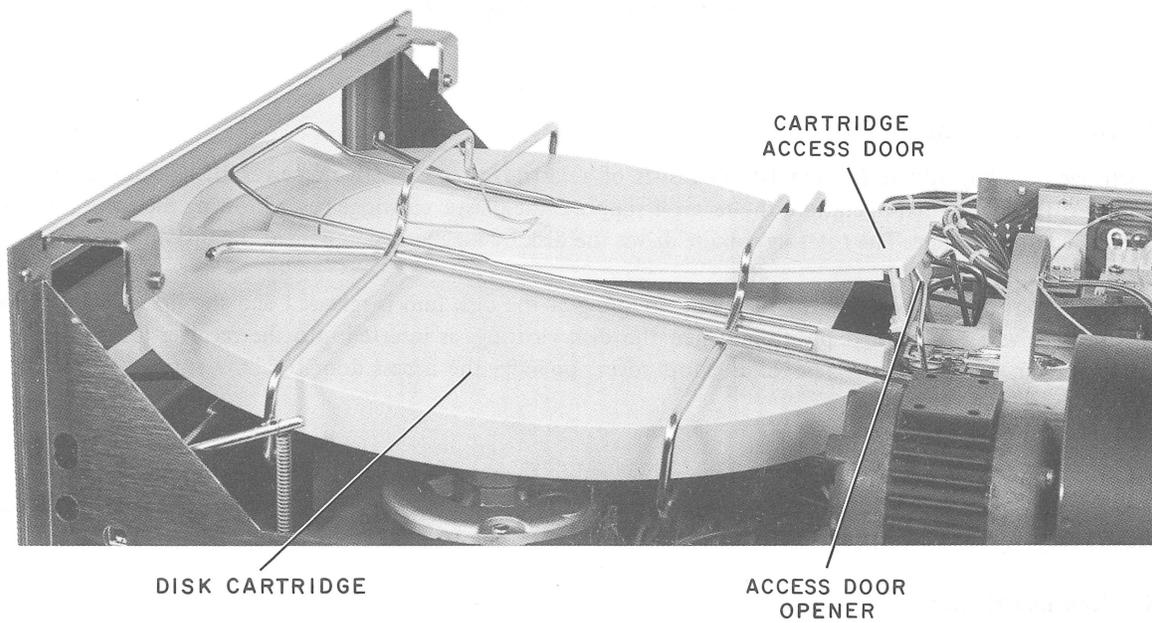
As the drive front door is closed, the cartridge is lowered to the operating position and the magnetic coupling again engages the disk hub. When the cartridge is in the operating position, the plastic case depresses the cartridge-on switch and removes the no-cartridge interlock condition.

1.4.5 Electronic Module

The electronic module (Figure 1-1), located in the right rear portion of the disk drive, holds eight printed circuit cards. Three of these cards contain the system logic and the read/write circuits. Two cards contain the positioner servo logic. One card is the cable connector that interfaces the electronics with the positioner and other chassis mounted components, while the remaining two cards contain the interface cables and terminators.



a. Cartridge Removed

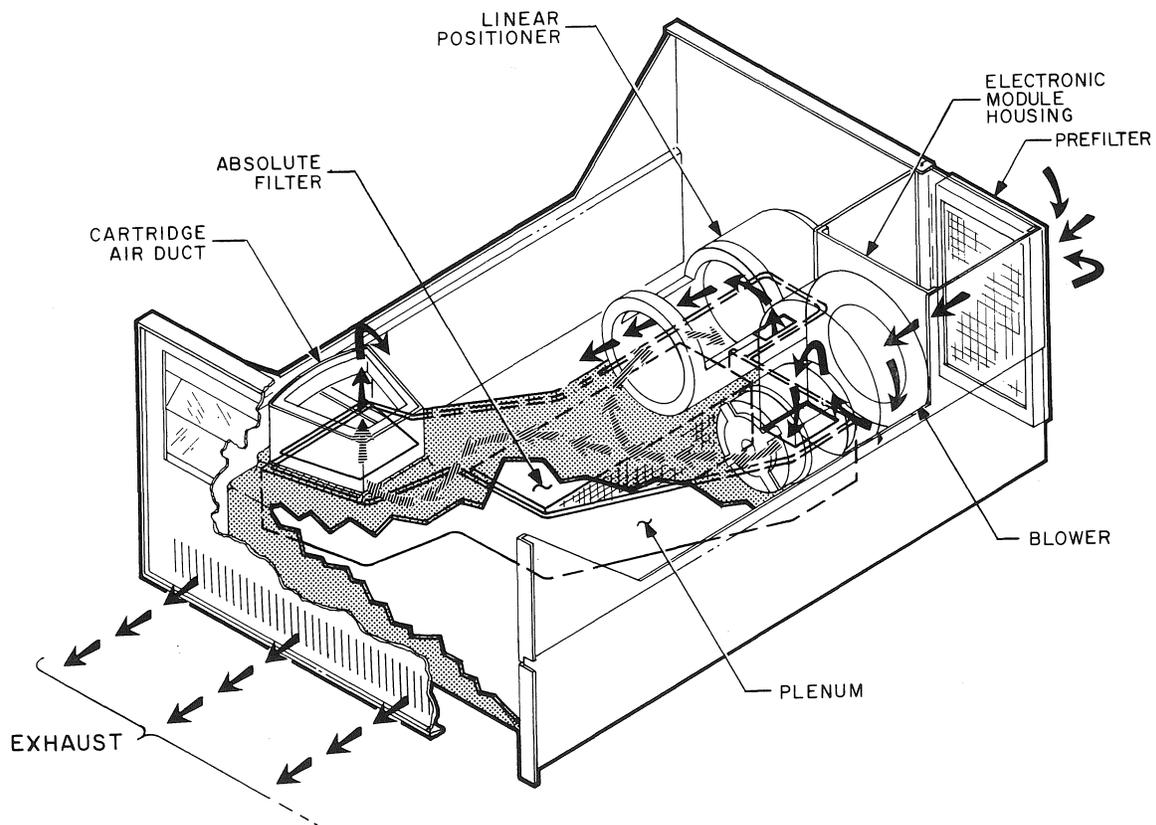


b. Cartridge Inserted

Figure 1-5 Cartridge Handling System

1.4.6 Air System

The air system (Figure 1-6) consists of the prefilter, blower, absolute filter, plenum chamber, and the cartridge air duct. As the blower rotates, unfiltered air is drawn through the prefilter, where it is purged of large dust particles. The prefiltered air is then circulated through the electronic module and into the plenum. From here, the air passes through the absolute filter (where minute contamination is removed), up the cartridge air duct, and into the disk cartridge. Cooling air from the absolute filter is also shunted, by the plenum, through the linear positioner. Exhaust air exits through the front grill of the drive.



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Figure 1-6 Air System

1.4.7 Power Supply

The power supply (Figure 1-1), located in the left rear portion of the disk drive, furnishes all the dc voltages for the drive. The power supply can operate with a 115 or 230V, 50 or 60 Hz line voltage input (Paragraph 4.6).

CHAPTER 2

INSTALLATION

2.1 UNPACKING AND INSPECTION

The RK05 Disk Drive can be shipped in a rack as an integral part of a system or in a separate container. If the drive is shipped in a rack, position the rack in the final installation location and unpack it as follows:

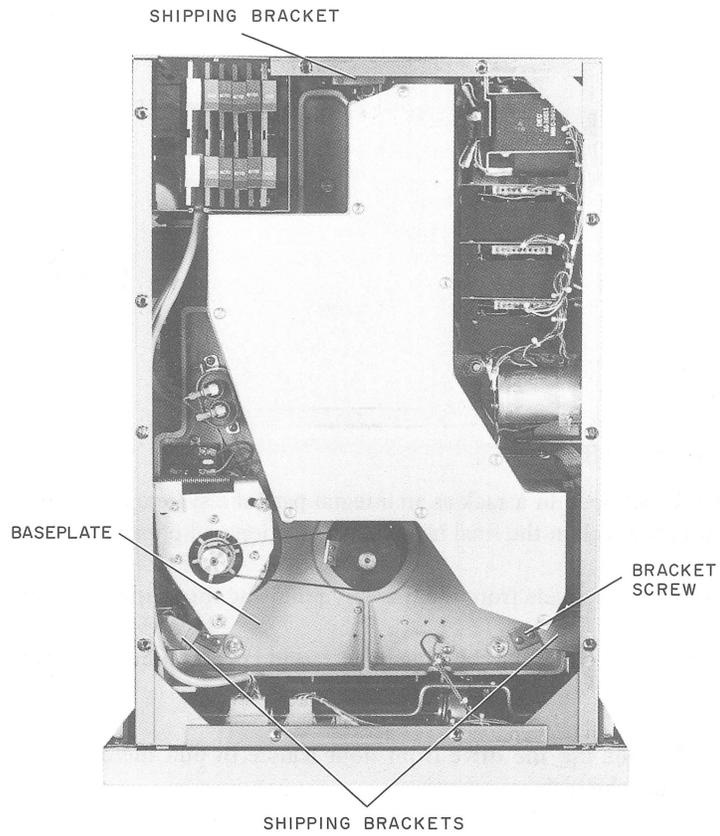
1. Remove the shipping brackets from the drive by removing the snap-on bezel beneath the lowest drive.
2. Remove the screws attaching the shipping bracket and latch molding to both sides of the drive.

CAUTION

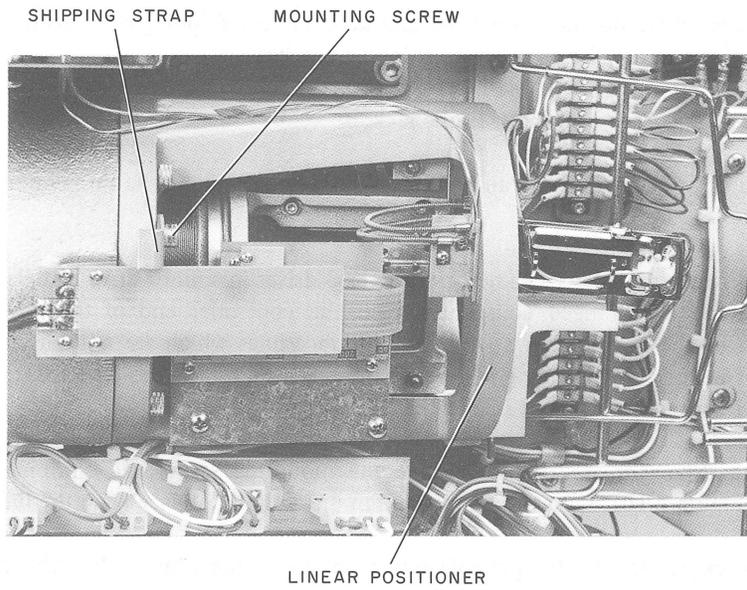
Do not use the drive front door handle to pull the drive out from the rack.

3. Slide the drive out about 3 in. from the rack and pull the shipping brackets out from the sides of the drive. Attach the latch molding back onto the drive with the shipping bracket screws.
4. Slide the lowest drive out far enough to gain access to the shipping brackets on the drive directly above it and remove the screws from these two shipping brackets.
5. Repeat Steps 3 and 4 for each drive in the rack.
6. Remove the drive bottom covers and remove the screws attaching the three internal shipping brackets to the baseplate (Figure 2-1a).
7. When RK05 drives are "daisy-chained" with RK03 drives in a multi-drive installation, it is recommended that the RK05s be arranged consecutively at the controller end of the bus. This is done to avoid interruption of the AC LOW and DC LOW interface lines which are not carried by the RK03s. If this arrangement is not possible, any RK05s that are separated on the bus by RK03s, require a separate cable connection between J06 (Figure 2-3) of the RK05s.
8. Remove the drive top cover and remove the mounting screw and shipping strap from the linear positioner (Figure 2-1b). Turn the shipping strap upward and replace it on the linear positioner.
9. Retain all packing material for possible return shipment and inspect the drive for damage. Report any damage to the carrier and to Digital Equipment Corporation.

If the drive is shipped in a separate container, use care while unpacking it. Do not drop or subject the drive to unreasonable impact.

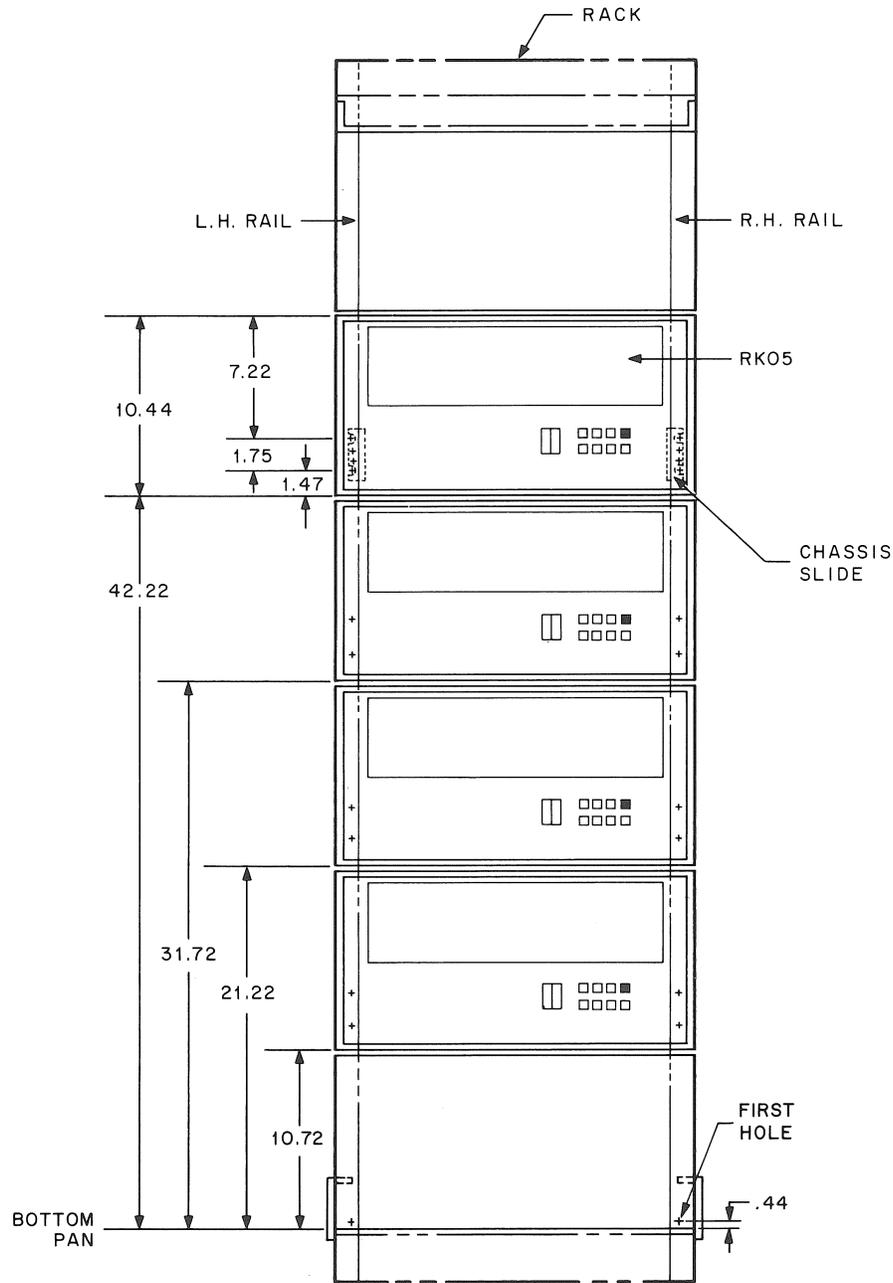


a. Shipping Brackets



b. Shipping Strap

Figure 2-1 Shipping Strap and Shipping Bracket Locations



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Figure 2-2 Chassis Slide Mounting

2.2 MECHANICAL INSTALLATION AND CHECKOUT

If the RK05 Disk Drive is to be installed in an existing rack, first install the chassis slides in the rack as illustrated in Figure 2-2, then mount the disk drive on the chassis slides as follows: (If necessary, refer to the RK05 Option Configuration Dwg. No. D-OC-RK05-0-15 for detailed mechanical specifications of a multi-drive installation.)

1. If the drive is to be mounted in a rack without sufficient weight to prevent tipping when the drive is fully extended, install cabinet stabilizers before mounting the drive.
2. Pull the chassis slides out until they lock in the extended position.

3. Slide the drive onto the chassis slides until it locks.
4. Remove the drive bottom covers and remove the screws attaching the three internal shipping brackets to the baseplate (Figure 2-1a).
5. Remove the drive top cover and remove the mounting screw and shipping strap from the linear positioner (Figure 2-1b). Turn the shipping strap upward and replace it on the linear positioner.
6. Inspect P2 (Figure 5-3) and the spindle pulley to ensure that the drive is configured properly for the input power to be used. If P2 contains two jumpers, the supply is configured for 115 Vac operation. If P2 contains only one jumper, the supply is configured for 230 Vac. The ac operating frequency is stamped on the spindle pulley.
7. Plug the interface cable card into card position 7 or 8 of the electronic module. If there is only one drive in the system or if this is the last drive of the "daisy-chain," ensure that an M930 terminator card (Dwg. No. RK05-0-2) is in the unused interface card position.
8. When RK05 drives are "daisy-chained" with RK03 drives in a multi-drive installation, it is recommended that the RK05s be arranged consecutively at the controller end of the bus. This is done to avoid interruption of the AC LOW and DC LOW interface lines which are not carried by the RK03s. If this arrangement is not possible, any RK05s that are separated on the bus by RK03s require a separate cable connection between J06 (Figure 2-3) of the RK05s.
9. If the drive is to be connected to an RK11C or RK11D controller, the interface cables may be installed as follows; however, it is preferred that all interface cables be installed as described in Step 10.
 - a. Fold the interface cables and route them through the slot just below the prefilter at the rear of the drive cabinet (Figure 2-3).
 - b. Hold the cables in position and replace the bottom cover.

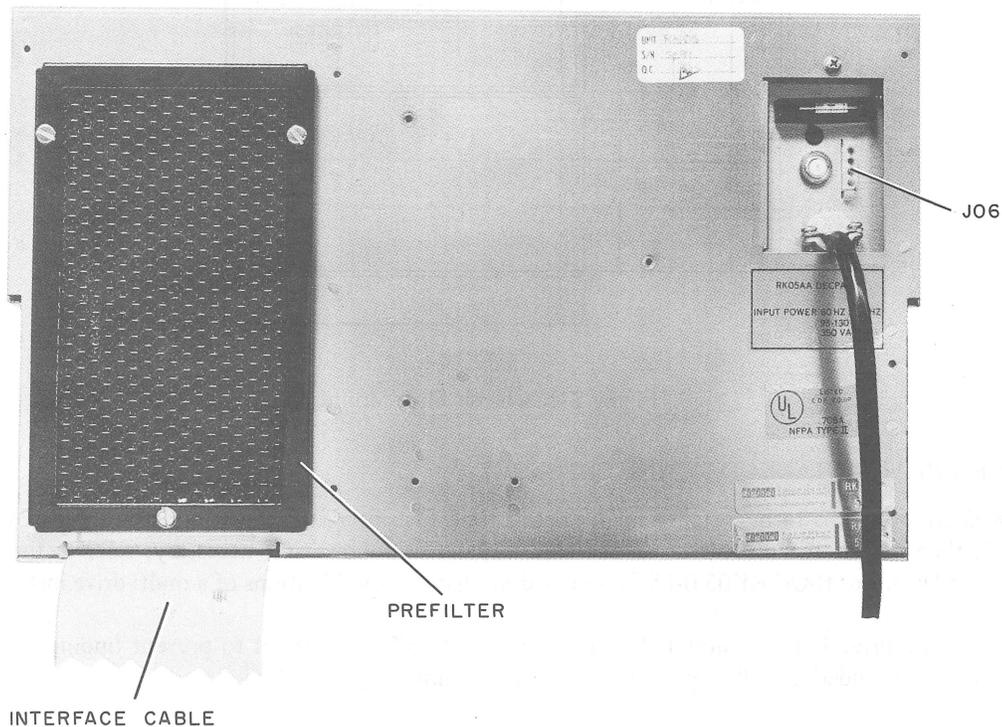


Figure 2-3 RK11C or RK11D Interface Cable Installation

10. If the drive is to be connected to an RK8/E controller, install the interface cables as follows:
- Remove the prefilter and frame.
 - Route the interface cables through the prefilter opening and reinstall the filter and frame so that the cables fit into the slot on the side of the frame (Figure 2-4).
 - Route the cables over the prefilter and fold them as indicated in Figure 2-4.
 - Place the cable retaining bracket over the fold in the cables and fasten the bracket to the chassis.

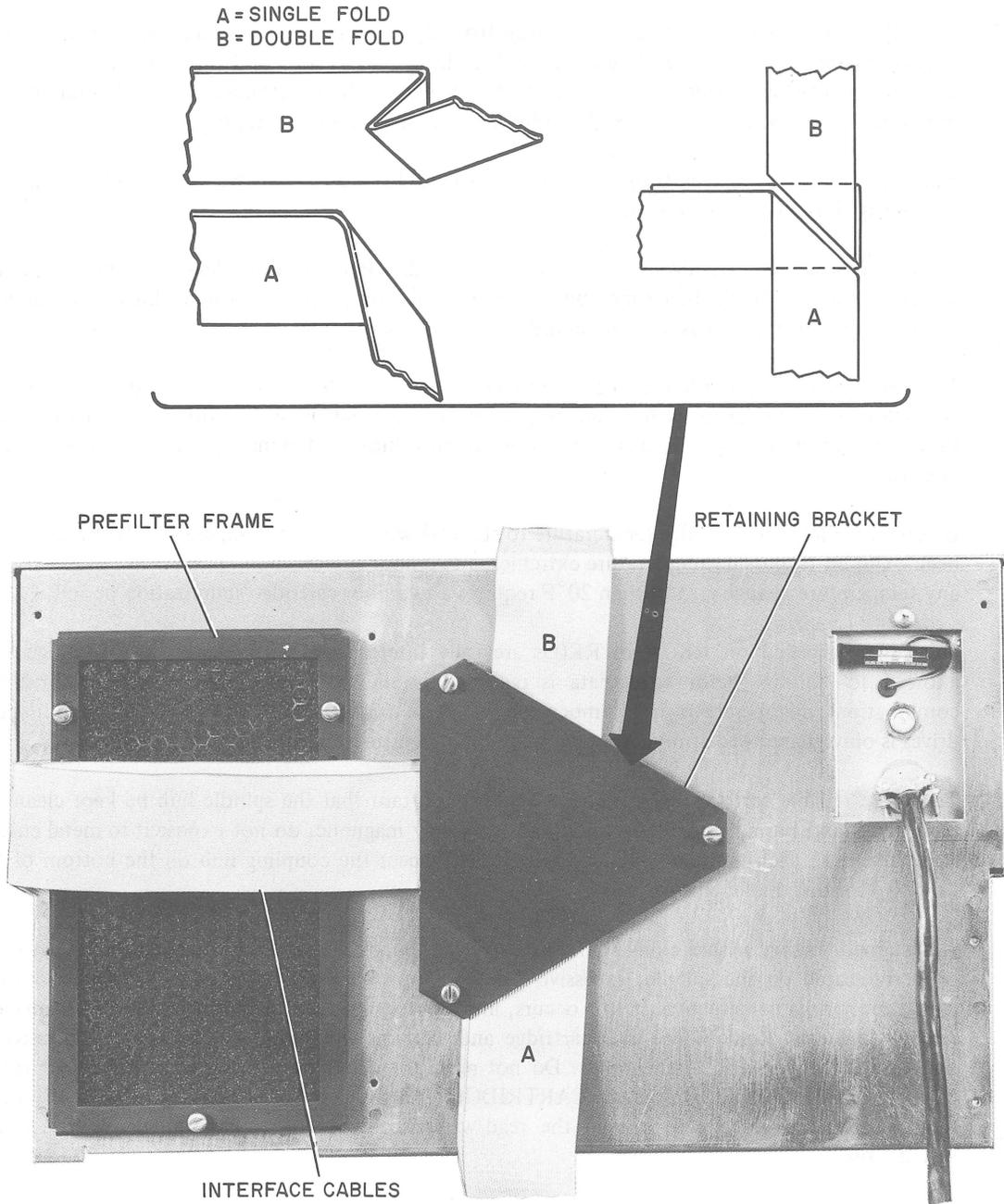


Figure 2-4 RK8/E Interface Cable Installation (Preferred Method)

11. Plug the power cord into the switched ac line receptacle.
12. Turn the processor keyswitch on to apply power to the drive.
13. Install a test cartridge on the spindle (Paragraph 2.4.1) and run the appropriate diagnostic tests to ensure proper electrical and mechanical drive operation.

2.3 CARTRIDGE HANDLING PRACTICES AND PRECAUTIONS

To obtain maximum performance and high reliability from the RK05 Disk Drive, observe the following precautions and cartridge handling practices.

1. Store the cartridges in a clean dry area, away from direct sunlight. Cartridges may be stored on edge or stacked on top of one another; however, avoid stacks of more than 3 or 4 cartridges. Do not place heavy items on the plastic cartridge cases. Under no circumstances store cartridges on top of computer cabinets or in other places where dirt can be blown by fans into the cartridge interiors.
2. When shipping or storing cartridges for extended periods of time, it is best to enclose the cartridge in a plastic bag to exclude dust or dirt.
3. Do not expose the cartridge to excessive heat or dirt. Periodic disk cleaning is not recommended; however, the disk should be cleaned whenever it is excessively dirty, or when a high transient error rate is encountered. For such cases, a special disk cleaning kit is available.
4. The front edge of the disk cartridge is provided with a molded frame which is designed to hold stiff cardboard or plastic labels without adhesives. Do not place labels on any other part of the cartridge as they may interfere with the drive operation or introduce contamination into the drive or cartridge interiors.
5. Before use, allow the cartridge temperature to stabilize with the room temperature. If the cartridges have been exposed to outside temperature extremes, a two hour stabilization period is necessary. In addition, any temperature change greater than 20°F requires a two hour cartridge stabilization period.
6. Cartridges recorded on RK03s or RK05s are fully interchangeable; however, the cartridges must be allowed to stabilize before new data is recorded on them. Even though a specific drive/cartridge combination will operate over a temperature range of 60 to 110°F, data interchangeability between drives is only guaranteed at no more than a 30°F temperature difference.
7. To ensure reliable cartridge operation, it is very important that the spindle hub be kept clean and free from nicks and burrs. Since the spindle hub is slightly magnetic, do not expose it to metal chips which may adhere to the mounting surface. Periodically inspect the coupling hub on the bottom of the disk cartridge for dirt, metal chips, etc.
8. A sustained tinging or scratching sound due to head-to-disk contact may occur if: the cartridge is not properly seated on the spindle, excessive contamination has built up in the cartridge interior, or the cartridge or drive is defective. If this occurs, immediately shut down the drive to avoid damage to the read/write heads. Remove the disk cartridge and examine the heads for damage or excessive dirt. If necessary, clean or replace the heads. Do not reuse the cartridge without first checking it for surface damage. **NEVER CYCLE A BAD CARTRIDGE THROUGH AN INSTALLATION OF SEVERAL DRIVES.** This practice can ruin all the read/write heads or contaminate all drives in a multi-drive installation.
9. Keep the drive front door closed at all times to prevent unnecessary entry of atmospheric dirt or dust.

2.4 CARTRIDGE PACKING AND SHIPPING

Contrary to many rumors, the data recorded on a cartridge is unaffected by the magnetometers used by airlines for detection of weapons. However, if cartridges are to be shipped in the cargo hold of an aircraft, certain precautions are necessary in case the cartridges are packed near magnetic sources. The best protection against accidental erasure of a cartridge is to physically separate the cartridge from the magnetic source. Adequate protection is provided, if no part of the cartridge is closer than 6 inches from the sides of the box in which the cartridge is shipped. This amount of physical separation guarantees that the cartridge will be unaffected by any magnetic sources likely to be encountered during transportation. Therefore, if this packing process is adhered to, it is not necessary to ship the cartridge in a specially shielded box.

2.5 NORMAL OPERATING PROCEDURES

All drives in a multi-drive system must have operating power applied even when the drive is not in use. In addition, unused drives should be left write-enabled, and with the RUN/LOAD switch in the LOAD position. **IMPORTANT: ON EARLIER MODEL RK05 DISK DRIVES EQUIPPED WITH A POWER ON/OFF SWITCH, DO NOT USE THE ON/OFF SWITCH DURING SYSTEM OPERATION TO REMOVE OPERATING POWER FROM AN INDIVIDUAL DRIVE.** Since the DC LOW interface signal is common to all drives in a multi-drive system, a power loss in any one drive disables all the drives in the system. If the drive power is controlled by a processor keyswitch, leave all drive ON/OFF switches ON; however, set all RUN/LOAD switches to LOAD before removing system power.

2.5.1 Cartridge Loading

1. Set the RUN/LOAD switch on all drives to LOAD and observe that the LOAD indicator lights.

CAUTION

**If the LOAD indicator is not lit, the drive front door is locked.
If this is the case, do not attempt to force the drive front door open.**

2. Open the drive front door and carefully insert a clean, operable disk cartridge fully into the cartridge receiver. Do not twist or force the cartridge during insertion.
3. Close the drive front door and set the RUN/LOAD switch to RUN.
4. Wait for the RDY and ON CYL indicators to light, at which point the drive is ready to perform seek, read, or write operations.

2.5.2 Cartridge Unloading

1. Set the RUN/LOAD switch to LOAD and observe that the RDY indicator goes out. After approximately 30 seconds, the LOAD indicator will light.
2. Open the drive front door and withdraw the disk cartridge.
3. If another cartridge is not loaded, close the drive front door to prevent unnecessary entry of atmospheric dirt or dust.

CHAPTER 3

INTERFACE

3.1 GENERAL

The flexibility achieved with the address select logic and the eight-position address select switch permits the RK05 Disk Drive to be connected to a variety of computer systems. In the RK11C and RK8/E systems, up to four drives can be serially connected to a single bus. However, in the RK11D system, up to eight drives may be serially connected.

Interface cable connection of the RK05 Disk Drive is made to card position 7 or 8 of the electronic module. These card positions are parallel-wired so that several drives may be connected in a multi-drive "daisy-chain" configuration. That is, card position 7 or 8 of the first drive is connected to card position 7 or 8 of the following drive, etc. If there is only one drive in the system, an M930 terminator card must be installed in the unused interface card position. If there is more than one drive in the system, only the last drive on the bus must have the M930 terminator card in the unused interface card position. The interface signal levels are determined by the M930 terminator card. An assertion or logic 1 is approximately +0.5 Vdc, while a negation or logic 0 is approximately +3.5 Vdc.

Figure 3-1 illustrates and the following paragraphs describe the function of each interface line.

3.2 INPUT INTERFACE LINES

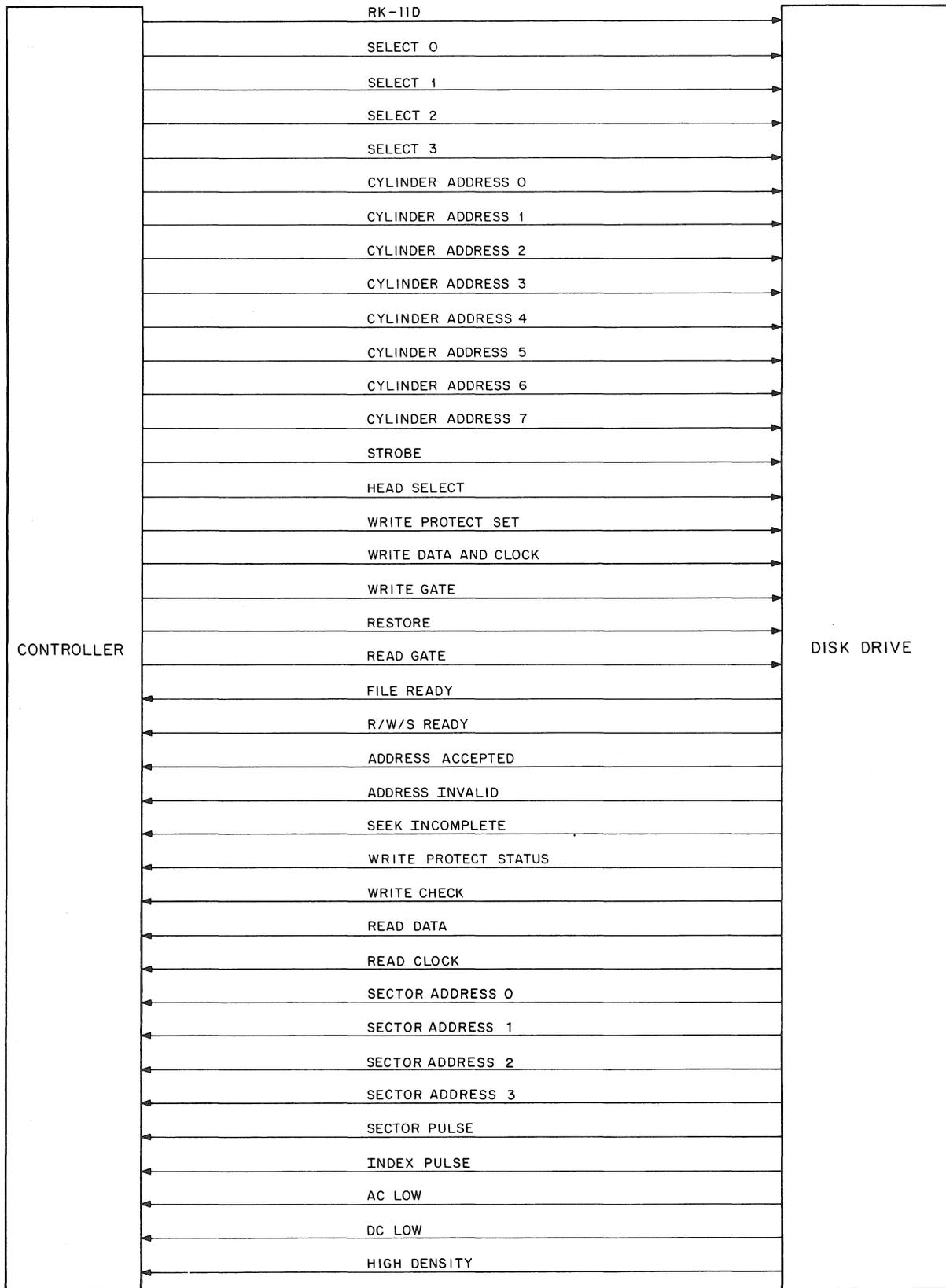
3.2.1 RK-11D

This line transmits a signal that configures the address select logic to operate with a particular controller type. A logical 0 on this line indicates that the controller is not an RK11D (the controller is either an RK11C or an RK8/E, both of which control only four drives on a single bus), while a logical 1 indicates that the controller is an RK11D.

3.2.2 Select (4 lines)

These four lines operate in conjunction with the RK-11D interface line and an eight-position address select switch on the M7700 card. These three factors determine the drive address assignment and selection by one of the following two methods:

- a. With a logical 0 on the RK-11D line, the M7700 selection circuit is configured to decode the four selection lines as a linear set. In a particular drive, only one of the four lines is internally connected (via positions 0 through 3 of the address select switch) to the drive control logic. To select a drive, the controller places a logical 1 on the desired SELECT line. This line remains at logical 1 throughout the entire data transfer or control operation.
- b. With a logical 1 on the RK-11D line, the M7700 selection circuit is configured to decode SELECT 0 through 2 as a binary-encoded set. To select a drive, the controller places a 3-bit binary code, which corresponds to the drive address, on these SELECT lines. This binary code is then translated by a three line-to-eight line decoder to activate only one of the eight address select switch positions.



CP-0238

Figure 3-1 Controller to Disk Drive Interface Lines

3.2.3 Cylinder Address (8 lines)

These eight lines determine the cylinder position of the read/write heads. In order to move the heads to a desired cylinder, the controller places a corresponding 8-bit binary code on the lines (valid codes = 0 through 202). These lines are then gated by the STROBE signal to position the heads at the selected cylinder. The binary code remains on the lines until either the ADDRESS ACCEPTED or ADDRESS INVALID signal is returned from the drive (Paragraph 3.3.3).

3.2.4 Strobe

This line transmits a signal that gates the CYLINDER ADDRESS or RESTORE lines. The controller places a logical 1 on the STROBE line, only after the CYLINDER ADDRESS or RESTORE signals (Paragraph 3.2.9) are fully settled on their respective lines. STROBE remains at logical 1 until either the ADDRESS ACCEPTED or ADDRESS INVALID signal is returned from the drive.

3.2.5 Head Select

This line transmits a signal that determines which of the two read/write heads is to be selected. The controller places a logical 1 on this line to select the upper head, and a logical 0 to select the lower head. Either signal remains on the line throughout the entire read or write operation.

3.2.6 Write Protect Set

This line transmits a signal that disables the drive write amplifiers to prevent a write operation. The controller places a logical 1 on this line to set the Write Protect flip-flop and inhibit the write capability of the drive. The Write Protect flip-flop is also set if the WT PROT indicator is off and the operator presses the WT PROT switch (Paragraph 1.4.1).

The Write Protect flip-flop is reset if the WT PROT indicator is on and the operator presses the WT PROT switch or the operator sets the RUN/LOAD switch to LOAD and then back to RUN. When power is applied to the drive, the internal power start sequence also resets the Write Protect flip-flop. Thus, in the event of a power failure and subsequent power restoration, the drive is write-enabled regardless of the previous conditions.

3.2.7 Write Data and Clock

This line transmits multiplexed data and clock pulses to the disk drive.

3.2.8 Write Gate

This line transmits a signal to simultaneously turn on both the write and erase current in the selected write head. The controller places a logical 1 on this line 1 μ s prior to transmitting the write data. This line remains at logical 1 throughout the data transmission time.

3.2.9 Restore (RTZ)

This line transmits a signal to position the read/write heads at cylinder zero. The controller places a logical 1 on this line prior to issuing the STROBE SIGNAL. About 2 μ s after STROBE is issued, the drive returns an ADDRESS ACCEPTED signal, clears the address register, and moves the heads to cylinder zero. The RESTORE line remains at logical 1 until ADDRESS ACCEPTED is received by the controller.

3.2.10 Read Gate

This line transmits a signal that allows data to be read from the drive. The controller places a logical 1 on this line to enable the READ CLOCK and READ DATA output lines. This line remains at logical 1 throughout the entire read operation.

3.3 OUTPUT INTERFACE LINES

3.3.1 File Ready

This line transmits a logical 1 to indicate the following conditions:

- a. Drive operating power is correct.
- b. A disk cartridge is properly loaded.
- c. The drive front door is closed.
- d. RUN/LOAD switch is in the RUN position.
- e. Spindle is rotating at the correct speed.
- f. Read/write heads are loaded.
- g. WRITE CHECK is false.

3.3.2 R/W/S Ready (Read, Write, or Seek Ready)

This line transmits a logical 1 to indicate that the drive is in the File Ready condition (Paragraph 3.3.1) and is not performing a seek operation.

3.3.3 Address Accepted

This line transmits a 5- μ s negative pulse to indicate that the drive has accepted a Seek command with a valid address and the command execution has begun. The negative pulse is generated about 2 μ s after receipt of the STROBE signal, even if there is no change from the present address.

3.3.4 Address Invalid

This line transmits a 5- μ s negative pulse to indicate that the drive has received a nonexecutable Seek command with a cylinder address greater than 202. For this case, the Seek command is suppressed in the drive and the heads are not moved. The pulse generation time is the same as for ADDRESS ACCEPTED.

3.3.5 Seek Incomplete

This line transmits a logical 1 to indicate that some malfunction in the drive did not allow the seek operation to be completed. This line remains low until a Restore command is received or the operator sets the RUN/LOAD switch to LOAD and then back to RUN.

3.3.6 Write Protect Status

This line transmits a logical 1 to indicate that the drive is write-protected (write capability inhibited). When this line is at logical 1, the WT PROT indicator on the drive control panel lights (Paragraph 1.4.1).

3.3.7 Write Check

This line transmits a logical 1 to indicate the following conditions:

- a. erase or write current without a WRITE GATE or,
- b. the linear positioner transducer lamp is inoperative.

When WRITE CHECK is at a logical 1, all external commands to the drive are suppressed and the FAULT indicator on the drive control panel lights. If the fault condition is temporary, the operator may press the WT PROT switch to turn off the FAULT indicator. This action causes the FAULT indicator to go out; however, the WT PROT indicator lights. The WT PROT switch must be pressed a second time to turn off the WT PROT indicator (Paragraph 1.4.1).

3.3.8 Read Data

This line transmits read data only (160-ns pulses).

3.3.9 Read Clock

This line transmits read clock pulses only (160-ns pulses).

3.3.10 Sector Address (4 lines)

These four lines indicate which sector is passing under the read/write heads. The sector address is a 4-bit binary code derived from the Sector Address counter.

3.3.11 Sector Pulse

This line transmits a 2- μ s negative pulse each time a sector slot passes the sector transducer. The index slot (unique slot) is suppressed in this line and is transmitted on a separate INDEX PULSE line.

3.3.12 Index Pulse

This line transmits a single 2- μ s negative pulse for each revolution of the disk. The INDEX PULSE occurs 600 μ s after the last sector pulse and is generated each time the index slot (unique slot) is detected by the sector transducer.

3.3.13 AC Low

This line transmits a logical 1 when there is a loss (for more than 45 ms) of the 30 Vac within the drive. When AC LOW occurs, the drive finishes reading/writing the current sector, then initiates a normal head-retract and unload cycle. If a total power loss occurs before the heads are completely retracted, the safety relay is de-energized to retract the heads under battery power (emergency retract).

3.3.14 DC Low

This line transmits a logical 1 when the ± 15 Vdc within the drive drops to 12 Vdc or below. When DC LOW is generated, the safety relay is de-energized to retract the heads under battery power (emergency retract). Since the RUN gate of each drive is connected to the DC LOW bus, a DC LOW signal from any one drive in a multi-drive system disables all the drives in the system.

3.3.15 High Density

This line transmits a logical 1 (indicating high density only) whenever the drive is selected.

CHAPTER 4

THEORY OF OPERATION

4.1 FUNCTIONAL DESCRIPTION

Figure 4-1 illustrates the major areas and associated signals of the RK05 Disk Drive. Together, they rotate the recording disk, align the heads at a specified cylinder, and perform the read and write functions.

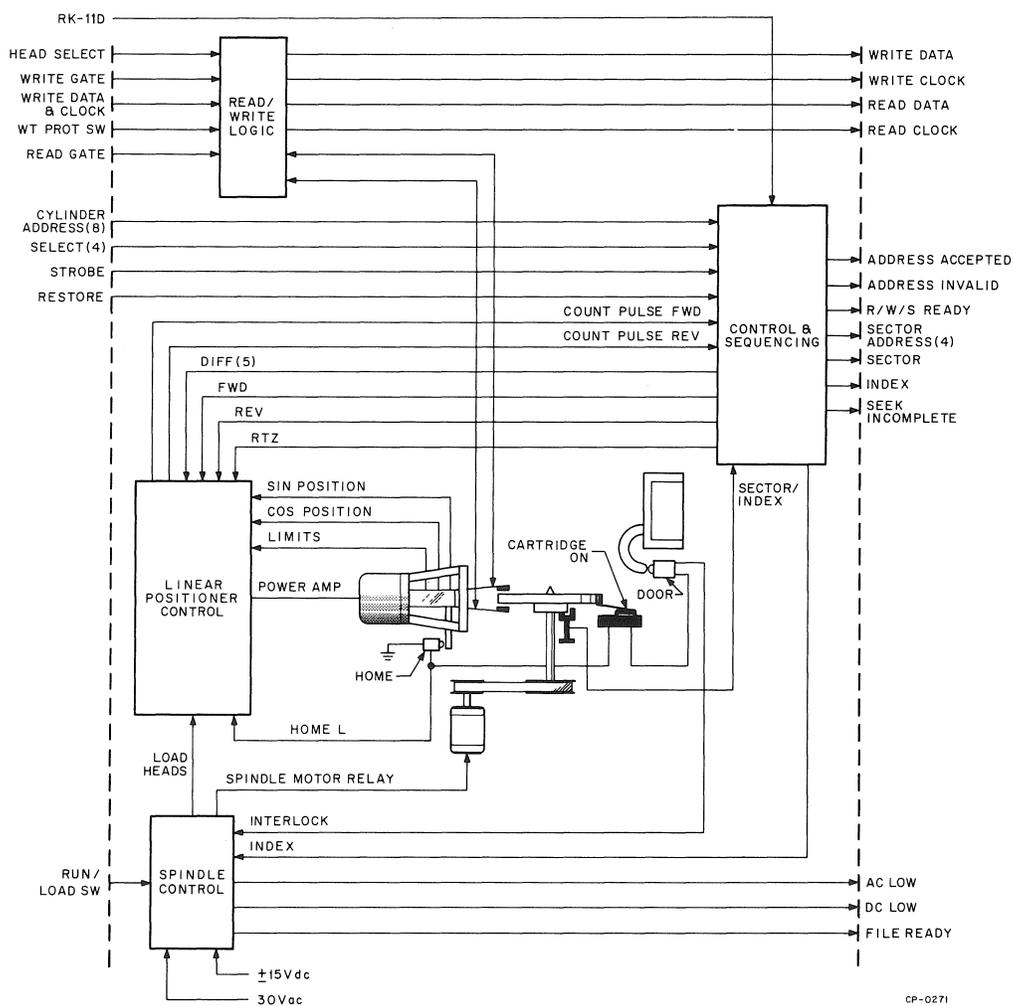


Figure 4-1 Functional Block Diagram

Paragraphs 4.1.1 through 4.1.5 describe the major operations of the disk drive; Paragraphs 4.2.1 through 4.5 describe the detailed logical sequence of each major operation.

4.1.1 Start

During the start cycle, the control and interlock logic controls the spindle motor operation. To energize the spindle motor, the RUN/LOAD switch must be in the RUN position and the following interlock conditions present:

- a. operating power applied to all drives
- b. the drive front door closed
- c. a disk cartridge properly installed.

If the preceding interlock conditions are safe, the spindle motor is energized. After an 8-second delay to allow the spindle to accelerate to operating speed, the control and interlock logic generates an internal LOAD HEADS signal which loads the read/write heads and positions them at cylinder zero (Paragraph 4.2.5.1). When the heads are loaded and positioned at cylinder zero, the RDY and ON CYL indicators light, and the READY interface line goes low.

Figure 4-2 illustrates the logical sequence during the start cycle. Refer to Paragraph 4.2.2 for a detailed logic description of the preceding events.

4.1.2 Stop

The three ways in which the disk drive can enter a stop cycle are:

- a. placing the RUN/LOAD switch to LOAD
- b. a loss of spindle speed
- c. a loss of operating power in any drive on the bus.

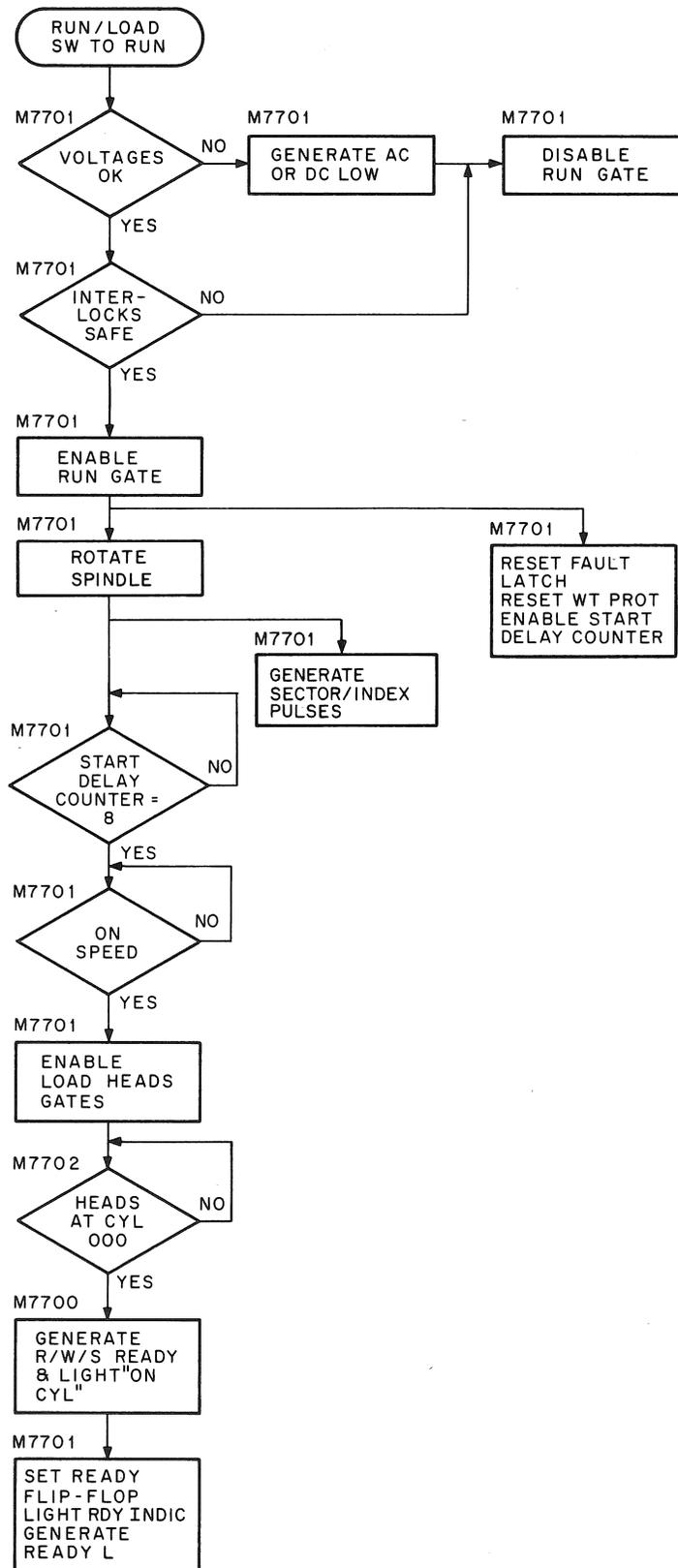
If any of the preceding conditions occur, the control and interlock logic removes the internal LOAD HEADS signal and brings the READY interface line high. When LOAD HEADS is removed, the positioner control logic retracts the read/write heads. After the heads are fully retracted, the spindle motor is de-energized and the spindle coasts to a stop (about 30 seconds). When the spindle has stopped rotating, the LOAD indicator lights and the drive front door is unlocked.

Figure 4-3 illustrates the logical sequence during the stop cycle. Refer to Paragraph 4.2.3 for a detailed logic description of the preceding events.

4.1.3 Track Addressing and Head Positioning

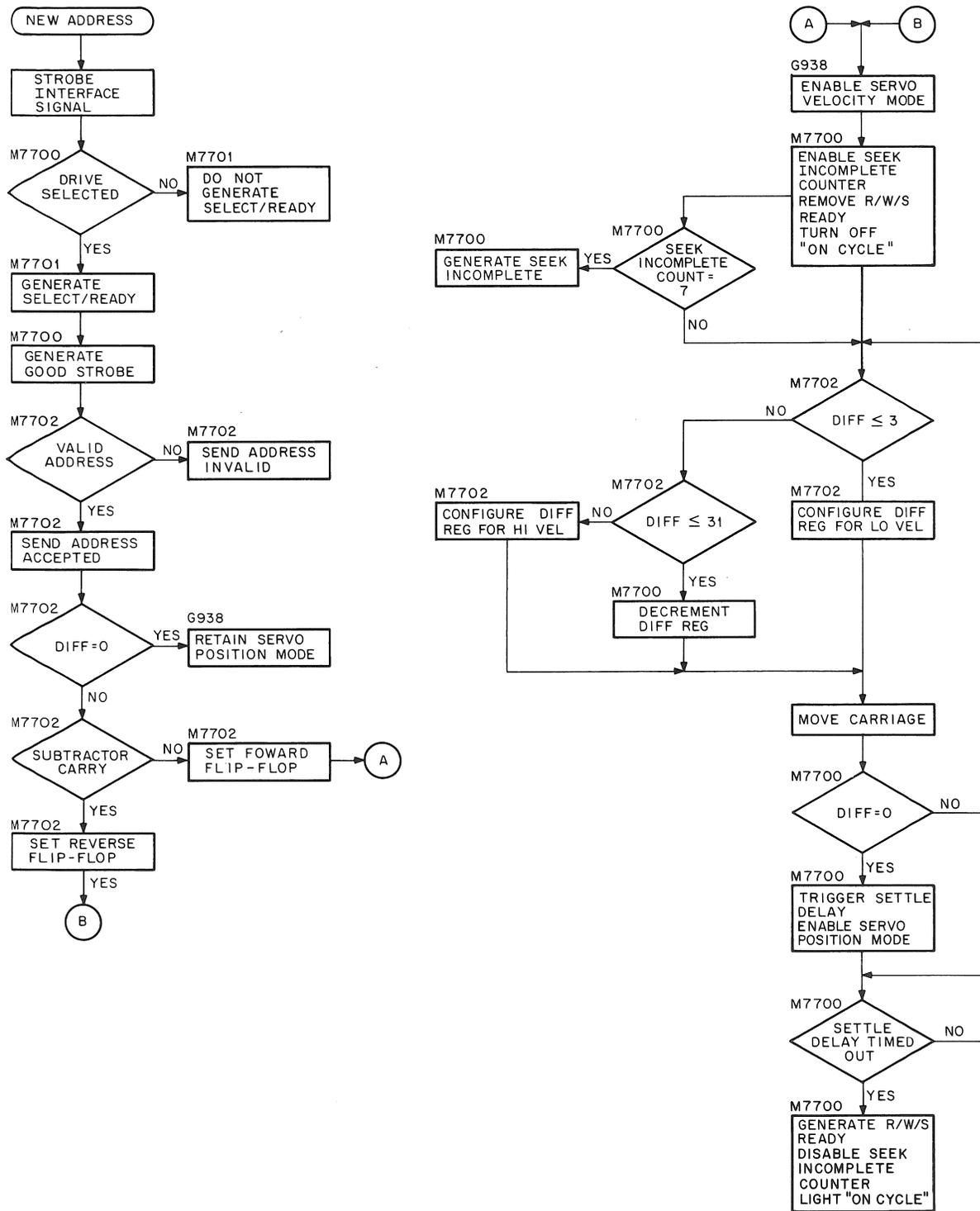
To move the read/write heads from a current location to a new location above the disk (a seek operation), a selected drive must first receive an 8-bit binary cylinder address from the controller. If the new address exceeds cylinder 202, the ADDRESS INVALID interface signal is generated and head motion is suppressed. If the new address does not exceed cylinder 202, the ADDRESS ACCEPTED interface signal is generated and the new address is compared to the current address. The comparison result (difference) is fed to a positioner servo system to move the heads.

As the heads pass each cylinder, output pulses from the linear positioner transducer trigger a Difference register to control the velocity of head motion (Paragraph 4.3). As the heads approach the destination cylinder, the head positioner decelerates, eventually stopping the heads at the designated cylinder. After a small delay to allow the heads to settle at the new location, the ON CYL indicator on the control panel lights and the R/W/S READY interface line goes low.



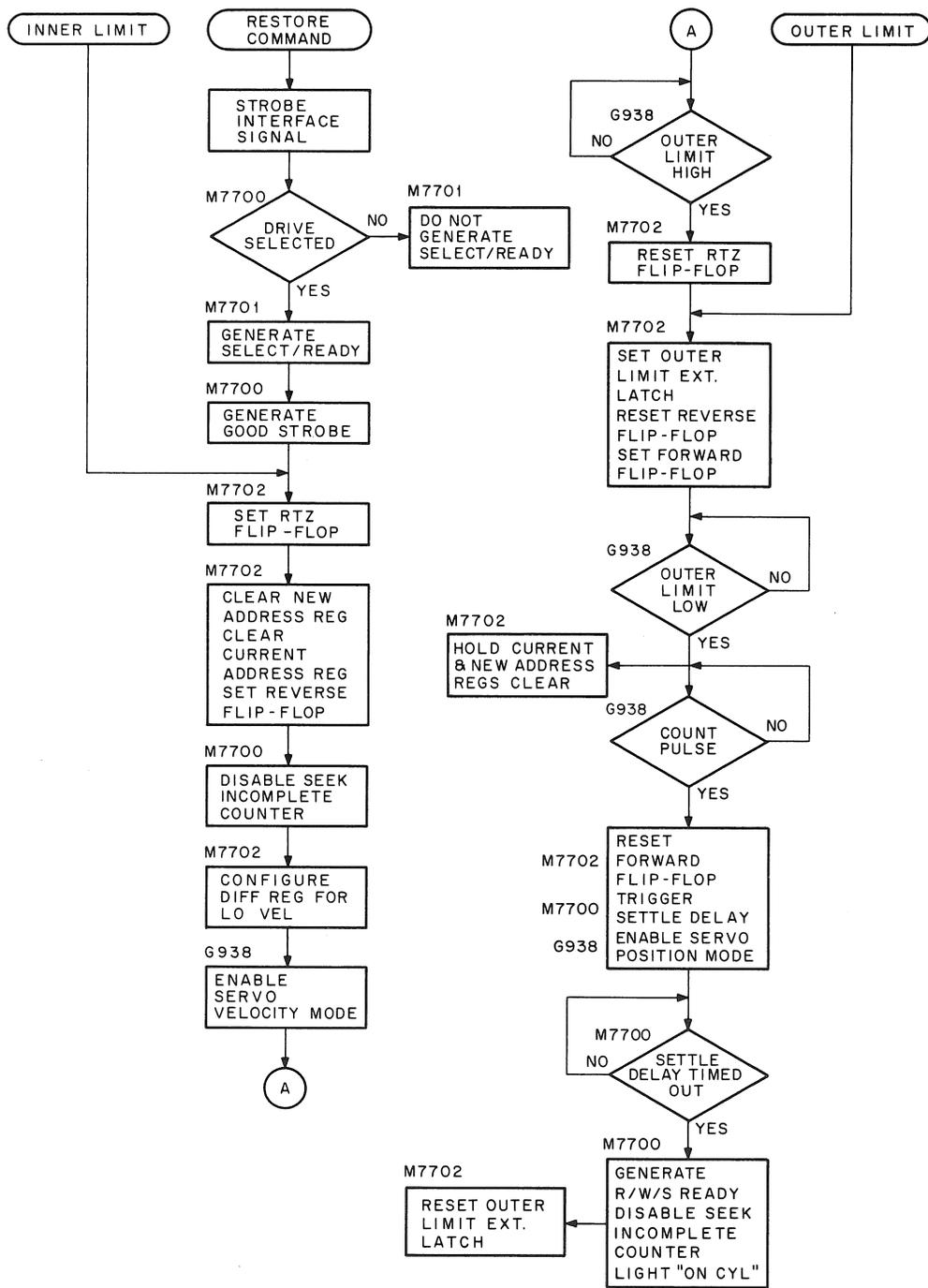
CP-0241

Figure 4-2 Start Flow Chart



CP-0276

Figure 4-4 Seek Flow Chart



CP-0275

Figure 4-5 Return-to-Zero (Restore) Flow Chart

4.1.4 Read/Write Heads

There are two ramp-loaded read/write heads in the RK05 Disk Drive. One head functions on the top and the other on the bottom surface of the recording disk. The heads are mounted on suspension arms that rest, when the heads are unloaded, on a plastic cam block of the duckbill (Figure 4-6). Flat cantilever springs connect the suspension arms to the head-support tail pieces. When the drive is placed in the RUN mode, the positioner moves the heads forward toward cylinder zero. When the entire head slider pad has passed the edge of the disk, a ramp on the suspension arm slides down the edge of the plastic cam block, thereby moving (loading) the heads close to the disk surface. When loaded, the heads "fly" 80 to 100 microinches from the disk surface. A film of air (air bearing) between the disk and the head acts as a force away from the disk, while the cantilever spring is a counterbalancing force towards the disk. Thus, as long as the disk rotation remains constant, the heads remain at a relatively constant distance away from the disk surface.

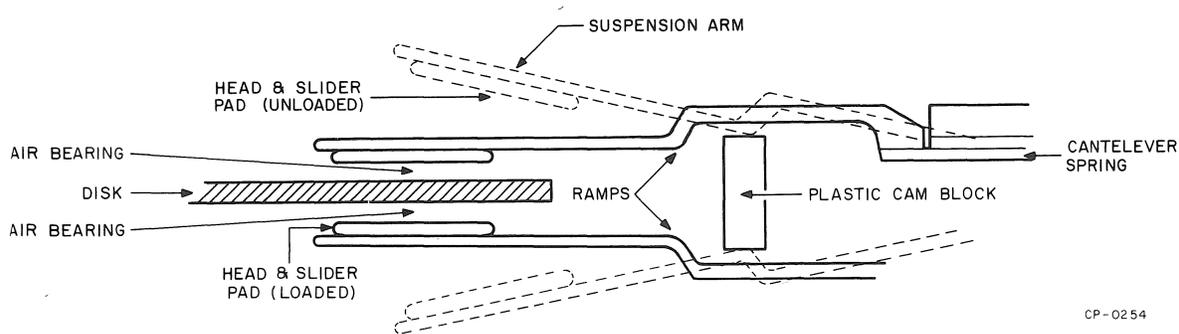


Figure 4-6 Head Loading

Each head is a 4-terminal magnetic device containing two coils. A center-tapped coil performs the read or write function, while the other series-connected coil performs the erase function. The head (Figure 4-8) is designed so that the erase coil is electrically connected to the center tap of the read/write coil and is energized (Figure 4-7) whenever a write operation occurs. This head configuration, called "straddle erase," erases any residue from a previous recording between the .006-in. wide tracks and thus eliminates track "crosstalk" or interference from a previous recording. During a write operation, current through the write coil automatically overwrites old data.

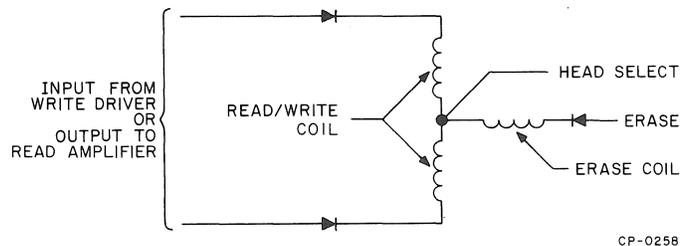
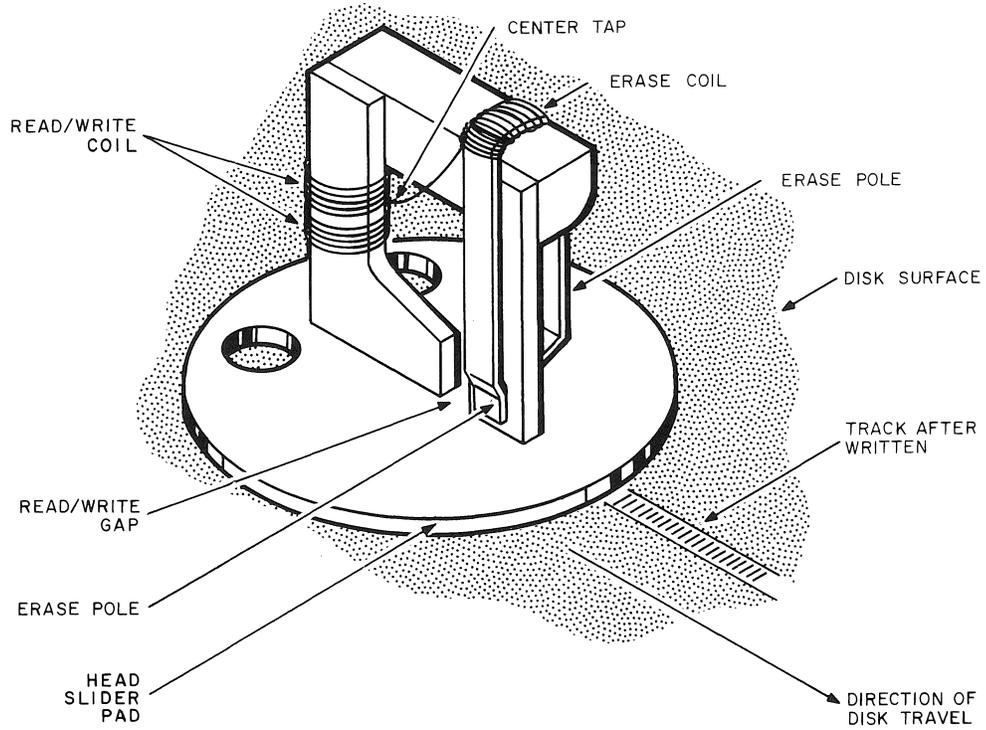


Figure 4-7 Simplified Read/Write Head Circuit

4.1.5 Recording Technique

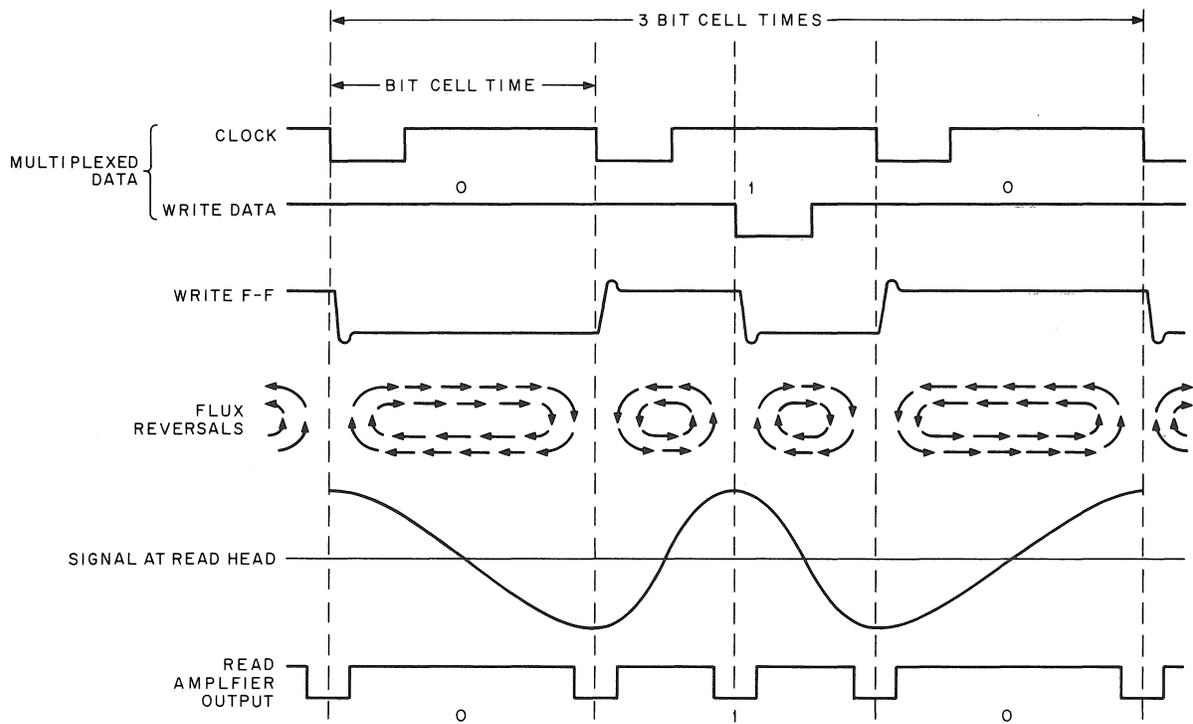
The recording device (read/write head) is a coil-wound ferrite core with an air gap. As current flows through the coil, the induced flux magnetizes the surface of the disk passing under the gap. During a write operation, when the current direction in the coil is reversed, a flux reversal is recorded on the disk. During a read operation, the previously recorded flux pattern on the disk induces current in the head. Any flux reversal on the recording surface produces a pulse.

The RK05 Disk Drive uses a double-frequency, nonreturn-to-zero (NRZ) method of magnetic recording. In this method, flux reversals (clock pulses) are recorded on the magnetic disk at regularly spaced intervals (Figure 4-9). The time period between these clock pulses is a bit cell and data storage occurs within these cells. A flux reversal during a bit cell represents a logical 1, while the absence of a flux reversal during a bit cell represents a logical 0.



CP-0257

Figure 4-8 Read/Write Head



CP-0259

Figure 4-9 Double Frequency Pulse Relationship

4.2 LOGICAL DESCRIPTION

4.2.1 Power On/Off Sequence

Application of ac power lights the PWR indicator, turns on the blower, energizes the various voltage regulators, and activates the elapsed time indicator. If ac power is removed when the read/write heads are not in the "home" position, the "home" microswitch applies battery power to the linear motor, retracting the heads to the "home" position.

4.2.2 Start

Figure 4-10 is a block diagram that illustrates the logic elements used in a start/stop cycle. These logic elements are located on the M7701 card.

Placing the RUN/LOAD switch on the front control panel in the RUN position enables the Run gate provided:

- a. A disk cartridge has been properly installed.
- b. The drive front door is closed and locked.
- c. The +15 and -15 Vdc are above 12 Vdc (Paragraph 4.2.3.4).

With the Run gate enabled, the Spindle Motor latch is set to energize the spindle motor relay and initiate disk rotation. Simultaneously, the Start Delay counter begins to count pulses (at a one pulse per second rate) from the Slow Clock. When a count of eight (8 seconds) is reached, a feedback output from the counter prevents it from incrementing further. By this time, if the spindle has accelerated to the correct operational speed (Paragraph 4.2.3.2), the set output from the On Speed flip-flop is ANDed with the Start Delay counter output to enable the Load Heads gate and produce the LOAD HEADS signal. This signal enables the D input of the Ready flip-flop and also allows the positioner to move the read/write heads to cylinder zero (Paragraph 4.2.5.1). Once the heads are positioned and settled at cylinder zero, the signal R/W/S READY is produced which lights the ON CYL indicator (M7700) and clocks the Ready flip-flop set. When the Ready flip-flop sets, the READY interface signal is produced and the RDY indicator on the control panel lights. The drive is now ready to perform a seek, read, or write operation.

4.2.3 Stop

The following paragraphs describe the three ways that the disk drive can enter a stop cycle. Figure 4-10 is a block diagram that illustrates the logic elements used in a start/stop cycle. These logic elements are located on the M7701 card.

4.2.3.1 Normal Stop – Placing the RUN/LOAD switch on the front control panel in the LOAD position enables the Disk Stopped counter and disables the Run gate, causing RUN L to come high. Once enabled, the Disk Stopped counter begins to increment; however, it is repetitively reset by every SECTOR/INDEX pulse before it reaches a count of two. This counter reset technique keeps the door unlocking solenoid de-energized to prevent the operator from opening the drive front door before the disk has come to a complete halt.

RUN L high clears the Start Delay counter, disabling the Load Heads gate, thus removing the LOAD HEADS signal. (Once cleared, the Start Delay counter must again increment to eight before the LOAD HEADS signal can be regenerated. This practice allows the heads to fully retract (unload) before they can be loaded again.) Removal of the LOAD HEADS signal resets the Ready flip-flop and also allows the positioner to retract the read/write heads (Paragraph 4.2.5.3). When the heads have fully retracted (unloaded), the "home" microswitch closes to generate the HOME L signal. HOME L resets the Spindle Motor latch, de-energizing the spindle motor and allowing the spindle to coast to a stop.

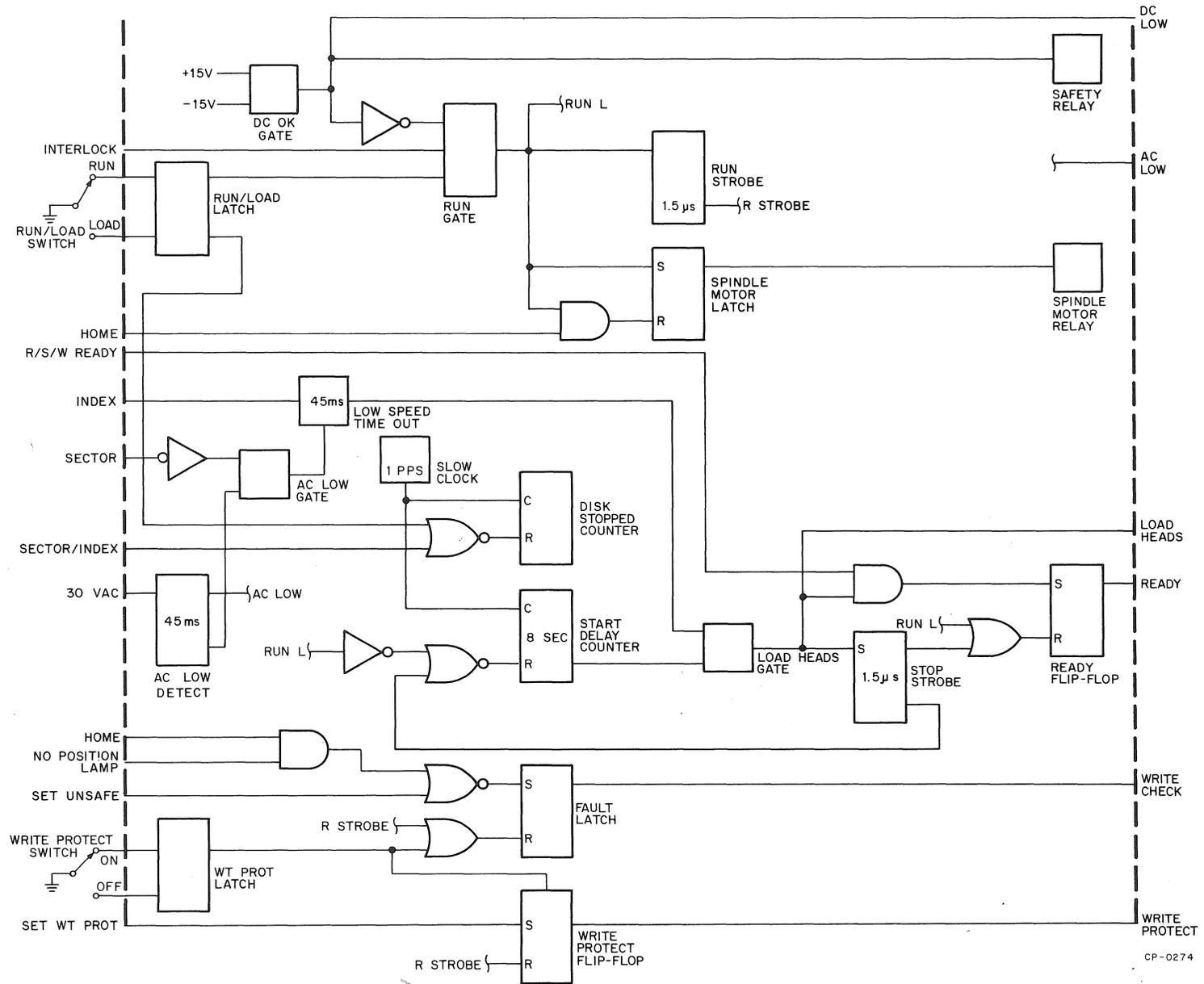


Figure 4-10 Control and Interlock Block Diagram

As the spindle decelerates, SECTOR/INDEX pulses occur at a slower rate. Approximately 30 seconds after the Disk Stopped counter is enabled, the disk stops rotating, SECTOR/INDEX pulses cease, and the Disk Stopped counter is incremented by two pulses from the Slow Clock. When the counter reaches two (2 seconds from receipt of the last SECTOR/INDEX pulse), a feedback output from the counter prevents it from incrementing further, while the counter set output energizes the door unlocking solenoid and lights the LOAD indicator on the control panel. The drive front door can now be opened and the cartridge removed.

4.2.3.2 Low Speed Stop – When the disk is rotating at normal speed (1500 rpm), INDEX pulses are generated every 40 ms to trigger the 45-ms Low Speed Time Out one-shot. The one-shot output is applied to an associated On Speed flip-flop. As long as the spindle rotation remains above an unsafe speed, successive INDEX pulses keep the On Speed flip-flop set, thus maintaining the LOAD HEADS signal. If the spindle speed drops below approximately 1200 rpm, the INDEX pulse interval increases beyond 45 ms. If this occurs, the Low Speed Time Out one-shot expires and resets the On Speed flip-flop. With the flip-flop reset, the LOAD HEADS signal is removed, thereby causing the positioner to retract the read/write heads (Paragraph 4.2.5.3). When LOAD HEADS is removed, the 1.5- μ s Stop Strobe one-shot triggers, clearing the Start Delay counter. Once cleared, the Start Delay counter must again increment to eight before the LOAD HEADS signal can be regenerated. This practice allows the heads to fully retract (unload) before they can be loaded again.

The remainder of the low speed stop cycle is the same as a normal stop (Paragraph 4.2.3.1).

4.2.3.3 AC Low Stop – During normal operation, the 45-ms AC Low Detect one-shot is repeatedly triggered set by the presence of 30 Vac. If this voltage is removed for more than 45 ms, the AC Low Detect one-shot times out. With the one-shot reset, the AC LOW interface signal is generated. Following the AC LOW signal, the drive continues to operate until the next SECTOR pulse occurs. At this time, the reset output from the AC Low Detect one-shot is ANDed with the SECTOR pulse to reset the Low Speed Time Out one-shot. Thus, a data transfer in progress continues until the end of the sector before the interface signals are removed.

The remainder of the ac low stop cycle is the same as a low speed stop (Paragraph 4.2.3.2). However, if a total power loss occurs before the heads are completely retracted, the safety relay closes to retract the heads under battery power (emergency retract) and maintain the AC LOW interface signal.

4.2.3.4 DC Low Stop – If the +15 or -15 Vdc drops below 12 Vdc, the DC OK gate is disabled. The output from this gate immediately disables the Run gate, de-energizes the safety relay to retract the heads under battery power, and generates the DC LOW interface signal.

4.2.4 Disk Drive Addressing

For greater flexibility in a multi-drive system, a drive address assignment can be changed by changing the position of the address select switch (S1) on the M7700 card. This switch operates in conjunction with the RK-11D interface line plus the address select decoding logic (M7700), as described in the following paragraphs.

4.2.4.1 RK11D Address Selection – If the operating controller is an RK11D, the interface signal RK-11D L is present. This signal, applied through an inverter, enables a three line-to-eight line binary decoder and disables the linear input gates. Thus, when the binary-encoded (SELECT 0 through 2) drive address is applied through the input gates to the binary decoder, the decoder translates the 3-bit binary code and activates one of the eight address select switch positions. If the address select switch has been set to this activated position, the signal SELECT H is produced. SELECT H, ANDed with the set output from the Ready flip-flop (M7701) and the reset output from the Fault latch, produces the signal SELECT/READY L. This signal allows the drive to perform the various control and read/write operations.

4.2.4.2 RK11C or RK8/E Address Selection – If the operating controller is an RK11C or RK8/E, the interface signal RK-11D L is not present. Hence, the three line-to-eight line binary decoder is disabled and the linear input gates are enabled. This circuit configuration connects the SELECT lines, as a linear set, directly to positions 0

through 3 of the address select switch. If the address select switch is set to one of the first four positions and the corresponding SELECT line is at a logical 1, the signal SELECT/READY L is produced as previously described in Paragraph 4.2.4.1.

4.2.5 Seek

4.2.5.1 Load Heads Seek – Placing the RUN/LOAD switch in the RUN position generates the signal LOAD HEADS L (Paragraph 4.2.2). Since the read/write heads are in the “home” position at this time, the signal OUTER LIMIT H is present (M7702). This signal is ANDed with the inverted LOAD HEADS L signal to set the Forward and reset the Reverse flip-flops. In addition, OUTER LIMIT H sets the Outer Limit Extender latch to hold the New and Current Address registers at 0.

The \bar{Q} outputs from the New Address register and the Q outputs from the Current Address register are applied to the subtractor. Use of the \bar{Q} outputs from the New Address register effectively complements the new address and thus allows a 1’s complement addition to take place in the subtractor. During this addition, the second stage of the subtractor performs an end-around carry operation. Since the Current Address register and the New Address register were both cleared, the remainder from the 1’s complement addition is zero; thus, a no-carry condition is produced. The binary 0 from the subtractor is then applied, through exclusive OR circuits and the “>3” decoding gate, to set the Difference register to a low velocity binary output.

NOTE

Low velocity is when all stages of the Difference register are set. High velocity is when all stages are cleared.

When the Forward flip-flop sets, FWD H and MOVE L are generated. FWD H is applied to the servo logic to place it in the velocity mode (Paragraph 4.3.1.1) and initiate forward head motion.

As the heads begin to move at low velocity toward cylinder zero, count pulses are generated by the positioner transducer (Paragraph 4.2.6). When the heads pass the outer limit of the recording disk, OUTER LIMIT H goes low, applying a low to the D input of the Forward flip-flop. As the heads approach cylinder zero, COUNT PULSE REV H (first count pulse after OUTER LIMIT H goes low) resets the Forward flip-flop. This action removes FWD H and MOVE L and places the servo logic in the detent mode (Paragraph 4.3.1.2).

MOVE L high triggers the 5-ms Positioner Settle Delay one-shot (M7700). When this one-shot times out, the R/W/S Ready flip-flop sets to disable the Seek Incomplete counter, light the ON CYL indicator, and generate the R/W/S READY L interface signal. In addition, R/W/S READY H resets the Outer Limit Extender latch.

4.2.5.2 Forward Seek – To move the read/write heads closer to the disk spindle (forward seek), the controller places an 8-bit binary address on the CYLINDER ADDRESS interface lines, transmits a STROBE pulse, and simultaneously addresses the disk drive (Paragraph 4.2.4). Reception of the STROBE pulse (M7700) generates the GOOD STROBE L pulse to clock the cylinder address from the interface lines (M7702) into the New Address register.

The \bar{Q} outputs from the New Address register are applied to both the subtractor and the Invalid Address Detector. Use of the Q outputs of the New Address register effectively complements the new address and thus allows a 1’s complement addition to take place in the subtractor. During this addition, the second stage of the subtractor performs an end-around carry operation.

If the New Address register output is greater than 202, the ADDRESS INVALID L signal is generated. If this is the case, ADDRESS ACCEPTED L remains high, keeping the Forward or Reverse flip-flops reset and preventing the Difference register from changing states.

If the New Address register output is equal to or less than 202, ADDRESS INVALID L remains high. This signal is ANDed with the output of the Strobe Generator one-shot (M7700) to produce the ADDRESS ACCEPTED L signal.

Simultaneously, the complemented New Address register output is added in the subtractor to the output of the Current Address register. If, after this addition process, a carry condition has not occurred, the positioner must either move the heads forward (toward the disk spindle) or retain the heads at their current location. To determine this fact, the subtractor carry output is inverted by the exclusive OR circuits for only a no-carry condition. If the heads are to move forward, the high output from the “not zero” decoding gate is ANDed with the inverted carry output and applied to the D input of the Forward flip-flop.

When ADDRESS ACCEPTED L goes low, the Forward flip-flop sets, generating MOVE L and FWD H. FWD H is applied to the servo logic to place it in the velocity mode (Paragraph 4.3.1.1) and initiate forward head motion. MOVE L resets the R/W/S Ready flip-flop (M7700) to accomplish the following:

- a. enable the Seek Incomplete counter
- b. remove the R/W/S READY interface signal
- c. turn off the ON CYL indicator

Once enabled, the Seek Incomplete counter begins to count INDEX pulses (40 ms repetition rate). If the counter reaches a count of seven (seek incomplete condition), the Seek Incomplete latch is set to generate the SEEK INCOMPLETE interface signal. If this occurs, the controller must issue a return-to-zero (Restore) command or the operator must set the RUN/LOAD switch to LOAD and then back to RUN to continue normal operation.

If a seek incomplete has not occurred, and the distance from the present to the destination cylinder is greater than 31, an output from the “>31” decoding gate clears the Difference register (M7702) to a high velocity binary output. This binary output is applied to the servo logic to move the heads forward at high velocity.

NOTE

High velocity is when all stages of the Difference register are cleared. Low velocity is when all stages are set.

As the read/write heads move across each track, output pulses (COUNT PULSE FWD H) derived from the positioner transducer are generated. As long as the Reverse flip-flop remains reset, each COUNT PULSE FWD H clocks the Forward flip-flop set and increments the Current Address register. Each time this register increments, the previously described addition process is repeated in the subtractor.

When the heads are 31 cylinders from the destination cylinder, the “>31” decoding gate is disabled, permitting the Difference register to be decremented directly by the decoded output of the subtractor. When the heads are 3 cylinders from the destination cylinder, the “≤3” decoding gate is enabled to set the Difference register to a low velocity binary output. The Current Address register continues to decrement until the heads are within one-half cylinder of the destination cylinder. At this point, the “not zero” decoding gate is disabled and the Forward flip-flop is reset, thereby removing FWD H and MOVE L.

FWD H low places the servo logic in the detent mode (Paragraph 4.3.1.2), while MOVE L high triggers the 5-ms Positioner Settle Delay one-shot (M7700). When this one-shot times out, the R/W/S Ready flip-flop sets to disable the Seek Incomplete counter, light the ON CYL indicator, and generate the R/W/S READY interface signal. The drive is now ready to perform a read, write, or another seek operation.

4.2.5.3 Reverse Seek – A reverse seek is similar to a forward seek (Paragraph 4.2.5.2); however, if the current and new addresses are not alike, the subtractor (M7702) addition operation always results in a carry condition. Because

of this fact, the “not zero” decoding gate is not used during this operation. The carry output from the subtractor sets the Reverse flip-flop to allow the Current Address register to decrement.

NOTE

Due to unique timing considerations during the reverse seek, inverted count pulses are used to decrement the Current Address register.

If, during the initial power-on cycle, the heads are not fully retracted (unloaded), the “home” microswitch at the rear of the positioner is not made and the HOME L signal is high. HOME L is ANDed with LOAD HEADS L (high because the RUN/LOAD switch is in the RUN position) to generate REV H and MOVE L. Simultaneously, LOAD HEADS L sets the Difference register to a low velocity binary output, thereby retracting the heads at low speed to the “home” position. At this position, the carriage contacts the “home” microswitch, causing the HOME L signal to go low and thus remove REV H and MOVE L.

Normally, the heads would not be over the disk during the initial power-on cycle. Therefore, the preceding operation guarantees that the positioner does not move forward until the drive is placed in the run mode.

4.2.5.4 Return-to-Zero (Restore) Seek – To return the read/write heads to cylinder zero, the controller generates a RESTORE L signal, transmits a STROBE pulse, and simultaneously addresses the disk drive (Paragraph 4.2.4). Reception of the STROBE pulse (M7700) generates the GOOD STROBE H pulse. This pulse, ANDed with RESTORE H, resets the Seek Incomplete latch to remove the SEEK INCOMPLETE interface signal. RESTORE H also sets the RTZ flip-flop (M7702) to accomplish the following:

- a. clear the New Address register
- b. clear the Current Address register
- c. set the Reverse flip-flop
- d. produce the RTZ L signal

RTZ L resets the Seek Incomplete counter and prevents it from incrementing.

When the Reverse flip-flop sets, REV H and MOVE L are generated. REV H is applied to the servo logic to place it in the velocity mode and initiate reverse head motion (Paragraph 4.2.6.1). MOVE L resets the R/W/S Ready flip-flop (M7700) to accomplish the following:

- a. reset the RTZ flip-flop
- b. set the Outer Limit Extender latch, which holds the New and Current registers at zero
- c. reset the Reverse and set the Forward flip-flops

When the Forward flip-flop sets, the heads begin to return toward cylinder zero. Just before the heads reach cylinder zero, OUTER LIMIT H goes low. The next output pulse (COUNT PULSE REV H) from the positioner transducer (Paragraph 4.3.2.1) resets the Forward flip-flop and thus removes FWD H and MOVE L.

FWD H low places the servo logic in the detent mode (Paragraph 4.3.1.2), while MOVE L high triggers the 5-ms Positioner Settle Delay one-shot (M7700). When this one-shot times out, the R/W/S Ready flip-flop resets to disable the Seek Incomplete counter, light the ON CYL indicator, and generate the R/W/S READY interface signal. R/W/S READY H also comes high at this time to clear the Outer Limit Extender latch.

If, at any time during normal operation, the read/write heads reach the inner limit of the recording disk, INNER LIMIT H (M7702) comes high. This signal sets the RTZ and Seek Incomplete flip-flops to automatically initiate a return-to-zero seek.

4.2.6 Sector/Index Pulse Generation

To read or record data with specific formats (e.g., data blocks) as well as retrieve or store data at designated areas (sectors) on the disk, a timing scheme related to the rotational position of the disk is required. The SECTOR and INDEX pulses are used to accomplish this. These pulses are generated by slots in the recording disk hub that pass through a groove in the sector transducer. There are 12 equally spaced sector slots (16 slots for an RK8/E) which designate the 12 or 16 sectors on the disk. There is also one uniquely spaced index slot on the disk to indicate the last sector (one complete revolution). The sector transducer, located directly in front of the spindle, is an optical device that contains a light-emitting diode and a photosensor. As the recording disk rotates, the slots on the disk pass between the light-emitting diode and the sensor, thereby producing negative SECTOR/INDEX pulses (Figure 4-11). Since both the SECTOR and INDEX pulses are produced from a single transducer, logic elements on the M7700 card separate these two pulses and also encode the sector address.

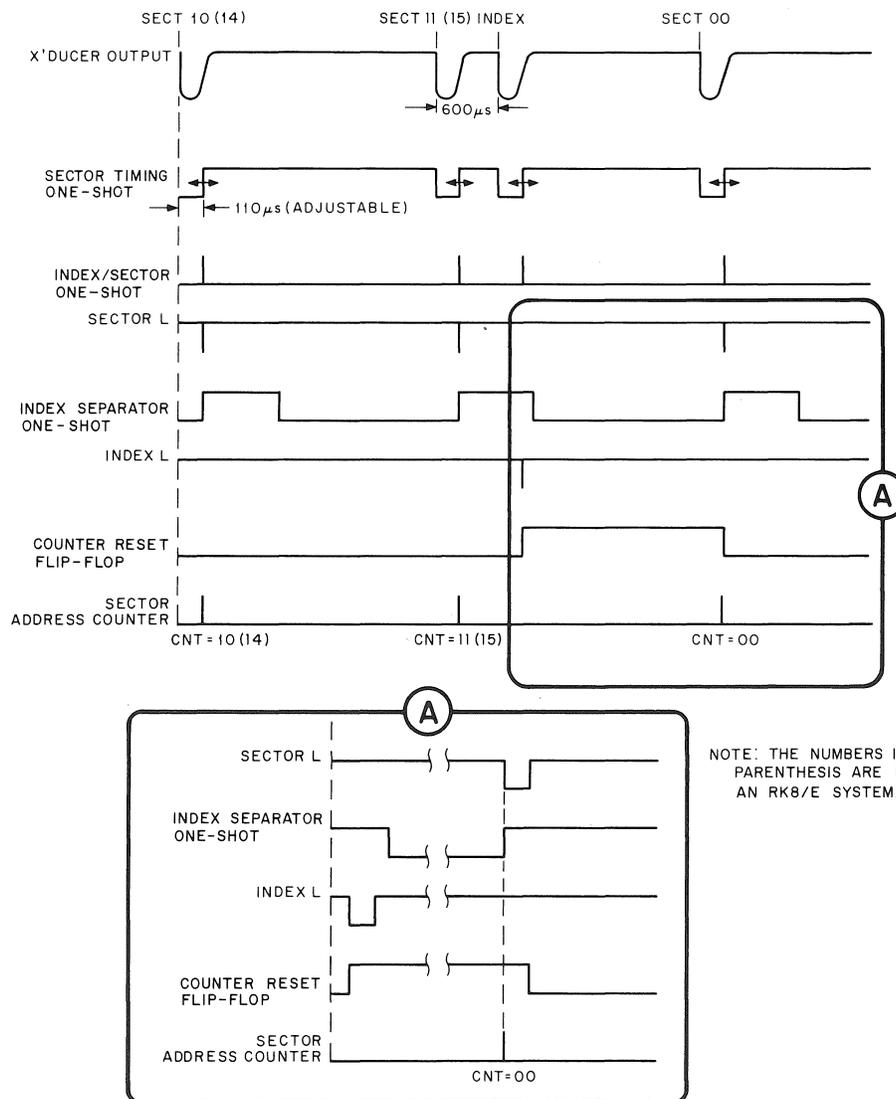


Figure 4-11 Sector/Index Timing

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During disk rotation, SECTOR/INDEX pulses from the disk trigger the Sector Timing one-shot. The pulse width of this one-shot can be adjusted to compensate for different sector transducer locations within various disk drives. Thus, when disk cartridges are interchanged, each data record is properly located with respect to the associated SECTOR pulse. The trailing edge from the Sector Timing one-shot triggers the Index/Sector one-shot to generate a 2- μ s INDEX/SECTOR L pulse. The trailing edge of this pulse in turn triggers the 1-ms Index Separator one-shot. The output signals from this one-shot are applied to decoding gates to separate the SECTOR pulses from the INDEX pulse. If another slot has not passed the transducer, the SECTOR L signal is produced and the 4-stage Sector Address counter is incremented. The preceding events are repeated for every sector on the disk hub.

The occurrence of the last SECTOR pulse triggers the Index/Sector one-shot as before; however, 600 μ s later, the INDEX pulse from the disk hub retriggers this one-shot. The set output from this one-shot is then ANDed with the set output from the Index Separator one-shot (still high from the previous triggering) to generate the INDEX PULSE L signal and also set the Counter Reset flip-flop. The leading edge of the next SECTOR pulse (sector 00) clears the Sector Address counter while the trailing edge of this pulse resets the Counter Reset flip-flop. Thus, for every revolution of the disk, the counter is cleared to maintain the correct counter-to-disk relationship.

4.3 CARRIAGE POSITIONING

4.3.1 Positioner Servo Description

The positioner servo system (G938) controls the carriage movement. There are two control loops within this system. A velocity loop controls the carriage velocity during a seek operation (velocity mode) and a position loop electronically detents the heads at a fixed cylinder location when a seek operation is not being performed (detent mode). During the velocity mode, velocity and direction commands are obtained from the cylinder address and difference logic (Paragraph 4.2.5). During the detent mode, velocity and position feedback signals are derived from the linear positioner transducer (Paragraph 4.3.2.1).

The servo system (Figure 4-12) is composed of the following functional areas.

- a linear positioner transducer that produces two sinusoidal signals. During the velocity mode these signals are used to control the rate of carriage movement. During the detent mode, only one of these signals is used to electronically detent the carriage. In addition, the transducer also generates two limit signals which indicate the extremities of carriage travel.
- a velocity function generator that converts the digital difference signal into corresponding analog velocity commands.
- a velocity synthesizer that generates a feedback control signal from the transducer output.

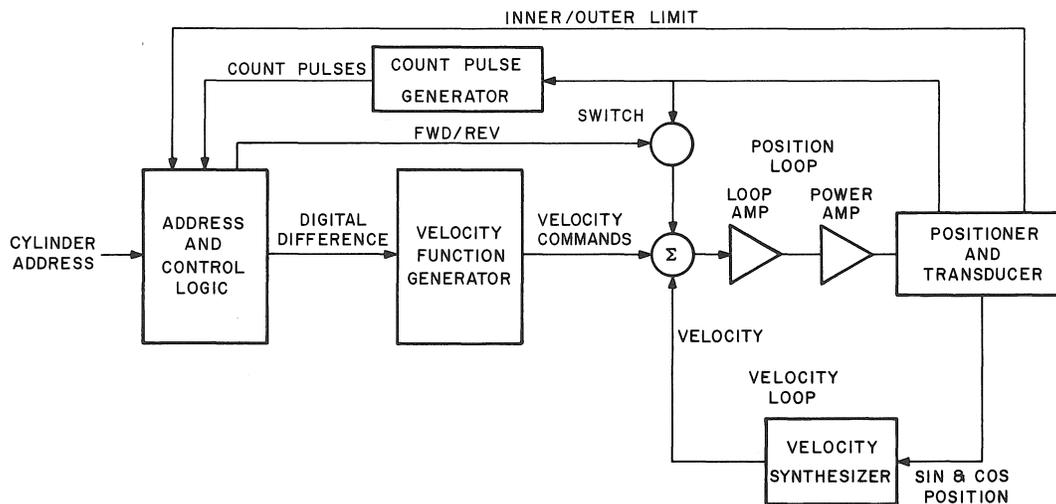


Figure 4-12 Servo System Block Diagram

4.3.1.1 Velocity Mode – During a seek operation, the cylinder address and difference logic computes the digital difference between the present cylinder address and the destination cylinder (Paragraph 4.2.5). This digital difference is then converted, by the D/A velocity function generator, to an analog velocity command. The amplitude of the analog signal depends upon the distance to the destination cylinder. If this distance is greater than 31 cylinders, a maximum velocity command is produced and applied to the velocity control loop. As the carriage accelerates, a feedback velocity signal is generated by the velocity synthesizer. When a speed of 35 ips is obtained, this feedback signal inhibits further acceleration and maintains a constant 35 ips carriage speed until the heads are 31 cylinders from the destination cylinder. From this point, the carriage decelerates at a controlled rate which is governed by the decremting digital difference that is applied to the function generator.

When the heads are 3 cylinders away from the destination cylinder, the velocity generator produces a fixed low velocity command which continues to move the carriage at low velocity (about 3 ips) until the heads are approximately one-half cylinder from the destination cylinder. At this point, the low velocity command is removed; however, the velocity signal remains to damp the carriage movement and prevent overshoot. Once the destination cylinder is reached, the position loop electronically detents the carriage.

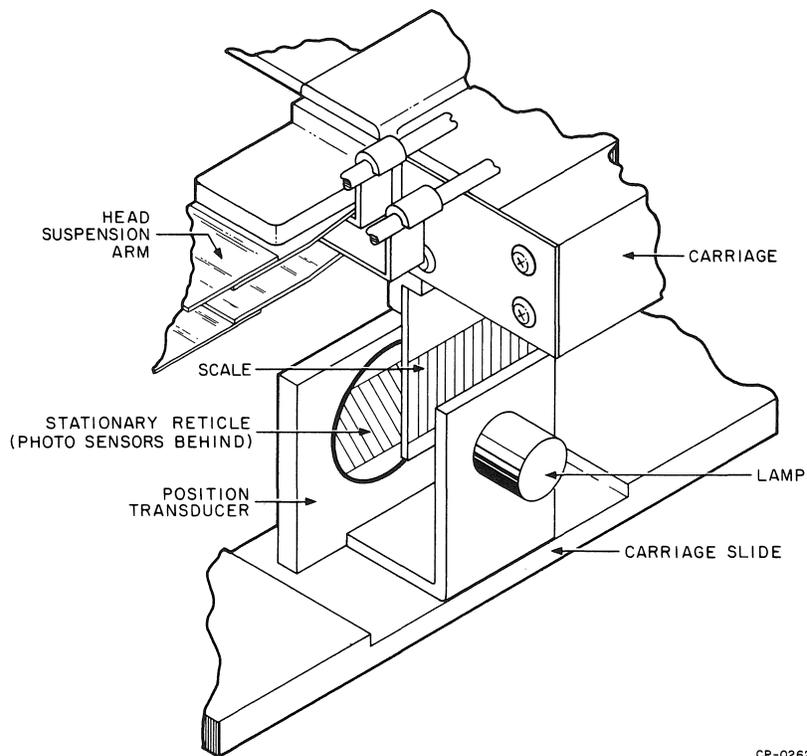
4.3.1.2 Detent Mode – The detent mode of operation electronically retains the read/write heads at a desired cylinder with a force greater than 2000 pounds per inch. During this operational mode, the velocity command from the function generator is zero, thereby allowing the small velocity feedback signal to produce a stable position loop. If the heads tend to deviate from the desired cylinder, an error correction signal (SIN POSITION), which is opposite in polarity from the direction of deviation, is generated by the positioner transducer. This error signal is then directly applied through the loop amplifiers to move the carriage back to the desired cylinder.

4.3.2 Servo Circuit Description

4.3.2.1 Linear Positioner Transducer – The positioner transducer (Figure 4-13), located on the underside of the carriage, is an optical device which consists of two parts. The stationary portion (reticle) of the transducer is constructed in a U shape and is attached to the carriage slide. One side of the U contains a lamp while the other side contains a stationary reticle with minute diagonal transparent slots, plus six photosensors located behind the slots. The movable portion (scale) of the transducer contains a similar section of minute vertical transparent slots and is attached to the movable carriage. As the scale moves in the middle of the U-shaped reticle, the vertical and diagonal slots allow varying light patterns to shine onto the photosensors. This action produces two sine wave output signals that occur 90 degrees out of phase. These signals (SIN POSITION and COS POSITION) are used to control the carriage movement.

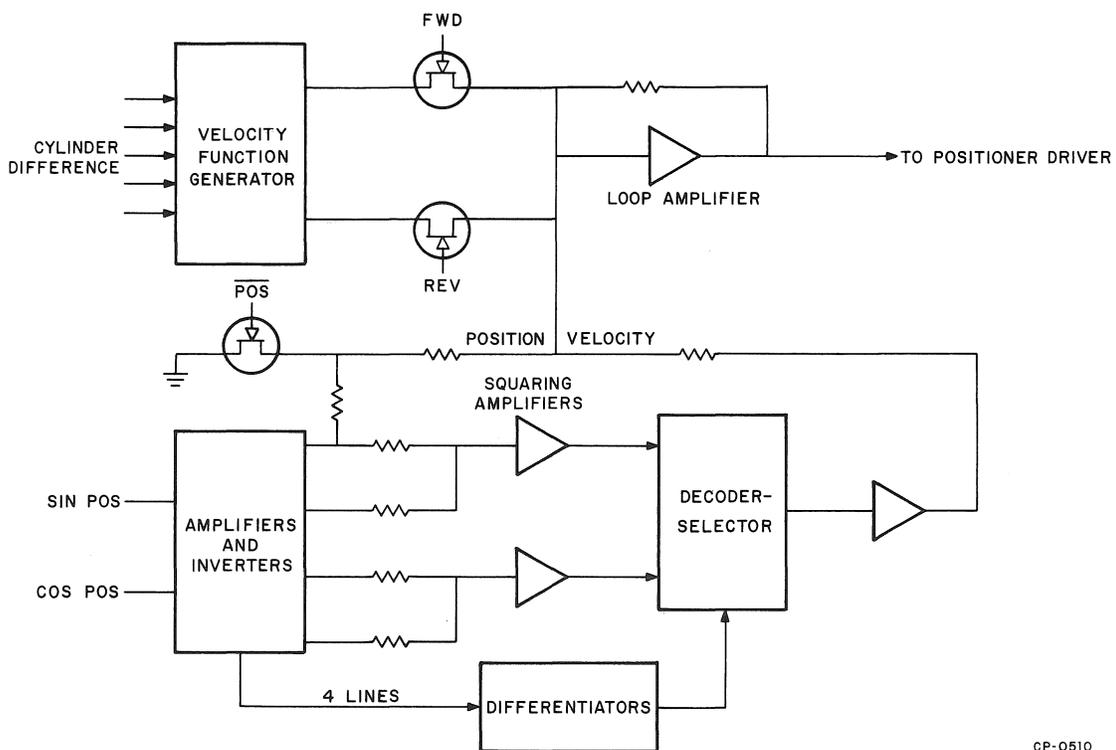
Two dc signals (INNER LIMIT and OUTER LIMIT) are also generated by the transducer. As long as the scale travel remains within the slotted section (cylinder 0 through 202), neither one of these signals is produced; however, when the scale reaches the inner travel extremity ($>$ cylinder 202), the inner limit photosensor is uncovered and the negative INNER LIMIT signal is produced. The positive OUTER LIMIT signal is produced in a similar manner at the outer travel extremity ($<$ cylinder 0). Both of these signals are used during a seek operation (Paragraph 4.2.5).

4.3.2.2 Velocity Function Generator – The velocity function generator (Figure 4-14) is a 5-bit D/A converter. The generator logic elements are located on the G938 card. The 5-bit digital input to this logic component is derived from the five low order difference bits from the cylinder address and difference logic. During a seek operation, these five bits represent the distance from the present cylinder address to the destination cylinder (Paragraph 4.2.5). If this distance is greater than 31, all five input bits are logic 0, producing a maximum amplitude output signal (velocity command). If the travel distance is less than or equal to 3, all five input bits are logic 1, producing a minimum velocity command. For differences between 4 and 30, the velocity command is proportional to the 5-bit binary representation. The velocity command is connected by field effect transistors (FETs) to the summing node of the loop amplifier. To initiate carriage motion, the FWD or REV signal turns on the appropriate FET, thereby applying the velocity and direction command to the loop amplifier.



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Figure 4-13 Linear Positioner Transducer



CP-0510

Figure 4-14 Simplified Positioner Servo Logic

4.3.2.3 Velocity Synthesizer – In a closed loop servo system, a speed sensing, feedback control signal is required to prevent uncontrolled velocity within the system. In the RK05, this control or tachometer signal is electronically derived in the velocity synthesizer. Figure 4-14 illustrates the circuit relationship of the logic elements within the velocity synthesizer. These elements are located on the G938 card.

During a seek operation, the SIN POSITION and COS POSITION signals from the positioner transducer are applied to amplifiers and unity gain inverters to provide four phases of position signal at the input of the synthesizer. The inverter/amplifier outputs are also applied to four differentiator networks. Appropriate pairs of amplifier/inverter outputs are applied to the summing junctions of two squaring amplifiers. The resultant square wave signals are displaced 90 degrees from each other and when these signals are gated together in the decoder/selector, they produce four separate selection signals of 90 degree duration. Each selection signal is centered around the peak of the corresponding differentiated signal. The derivative signals are then selectively summed in an operational amplifier to produce the velocity feedback signal. This signal is then applied, through a gain setting resistor, to the summing node of the loop amplifier. Here, the velocity command from the velocity function generator is summed with the velocity feedback signal to produce a velocity profile signal (Figure 4-15). Thus, for a 200 cylinder seek (full carriage stroke), a maximum velocity profile is produced. The dotted lines on the figure represent the initial portions of shorter seeks; however, the terminating portion of all seeks remains the same.

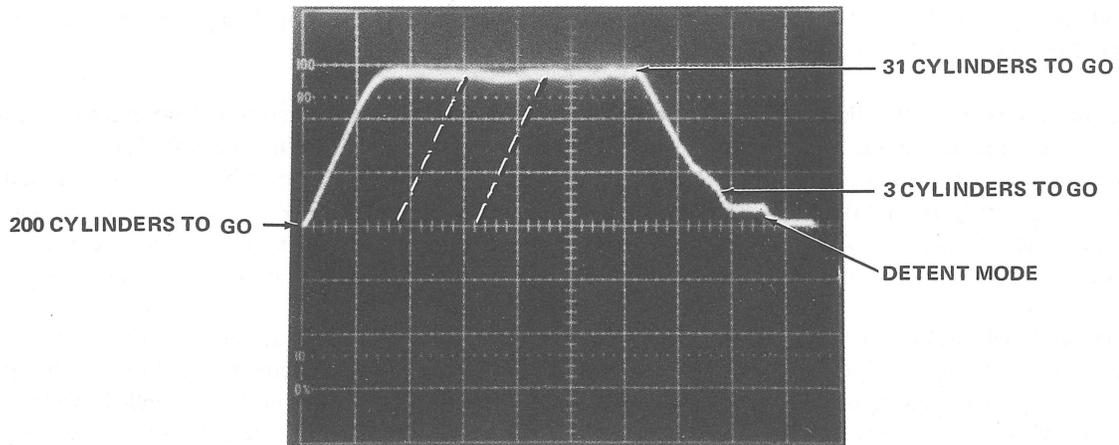


Figure 4-15 Velocity Profile

During the detent mode of operation the $\overline{\text{POS}}$ signal turns on a FET which applies the SIN POSITION signal directly to the summing node of the loop amplifiers. This circuit configuration retains the heads at the desired cylinder location.

4.4 READ/WRITE

All the circuit elements required for head selection, level changing, and waveform shaping during a read/write operation are on the G180 card which is located in the first position of the electronic module. The read/write head connectors are directly attached, through an opening in the side of the electronic module, to connector pins on this card.

4.4.1 Read Operation

During a read operation, the selected read/write head detects flux reversals from a recorded data track on the rotating disk. Each flux reversal generates a small voltage peak whose polarity corresponds to the direction of the flux reversal. The read waveform is then amplified, filtered to remove high-frequency noise components, and applied to wave shaping circuits. These circuits convert each voltage peak to 160-ns logic level pulses and apply this pulse train to the data separator circuits. In the separator, the individual data and clock pulses are separated according to the double frequency recording scheme (Paragraph 4.1.5). The data separator also contains frequency tracking and peak-shift compensating circuits.

Figure 4-17 shows the time relationship and the waveforms for a read operation. The letters in parentheses () in the following text denotes the lettered waveforms on this figure.

To initiate a read operation, the controller:

- a. addresses a particular drive (Paragraph 4.2.4)
- b. positions the read/write heads at the appropriate cylinder (Paragraph 4.2.5)
- c. selects either the upper or lower read/write head (Paragraph 3.2.5).

If, for example, the lower read/write head is to be used, the signal HD SELECT (G180-0-1) is high. This signal is ANDed with UNSAFE L (high if no fault condition exists, Paragraph 4.5) to apply a ground potential to the center tap of the lower head.

As flux reversals on the disk surface pass under the lower read head, induced current flows through the lower head coil. The direction of this current flow depends upon the polarity of the flux reversal. These small read signals (approximately 5 mV) are then transmitted through the head-select diodes, through the series-isolation diodes, to a differential read preamplifier. The diode, resistor, and capacitive network between the read/write coils and the read preamplifier automatically isolates the preamplifier from the large write signals which occur during a write operation; however, this isolation circuit allows the small read signals which occur during a read operation to pass.

The amplified output from the preamplifier (approximately 300 mV) is then transmitted through a low-pass filter network to the read amplifier. The filter network removes noise and high-frequency disturbance but permits the lower frequency read signals to pass. The approximate 3.0V read amplifier output (A) is applied to a balanced delay circuit where the signal is differentiated (B) and the signal peaks converted into zero crossings. The complementary zero crossings are then applied to a pair of high gain differential comparators that convert the differentiated signal into square waves. Each square wave signal (C) triggers a corresponding one-shot, the outputs of which are combined to produce a composite 160-ns pulse train (D).

At this point, data and clock pulses are separated from the pulse train. Figure 4-16 is a simplified diagram of the data separation circuit. For a basic understanding of the following description, assume that the Data One Window Delay flip-flop remains set, keeping the input gate of the Window Control one-shot enabled.

If the Data Window flip-flop is in the reset state (G) when the leading edge of the first pulse on the pulse train occurs, the reset output gate is enabled to produce the READ CLOCK L interface signal (H) as well as trigger the Window Control one-shot (F). The reset output from this one-shot is applied to an integrator circuit. After integration, the average voltage output is then applied to the adjustable input of the one-shot. Thus, if data frequency variations occur, this circuit configuration automatically varies the one-shot pulse width and thus maintains a constant duty cycle.

4.4.2 Write Operation

During a write operation, multiplexed write data and clock pulses are applied to the complementary Write Encode flip-flop. If the Write Gate signal is present and one of the read/write heads has been selected, current flows through the erase coil as well as through one-half of the center-tapped write coil. Each pulse on the multiplexed input complements the Write Encode flip-flop and transfers current flow to the opposite half of the write coil; however, current flow through the erase coil remains constant throughout the write operation.

To initiate a write operation, the controller:

- a. addresses a particular drive (Paragraph 4.2.4)
- b. positions the read/write heads at the appropriate cylinder (Paragraph 4.2.5)
- c. selects either the upper or lower read/write head (Paragraph 3.2.5)

If, for example, the lower read/write head is to be used, HD SELECT (G180-0-1) is high. This signal is ANDed with UNSAFE L (high if no fault condition exists, Paragraph 4.5) to apply a ground potential to the center tap of the lower head.

At this point, the controller transmits the WRITE GATE L signal. WRITE GATE L is ANDed with SELECT/READY L to generate the signal SELECTED WRITE GATE H. The multiplexed data to be recorded is then transmitted over the WRITE DATA AND CLOCK interface line. If the WT PROT switch is off (drive not write-protected), the signal NO PROTECT L accomplishes the following:

- a. ANDs with R/W/S READY L to complete the base current return circuit for the write drivers (Q1 and Q2)
- b. ANDs with WRITE DATA AND CLOCK L to apply the data train to the complementary Write Encode flip-flop.

NOTE

The Write Encode flip-flop operates between +10V and +15V instead of the usual ground and +5V levels.

When the WRITE DATA or CLOCK pulse goes low, the Write Encode flip-flop sets, applying the +10V reset output to the base of write driver Q2, causing it to conduct. With Q2 conducting, approximately 32 mA of current (adjustable with R13) flows through the upper portion of the lower write coil. In addition, a low voltage is applied to the base of the Erase Current Switch Q3, causing it to conduct. When Q3 conducts, one leg of the Unsafe gate is enabled (Paragraph 4.5) and erase current flows through the lower erase coil.

When the WRITE DATA or CLOCK pulse goes low again, the Write Encode flip-flop resets, causing write driver Q1 to conduct and Q2 to cut off. This circuit configuration transfers the current path to the lower portion of the lower write coil; however, the current direction in the erase coil remains constant. Thus, with each current transfer in the head coil, a flux reversal is recorded on the rotating disk surface.

4.5 FAULT DETECTION

If, during normal operation, the following two fault conditions are detected, all external commands to the drive are suppressed and the FAULT indicator on the drive control panel lights. The fault conditions are:

1. erase or write current without a WRITE GATE
2. linear positioner transducer lamp inoperative

4.5.1 Current Fault

During a write operation, write driver Q1 or Q2 (G180-0-1), depending upon the polarity of the input data, is conducting. The low voltage output from either write driver turns on Erase Current Switch Q3 to enable one leg of the Unsafe gate. If the WRITE GATE L signal is present, the second leg of this gate is disabled; thus Q4 conducts to keep the signal SET UNSAFE L high.

If, for any reason (e.g., shorted transistor), the Erase Current Switch should conduct without a WRITE GATE L signal present, the Unsafe gate is enabled. This action turns off Q4 to generate the signal SET UNSAFE L. This signal accomplishes the following:

- a. sets the Fault latch (M7701)
- b. generates the WRITE CHECK interface signal and lights the FAULT indicator (M7701)
- c. deselects both read/write heads (G180-0-1)

4.5.2 Positioner Lamp Fault

This fault condition can only be detected when the read/write heads are in the "home" position. If the positioner lamp fails at any other time, various other checks will disclose this fact (e.g., SEEK INCOMPLETE generated or R/W/S READY never generated etc.). Therefore, the positioner lamp check is accomplished during the initial power-on cycle, or if the heads drift back to the "home" position after having once been loaded.

If the lamp fails and the heads are in the "home" position, HOME H (M7701) is present; however, OUTER LIMIT H (heads are at or beyond the outer portion of the disk) is low. This signal combination sets the Fault latch to light the FAULT indicator and generate the WRITE CHECK interface signal.

4.6 POWER SUPPLY DESCRIPTION

The RK05 Disk Drive power supply (H743) and associated electronic cards are located in the left rear portion of the disk drive. The power supply itself can be operated from a 115 or 230 Vac line voltage input and consists of a dual transformer, two bridge rectifiers, and three voltage regulators. For 115 Vac operation, two jumpers must be connected to P2 pins 1 and 2, and P2 pins 3 and 4. This configuration connects the dual primaries of transformer T1 in parallel. For 230 Vac operation, only one jumper must be connected to P2 pins 2 and 3. This configuration connects the dual primaries of transformer T1 in series, thus maintaining 115 Vac across each primary. With either configuration, the 115 Vac blower motor is connected across T1 pins 1 and 2, while the 115 Vac spindle motor is connected across T1 pins 3 and 4.

When the power supply is activated, the secondary output of T1 pins 7 and 8 is applied through full-wave bridge rectifier D2, across capacitor C2, to the input of both the +15V and +5V regulators. The other T1 secondary output is likewise applied through full-wave bridge rectifier D1, across capacitor C1, to the input of the -15V regulator. The regulator outputs are maintained within the following specified voltage limits:

- a. $+15 \pm 0.75$ Vdc
- b. -15 ± 0.75 Vdc
- c. $+5 \pm 0.15$ Vdc

All three regulators contain current-limiting circuitry and are further protected against short circuits by a permanent fuse. Only the +5 Vdc regulator (logic power) contains a nonadjustable Zener diode for automatic over-voltage protection.

CHAPTER 5

MAINTENANCE

5.1 RECOMMENDED TOOLS AND TEST EQUIPMENT

Table 5-1 lists the recommended tools and test equipment that are to be used with the standard tools for proper maintenance of the RK05 Disk Drive.

Table 5-1
Recommended Tools and Test Equipment

Equipment	Manufacturer and Model/Part No.
Multimeter	Triplett 310 or Simpson 360
Oscilloscope	Tektronix 453
Oscilloscope Probes	
Voltage	Tektronix P6010
Current	Tektronix P6019 clip-on with passive terminator
Wire Wrap Tool (24-gauge)	DEC H811
Unwrapping Tool (24-gauge)	DEC H812
Wire Wrap Tool (30-gauge)	DEC H811A
Unwrapping Tool (30-gauge)	DEC H812A
Module Extender Board	DEC H982
Torque Wrench	C-IA-9605893-0-0
Head Cleaning Kit	
Tex Pads	29-19557
Wand	29-19558
Inspection Mirror	29-19663
Isopropyl Alcohol	29-19665
Q-Tips	90-08436
0.005-in. Blue Shim Stock	29-19664

5.2 PREVENTIVE MAINTENANCE

When the disk drive is operated in a normal office environment on a one shift basis, perform the preventive maintenance (PM) procedures as indicated in Table 5-2. An abnormally dirty environment or a high incidence of cartridge exchange may require more preventive maintenance than that indicated in the schedule. During the PM procedures, unless specifically indicated, do not alter any adjustments on drives that are performing satisfactorily.

Table 5-2
Preventive Maintenance Schedule

Frequency (hours)	Area	Action	Reference
500	Read/Write Heads	Clean – heavy operation (e.g., extensive cartridge exchange with frequent starts and stops. Frequent use of virgin cartridges).	Paragraph 5.2.2
1,000	Read/Write Heads	Clean – medium operation	Paragraph 5.2.2
1,500	Read/Write Heads	Clean – light operation (e.g., minimum cartridge exchange with infrequent starts and stops).	Paragraph 5.2.3
	Prefilter	Clean	Paragraph 5.2.3
	Spindle	Clean Check for bearing noise	Paragraph 5.2.3 Paragraph 5.2.3
3,000	Prefilter	Replace	
	Absolute Filter	Replace	Paragraph 5.2.5
	Spindle Belt Tension	Check	Paragraph 5.2.4
6,000	Linear Positioner	Inspect flexstrip for cracks in copper leads. Check ease of forward and backward motion. Check for excessive lateral motion. Check velocity profile (64-cylinder seek waveform).	Paragraph 5.4.2
	Read/Write Heads	Check head alignment.	Paragraph 5.4.5
7,500	Spindle Ground	Check contact with ohmmeter	
15,000	Spindle Ground	Remove spindle and replace ground assembly.	Paragraph 5.3.4
	Spindle Drive Belt	Replace and clean pulleys.	Paragraph 5.3.5.3
	Blower	Remove and clean impeller.	Paragraph 5.3.6

**Table 5-2 (Cont)
Preventive Maintenance Schedule**

Frequency (hours)	Area	Action	Reference
30,000	Spindle	Replace	Paragraph 5.3.4
	Spindle Motor	Replace	Paragraph 5.3.5
	Blower Motor	Replace	Paragraph 5.3.7
	Linear Transducer	Clean scale, reticle, and lens with 91% isopropyl alcohol	

5.2.1 Elapsed Time Indicator

The elapsed time indicator (Figure 5-1), located on the rear of the disk drive, indicates the number of hours that the drive has been operating. When power is applied to the drive, a bubble indicator moves from left to right within a mercury column. The movable scale beneath the bubble is graduated in 200-hour increments and furnishes a direct hour read-out. When performing the 1500-hour preventive maintenance procedure, record the data and the elapsed time indication in the maintenance log book and reset the indicator as follows:

1. Remove the top cover of the elapsed time indicator and rotate the cover so that the bubble is in the left portion of the cover.
2. Place the cover (back-side up) against the movable scale.
3. Using a pocket screwdriver, slide the movable scale until the zero reference mark is aligned with the bubble.
4. Turn the cover right-side up and recheck the zero reference alignment.
5. Snap the cover into place.

5.2.2 500-Hour PM Procedure

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Inspect the read/write heads for excessive dirt or oxide. If necessary, clean the heads with the wand and tex pads supplied with the Head Cleaning Kit. If the cleaning kit is not available, the heads may be cleaned with a Q-tip soaked in 91% isopropyl alcohol. Dry the heads with a clean, dry Q-tip.
4. Restore the drive to normal operation.

5.2.3 1,500-Hour PM Procedure

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Record the elapsed time indication in the maintenance log and reset the elapsed time indicator (Paragraph 5.2.1).

4. Inspect and clean the read/write heads if required (Paragraph 5.2.2, Step 3).
5. Vacuum the prefilter outer face (Figure 5-1). If there is excessive dirt on the prefilter, remove the filter and clean it with a mild liquid detergent (e.g., Ivory) and warm water. Using the vacuum cleaner exhaust, air-dry the filter completely before installation.
6. Remove the flexible magnet from the spindle and clean the armature plate with a clean cloth moistened with 91% isopropyl alcohol. Using the sticky side of some masking tape, remove any metallic particles from the armature plate. Reinstall the flexible magnet.
7. Restore the drive to normal operation and check for excessive spindle bearing noise while the spindle is rotating. Replace the spindle (Paragraph 5.3.4) if excessive noise occurs.

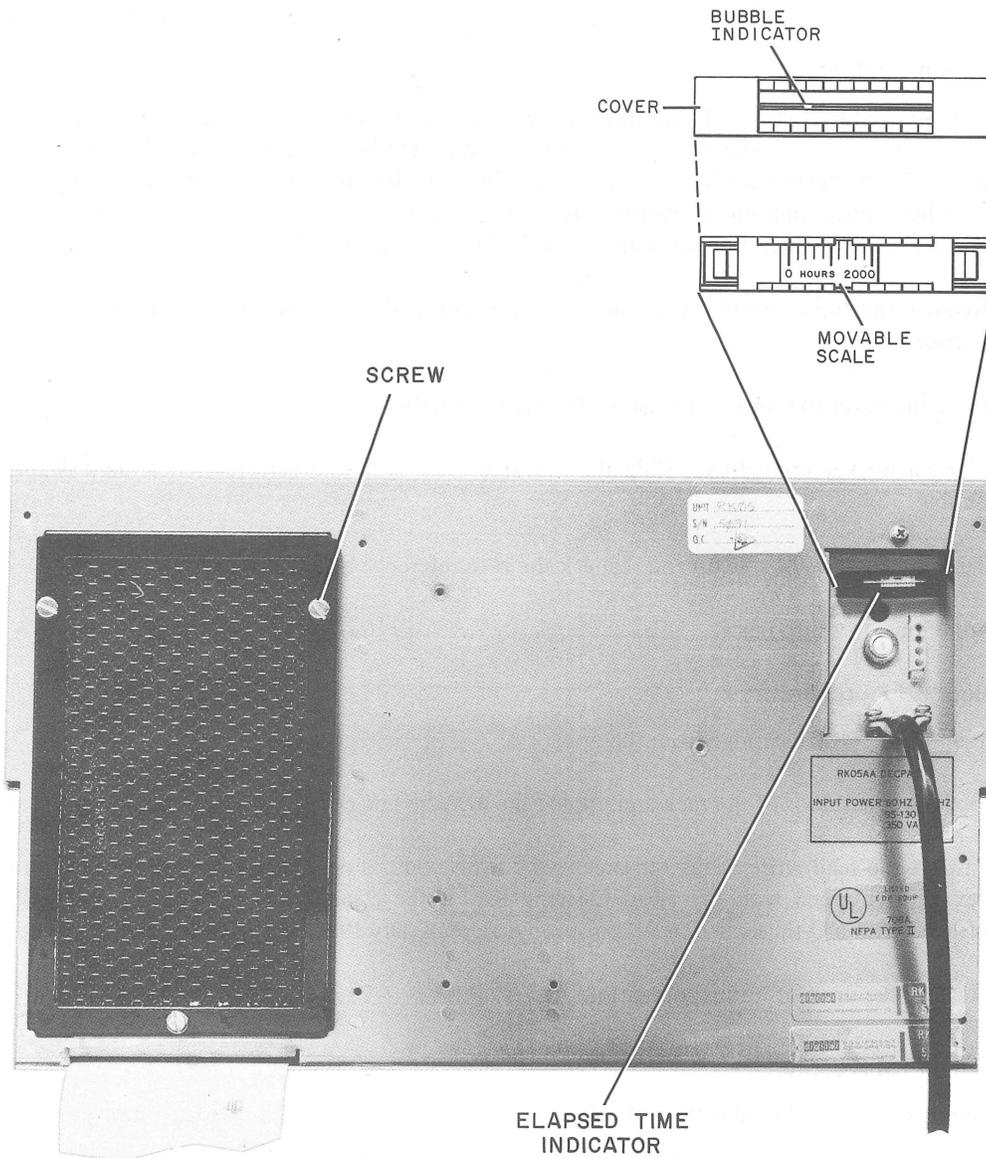


Figure 5-1 Prefilter and Elapsed Time Indicator

5.2.4 3,000-Hour PM Procedure

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Inspect and clean the read/write heads if required (Paragraph 5.2.2, Step 3).
4. Replace the prefilter.
5. Replace the absolute filter (Paragraph 5.2.5).
6. Check the spindle drive belt tension by squeezing the belt together and ensuring that, when the belt is released, the tension spring restores the motor mounting plate enough to keep tension on the belt. If not, replace the belt (Paragraph 5.3).
7. Restore the drive to normal operation.

5.2.5 Absolute Filter Removal and Replacement

1. Open the rear door of the rack and unplug the drive ac line cord.
2. Slide the drive out of the rack until it locks in the extended position.
3. Remove the bottom and plenum covers (Figure 5-2).

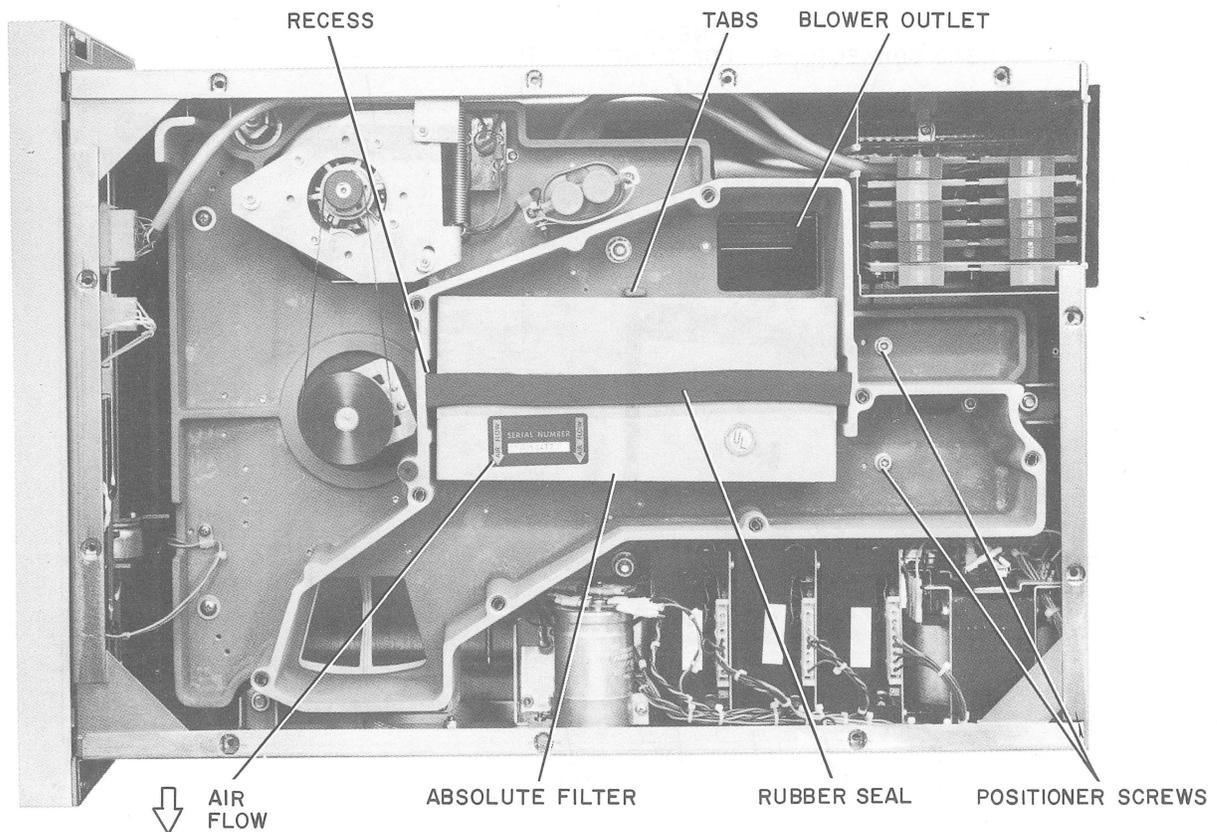


Figure 5-2 Absolute Filter Removal

4. Remove the absolute filter.
5. Install a new filter with the arrow (air flow) pointing away from the blower outlet. Ensure that the filter is positioned between the two tabs and that the rubber seal is in the baseplate recess.
6. Replace the plenum and bottom covers.
7. Slide the drive into the rack, connect the ac line cord, and close the rear door.

5.3 CORRECTIVE MAINTENANCE

5.3.1 Linear Positioner

5.3.1.1 Positioner Removal

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Slide the drive out of the rack until it locks in the extended position.
4. Remove the top, bottom, and plenum covers.
5. Disconnect P5 (Figure 5-3) from the power supply chassis.

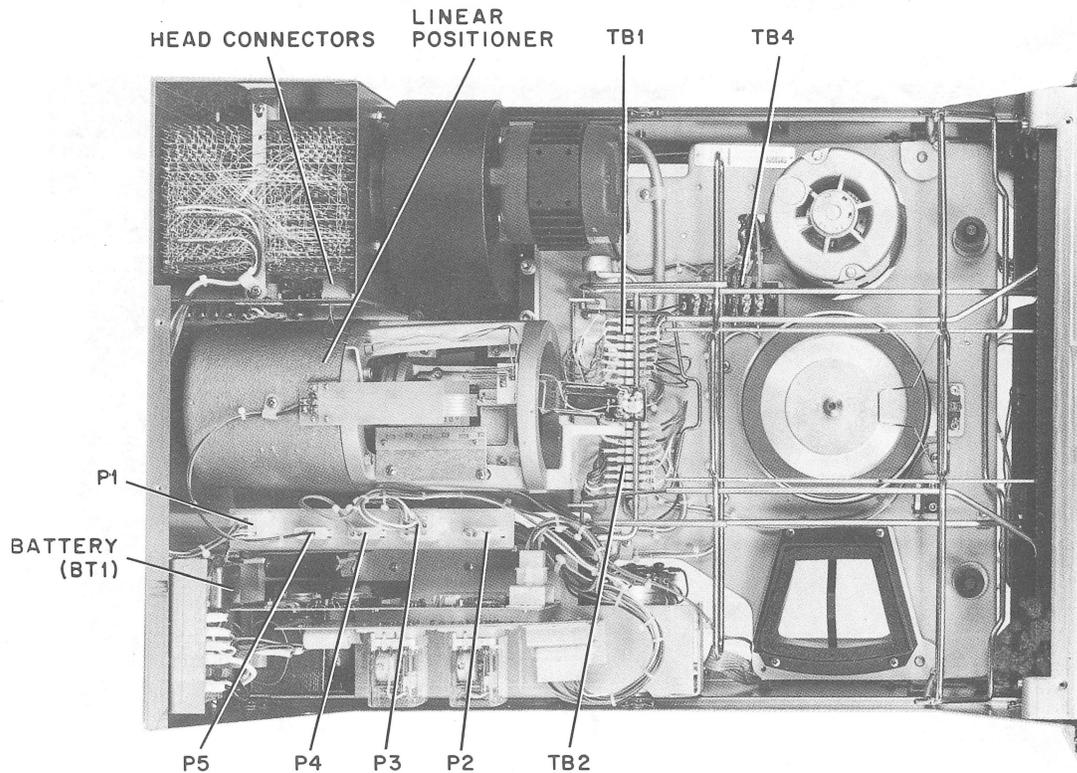


Figure 5-3 Top View with Cover Removed

6. Remove the position transducer wires from TB1 pins 1 through 9 and TB2 pins 8 and 9.
7. Disconnect the head connectors from the electronic module.
8. Remove the absolute filter (Figure 5-2).
9. Remove the three screws, beneath the baseplate, attaching the positioner to the baseplate (Figure 5-2).
10. Carefully maneuver the positioner off the locating pins on top of the baseplate and lift the positioner straight up from the baseplate.

5.3.1.2 Positioner Replacement

1. Carefully place the positioner on the three locating pins on top of the baseplate (Figure 5-3). Ensure that the two front pins rest against the front surface of the motor housing and the third diamond shaped pin is in the centerhole of the mounting face.
2. Insert the three positioner holding screws (Figure 5-2) through the bottom of the baseplate and finger tighten the screws.
3. Ensure that the positioner is located securely against the front locating pins by tightening the holding screws while applying forward pressure to the rear of the positioner.
4. Check with a feeler gauge for less than .002-in. clearance between the front of the motor housing and the baseplate. If the clearance is not less than .002 in., loosen the positioner holding screws and repeat Step 3.
5. Connect the position transducer wires to TB1 and TB2 (Figure 5-3).

NOTE

Refer to the chassis wiring diagram for TB1 and TB2 connection color code.

6. Plug P5 into the power supply chassis.
7. Connect the head leads to the electronic module. Refer to the decal on the electronic module for the correct lead connections.
8. Install the absolute filter with the arrow (air flow) pointing away from the blower outlet (Figure 5-2). Ensure that the filter is positioned between the two tabs and that the rubber seal is in the baseplate recess.
9. Replace the plenum and bottom covers.
10. Connect the ac line cord and check the read/write head alignment (Paragraph 5.4.5).
11. Replace the top cover.
12. Close the rear door, install a test cartridge, and exercise the drive.

5.3.2 Carriage

5.3.2.1 Carriage Removal

1. Remove the linear positioner (Paragraph 5.3.1.1).
2. Remove the read/write heads (Paragraph 5.3.3.1).
3. Remove the four flexstrip connector and flexstrip holddown screws (Figure 5-4). Do not disconnect the flexstrip coupling from the armature.
4. Remove the cable clamp screw from the top of the motor housing.
5. Remove the home switch and bracket from the carriage slide.
6. Remove the five screws securing the carriage slide to the motor housing.
7. Slowly pull the carriage and slide straight out from the motor housing.
8. Slide the carriage and armature out from the back of the carriage slide, ensuring that the transducer block does not contact the glass scale.

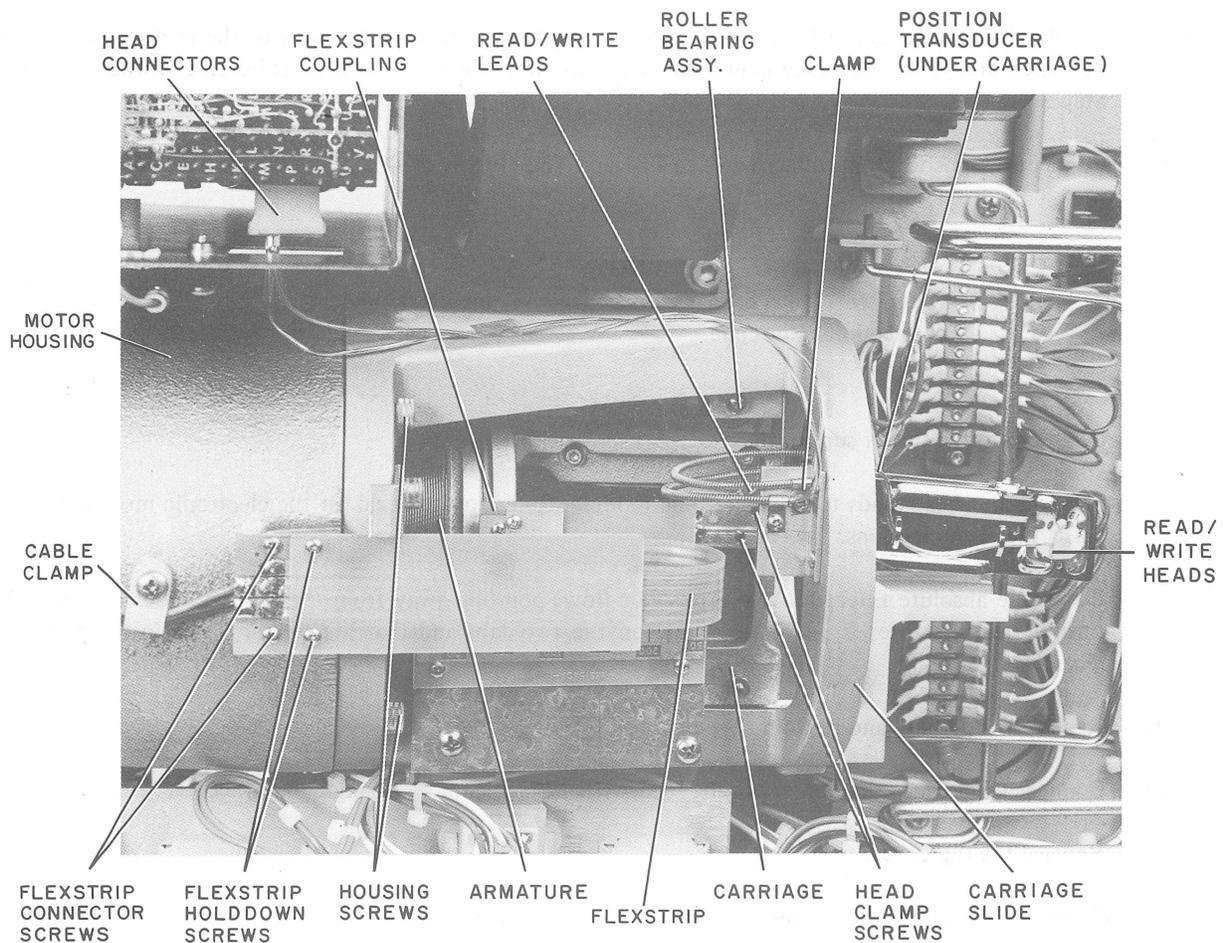


Figure 5-4 Carriage Removal

5.3.2.2 Carriage Replacement

1. Carefully insert the armature and carriage into the carriage slide, ensuring that the transducer block does not contact the glass scale.
2. Insert the armature and carriage slide into the motor housing, ensuring that the dowel pin on the housing goes into the "V" groove on the carriage slide.
3. Replace the five screws that secure the carriage slide to the motor housing (Figure 5-4).
4. Loop the flexstrip onto the top of the motor housing and replace the four flexstrip connector and holddown screws.
5. Replace the cable clamp.
6. Replace the home switch and bracket on the carriage slide.
7. Stand the positioner up on the motor housing end, and adjust the home switch as follows:
 - a. Pull the carriage out from the motor housing until the switch actuator on the carriage is free from the switch.
 - b. Hold a steel scale across the machined face of the carriage slide and stand another scale on the machined face (near the head mounting holes) of the carriage.
 - c. Slowly move the carriage in towards the motor housing until the home switch "clicks." At this point, the vertical steel scale on the carriage face should indicate $2.050 \pm .020$ in. **IMPORTANT: THE SWITCH CHECK AND ADJUSTMENT MUST BE MADE ON THE BACKWARD "CLICK" OF THE HOME SWITCH AND NOT WHILE THE CARRIAGE IS MOVING FORWARD.**
 - d. If the switch adjustment is incorrect, bend the leaf actuator on the switch until the Step c. measurement is obtained.
8. Replace the read/write heads (Paragraph 5.3.3.2).
9. With a piece of blue plastic shim stock check for .005-in. clearance between the transducer glass scale and the reticle. If the clearance is incorrect, loosen the transducer block mounting screws and reposition the block to obtain the correct clearance.
10. Replace the linear positioner (Paragraph 5.3.1.2).
11. Perform the servo system timing adjustment (Paragraph 5.4.2).
12. Check the read/write head alignment (Paragraph 5.4.5).

5.3.2.3 Carriage Bearing Assembly Removal

1. Remove the linear positioner (Paragraph 5.3.1.1).
2. Remove the carriage from the linear position (Paragraph 5.3.2.1).
3. Using a 3/8-in. nut driver, loosen the bearing shaft nut (Figure 5-5) one-half turn.

4. Hold the 3/8-in. bearing shaft nut and remove the retaining nut from the other end of the shaft.
5. Remove the bushing from the shaft and unscrew the bearing shaft.
6. Remove the bearing.

NOTE

Replace all four bearings at the same time.

5.3.2.4 Carriage Bearing Assembly Replacement

1. Insert the bearing into the bearing pocket. Ensure that the widest machined surface of the bearing (Figure 5-5 Insert) is towards the threaded hole in the pocket.
2. Insert the bearing shaft into the threaded pocket hole and through the center hole in the bearing.
3. Turn the 3/8-in. bearing shaft nut just a few turns to start the shaft threads into the pocket hold threads. Do not tighten the shaft at this time.
4. Insert the bushing on the other end of the shaft and replace the retaining nut.

NOTE

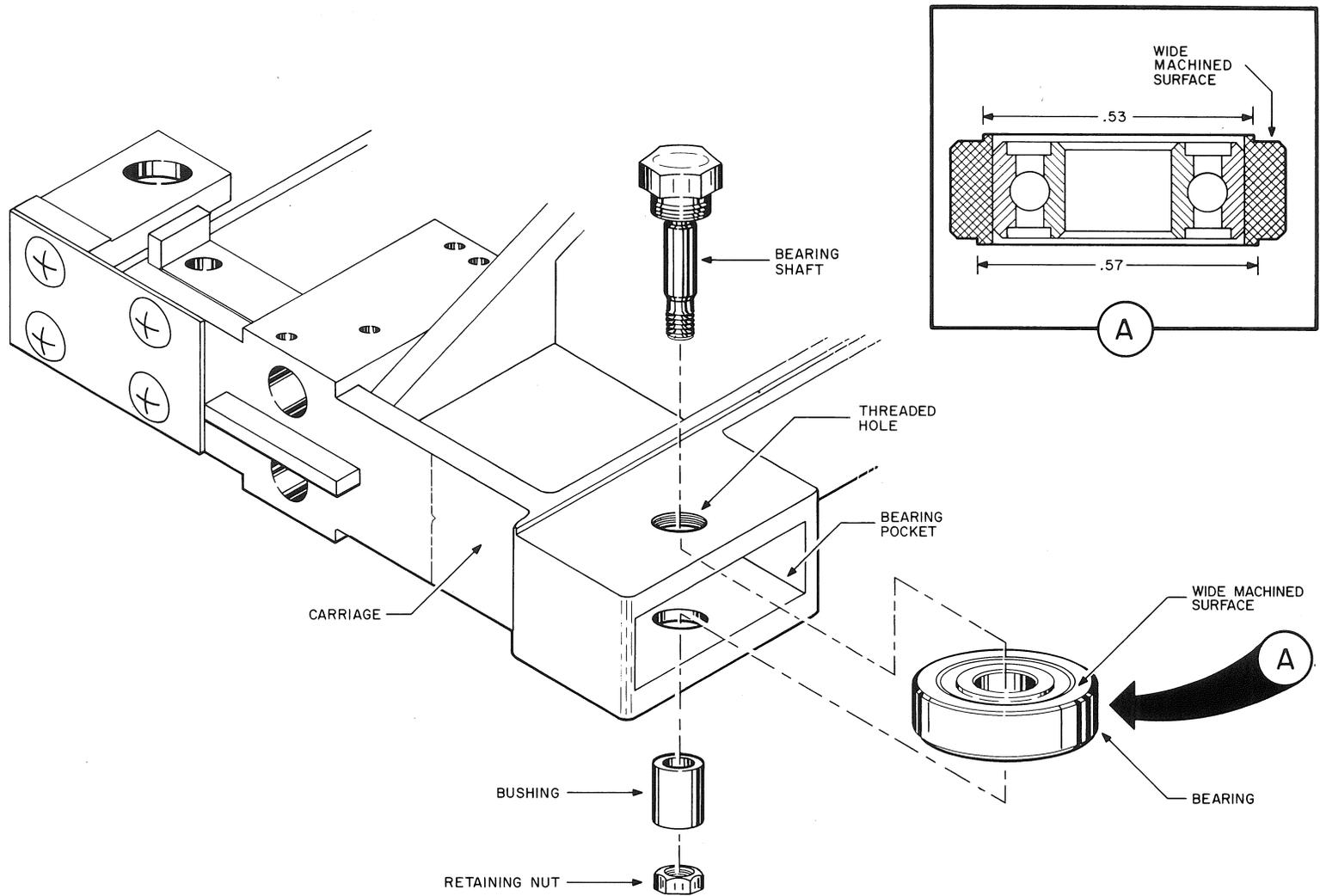
When performing Steps 5 and 6, do not allow the bearing assembly to touch the top or bottom of the carriage pocket.

5. Hold the 3/8-in. bearing shaft nut and tighten the retaining nut until the bushing moves the bearing close to the pocket top. Now tighten the 3/8-in. bearing shaft nut until the bearing moves close to the pocket bottom.
6. Continue alternate nut tightening as described in Step 5 until the bearing shaft and retaining nuts are secure.
7. Replace the carriage in the linear positioner (Paragraph 5.3.2.2).
8. Replace the linear positioner (Paragraph 5.3.1.2).
9. Check the read/write head alignment (Paragraph 5.4.5).

5.3.2.5 Transducer Block Removal and Replacement

1. Remove the linear positioner (Paragraph 5.3.1.1).
2. Remove the clamp attaching the position transducer leads to the carriage slide.
3. Remove the two screws attaching the transducer block to the carriage slide and carefully maneuver the transducer block out of the slide, ensuring that the block does not scratch the glass scale.
4. Install the new transducer block on the carriage slide with the previously removed hardware.
5. Replace the transducer leads in the clamp and attach the clamp to the carriage slide.

(continued on page 5-12)



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Figure 5-5 Carriage Bearing Assembly Removal

6. With a piece of blue plastic shim stock check for .005-in. clearance between the transducer glass scale and the reticle. If the clearance is incorrect, loosen the transducer block mounting screws and reposition the block to obtain the correct clearance.
7. Replace the linear positioner (Paragraph 5.3.1.2) and perform the servo system timing adjustment (Paragraph 5.4.2).
8. Align the read/write heads (Paragraph 5.4.5).

5.3.3 Read/Write Heads

5.3.3.1 Head Removal

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Slide the drive out of the rack until it locks in the extended position.
4. Remove the top cover.
5. Disconnect the head connectors (Figure 5-3) from the electronic module.
6. Disconnect P5 from the power supply chassis (Figure 5-6a).
7. Remove the head clamp and head adjusting screws.
8. Retract the carriage to unload the heads and carefully remove the upper head.
9. Extend the carriage (Figure 5-6b) and remove the lower head.

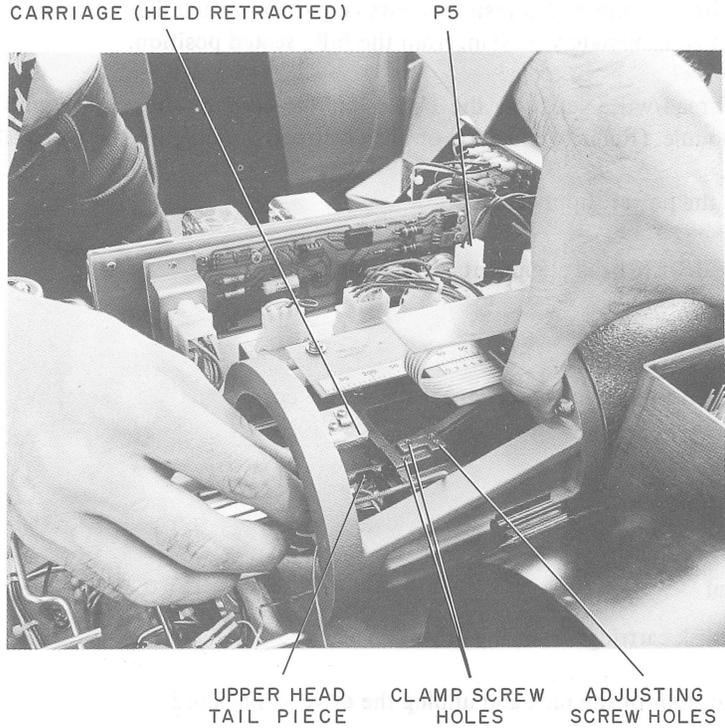
5.3.3.2 Head Replacement

1. Extend the carriage and insert the lower head tail piece into the carriage (Figure 5-6b).
2. Retract the carriage to the home position so that the lower head is supported by the lifting block on the duckbill.
3. To install the upper head, it is necessary to straighten the head from its natural position. Carefully install the upper head as follows:
 - a. Insert the end of the tail piece slightly into the carriage hole (Figure 5-6a).

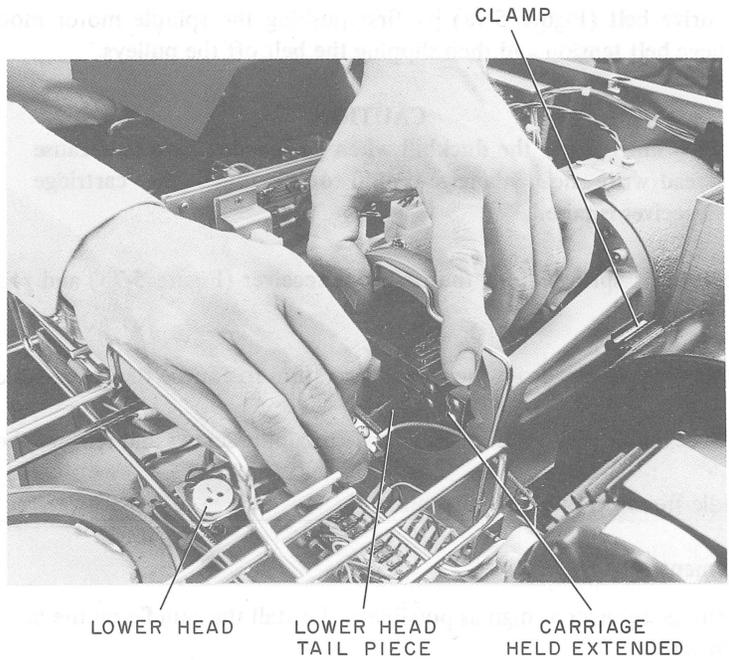
CAUTION

Exercise extreme care while performing Step b. If the yield point of the spring is exceeded during the straightening process, the loading force on the head will change.

- b. Simultaneously press down at the front of the tail piece and lift the front of the suspension spring while pushing the head backwards. This process tends to straighten the head suspension spring for easier insertion into the carriage hole. Do not over-bend the suspension spring and avoid touching the ceramic surfaces of the head pads during installation.



a. Upper Head Removal and Installation



b. Lower Head Removal and Installation

Figure 5-6 Read/Write Head Replacement

4. Replace the head clamp and adjusting screws (Figure 5-6a) and lightly tighten the clamp screws with the heads located approximately .030 in. from the fully seated position.
5. Replace the read/write leads in the clamp on the carriage slide and connect the head leads to the electronic module. (Refer to the decal on the electronic module for the correct lead connections.)
6. Plug P5 into the power supply chassis.
7. Check the read/write head alignment (Paragraph 5.4.5).
8. Replace the top cover.
9. Slide the drive into the rack and connect the ac line cord.
10. Close the rear door.

5.3.4 Spindle

5.3.4.1 Spindle Removal

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Slide the drive out of the rack until it locks in the extended position.
4. Remove the top and bottom covers.
5. Remove the drive belt (Figure 5-7a) by first pushing the spindle motor mounting plate towards the spindle to relieve belt tension and then slipping the belt off the pulleys.

CAUTION

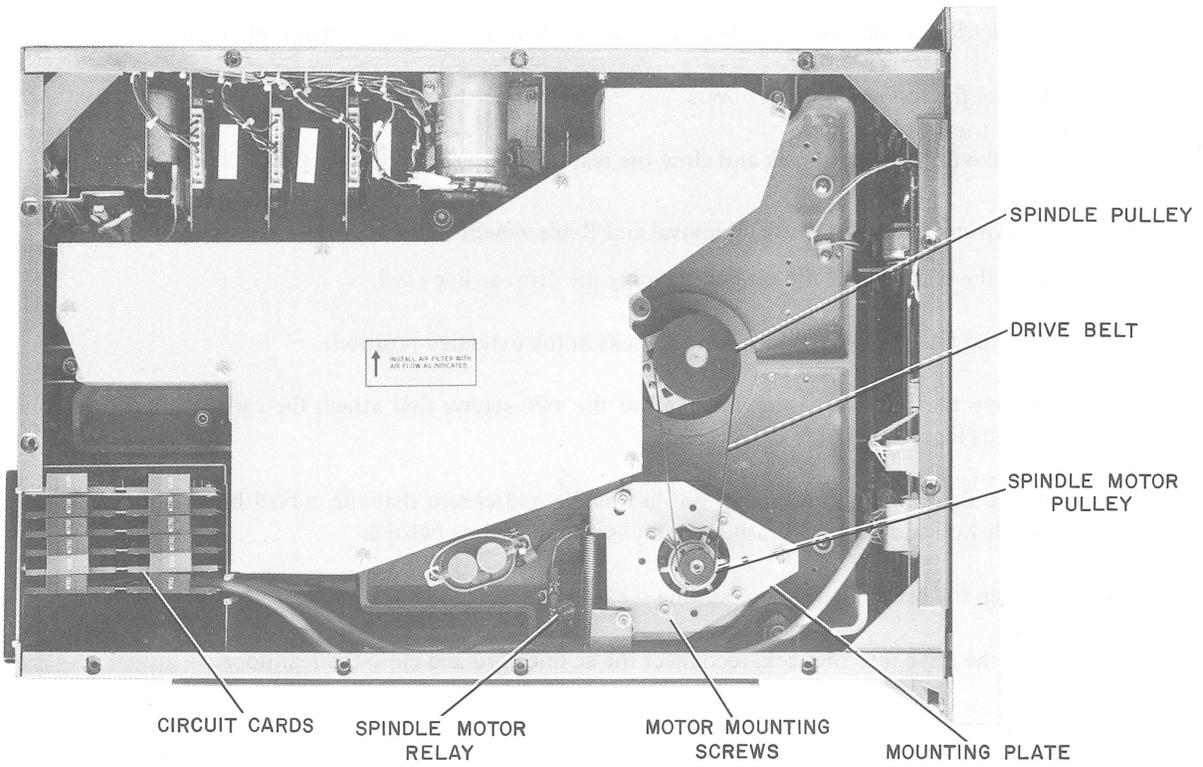
Do not remove the duckbill when performing Step 6, because read/write head damage could occur when the cartridge receiver is raised.

6. Remove the tension springs from the cartridge receiver (Figure 5-7b) and raise the receiver as high as possible.
7. Remove the flexible magnet from the spindle armature to expose the access hole in the spindle plate.
8. Position the access hole over each of the spindle retaining screws and remove them.
9. Lift the spindle free from the drive baseplate.

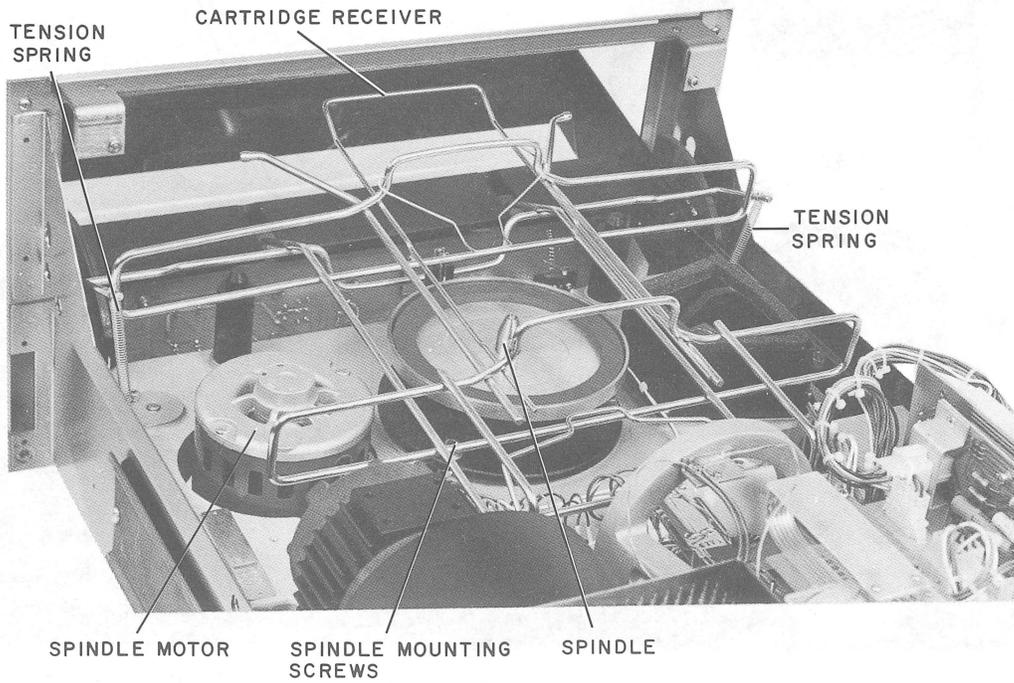
5.3.4.2 Spindle Replacement

1. Raise the cartridge receiver as high as possible and install the spindle on the baseplate with the previously removed hardware.
2. Lower the cartridge receiver and attach the tension springs (Figure 5-7b).
3. Push the spindle motor mounting plate (Figure 5-7a) towards the spindle and slip the drive belt around the pulleys.

(continued on page 5-16)



a. Drive Belt



b. Spindle

Figure 5-7 Spindle Replacement

4. Connect the ac line cord and check the read/write head alignment (Paragraph 5.4.5).
5. Replace the top and bottom covers.
6. Slide the drive into the rack and close the rear door.

5.3.4.3 Spindle Ground (Carbon Brush) Removal and Replacement

1. Open the rear door of the rack and unplug the drive ac line cord.
2. Slide the drive out of the rack until it locks in the extended position.
3. Remove the bottom covers and remove the two screws that attach the carbon brush assembly to the spindle (Figure 5-8).
4. Mount the new brush assembly on the spindle and ensure that the curved brushes are centered on the spindle hub and that the brush assembly is not cocked or twisted.
5. Tighten the brush assembly mounting screws and replace the bottom covers.
6. Slide the drive into the rack, reconnect the ac line cord and close the rear door.

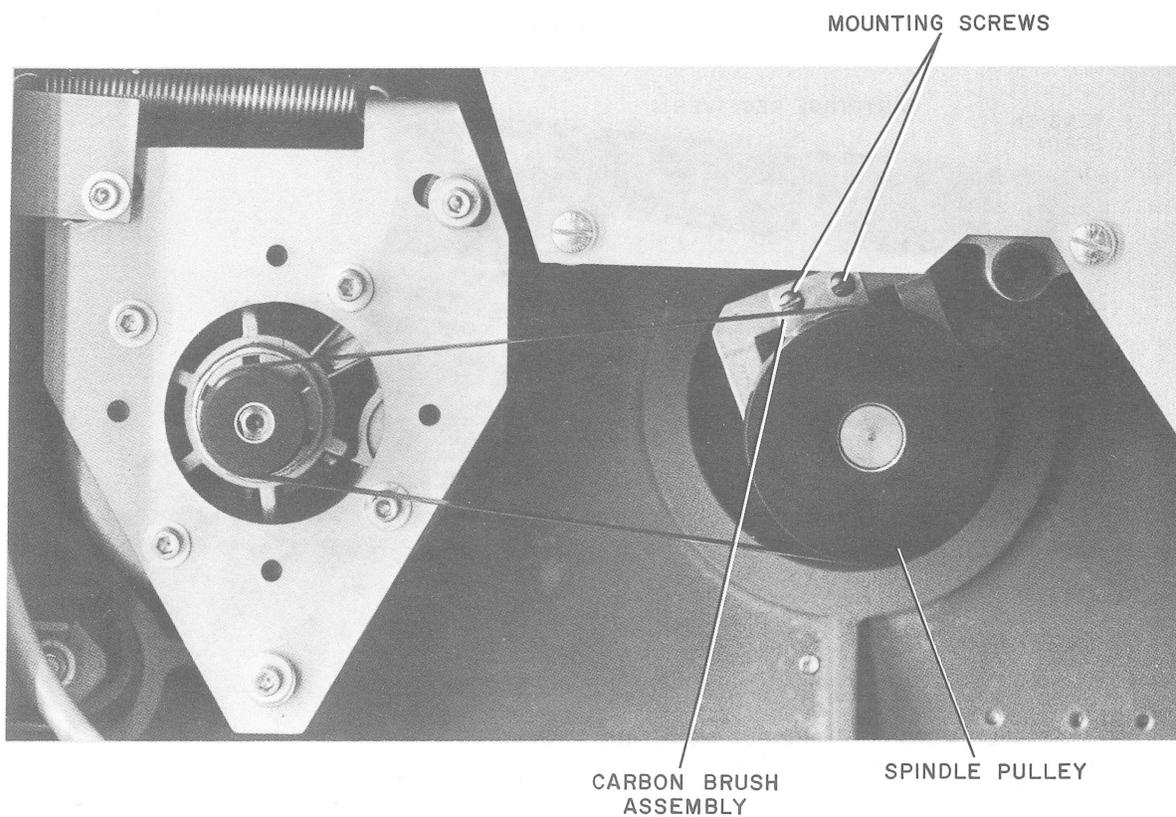


Figure 5-8 Carbon Brush Replacement

5.3.5 Spindle Drive Motor

5.3.5.1 Motor Removal

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Slide the drive out of the rack until it locks in the extended position.
4. Remove the top and bottom covers.
5. Disconnect the spindle motor leads from TB4 (Figure 5-9) and the spindle motor relay (Figure 5-7a).
6. Remove the drive belt (Figure 5-7a) by first pushing the spindle motor mounting plate towards the spindle to relieve belt tension and then slipping the belt off the pulleys.

NOTE

To allow 50/60 Hz operation, the spindle motor is mounted in one of two sets of holes on the mounting plate. Prior to performing Step 7, it is important to note which set of holes are used to ensure correct motor replacement.

7. Remove the four screws attaching the motor to the mounting plate and remove the motor through the top of the baseplate.

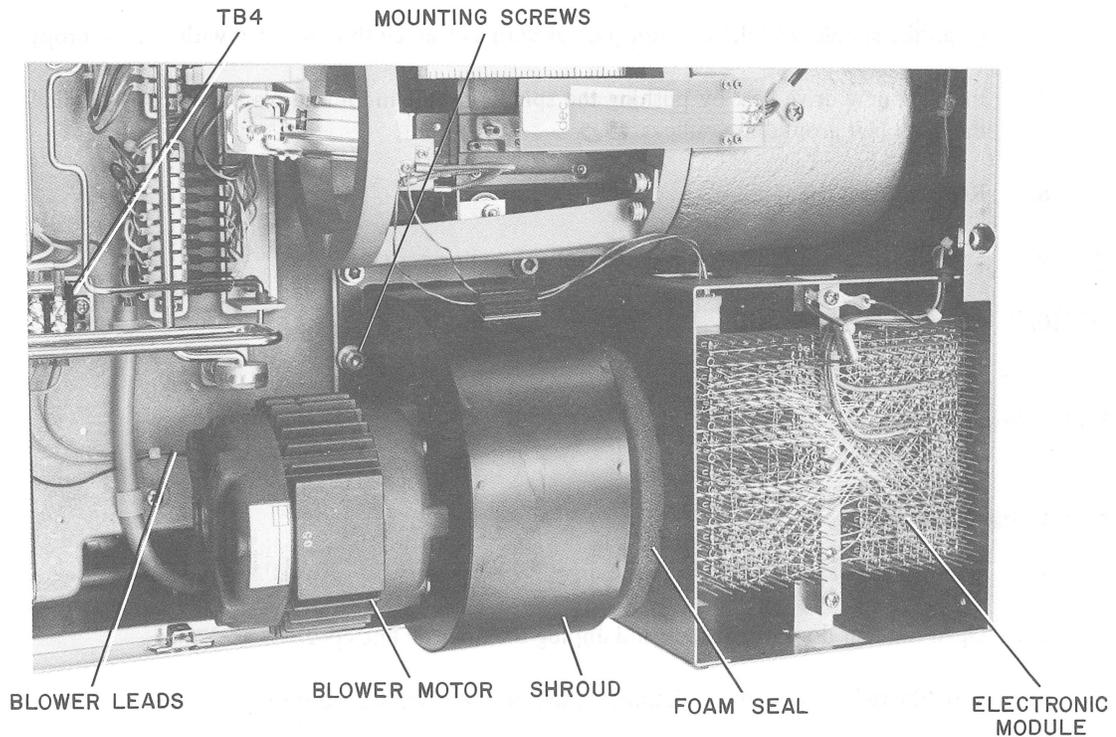


Figure 5-9 Blower Motor Removal

5.3.5.2 Motor Replacement

1. Insert the spindle motor through the top of the baseplate (Figure 5-7a) and attach the motor to the mounting plate with the previously removed hardware.
2. Push the spindle motor mounting plate towards the spindle and slip the drive belt around the pulleys.
3. Connect the spindle motor leads to TB4 (Figure 5-9) and to the spindle motor relay (Figure 5-7a). Refer to the chassis wiring drawing for TB4 and the spindle motor relay connection color code.
4. Replace the top and bottom covers.
5. Slide the drive into the rack and connect the ac line cord.
6. Close the rear door.

5.3.5.3 Drive Belt Removal and Replacement

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Slide the drive out of the rack until it locks in the extended position.
4. Remove the bottom cover.
5. Push the spindle motor mounting plate (Figure 5-7a) towards the spindle to relieve belt tension and slip the belt off the pulleys.
6. Clean the spindle and drive motor pulleys with a clean cloth moistened with 91% isopropyl alcohol.
7. Install a new drive belt by pushing the spindle motor mounting plate towards the spindle and slipping the drive belt around the pulleys.
8. Replace the bottom cover.
9. Slide the drive into the rack and connect the ac line cord.
10. Close the rear door.

5.3.6 Blower Motor

5.3.6.1 Blower Removal

1. Remove the disk cartridge from the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Slide the drive out of the rack until it locks in the extended position.
4. Remove the top and bottom covers.

5. Disconnect the blower leads from TB4 (Figure 5-9).
6. Remove the four blower mounting screws and carefully remove the blower and shroud from the baseplate. Be careful not to damage the foam seal while removing the blower.

5.3.6.2 Blower Replacement

1. Carefully insert the shroud inlet ring into the foam seal (Figure 5-9) and secure the blower and shroud to the baseplate with the previously removed hardware.
2. Connect the blower leads to TB4.
3. Replace the top and bottom covers.
4. Slide the drive into the rack and connect the ac line cord.
5. Close the rear door.

5.4 ALIGNMENT, CHECKS, AND ADJUSTMENTS

5.4.1 2315 CE Test Cartridge Shim Installation

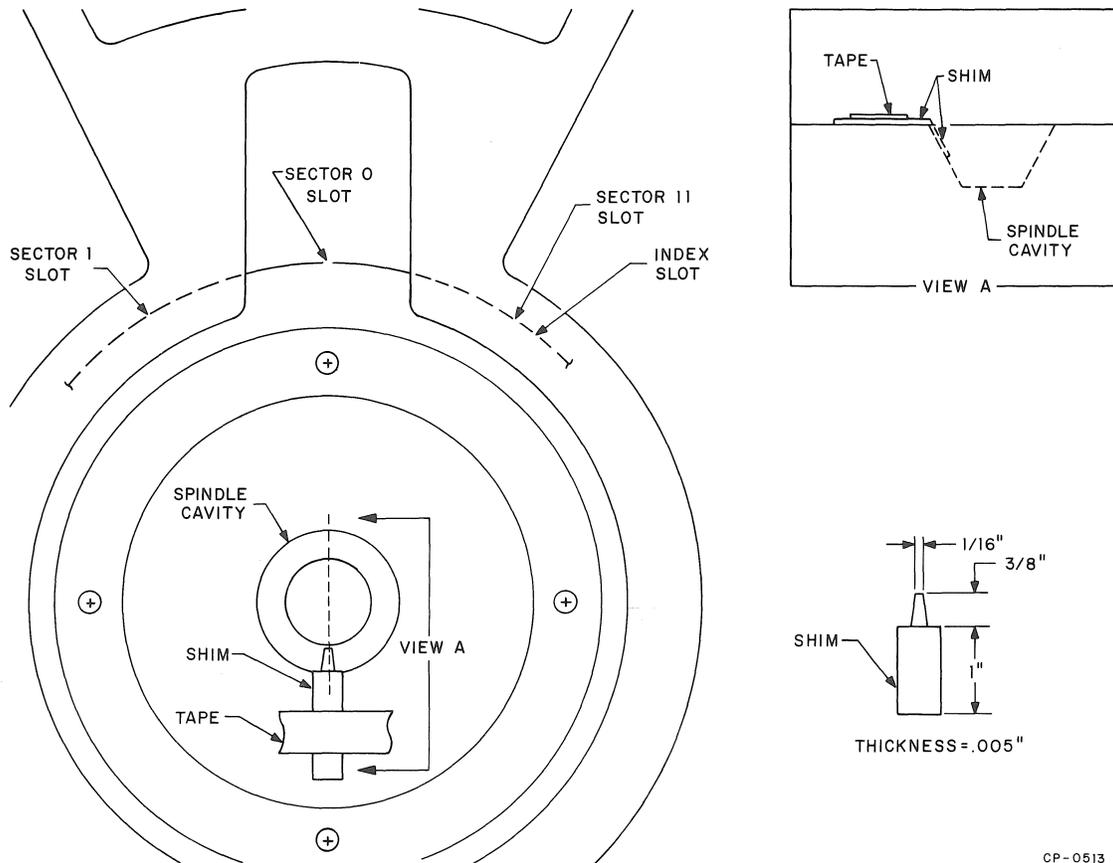
Before a 2315 CE test cartridge can be used for any RK05 alignment procedure, a .005-in. shim must be installed in the disk hub. Since the 2315 cartridge is recorded at low density and the RK05 uses a high density cartridge, this shim is required to accentuate the “wobble” of the low density cartridge and allow it to be used for high density alignments. To install the shim properly, trim a piece of .005-in. shim stock as indicated in Figure 5-10 and attach it to the disk hub as follows:

1. Locate sector 00 by holding the cartridge upside down and observing the sector slots in the metal lip of the disk hub (Figure 5-10). Rotate the disk clockwise inside the plastic case until two slots which are close together are found (sector 11 and index slots). Continue to rotate the disk clockwise, stopping at the next slot (sector 00).
2. Position the shim 180 degrees from the sector 00 slot. Ensure that the narrow portion of the shim is in the spindle cavity and that the shim does not reach the bottom of the cavity.
3. Tape the shim in position.

5.4.2 Servo System Timing Checks and Adjustments

The servo system timing adjustments are precisely set at the factory and they should not be routinely adjusted or “fine-tuned” as part of any PM procedure. If a positioner malfunction is suspected, first examine all waveforms relating to each phase of the servo operation, then diagnose the possible trouble before attempting any of the servo adjustments. Since some of the servo check tolerances differ from the adjustment tolerances, refer to the check tolerances in Table 5-3 prior to making an adjustment. **DO NOT ADJUST ANY SETTINGS THAT ARE WITHIN THE TOLERANCES LISTED IN THIS TABLE.**

For most malfunction cases, the positioner system will operate enough to allow dynamic measurements to be taken. However, if the positioner does not operate or operates very erratically, perform the static checks and adjustments described in Paragraph 5.4.2.2.



CP-0513

Figure 5-10 CE Test Cartridge Shim Installation

Table 5-3
Servo System Checks

Checks	Drive Configuration	Test Point	Tolerance	Reference
Sine Amplitude/ Offset	4 cyl osc seek	A05M1	$10 \pm 1V$ p-p, ground symmetrical within $\pm 10\%$	Fig. 5-11
Velocity Offset	4 cyl osc seek	A05M1	ground symmetrical within $\pm 10\%$	Fig. 5-11
Cosine Amplitude	4 cyl osc seek	A05S1	$10 \pm 1V$ p-p, ground symmetrical within $\pm 10\%$	Fig. 5-12
Velocity Amplitude	2 cyl osc seek	A05M1	center pulse dura- tion = $3.2 \pm .05$ ms	Fig. 5-13
Acceleration	64 cyl osc seek	A05H1	14 ms rise time	Fig. 5-14

Table 5-3 (Cont)
Servo System Checks

Checks	Drive Configuration	Test Point	Tolerance	Reference
Full Stroke Profile	202 cyl osc seek	A05H1	<90 ms waveform duration with plateau at trailing edge	Fig. 5-15
Full Stroke Position	202 cyl osc seek	A05M1	equal beginning & end amplitudes within 5%. <1V overshoot	Fig. 5-16
Outer Limit	rep RTZ	A05J1	3 to 3.5V amplitude. <0.3V plateau	Fig. 5-17

5.4.2.1 Dynamic Off-Line Checks and Adjustments – If on-line diagnostics or an RK05 Exerciser are not available to exercise the positioner, disconnect the RK05 from the interface bus and operate the drive off-line. In this operational mode, SECTOR pulses are jumpered to simulate STROBE pulses and a SECTOR ADDRESS line is jumpered to provide changing inputs to selected CYLINDER ADDRESS lines. These jumper installations permit oscillating seeks between cylinder 00 and any selected cylinder to be obtained.

To operate the drive off-line, proceed as follows:

1. Unplug the drive ac line cord to remove power.
2. Install an M930 terminator card in position 7 or 8 of the electronic module.
3. Set the address select switch on the M7700 card (card position 2) to the first switch position.
4. Select the drive by connecting a jumper from A08T1 (ground) to A08J2 (switch pos 1).
5. Reconnect the ac line cord to apply power to the drive and cycle the drive up to operating status.
6. Perform an off-line oscillating seek with the jumpers as follows:

NOTE

It is also possible to perform the following adjustments using the RK05 Exerciser or simple test programs.

- a. Connect a jumper from B08H1 (STROBE) to B08N2 (SECTOR PULSE).
- b. Determine the seek length by connecting A08P2 (SECTOR ADDRESS) to the desired points indicated in the following table.

NOTE

For seeks not listed in the table, connect A08P2 to the appropriate CYLINDER ADDRESS lines required for the seek.

Seek Length	Jumper Connections
2	A08D1
4	A08L1
64	A08E1
100	A08E1 A08J1 A08L1
105	A08E1 A08J1 A08C1 A08K1
202	A08H1 A08E1 A08C1 A08D1
Restore (RTZ)*	A08M1 (RESTORE) to A07T1 (or any available ground) B08H1 (STROBE) to B08M1 (INDEX)

*Connect only the points listed in the table

7. Unless otherwise indicated, set the oscilloscope controls (Tektronix 453 or equivalent) as follows:

- vertical
 - mode = channel 1
 - sensitivity = 2V/div
 - trigger = channel 1
 - coupling = dc

- sweep
 - A sweep
 - time = 10 ms/div
 - trigger = normal

- trigger
 - source = external*
 - coupling = ac
 - slope = +

*Connect the scope external trigger input to B05J2 (FWD H)

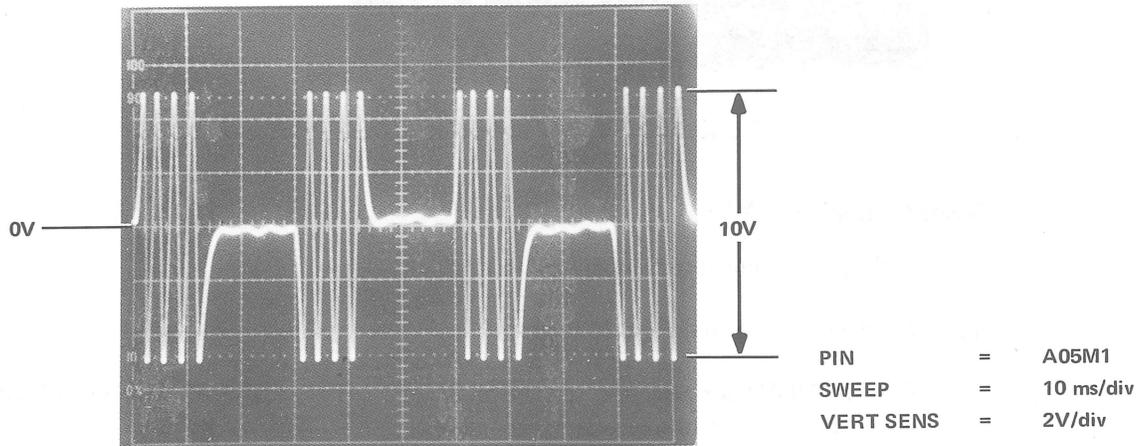
8. To avoid excessive scope control changes and to keep the probe test point changes to a minimum, perform the following checks and adjustments in the listed sequence.

Sine Amplitude (SA) and Offset (SO)

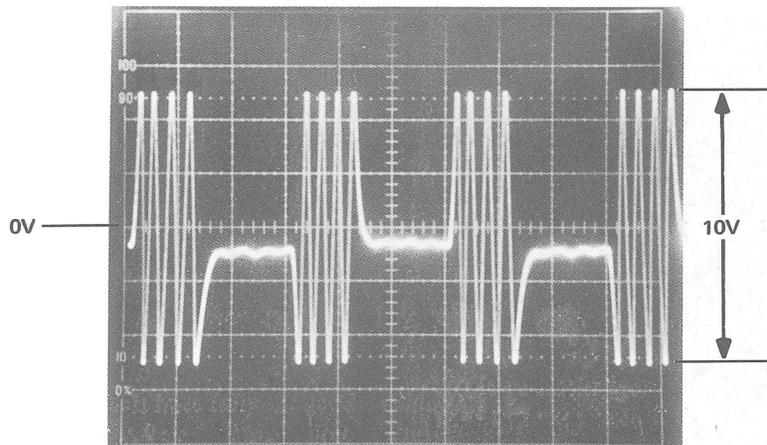
- Perform a 4 cylinder oscillating seek (Step 6).
- Observe A05M1 (SIN POSITION) for a scope display as illustrated in Figure 5-11a. The waveform amplitude must be $10 \pm 1V$ p-p and symmetrical about ground.
- If necessary, adjust SA (Table 5-4) for the correct amplitude and SO for the ground symmetry.

Velocity Offset (VO)

- Perform a 4 cylinder oscillating seek (Step 6).
- Observe that the voltage minimums at A05M1 (SIN POSITION) are symmetrical about ground (Figures 5-11a and 5-11b). A small amount of ripple at the minimum voltage levels is normal. To estimate the degree of symmetry, use the average value of the ripple as the voltage minimum.
- If necessary, adjust VO (Table 5-4) for the required symmetry.



a. Correct Waveform (Symmetrical Signal)



b. Incorrect Waveform (Signal not Symmetrical about Ground)

Figure 5-11 Sine Amplitude/Offset and Velocity Offset Waveform

Cosine Amplitude (CA) and Offset (CO)

- Perform a 4 cylinder oscillating seek (Step 6).
- Observe A05S1 (COS POSITION) for a scope display as illustrated in Figure 5-12. The waveform amplitude must be $10 \pm 1V$ p-p and symmetrical about ground.
- If necessary, adjust CA (Table 5-4) for the correct amplitude and CO for the ground symmetry.

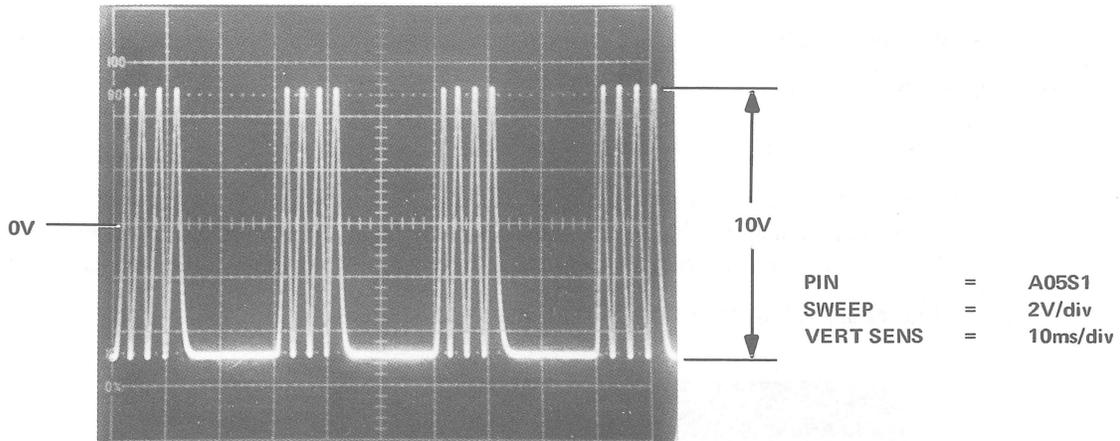


Figure 5-12 Cosine Amplitude/Offset Waveform

Velocity Amplitude (VA)

- Perform a 2 cylinder oscillating seek (Step 6).
- Set the scope sweep time to 1 ms/div.
- Observe A05M1 for a scope display as illustrated in Figure 5-13. The duration of the center cycle must equal $3.2 \pm .05$ ms.
- If necessary, adjust VA (Table 5-4) for the correct time.

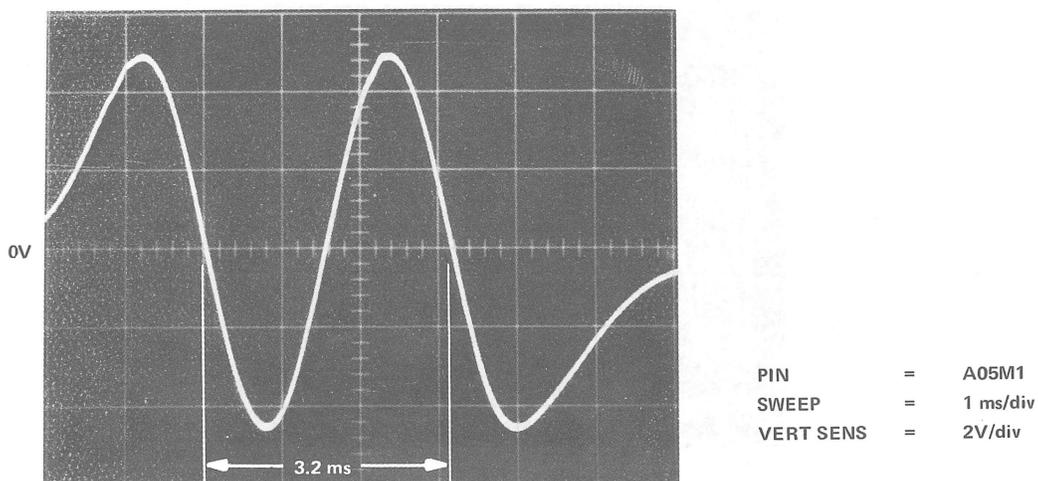


Figure 5-13 Velocity Amplitude Waveform

Acceleration (Positioner Current)

- Perform a 64 cylinder oscillating seek (Step 6).
- Set the scope sweep time to 5 ms/div and the vertical sensitivity to 0.5V/div.
- Observe A05H1 (VELOCITY) for a velocity profile as illustrated in Figure 5-14.
- If necessary, adjust R15 (on H604) for a 14 ms rise time.

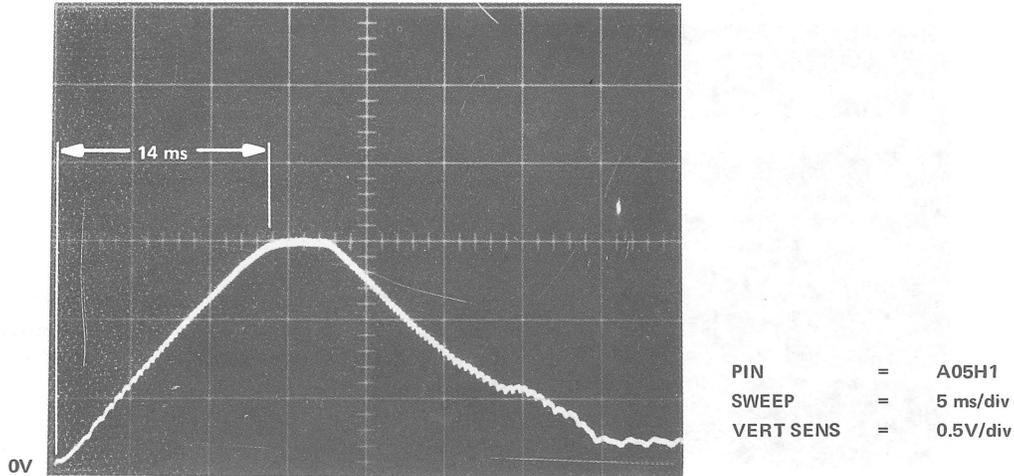


Figure 5-14 Acceleration Waveform

Full Stroke Profile

- Perform a 202 cylinder oscillating seek (Step 6).
- Set the scope sweep time to 10 ms/div and the vertical sensitivity to 0.5V/div.
- Observe A05H1 (VELOCITY) for a scope display as illustrated in Figure 5-15. The 0V level of the profile must be reached in less than 90 ms from the start of the seek. In addition, there must be a definite plateau (constant voltage level) at the end of the seek. If this is not the case, recheck the Velocity Amplitude (VA) and the Acceleration (Positioner Current). Adjust the appropriate potentiometer (Table 5-4) as required to obtain the correct waveform.

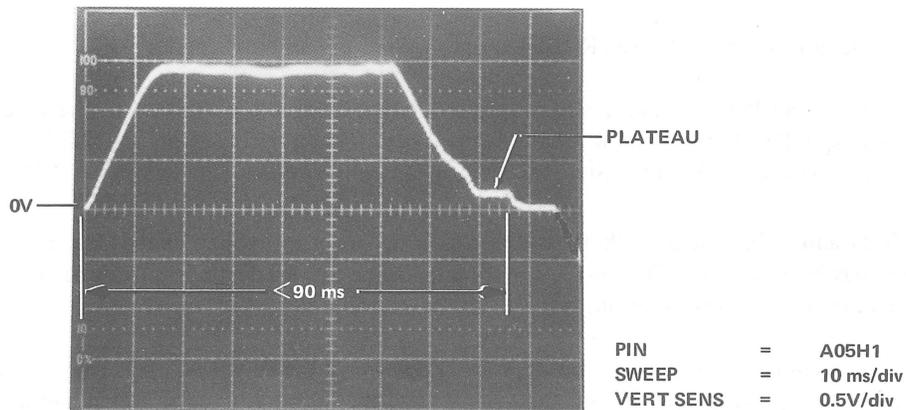


Figure 5-15 Full Stroke Waveform

Full Stroke Position Waveform

- a. Maintain the same configuration as the Full Stroke Profile.
- b. Set the scope vertical sensitivity to 2V/div and observe A05M1 (SIN POSITION) for a scope display as illustrated in Figure 5-16. The waveform amplitudes at the start and end of the seek must be equal within 5% and the overshoot at the end of the seek must not exceed 1V.

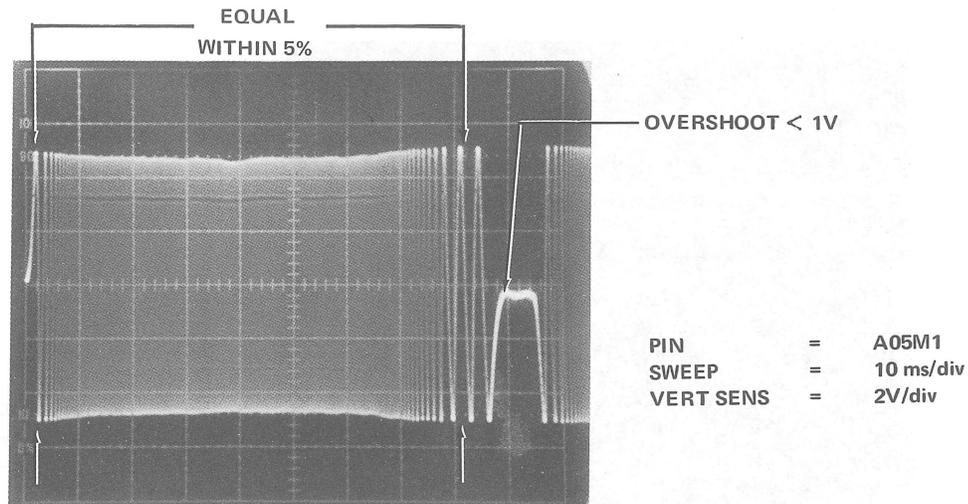


Figure 5-16 Full Stroke Position Waveform

Outer Limit (dynamic test)

- a. Perform a repetitive restore operation (Step 6).
- b. Trigger the scope from B05K2 (REV H).
- c. Set the scope vertical sensitivity to 1V/div and observe A05J1 (LIMIT) for a scope display as illustrated in Figure 5-17. The waveform peak amplitude must be 3 to 3.5V with a minimum level of 0V. In addition, the voltage plateau immediately following the trailing edge must not exceed 0.3V. If not, perform the Static Limit Adjustment procedure (Paragraph 5.4.2.2).
- d. Disconnect the B08H1 (STROBE) jumper to halt the repetitive restore.
- e. Check the INNER LIMIT signal by physically moving the positioner to the inner limit (towards the spindle). If the INNER LIMIT signal is operative, a restore operation will be initiated. If this is not the case, perform the Static Limit Adjustment procedure (Paragraph 5.4.2.2).

5.4.2.2 Static Tests and Adjustments – Perform the following procedure when the positioner or a major servo system component has been replaced. This procedure should also be followed as a diagnostic aid when the positioner system is inoperative or unstable in operation.

To make the required adjustments, remove the disk cartridge from the drive and physically move the positioner carriage back and forth while observing the selected signal. Use the automatic scope sweep and do not attempt to sync the sweep to the observed signal. With a little practice, the most convenient sweep speed setting and the type of positioner motion required will quickly be discovered.

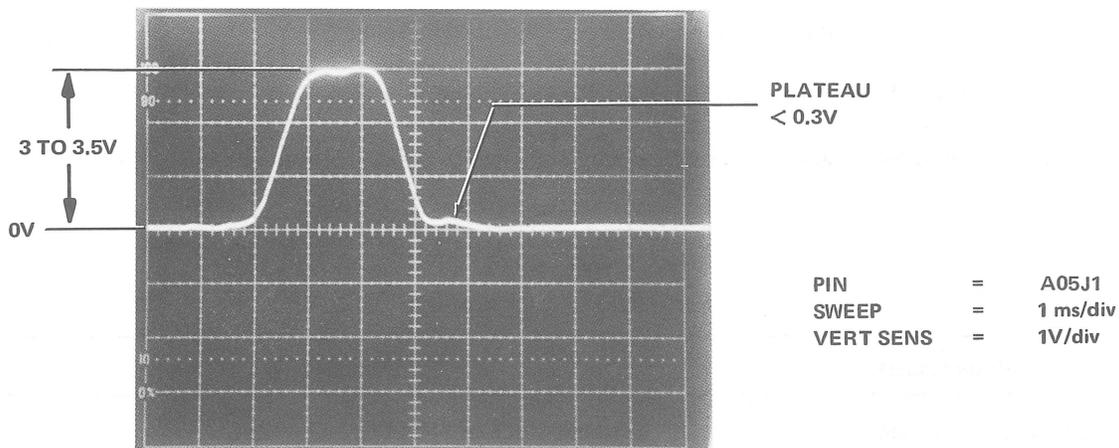


Figure 5-17 Outer Limit Waveform

To make the static adjustments, proceed as follows:

1. Do not install a disk cartridge in the drive.
2. Place switch S1 (on H604) in the down or off position.
3. Make the following checks and adjustments.

Sine Amplitude (SA) and Offset (SO)

- a. Set the scope vertical sensitivity to 2V/div and adjust the ground reference to the center of the scope screen.
- b. Observe A05M1 (SIN POSITION) while manually moving the positioner back and forth. Adjust SA (Table 5-4) for a 10V p-p signal amplitude.
- c. Adjust SO until the signal is symmetrical about ground.

Cosine Amplitude (CA) and Offset (CO)

Observe A05S1 and adjust CA and CO (Table 5-4) in the same manner as the preceding Sine procedure.

Limit Signal Amplitude (LSA) and Offset (LSO)

- a. Set the scope vertical sensitivity to 1V/div and adjust the ground reference to the center of the scope screen.
- b. Observe A05J1 with the positioner stationary at approximately the center of travel. Adjust LSO (Table 5-4) for a ground signal at the center of the scope screen.
- c. Move the positioner to the inner limit and observe the voltage change on the scope. Similarly, move the positioner to the outer limit and observe the voltage change.

- d. Adjust LSA until the smaller voltage level obtained in Step c is 3.0V.
- e. Return the positioner to the center of travel and readjust LSO for 0V.
- f. Repeat Step c and, if necessary, readjust the smaller voltage level to 3.0V.

Table 5-4
Servo System Adjustments

Potentiometer*	Function
SA (Sine Amplitude)	Sets amplitude of SIN POSITION signal
SO (Sine Offset)	Adjusts SIN POSITION symmetry about ground
CA (Cosine Amplitude)	Sets amplitude of COS POSITION signal
CO (Cosine Offset)	Adjusts COS POSITION symmetry about ground
VO (Velocity Offset)	Adjusts velocity generator output at zero velocity. (Provides offset control to position loop.)
LSA (Limit Signal Amplitude)	Simultaneously adjusts amplitude of both Limit signals before digitizing
LSO (Limit Signal Offset)	Sets zero level of Limit signal with positioner in normal recording area of disk
CURRENT (on H604)	Sets maximum positioner current (determines acceleration)

*Potentiometers are located on the G938 card (card position 5) of the electronic module. Remove the prefilter at the rear of the drive to gain access to these potentiometers.

5.4.3 Read/Write Data Separator (G180 Card) Adjustment

Adjustment of the data separator is not part of the normal maintenance and therefore is not recommended unless a G180 component that effects the data separator section has been replaced. If this occurs, set the width of the data window as follows:

NOTE

R13 is the write current adjustment potentiometer and should not be adjusted in the field.

1. Install a prerecorded cartridge in the drive.
2. Place the drive in the run mode and manually position the heads at any recorded cylinder. An all ZERO data recording is preferable; however, any recorded pattern is sufficient.

3. Set the oscilloscope controls as follows:

- vertical
 - mode = channel 1
 - sensitivity = 1V/div
 - trigger = channel 1
 - coupling = dc

- sweep
 - A sweep
 - time = 100 ns/div
 - trigger = normal

- trigger
 - source = internal
 - coupling = ac
 - slope = +

4. Connect the channel 1 scope probe to TP1 of the G180 card (card position 1). It should be possible to obtain solid scope synchronization at the sweep start. (Disregard the unsynchronized pulses that follow.)
5. Adjust R55 counterclockwise until no further increase in pulse width is observed.
6. Adjust R54 to obtain a 500-ns pulse width as measured from the start of the rise to the start of the fall.
7. Readjust R55 clockwise until the pulse width decreases to 420 ns as measured from the start of the rise to the start of the fall.

5.4.4 Index/Sector Timing Adjustment

1. Unplug the drive ac line cord to remove power.
2. Disconnect the drive interface cable card from the electronic module and install an M930 terminator card in its place.
3. Reconnect the ac line cord to apply power to the drive and cycle the drive up to operating status.
4. Install a 2315 CE test cartridge on the spindle and operate the drive in the run mode for at least 30 minutes. This must be done to allow the CE cartridge and the drive components to achieve thermal stabilization.
5. Using the WR PROT switch, place the drive in the write protect condition.
6. Set the oscilloscope controls as follows:

- vertical
 - mode = ADD (invert CHAN 2)
 - sensitivity = 0.2V/div
 - coupling = dc

- sweep
 - A sweep
 - time = 10 ms/div
 - trigger = normal

- trigger
 - source = external*
 - coupling = ac
 - slope = -

*Use a 1:1 probe to connect the scope external trigger input to A02R2 (INDEX).

7. Connect the channel 1 probe to TP3 and the channel 2 probe to TP4 of the G180 card. (Use 10:1 probes.)
8. Ensure that the positioner track scale indicates cylinder 00.
9. Select cylinder 100 with jumpers as follows:

NOTE

It is also possible to perform the following adjustments using the RK05 Exerciser or simple test programs.

- a. Connect backboard jumpers from A07T1, A07C2, or any available ground pins to the following points:

A08E1	CYL ADD 6 (64)
A08C1	CYL ADD 5 (32)
A08L1	CYL ADD 2 (4)
	100
A04V1	SEL/RDY L

- b. Connect a jumper from B08H1 (STROBE) to B08N2 (SECTOR PULSE). The positioner should move to cylinder 100. Confirm this by observing the track scale indicator.
10. Monitor the scope for a single pulse followed by a 1 ms burst of data.
11. Expand the sweep time to 10 μ s/div and check that the single pulse occurs 70 \pm 10 μ s from the start of the sweep (Figure 5-18).
12. Ground B08M2 to select the upper head and check for the same pulse tolerances as Step 11. If necessary, adjust R6 on the M7700 card (card position 2) until the average time for the two pulses is 70 μ s and the 70 \pm 10 μ s individual pulse requirement is maintained.

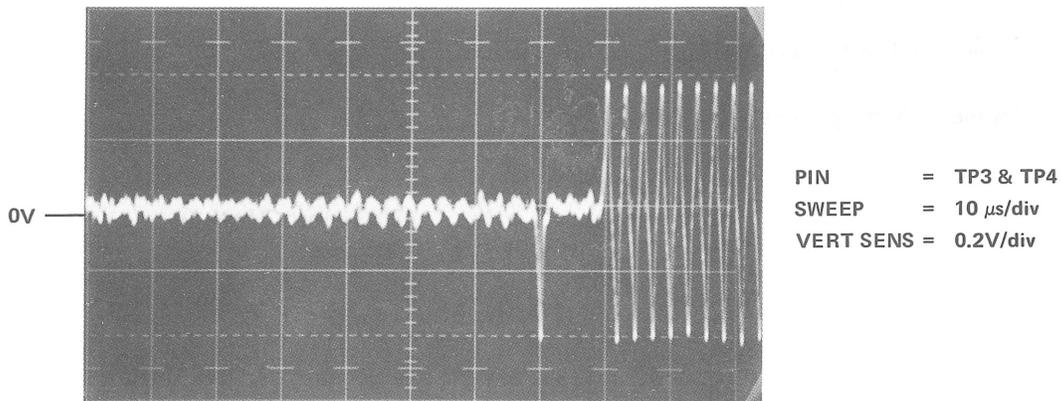


Figure 5-18 Index/Sector Waveform

5.4.5 Read/Write Head Check and Alignment

The following procedure describes the complete read/write head alignment. Before attempting this alignment procedure, ensure that the drive operates correctly and that the heads have not been contaminated by exposure to a defective cartridge. If new heads have been installed, it is recommended that this alignment procedure be performed off-line using backboard jumpers to move the positioner to the alignment cylinder. Off-line alignment is strongly recommended because of the ease of returning to the alignment cylinder whenever the positioner has been physically moved. However, simple maintenance routines or an RK05 Exerciser may also be used to move the positioner.

For a simple check of the head alignment, the appropriate on-line diagnostics may be used; however, **DO NOT ADJUST A HEAD THAT HAS LESS THAN A 50% ERROR** (Figure 5-19).

To align or check the heads proceed as follows:

1. Unplug the drive ac line cord to remove power.
2. Disconnect the drive interface cable card from the electronic module and install an M930 terminator card in its place.
3. Reconnect the ac line cord to apply power to the drive and cycle the drive up to operating status.
4. Install a 2315 CE test cartridge on the spindle and operate the drive in the run mode for at least 30 minutes. This must be done to allow the CE cartridge and the drive components to achieve thermal stabilization.
5. Using the WT PROT switch, place the drive in the write protect condition.
6. Set the oscilloscope controls as follows:

- vertical
 - mode = ADD (invert CHAN 2)
 - sensitivity = 20 mV/div
 - coupling = dc
- sweep
 - A sweep
 - time = 10 ms/div
 - trigger = normal
- trigger
 - source = external*
 - coupling = ac

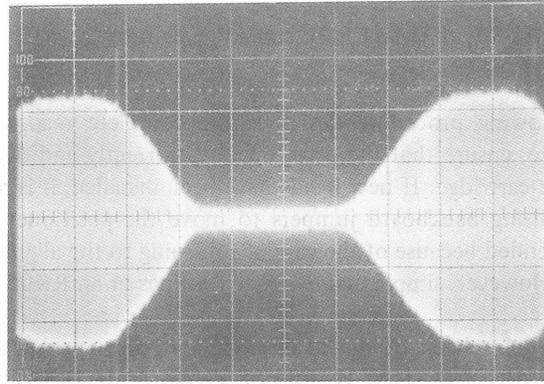
*Use a 1:1 probe to connect the scope external trigger input to A02R2 (INDEX).

7. Connect the channel 1 probe to TP3 and the channel 2 probe to TP4 of the G180 card. (Use 10:1 probes.)
8. Ensure that the positioner track scale indicates cylinder 00.

(continued on page 5-34)

a. Out of Sight

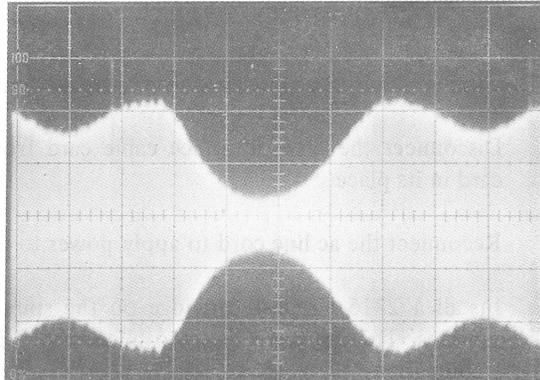
Large misalignment. Head close to CYL 104.
(Further misalignment only reduces amplitude of peaks.)



b. Way Out

Head considerably misaligned. Smaller left null indicates head position less than CYL 105.

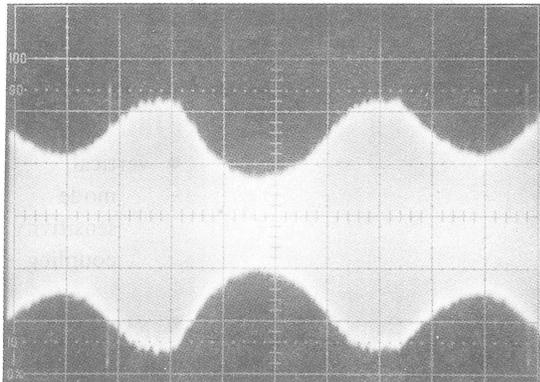
error = -60%



c. Far Out

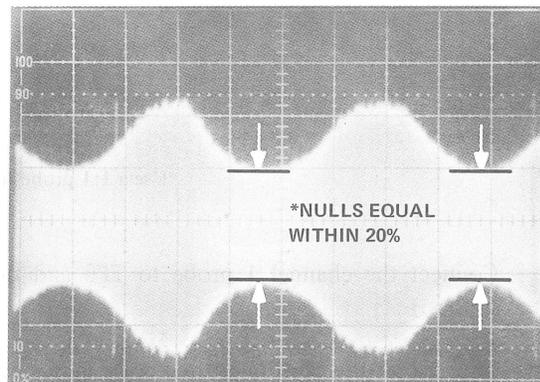
Head slightly misaligned. Smaller left null indicates head position less than CYL 105.

error = -33%



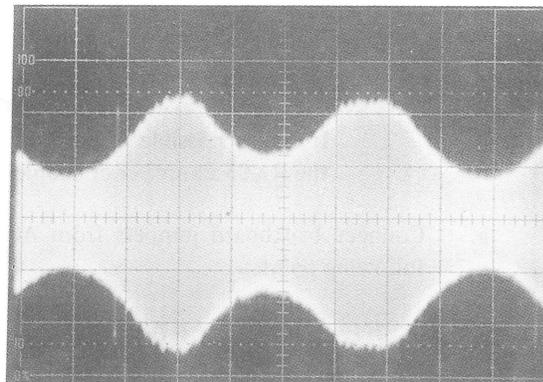
d. Right On

Head correctly aligned at CYL 105. Null amplitudes are equal.



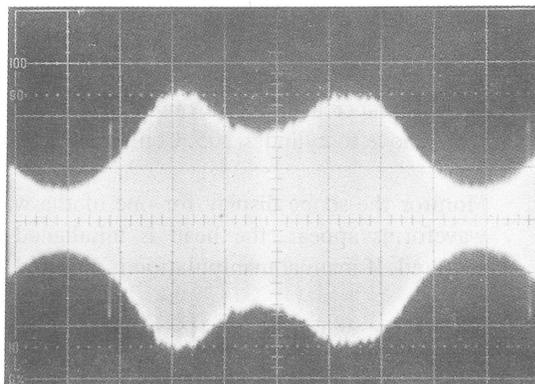
e. Up Tight

Head slightly misaligned. Larger left null indicates head position more than CYL 105.
error = +26%



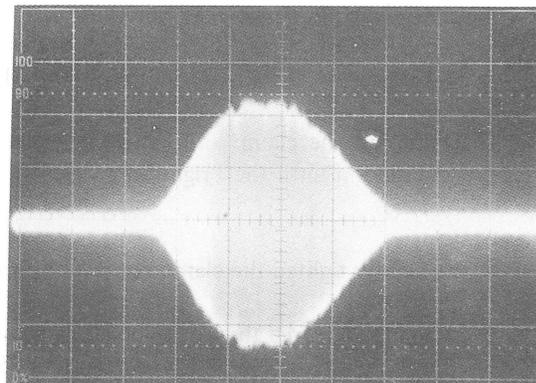
f. Gross

Head considerably misaligned. Larger left null indicates head position more than CYL 105.
error = +71%



g. Gross Out

Large misalignment. Head close to CYL 106.
(Further misalignment only reduces amplitude of peak.)



*To calculate % of error, use the following formula:

$$\% \text{ error} = \frac{x_1 - x_2}{x_1 + x_2} \times 100$$

x = null amplitudes and the resultant sign denotes the direction of error. A negative (-) sign indicates that the head is back too far.

Figure 5-19 Head Alignment Waveforms

9. Select cylinder 105 as follows:

NOTE

It is also possible to perform the following adjustments using the RK05 Exerciser or simple maintenance routines.

- a. Connect backboard jumpers from A07T1, A07C2, B07T1 or any available ground pins to the following points:

A08E1	CYL ADD 6 (64)
A08J1	CYL ADD 5 (32)
A08C1	CYL ADD 3 (8)
A08K1	CYL ADD 1 (1)
	105
A04V1	SEL/RDY L

- b. Connect a jumper from B08H1 (STROBE) to B08N2 (SECTOR PULSE). The positioner should move to cylinder 105. Confirm this by observing the track scale indicator.
10. Monitor the scope display for one of the waveforms illustrated in Figure 5-19. If none of the illustrated waveforms appear, the head is misaligned so badly that manual manipulation of the positioner is required. If manual manipulation is required, perform the following steps; if not, proceed to Step 11.
- a. Place switch S1 (on H604) in the down or off position.
- b. Slowly move the positioner by hand until the alignment pattern occurs. Since cylinder 110 has an identical pattern, be sure that the displayed pattern is for cylinder 105.
- c. Observe the track scale and note the cylinder indication when the "right on" waveform (Figure 5-18) is obtained. If the scale indicates less than 105, the head is too far forward in the carriage. Conversely, if the scale indicates more than 105, the head is back too far in the carriage.
- d. Loosen the clamp and adjustment screws (Figure 5-20) and move the head in the appropriate direction until the "right on" waveform is obtained and the scale indication is slightly greater than 105.
- e. Lightly tighten the clamp screw and turn on the positioner power (S1 up).
- f. Manually force the positioner fully forward to initiate a restore (RTZ) operation. The positioner will automatically return to cylinder 105 following the RTZ.
11. If one of the illustrated waveforms is present, note the direction in which the head must be moved to obtain the "right on" indication. If the head must be moved backward, loosen the head clamp and adjustment screws and gently push the head all the way back into the carriage. If the head must be moved forward, loosen only the clamp screw, then turn the adjustment screw until the correct waveform is obtained. (The adjustment screw is a vernier which only moves the head forward and should not be left torqued down after this adjustment.)

NOTE

If the positioner is moved from cylinder 105 during the adjustment procedure, manually force the positioner fully forward to initiate a restore (RTZ) operation. The positioner will automatically return to cylinder 105 following the RTZ.

12. Ground B08M2 to select the upper head and repeat the preceding steps.
13. If available, use a torque wrench (C-IA-9605893-0-0) and tighten the head clamp screw until the wrench begins to ratchet (55 oz/in.). If a torque wrench is not available, use the appropriate Allen wrench to tighten the head clamp screw snugly, however, do not over tighten.
14. Recheck to ensure that the clamping action did not disturb the head adjustment.

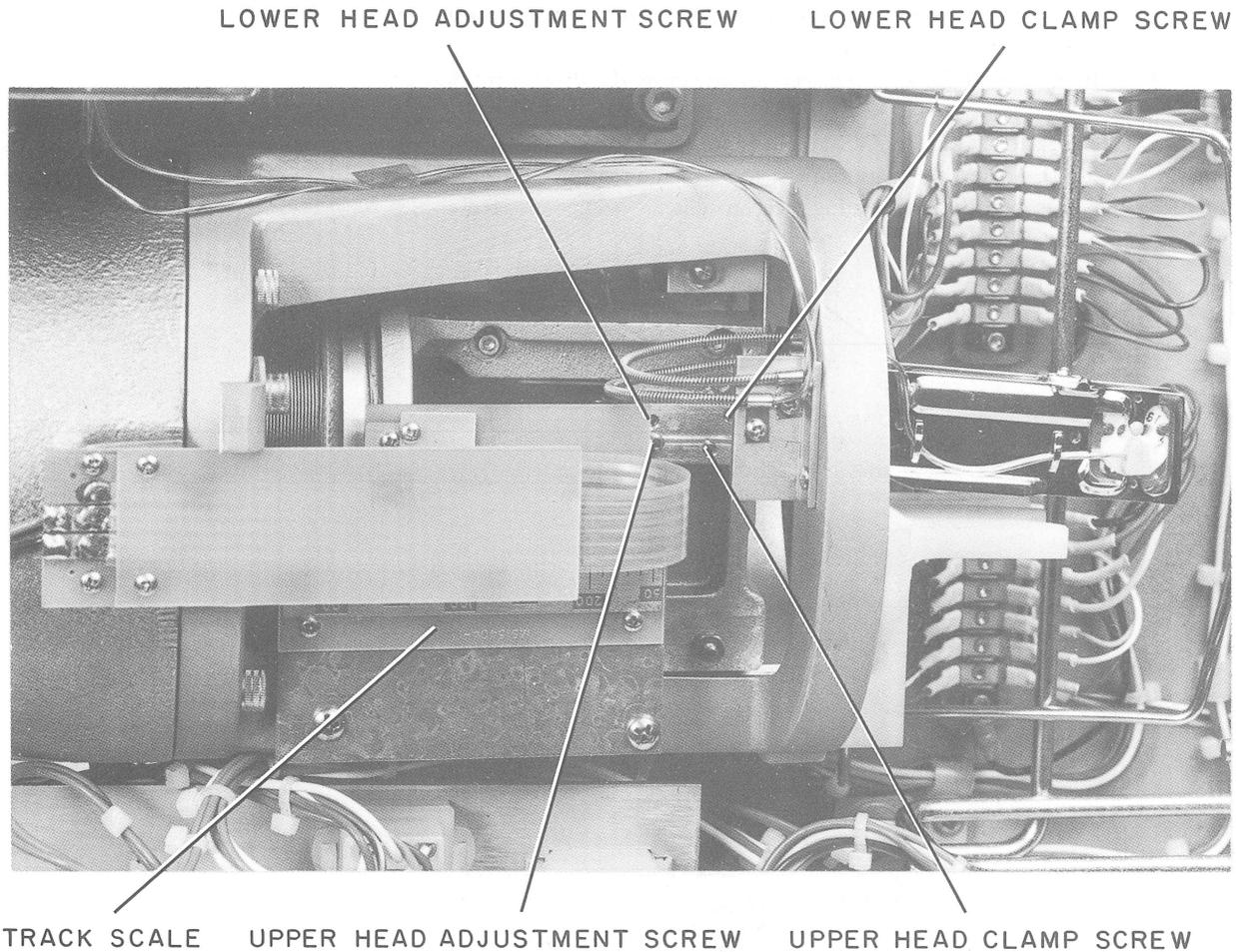


Figure 5-20 Read/Write Head Adjustments

5.4.6 Cartridge Receiver Alignment

Prior to shipment of the RK05 Disk Drive, the cartridge receiver is precisely aligned at the factory. Since it is not necessary to disturb the receiver alignment when performing any of the field maintenance procedures, cartridge receiver alignment is therefore not normally required in the field. However, if the duckbill, airduct, or cartridge support post are replaced, the cartridge receiver alignment must be checked. In addition, the Cartridge-On switch should also be checked for proper operation.

NOTE

The duckbill on later model drives is slightly different than the earlier models. If an earlier version duckbill is replaced with the later version, the airduct and cartridge support posts must also be replaced. Refer to the *RK05 Illustrated Parts Manual* (DEC-RK05-IPB-1) to identify which duckbill version is being replaced.

1. Slide the drive out of the rack and remove the top and bottom covers.
2. Insert a cartridge into the receiver and close the drive front door.
3. Check for a .020 to .040 in. clearance (A) between the plastic cartridge case and the receiver rails (Figure 5-21). Make this measurement towards the rear of the receiver at a point where the plastic cartridge case passes over the intersecting receiver rails.

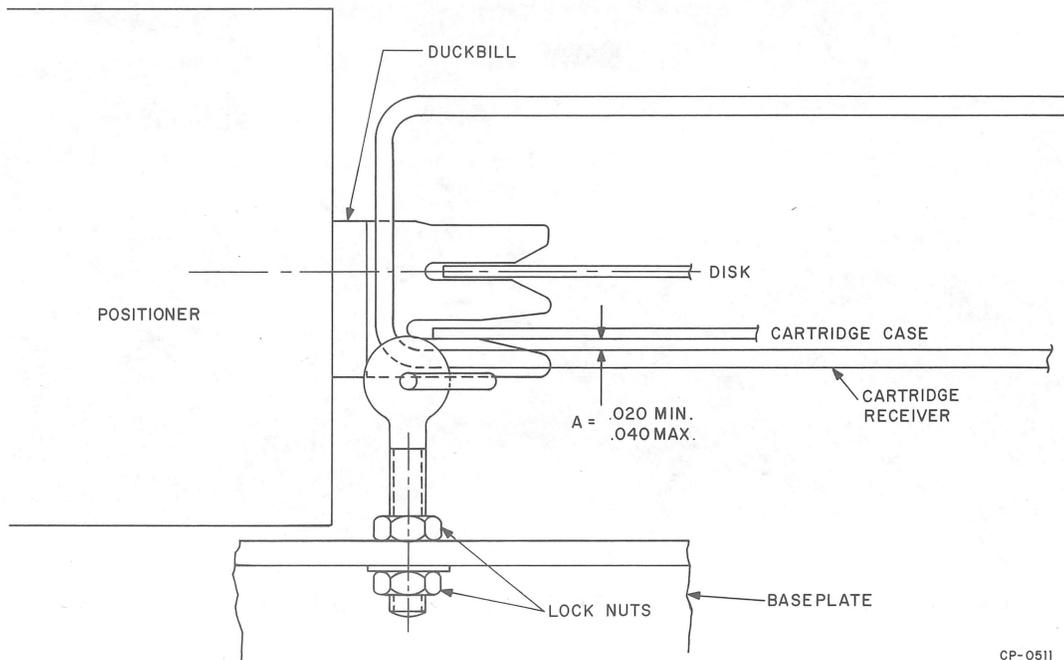


Figure 5-21 Cartridge to Receiver Clearance

4. If the (A) clearance is incorrect, loosen the pivot post lock nuts and adjust the height of both posts to obtain the proper clearance.
5. Lightly tighten the pivot post lock nuts and check the following (Figure 5-22):
 - a. Remove the cartridge and ensure that the clearances (B) between the upper receiver rails and the cartridge channel are equal, and that the receiver rails are as parallel as possible to the channel.

- b. Push the receiver all the way to one side and ensure that there is a slight clearance (C) of .010 to .040 in. between the pivot post and the receiver hinge rail. When making this check, do not push the receiver so hard that the pivot posts twist.
 - c. Push the receiver to the left and right and ensure that the front receiver rail does not touch either side of the chassis.
 6. Tighten the pivot post lock nuts and recheck all clearances. There must be a clearance at points A, B, and C; however, it is especially critical that clearances A and C do not exceed the limits.

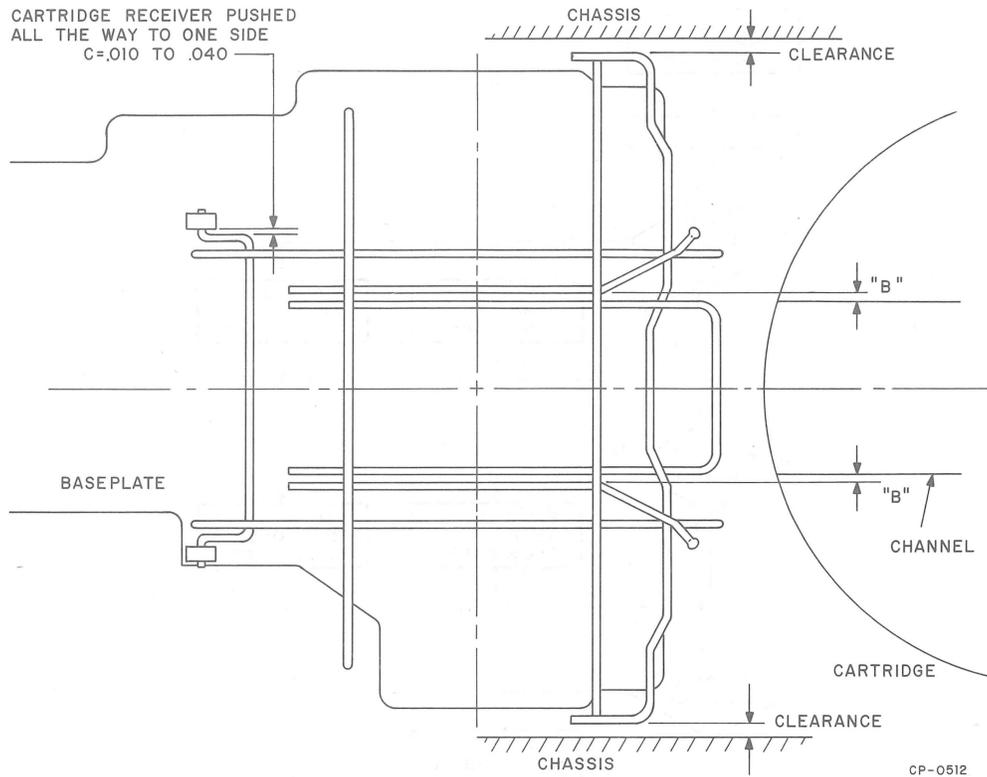


Figure 5-22 Cartridge Receiver Clearances

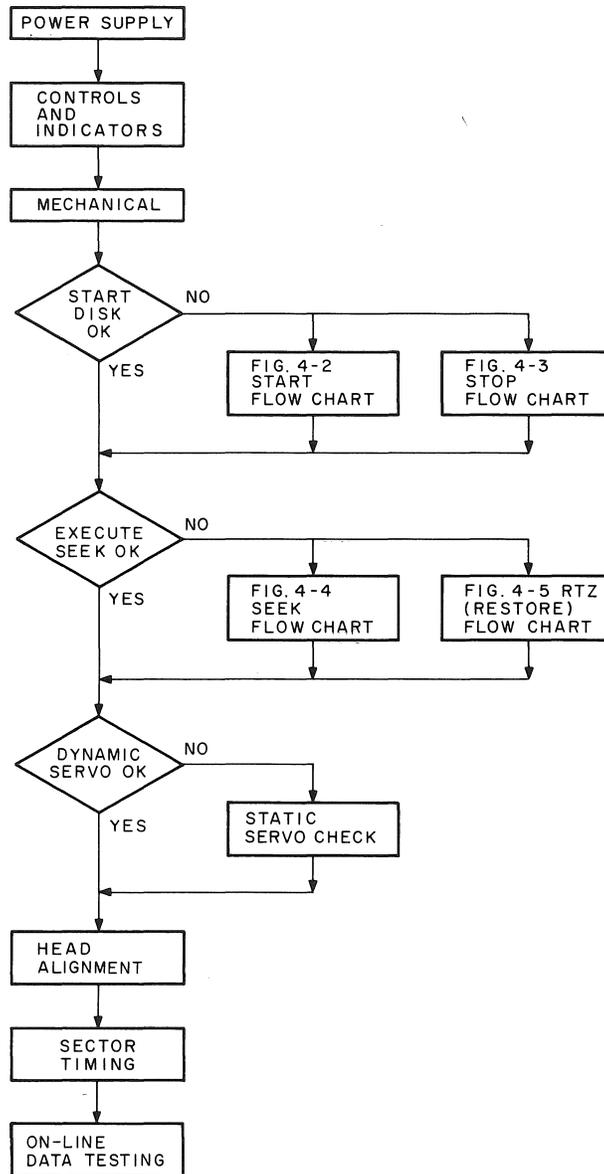
5.5 SPARE PARTS

Refer to the *RK05 Illustrated Parts Manual* (DEC-RK05-IPB-1) and the *H743 Power Supply Illustrated Parts Manual* (DEC-H743-IPB-1) for parts identification.

5.6 TROUBLESHOOTING

The information in this paragraph will aid the service technician in isolating a failing drive component. This information is intended only as a guide during trouble analysis and does not cover all possible malfunctions of a designated area. To eliminate correctly functioning areas of the drive and arrive at the area of failure, perform the checks described in Paragraphs 5.6.1 through 5.6.4. A basic knowledge of electronics, primary understanding of DEC logic, and logical deductive reasoning must then be employed to locate faulty components within the area of failure. Figure 5-23 is a quick reference flow chart which illustrates the checks that are described in detail in the following paragraphs.

Once the malfunction is diagnosed, corrective maintenance should be accomplished largely through module swapping. The term module includes those modules listed in the UML (Dwg. No. RK05-0-2) plus: the linear positioner, the +5 Vdc regulator, the ± 15 Vdc regulators and the H604 Servo Power Amplifier. Failures not attributable to these modules must be repaired at the faulty component level. If module replacement cannot be accomplished within a practical time period, repair of the defective modules should be undertaken, with the exception of a defective linear positioner. In all cases, return a defective linear positioner to Digital Equipment Corporation, Maynard, Mass.



CP-0533

Figure 5-23 Troubleshooting Flow Chart

5.6.1 Power Supply

1. Open the rear door of the rack and unplug the drive ac line cord.
2. Extend the drive fully on the slides and remove the top cover.
3. Disconnect P1 (Figure 5-3) from the power supply chassis.
4. Apply power to the drive and check J1 for the following voltages:
 - a. pin 1 = $+15 \pm 0.75$ Vdc
 - b. pin 2 = -15 ± 0.75 Vdc
 - c. pin 3 = $+5 \pm 0.15$ Vdc
5. Remove power from the drive and check for shorts between buses.
 - a. AT1, BT1 = GND
 - b. AA2, BA2 = $+5$ Vdc
 - c. AD2, BD2 = $+15$ Vdc
 - d. AB2, BB2 = -15 Vdc
6. Reconnect P1 and apply power to the drive.
7. Measure the $+5$, $+15$, and -15 Vdc at the buses as indicated in Step 5. The tolerances should be the same as Step 4.
8. Check for approximately 30 Vac at A04E1.
9. Remove power from the drive.

5.6.2 Controls and Indicators

1. Check that all modules are present and in their correct locations (Dwg. No. RK05-0-2).
2. Apply power to the drive and check that:
 - a. the PWR and LOAD indicators are lit and that the WT and RD indicators are off. (WT and RD can be checked while formatting a tape during the diagnostic exercise.)
 - b. the door unlocking solenoid is energized.
 - c. the blower is operating.
3. Press the WT PROT switch and check that the WT PROT indicator lights. (The drive should power-up with WT PROT off.)

5.6.3 Mechanical Checks

1. Install a test cartridge in the drive.
2. Open the rear door of the rack and unplug the drive ac line cord.
3. Extend the drive fully on the slides and remove the bottom covers.

4. Tape the door locking bar (located behind the front bezel) in the down position (Figure 5-24). This permits the drive front door to be opened and shut without power being applied.

CAUTION

Do not attempt to cycle up the drive with the locking bar disabled.

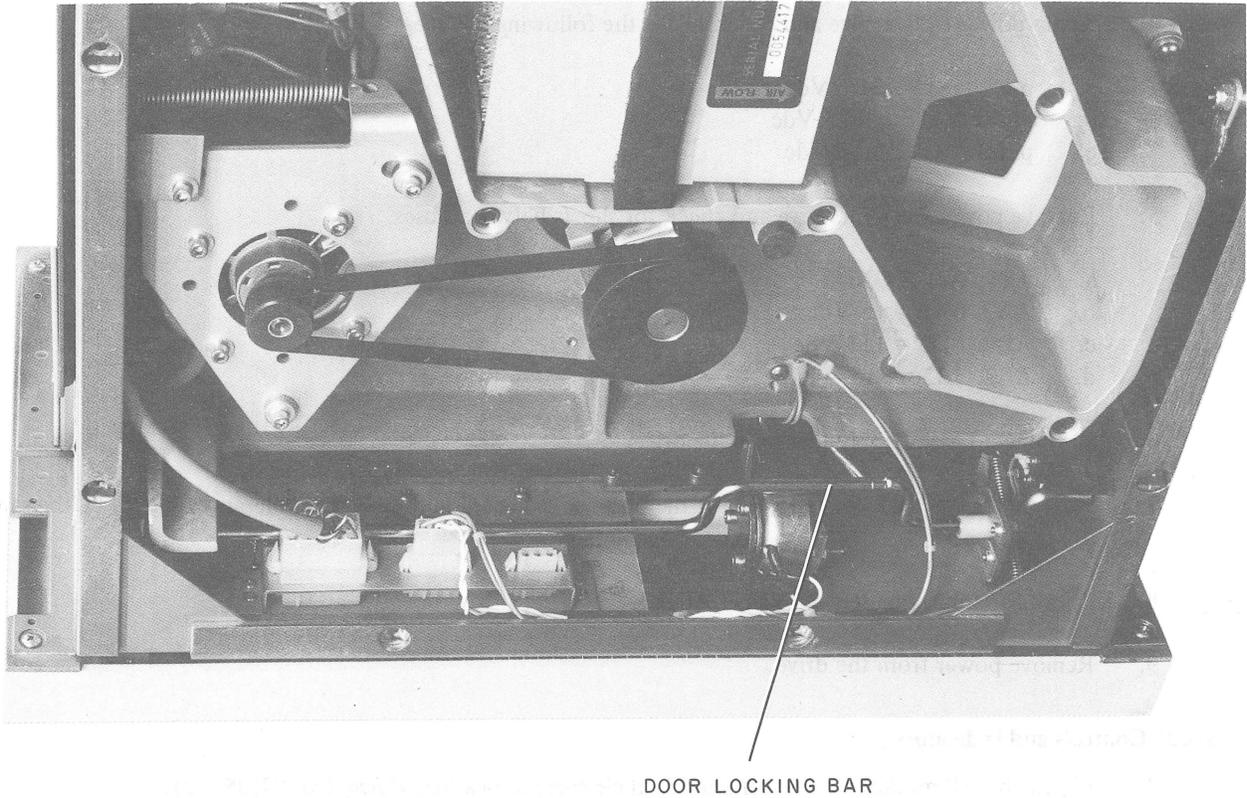


Figure 5-24 Door Locking Bar Location

5. Check the following to ensure that the cartridge is seated properly.
 - a. Ensure that there is a clearance between the lip on the metal disk hub and the sector transducer slot (Figure 5-25).
 - b. The airduct foam seal fits snugly to the bottom of the cartridge case.
 - c. The cartridge case rests securely on the front cartridge support posts. (No gaps between the cartridge case and the support post shoulders.)
6. Rotate the spindle pulley by hand and check that:
 - a. the disk surface does not touch the duckbill
 - b. there is no scrapping or rubbing sound within the drive
 - c. the drive belt is not stretched or worn.

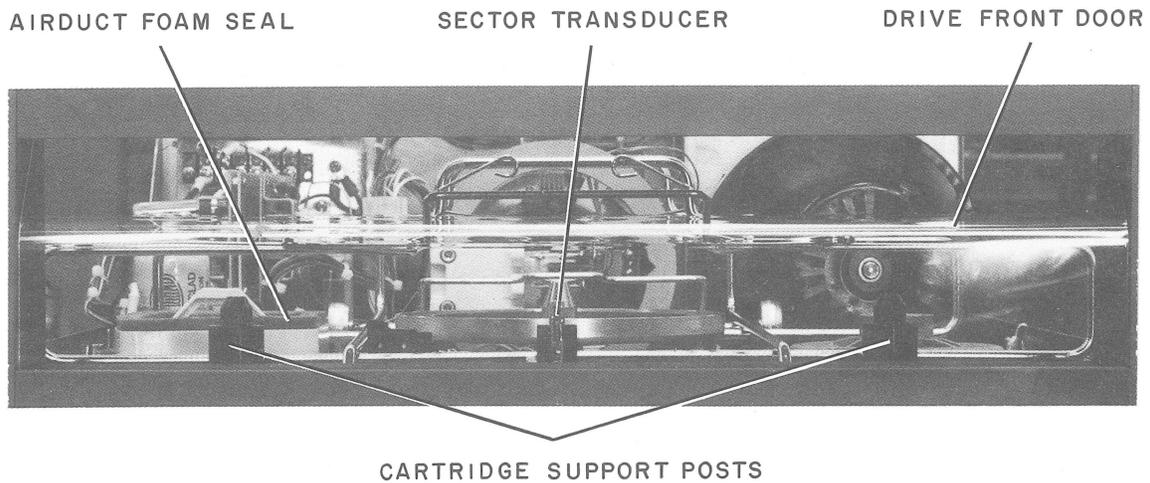


Figure 5-25 Cartridge Seating Elements

7. Remove the tape from the door locking bar, apply power to the drive, place the RUN/LOAD switch in the RUN position, and check that:
 - a. the PWR indicator is lit
 - b. the disk is rotating and there is still no rubbing sound from within the drive
 - c. after approximately 8 seconds, the heads load
 - d. the RDY and ON CYL indicators are lit.
8. Remove power from the drive.

5.6.4 Electronic Checks

1. If possible, perform the dynamic Off-Line Servo System Timing Checks (Paragraph 5.4.2.1). If the drive does not operate well enough to accomplish the dynamic servo timing checks, perform the Static Tests and Adjustments (Paragraph 5.4.2.2).

NOTE

When attempting the preceding checks, if the drive does not start or stop correctly, refer to Figure 4-2 (Start Flow Chart) or Figure 4-3 (Stop Flow Chart) for areas of possible malfunction. If the drive starts properly but does not execute a Seek or Restore command correctly, refer to Figure 4-4 (Seek Flow Chart) or Figure 4-5 (Restore Flow Chart).

2. Verify that the heads are aligned correctly (Paragraph 5.4.5).
3. Check the Index/Sector Timing (Paragraph 5.4.4).
4. Remove all jumpers and configure the drive for normal operation.
5. Run the appropriate diagnostic tests to exercise the remaining portions of the drive.

READER'S COMMENTS

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DEC-00-RK05-DB**

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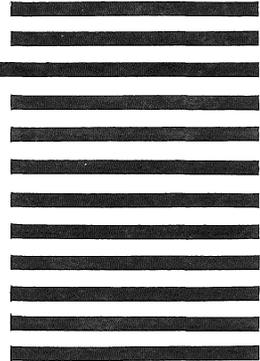
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