EVOTEK

OEM MANUAL

ET-5000
FAMILY

August 1982
Publication NO. 100198

PREFACE

CHANGE INFORMATION

The EVOTEK ET-5000 Family of 5¼-inch Winchester disk drives is constantly being improved. A replacement part on a newer drive may not be the same as the part used in the original installation, but all parts with a common part number are directly interchangeable. If a specification in this manual differs from one in an earlier source, disregard the earlier specification.

REPRODUCTION OF MANUAL

Neither this manual nor the information contained herein shall be disclosed to others for purposes not related to interfacing or installation. Disclosure of this information for manufacturing purposes is specifically forbidden.

WARRANTY

All EVOTEK products are warranted against defects in material and workmanship. The period of coverage and other warranty details are clearly specified in the EVOTEK purchase agreement. Check this purchase agreement for exact warranty details.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

LIST OF ILLUSTRATIONS

LIST OF TABLES

Section 1

GENERAL INFORMATION

1.1 PURPOSE OF MANUAL

This manual contains interfacing, installation, and maintenance information for the EVOTEK ET-5000 Family of 5¼-inch Winchester disk drives. It is intended to provide hardware and systems engineers with the information necessary to attach an EVOTEK drive to a system. In addition to interface information, the theory of operations section describes design details and operational characteristics to provide the user with an overview of the internal functioning of the drive.

1.2 OVERVIEW

The EVOTEK ET-5000 Family consists of two disk drive series; the ET-5500 Series and the ET-5800 Series, each of which offers models with from one to four disks.

In the development of the ET-5000 Family of disk drives, EVOTEK's design philosophy has been to incorporate a level of design sophistication previously employed only in state-of-the-art 14-inch drives. As will be evident in this manual, and upon inspection of the drive, the results of this philosophy are most evident in the actuator mechanism, the access control system, and the spindle motor design. Using large drive design techniques and analytical methods, EVOTEK engineers have pushed performance parameters to unsurpassed limits and, yet, have controlled costs to provide an extremely cost competitive series of drives.

The ET-5000 Family is designed to replace existing 5¼-inch disk drives. It is form-factor and mounting-hole compatible with the industry standard for 5¼-inch rigid and floppy disk drives. See Figures 1-1 and 1-2 for physical dimensions and mounting hole locations.

1.3 STANDARD FEATURES

Some of the key features of the EVOTEK ET-5000 Family of Winchester disk drives are:

a. Thin-film-plated media for higher bit density and resolution.

b. Microprocessor-controlled accessing for fast operation and high reliability.

c. A single printed circuit board for easy maintenance and improved reliability.

d. Five-phase, microcontrolled stepper motor for highly accurate head positioning.

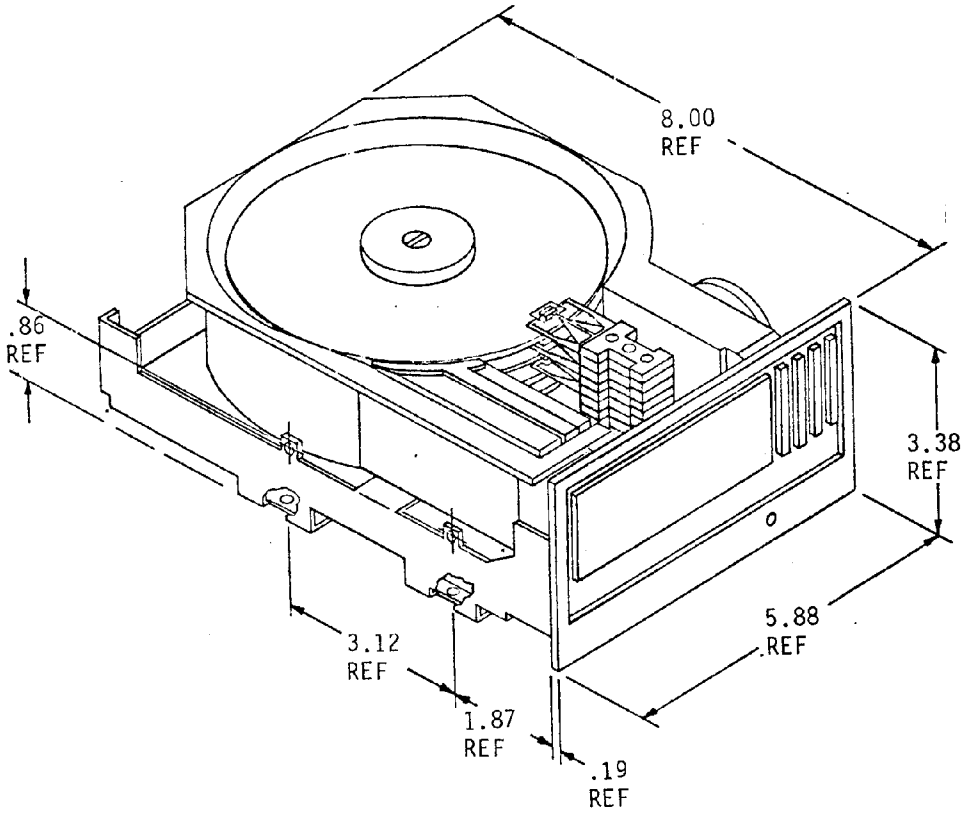


Figure 1-1. Overall Physical Dimensions

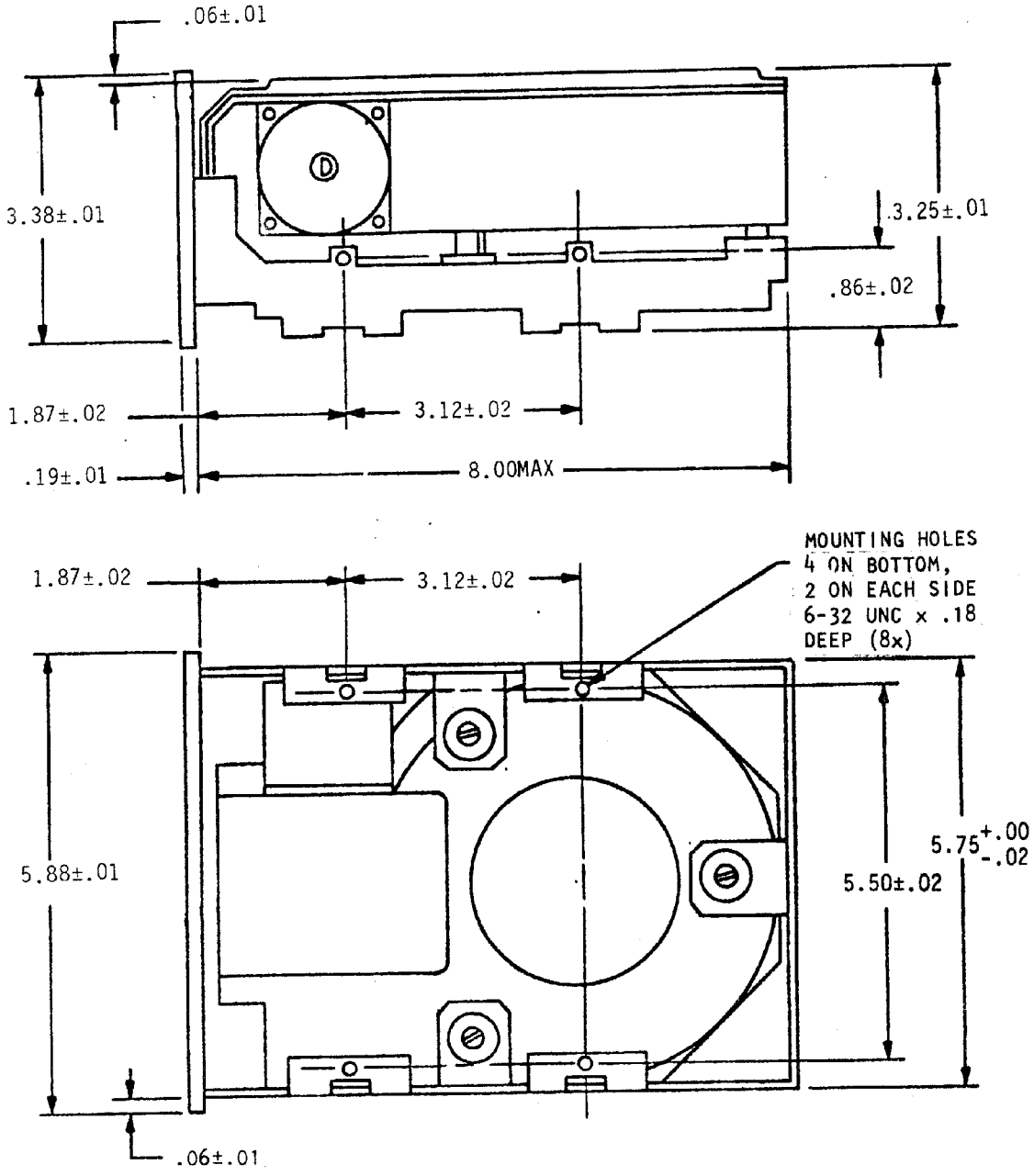


Figure 1-2. Mounting Physical Dimensions

Table 1-1. ET-5500 Series Specifications

Model	**ET-5510**	**ET-5520**	**ET-5530**	**ET-5540**
Disk	1	2	3	4
Heads	2	4	6	8
Cylinders	375	375	375	375
TPI	367	367	367	367
Data transfer rate - Mbits/sec	5.0	5.0	5.0	5.0
Tracks	750	1500	2250	3000
MFM capacity - unformatted Mbytes	7.81	15.62	23.43	31.24
BPI	9,825	9,825	9,825	9,825
Access time - with settling				
Track to track (ms)	6	6	6	6
153 cylinder average (ms)	30	30	30	30
375 cylinder average (ms)	49	49	49	49
Maximum (ms)	114	114	114	114
Latency - average (ms)	8.3	8.3	8.3	8.3

All Models	
Error rates	
Soft read	less than 1 in 10^{10} bits
Hard read	less than 1 in 10^{12} bits
Access	less than 1 in 10^{6} seeks
Power requirements	
+5 VDC $\pm$10%	1.25 amps
+12 VDC $\pm$10%	2.50 amps (4.0 peak for 2 sec)
Total dissipation	35 watts
Environmental specifications	
Operating temperature	50 to 115°F
Non-operating temperature	-40 to +140°F
Relative humidity	8% to 80%
Wet bulb temperature	78.8°F non-condensing
Reliability	
MTBF	more than 10,000 power-on hours
MTTR	less than 15 minutes
Recording technology	MFM and all run length limited codes
RPM	3600 $\pm$0.1%
Dimensions	Height: 3.25"
	Width: 5.75"
	Length: 8.00"

Specifications subject to change

Table 1-2. ET-5800 Series Specifications

Model	**ET-5810**	**ET-5820**	**ET-5830**	**ET-5840**
Disks	1	2	3	4
Heads	2	4	6	8
Cylinders	375	375	375	375
TPI	367	367	367	367
Data transfer rate - Mbits/sec	8.2	8.2	8.2	8.2
Tracks	750	1500	2250	3000
MFM capacity - unformatted Mbytes	12.90	25.83	38.75	51.68
BPI	16,250	16,250	16,250	16,250
Access time - with settling				
Track to track (ms)	6	6	6	6
153 cylinder average (ms)	30	30	30	30
375 cylinder average (ms)	49	49	49	49
Maximum (ms)	114	114	114	114
Latency - average (ms)	8.3	8.3	8.3	8.3

All Models	
Error rates	
Soft read	less than 1 in 10^{10} bits
Hard read	less than 1 in 10^{12} bits
Access	less than 1 in 10^{6} seeks
Power requirements	
+5 VDC ±10%	1.25 amps
+12 VDC ±10%	2.50 amps (4.0 peak for 2 sec)
Total dissipation	35 watts
Environmental specifications	
Operating temperature	50 to 115°F
Non-operating temperature	-40 to +140°F
Relative humidity	8% to 80%
Wet bulb temperature	78.8°F non-condensing
Reliability	
MTBF	more than 10,000 power-on hours
MTTR	less than 15 minutes
Recording technology	MFM and all run-length-limited codes
RPM	3600 ±0.1%
Dimensions	Height: 3.25"
	Width: 5.75"
	Length: 8.00"

Specifications subject to change

Section 2

THEORY OF OPERATIONS

2.1 OVERVIEW

Figure 2-1 is a simplified block diagram of the electrical interconnections in the EVOTEK disk drives. A brief description of each of the major blocks follows.

2.2 PRODUCT DESCRIPTION

2.2.1 HEAD DISK ASSEMBLY BASECASTING

A single head disk assembly (HDA) basecasting design is used for all eight models of the ET-5000 Family. The basecasting is die-cast aluminum for structural uniformity and strength. To ensure that basecasting vibration does not degrade actuator system performance, or cause head suspension dynamic instabilities, a series of comprehensive modal analyses have been performed on the casting. The unit was specifically designed to provide clear access for robotized head/carrier insertion, ensuring the highest levels of HDA quality.

2.2.2 SPINDLE MOTOR

EVOTEK has designed a low profile brushless DC spindle motor to provide space for four disks in the HDA, without exceeding the standard 5¼-inch package limitations. With a shorter and larger diameter coil and magnet assembly, the motor provides the torque necessary to accelerate as many as four disks to 3600 rpm in less than 15 seconds.

The spindle assembly has been designed with a very stiff spindle/bearing system to provide the highest degree of dynamic stability. Repeatable and non-repeatable runout is controlled to very stringent limits to minimize contributions to head-to-track misregistration. A cross-sectional view of the spindle/motor is shown in Figure 2-2. An integral magnetic shield is incorporated to eliminate motor field influences on the recording process.

2.2.3 BRAKING SYSTEM

Primary spindle braking force is provided by a +12 VDC controlled mechanical friction brake. With +12 VDC present the brake is inactive. When voltage drops below a defined level, brake force is applied. The brake provides much higher brake force than is typically found on 5¼-inch drives. This was implemented to ensure that the disk stack decelerates rapidly while the heads are in contact with the disks.

Since the heads fly in a noncontacting, stable attitude above 2000 rpm at the inner diameter (ID), and above 1200 rpm at the outer diameter (OD), there is no need to pick the brake solenoid above this speed

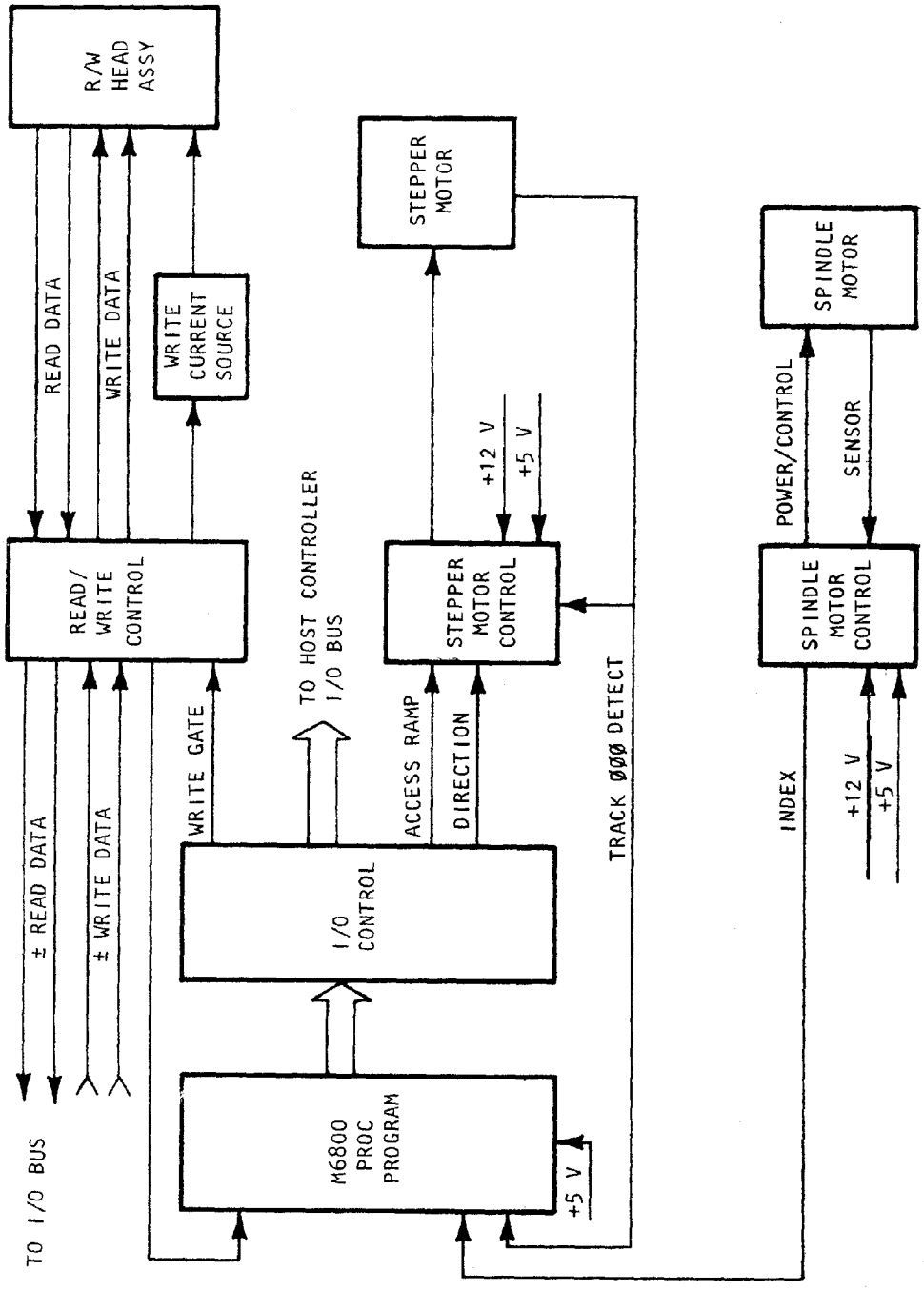
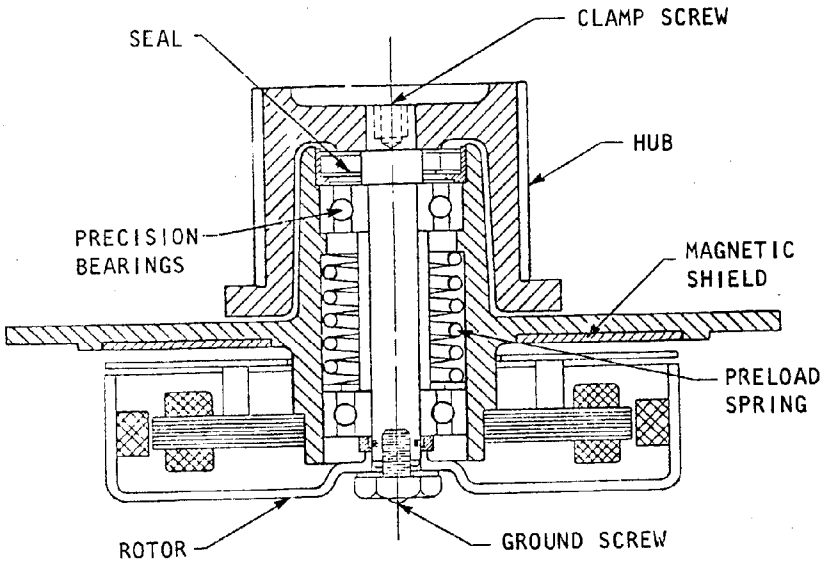


Figure 2-1. System Block Diagram



TECHNICAL FEATURES

- LOW PROFILE FOR 4 DISKS
- SINGLE CLAMPING SCREW
- INTEGRAL MAGNETIC SHIELD
- HIGH ANGULAR ACCELERATION
- REDUCED NON-REPEATABLE RUNOUT
- HIGH L/D BEARING/SHAFT GEOMETRY

Figure 2-2. Spindle Motor Assembly

range. A special circuit trips the brake at approximately 2000 rpm, minimizing brake pad wear. To supplement the friction brake, back-EMF of the rotating motor is used as a dynamic brake.

Reducing the amount of head-disk contact time increases the life expectancy of both the heads and the disks. This also results in fewer-than-normal nonrecoverable R/W errors over the lifetime of the product.

2.2.4 AIR FILTRATION

Through extensive air flow testing, EVOTEK has contoured the HDA casting and interior components to minimize interior pressure drops and thereby maximize the pressure differential across the HEPA filter. As a result of pressure optimization, it is not necessary to use the hub core as an air return path. This eliminates the need to return potentially contaminated air to the disk surface.

The stepper motor shaft entering the HDA is sealed with a ferro-fluidic ring to maintain positive air pressure within the HDA and prevent particulate contamination.

Air flow through the spindle bearings is eliminated by means of shaft sealing. Such sealing prevents the introduction of contaminants, and inhibits air flow through the spindle bearings, a primary cause of spindle failure (see Figure 2-3 for the air filtration flow path). Further, eliminating air flow through the disk hub maximizes internal positive pressure near the spindle seal.

A pressure equalization air inlet port is provided in the bottom of the filter assembly to ensure that only highly filtered air enters the HDA during cool down.

2.2.5 R/W HEADS

Read/write operations employ monolithic ferrite Winchester technology heads, flying from 12 to 16 microinches above the disk surface. To maximize head output, and to provide the frequency-response characteristics desired, manganese-zinc ferrite is used instead of the conventional nickel-zinc formulation. Further, head gap geometry on 5800 series drives has been optimized for 16,250 bpi performance.

To ensure the highest levels of read/write data integrity, EVOTEK has incorporated state-of-the-art head selection and preamplification techniques. Attached to the head carrier assembly are monolithic integrated preamplification and head selection circuits. These circuits, which were developed for 14-inch drives, amplify low-level head signals by a factor of 30, substantially improving overall signal-to-noise ratios. These circuits also provide wider band width and improved cross-talk rejection. Threshold discrimination techniques used

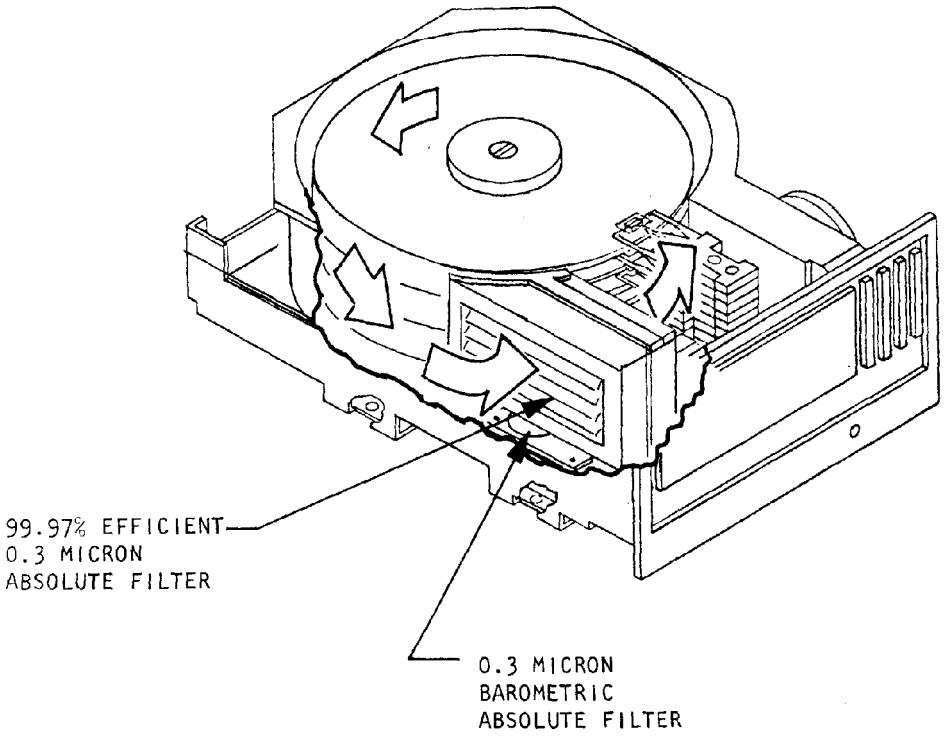


Figure 2-3. Air Flow Path

in the ET-5000 read/write channel enable the channel to operate over a very wide frequency range. This results in total compatibility with any of the run-length-limited codes.

2.2.6 RECORDING MEDIA

Recording media for all ET-5000 drives are comprised of an overcoated, thin film, magnetic plating, which results in high output amplitude, very high resolution, and superior phase margins compared with conventional oxide media. The magnetic material consists of a nickel-cobalt formulation electroplated on a superpolished convential 0.075-inch aluminum substrate. A highly abrasion-resistant material is uniformly deposited over the entire recording surface.

2.2.7 ACTUATOR MECHANISM

To achieve the desired positioning accuracy and access time, the access mechanism on all ET-5000 drives consists of a precision, six-bearing, linear actuator, which is driven through a stainless steel band by a 500-step-per-revolution (0.72°/step), five-phase, stepper motor.

Five-phase motors have greater torque and accuracy than typical four-pole motors (200 step/revolution, 1.8°/step). Asymmetrical phase vectors in the motor permit precision microstepping for off-track position control. Except during periods of thermal compensation, when microstepping is used, data tracks are positioned on full-track centers, avoiding the inaccuracies associated with half-stepping.

The head carrier assembly is driven on two precision ground, stainless-steel hardened ways and is supported by six bearings. The bearings and ways are identical to those used on state-of-the-art, 14-inch disk drives. Five bearings are fixed on the carrier; the sixth is coupled through a preload mechanism to compensate for tolerance variations and to ensure dynamic stability. Bearing-to-way alignment is controlled to ensure that resultant bearing toe and camber angles are well within the limits required to prevent wear.

Combined with the speed and accuracy of the microprocessor and hybrid stepper control driver circuit, the EVOTEK head positioning assembly can support many operations in less time than is required in a normal drive for a normal seek operation. Such operations include:

a. Buffered stepping

b. Ramped seeking

c. Microstepping

d. Electronic arrival damping

2.2.8 SEEK OPERATIONS

The drive access function is executed by hybridized control circuits, which are driven under real time control by the on-board microprocessor. Velocity-trajectory-following techniques are used to optimize carrier acceleration and deceleration. Electronic damping is used to minimize arrival transients.

All ET-5000 drives can function in either "normal step" or "buffered step" mode; to maximize drive efficiency, buffered stepping should be used. The microprocessor is aware at all times of the current location of the carrier. Upon receipt of a buffered step-pulse train, the microprocessor retrieves a velocity-trajectory algorithm corresponding to the starting and ending cylinders. The step pulses are fed to the stepper at the required variable interval until the seek has been completed (see Figure 2-8 for timing characteristics).

The inherent accuracy of the microprocessor-controlled stepper motor eliminates the need for a track-following servo system. This frees an extra disk surface for read/write operations, increasing the total storage capacity of the drive.

2.2.9 PHYSICAL STRUCTURE

The HDA and its associated motors are attached by isoelastic shock mounts to a subframe, which allows integration of the other major assemblies into a functional unit. The shock mounts, which isolate the HDA from shock and vibration, are sized according to the weight and load characteristics of the HDA and its components. An exploded representation of the parts in an EVOTEK disk drive is given in Figure 2-5.

A plastic bezel, which flexes to snap into place, is installed in slots on the front of the subframe. A Ready LED on the PCB protrudes through the bezel for visual confirmation of drive operation. Louvers molded into the bezel enable air to flow past the PCB and stepper motor.

The PCB houses all the controlling, interfacing, and spindle drive electronics, and is located below the spindle motor. The heart of the PCB is a 6800 microprocessor, which monitors disk operation, incoming control signals, and outgoing status signals. The microprocessor also controls the five-phase stepper motor for head positioning and the control lines of the stepper motor for direction and step functions.

Spindle speed is controlled within $\pm 0.1\%$ by a digital hybrid circuit, which receives status information on spindle speed from Hall effect sensors located in the motor. Spindle and stepper hybrid circuits are located on the multi-purpose PCB. Driver circuits receive their signals from the speed monitoring circuits.

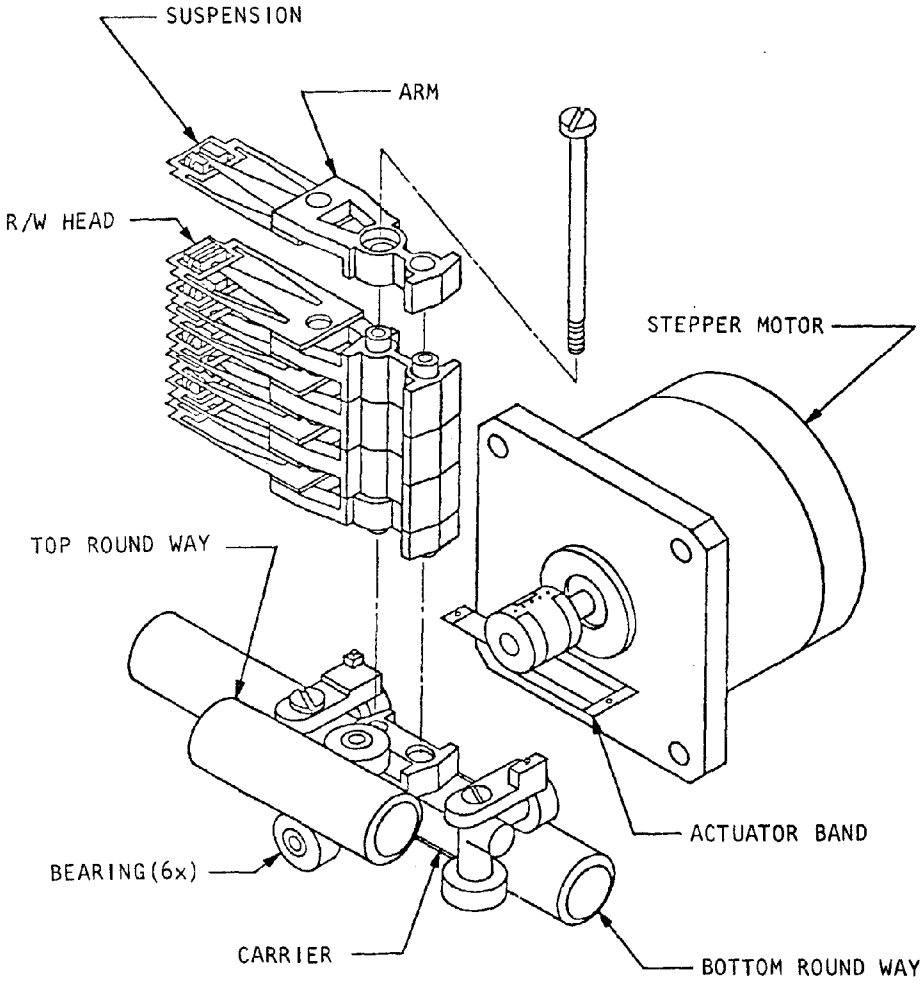


Figure 2-4. Actuator Assembly

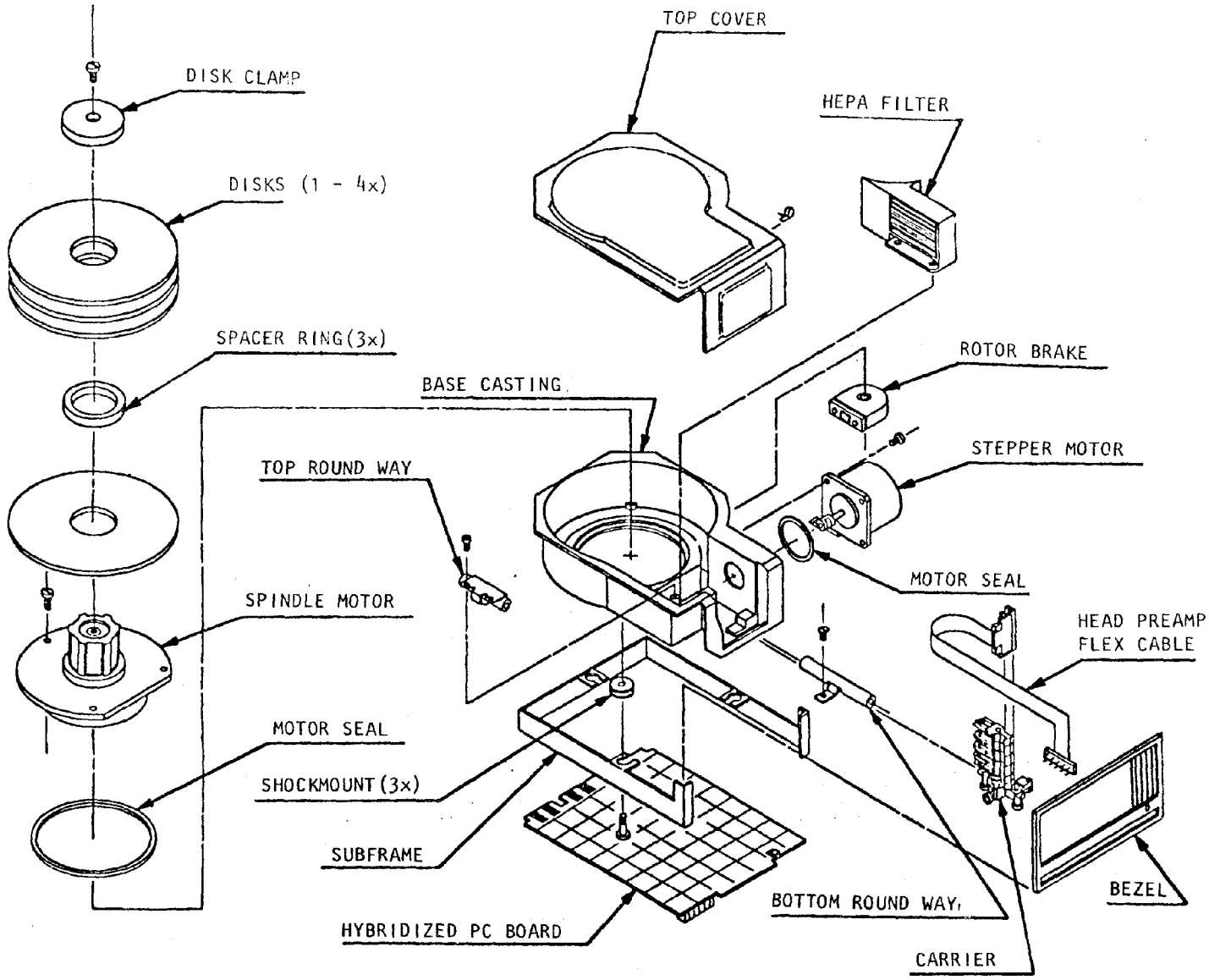


Figure 2-5. ET-5000 Disk Drive

2.3 **DESCRIPTION OF FUNCTIONS**

2.3.1 POWER SEQUENCING

The ET-5000 disk drive family operates on +12 VDC and +5 VDC supplied to connector J3 on the main PCB (see Figure 3-5 for the pin designations). Both the spindle motor and stepper motor use +12 V. The spindle will turn whenever these voltages are present. The +5 V is for the digital functioning of the PCB and its associated circuits (see Table 2-1 for the power specifications or consult the specifications in Section 1-4). The +12 VDC and +5 VDC may be provided to the drive in any sequence. To prevent power supply noise from interfering with drive operation, +12 VDC random and repetitive ripple should be less than 100 mv while the load is varying from 0-1.8A in 20-μsec. This worst case load variation corresponds to a 90 ma/usec slew rate.

Table 2-1. DC Power Required

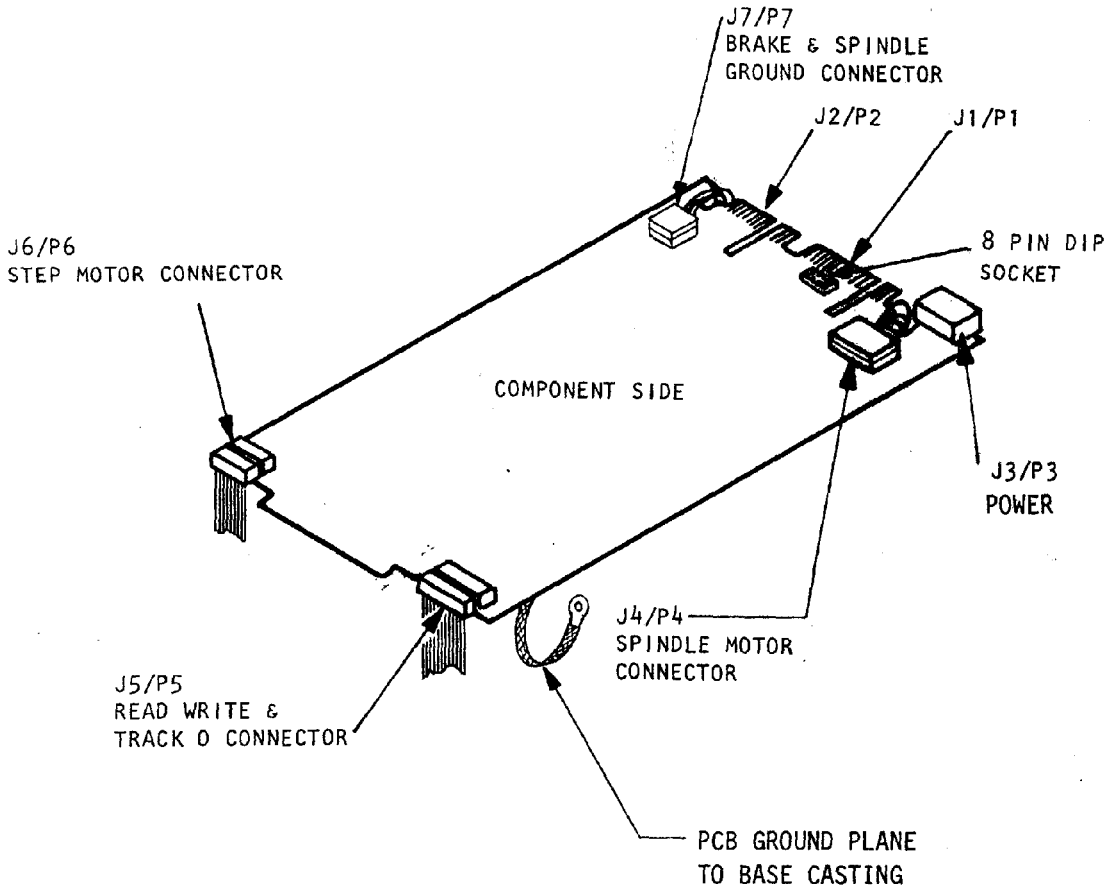
J3/P3	Voltage	Current Load
1	+12 VDC	2.5 Amp typical 4.0 Amp peak for two seconds
2	+12 return	
3	+5 return	
4	+5 VDC	1.25 Amp typical

2.3.2 DRIVE SELECTION

All EVOTEK disk drives are designed to be used as stand-alone units in a single-disk system and as one of up to four drives in a multiple-drive system. In a multiple configuration, the ET-5000 disk drives may be attached in a serial (daisy-chained) or radial (star) configuration. In all cases, each drive must be selected as a specific device number; two drives cannot have the same number in the same system. Unique number addressing is accomplished on the ET-5000 disk drives through use of a physical jumpering system (see Figure 2-7 for proper positioning of the jumper).

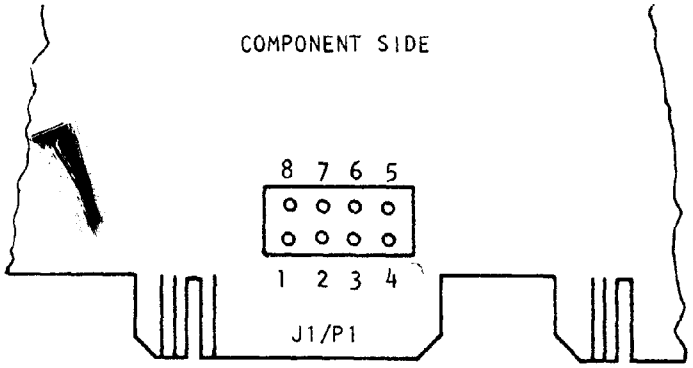
2.3.3 INTERFACING OVERVIEW

The ET-5000 disk drive electrical interface is identical to the ST-506 bus. For a detailed description of the signal pinouts and levels, consult Section 3.1 of this manual.



Note: A slip-on lug for a system ground is provided on the HDA casting.

Figure 2-6. PCB Connector Location



DRIVE ADDRESS	JUMPER
1	P1 TO P8
2	P2 TO P7
3	P3 TO P6
4	P4 TO P5

Figure 2-7. Drive Address Selection

2.3.4 TRACK ACCESSING

All of the EVOTEK ET-5000 disk drives support a variety of seek operations (see Figure 2-8 for seek timing conventions). With the on-board microprocessor and the specialized hybrid circuit module providing stepper motor drive, seek operations are faster and more accurate than in similar drives by other manufacturers. The microprocessor control circuit processes new seek commands and initiates seek operations from the current cylinder without recalibrating to track 0.

Users will appreciate the advantages of the buffered seek capabilities through minimized seek and settling time.

In Buffered Seek mode, the host controller ensures that Write Gate is inactive (high) and checks for Disk Ready. The controller also sets the direction line to desired level (low = seek in, toward higher numbered cylinders; high = seek out toward Track 0) and issues the required number of pulses on the Step signal line to reach the new target track. (One step pulse moves the stepper motor one track in the indicated direction.)

The microprocessor counts the number of step pulses received and causes the hybrid circuit to output a velocity ramp, in order to effect a seek of the desired length in a minimum amount of time. The end of this ramp

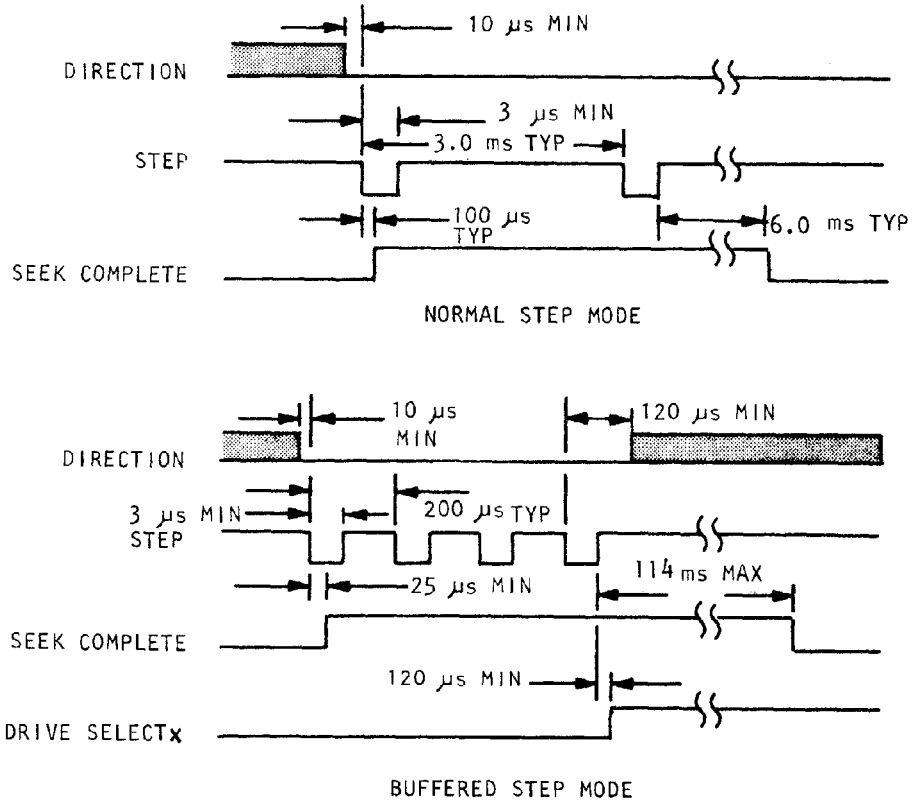


Figure 2-8. Step Pulse Timing

will also cause controlled carrier braking to occur which minimizes head settling time.

Before drives are shipped from EVOTEK, the heads are positioned in a landing zone at the disks inner tracks, off the data areas. This ensures the integrity of the data, alternate, and CE tracks (see Figure 2-9).

In addition to 375 customer usable data cylinders (cylinder addresses 0-374), two cylinders have been made available as alternates (cylinders 375 and 376), and two for diagnostic use (cylinders 377 and 378). The alternates may be reserved as spares for future use should a hard error develop. The diagnostic tracks can be used to run system level diagnostic programs against each drive without destroying customer recorded data.

A seek to cylinder 412 will cause the heads to be moved to a position inboard of any recorded data. This is recommended prior to removing power from the drive.

2.3.5 HEAD SELECTION

In order to read or write from any disk drive, it is necessary to select the head to perform the operation. The ET-5000 disk drives select heads by decoding the binary code applied on the Head Select 2^0, 2^1, and 2^2 interface lines in the control cable at J1.

Depending upon the number of disks in the particular unit, the heads are numbered from bottom to top on the carrier arms, starting with 0 on the lowest arm, and going to a maximum of 7 in a four disk configuration. See Figure 2-10 for a disk surface to head number relationship, and Table 2-2 for the binary head select decoding scheme.

Table 2-2. Head Select Decode

$\underline{2^2}$	$\underline{2^1}$	$\underline{2^0}$	Head Number	Disk Number
0	0	0	0	1
0	0	1	1	1
0	1	0	2	2
0	1	1	3	2
1	0	0	4	3
1	0	1	5	3
1	1	0	6	4
1	1	1	7	4

$\overline{0}$ = 0.0 to 0.4 V
1 = 2.5 to 5.25 V

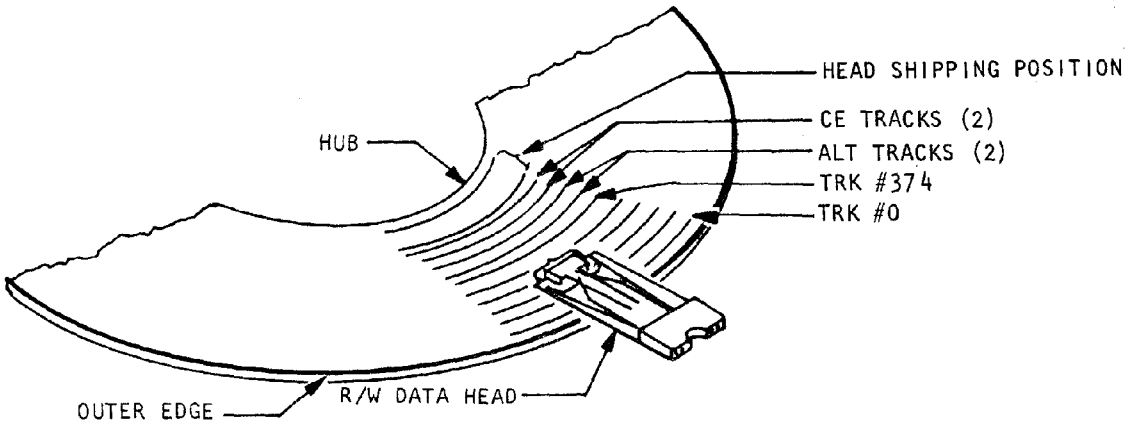


Figure 2-9. Disk Surface Layout

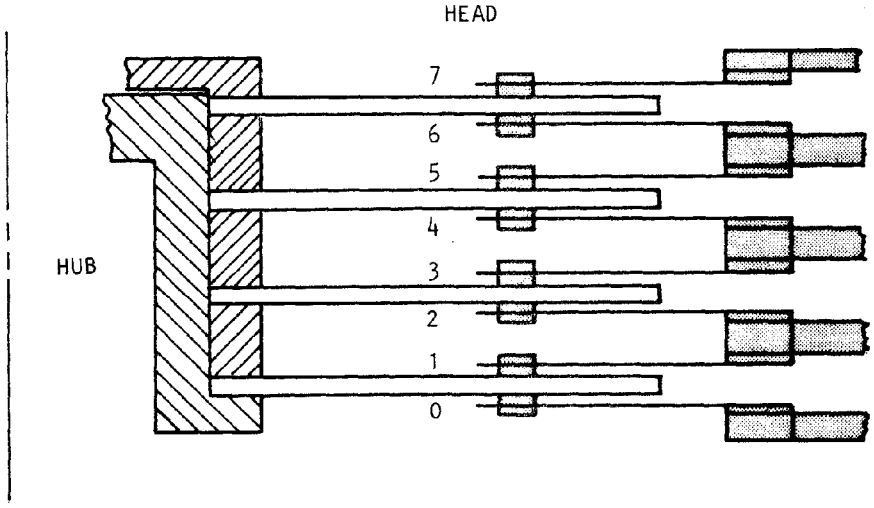


Figure 2-10. Disk/Head Orientation

2.3.6 INDEX AND SECTORING

A 110-µs index pulse is generated once per revolution to indicate the beginning of a track. A magnet, mounted on the spindle, passes in front of a Hall sensor and produces one pulse for each revolution of the spindle. This index pulse is sent to the host controller every 16.67 ms through connector J1 on the control cable.

The area in between the index marks on all EVOTEK disk drives can be formatted using any architecture the host system is set up to transmit and receive. There are no hard sector marks, so the size of a sector is completely flexible (up to one sector per track from ID header to index) As shipped, each track contains the standard format shown in Figure 2-11.

2.3.7 WRITE OPERATON

Write data is transferred from the host controller to the EVOTEK disk drive through two balanced, differentially driven signal lines on the J2 data cable. Data to be written on the disk can be in any format the user's system is capable of sending and receiving.

Before initiating a write operation, the host should check the status of the Ready and Seek Complete signal lines. If these signals are both proper, a write can be accomplished. First the proper disk drive and head must be selected. The Write Gate line must be activated, and data must be sent over the differential signal lines.

If MFM-encoded data is being used, the EVOTEK drive, with its plated media and higher bit resolution, does not require write precompensation. If your controller does precompensate, there is no problem; the EVOTEK drive can handle this with no adverse effects.

2.3.8 READ OPERATION

Read operations on an EVOTEK drive are the same as other drives. After selecting the proper disk drive with the Drive Address line, and monitoring Drive Ready and Seek Complete lines, only two more operations are necessary. First, make sure the Write Gate line is inactive; second, drive the +Write Data line lower than the -Write Data line. The drive will now read data off the track under the selected head and transmit it across the two balanced +Read Data and -Read Data lines. The +Read Data signal becoming more negative than the -Read Data signal indicates a flux change on the disk surface.

2.3.9 SYSTEM GROUNDING

Ground returns for the +5 VDC and +12 VDC are tied together on the main PCB at the power connector J3. Digital ground and chassis ground are tied together by a slip-on cable between the base casting and the main

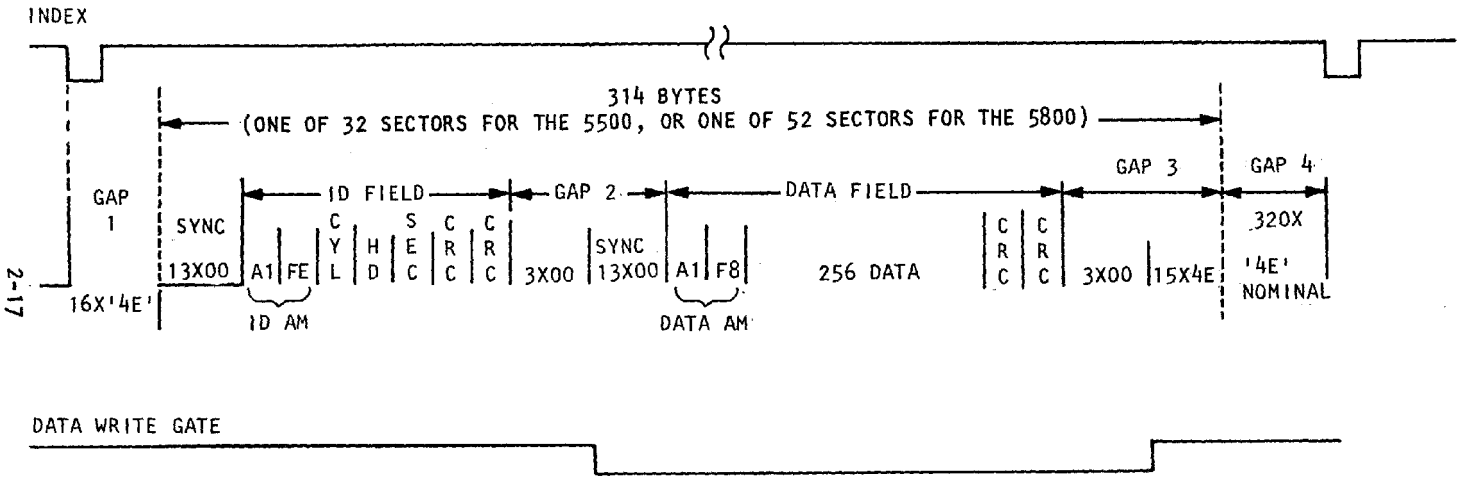


Figure 2-11. Track and Sector Format as Shipped

PCB next to the J5 connector (read/write and track 0). The system chassis ground can be connected to the slip-on plug on the bottom of the base casting. Refer to paragraph 3.1.4 for definition of the connector required.

2.4 NOISE SUPRESSION FEATURES

A static ground strap, attached to the PCB ground plane, contacts the bottom of the spindle motor.

2.5 SUGGESTED TRACK FORMAT

The main purpose of a track format is to organize the data recorded on the track into smaller and easier to handle blocks which are commonly called Sectors. The size of each sector (and the gaps and fields within a sector) is determined by many factors. Two of these factors are:

a. Spindle Speed Variance. The ET-5000 drive has a spindle speed variance of 0.1%.

b. Recovery time after a Head switch. This recovery time on the ET-5000 drive is 35 microseconds.

The format suggested is one that is commonly found in 5¼-inch rigid and 8-inch floppy disk drives. It does not take into consideration the improved performance of the ET-5000 drives. Actual Spindle Speed control and Read Recovery time has been ignored in selecting this format. Other advantages of the ET-5000, such as no need for Write Compensation, have also been ignored.

A later version of this manual will include a track formatting that is optimized for the improved performance of the ET-5000 Family of drives.

Figure 2-11 shows each track divided into 32 sectors for the ET-5500 and 52 sectors for the ET-5800. Each sector contains 314 bytes and has a data field of 256 bytes.

The beginnings of both the I.D. and data field are flagged by unique characters called address marks. The address mark shown is 2 bytes in length. The first byte is an "A1" data pattern which is followed by either an "FE" pattern (which is the pattern chosen to define an I.D. address mark) or an "F8" pattern (which is the pattern chosen to define a data address mark. With MFM encoding the "A1" pattern is made unique (by violating the encoding rules of MFM and omitting one clock transition between bits 4 and 5). This is to make the address mark pattern unique from any other serial bit combination.

Each I.D. and data field is followed by a 16 bit cyclic redundancy check (CRC) character used for data verification. Each CRC polynomial is unique for a particular data pattern. Each I.D. and data field is preceeded with 13 bytes of zeros to provide a VFO lock-on prior to data retrieval. The minimum number of bytes is dependent on the host data separator.

2.5.1 GAP 1

Gap 1 provides a head switching recovery period so that when switching from one head to another on the same cylinder, sequential sectors may be read without waiting the rotational latency time. Gap 1 is shown as 22 bytes long which corresponds to a head switching time of 35 microseconds. Gap 1 is immediately followed by a sync field for the I.D. field of the first sector.

2.5.2 GAP 2

Following the I.D. field, and separating the I.D. field from the data field, is Gap 2. Gap 2 provides three bytes of zeros for data field write update splice to occur. The remainder of this gap serves as the VFO lock-on area for the data field address mark. The length of Gap 2 is determined by the data separator lock up performance.

2.5.3 GAP 3

Gap 3, following the data field, is a spindle speed variation tolerance area. This allows for the situation where a track has been formatted while the disk is running slower than nominal, then updated with the disk running faster than nominal.

Gap 3 is at least 15 bytes in length when the spindle speed variance is $\pm 3\%$.

2.5.4 GAP 4

Gap 4 is a speed tolerance buffer for the entire track. This allows the disk to rotate at least 3% faster than normal without overflowing the track during the format operation. The format operation which writes the I.D. fields, begins with the first encountered index and continues to the next index.

Note

Gaps 3 and 4 can be reduced when using the ET-5000 Family of drives, because of $\pm$ 0.1% speed control.

Section 3

INTERFACE INFORMATION

3.1 OVERVIEW

All ET-5000 Winchester drives have an interface architecture identical to the ST-506. Data written on EVOTEK drives may be in virtually any encoding format (MFM, 3PM, 2-in-7, etc.).

Three cables are required to interface EVOTEK disk drives to an existing controller.

The Control Cable is comprised of 34 signal lines, each of which is an open-collector driven, TTL level, digital signal. This cable provides the input and command signals to the disk drive, and returns the output status signals to the host controller through connector J1.

The Data Cable is made up of 20 signal lines, one of which is a tri-state driven, TTL status line from the drive to the host. Four of the lines are differentially driven, data pairs. One pair is used to transmit write data to the drive; the second pair returns read data to the host controller. There is no data interpolation performed by the EVOTEK disk drives (these differential lines conform to EIA RS-422-A specifications). The data lines attach to edge connector J2.

The Power Cable is the same as required by the industry standard floppy drive. It has four pins to connect +12 V, +5 VDC, and their respective ground returns, from the power source to the EVOTEK disk drive. The power connector J3 on the primary PCB has been mounted at a 90° angle so that the power cable lies parallel to the PCB for ease of connection.

Consult Figures 3-1 through 3-5 and Tables 3-1 through 3-3 for details on interconnecting cable information and connector pin assignments between the host controller and the EVOTEK disk drive.

3.1.1 J1/P1 CONTROL CABLE CONNECTOR

Connection to J1 is through a 34-pin PCB edge connector. The dimensions for this connector are shown in Figure 3-3. The pins are numbered 1 through 34 with the even numbered pins located on the component side of the PCB and odd pins located on the opposite side of the PCB. Pin 2 is located on the end of the PCB connector closest to the J2 connector and is labeled. A Key Slot is provided between pins 4 and 6. The recommended mating connector for P1 is a Scotchflex ribbon connector P/N 3463-0001 or AMP ribbon connector P/N 88373-3.

3.1.2 J2/P2 DATA CABLE CONNECTOR

Connection to J2 is through a 20-pin PCB edge connector. The pins are numbered 1 through 20 with the even numbered pins located on the

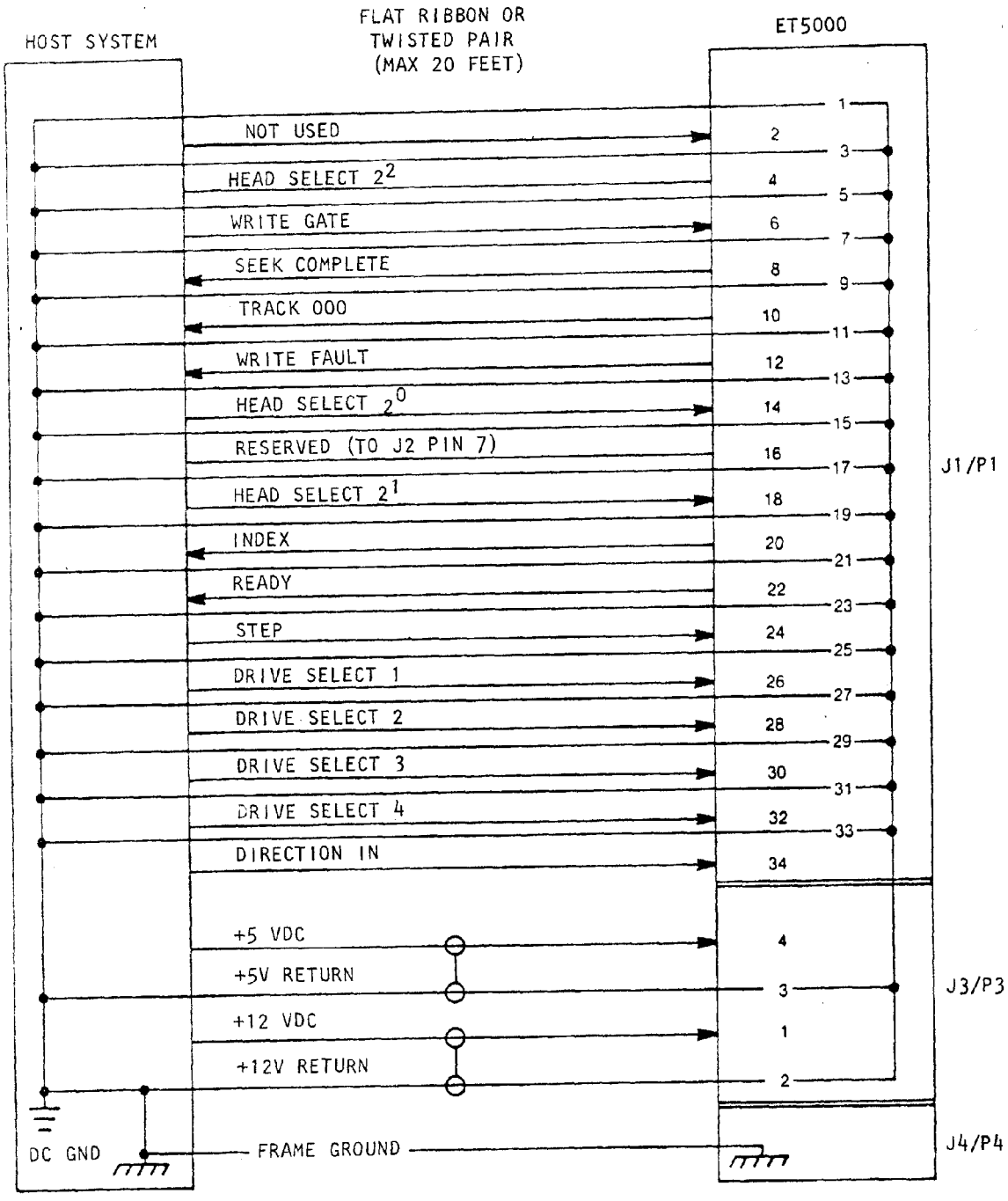


Figure 3-1. Drive Interface Control Signals

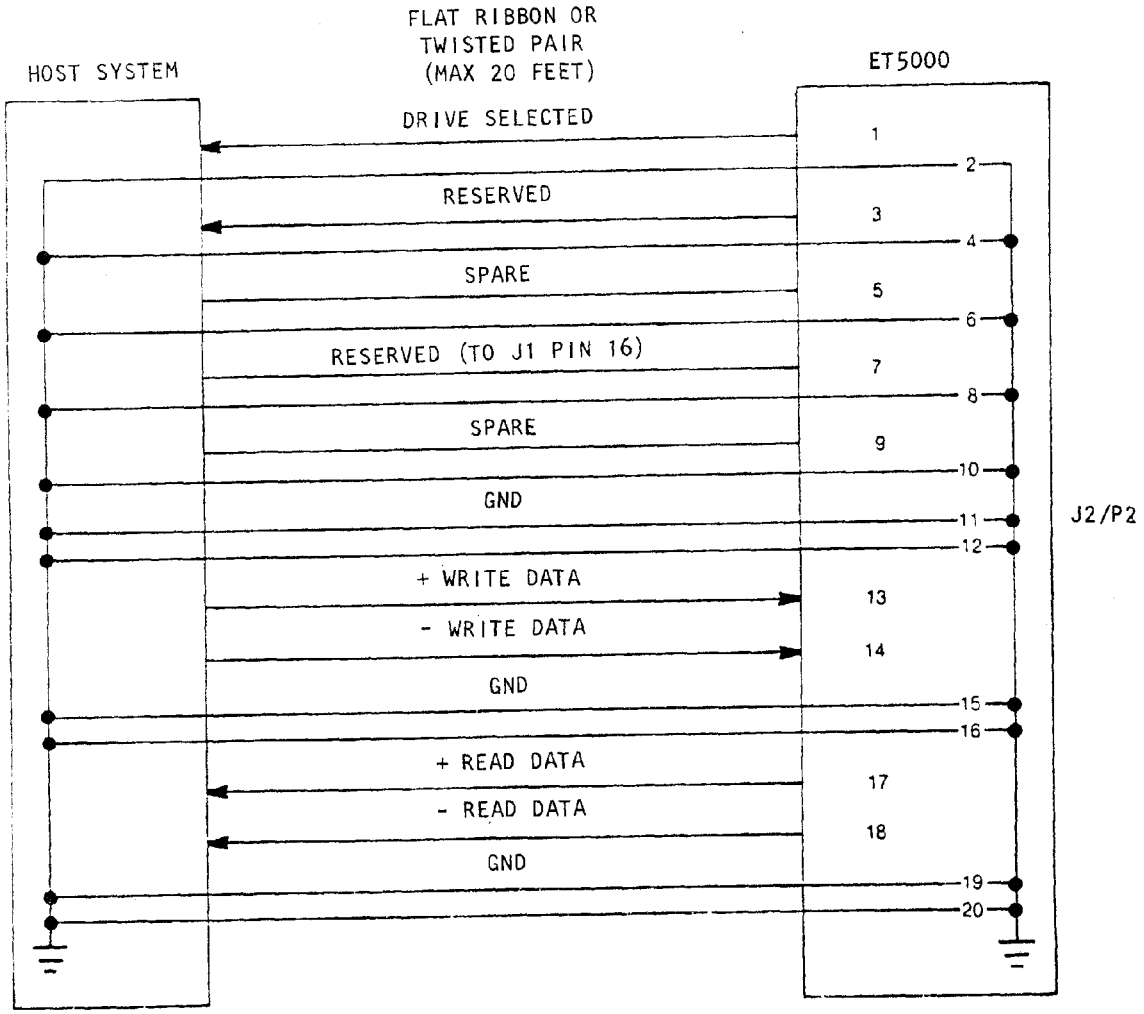


Figure 3-2. Drive Data Signals

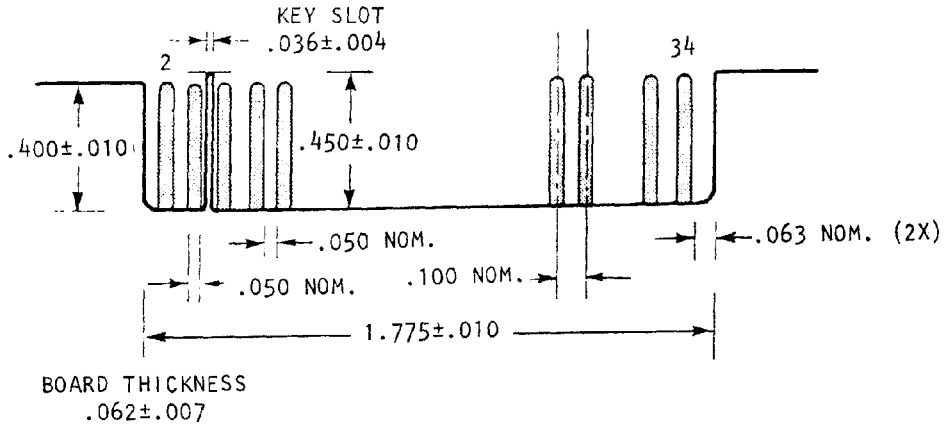


Figure 3-3. J1 Connector Dimensions
(From Component Side of Board)

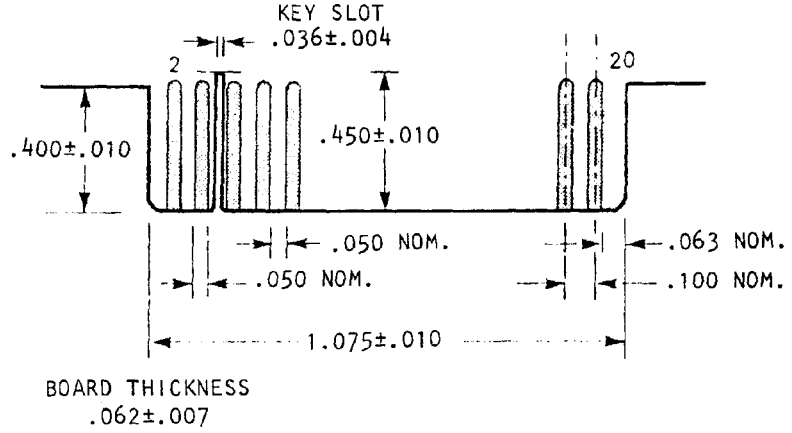


Figure 3-4. J2 Connector Dimensions
(From Component Side of Board)

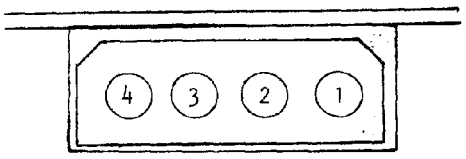


Figure 3-5. J3 Connector

Table 3-1. J1/P1 Control Connector Pin Assignments

Pin No. Gnd Rtn	Pin No. Signal	Signal Name
1	2	Not Used (reduced Write Current may be transmitted without problems)
3	4	-Head Select 2^2
5	6	-Write Gate
7	8	-Seek Complete
9	10	-Track 0
11	12	-Write Fault
13	14	-Head Select 2^0
15	16	Reserved
17	18	-Head Select 2^1
19	20	-Index
21	22	-Ready
23	24	-Step
25	26	-Drive Select 1
27	28	-Drive Select 2
29	30	-Drive Select 3
31	32	-Drive Select 4
33	34	-Direction In

Table 3-2. J2/P2 Data Connector Pin Assignments

Pin No. Gnd Rtn	Pin No. Signal	Signal Name
2	1	-Drive Selected
4	3	Reserved
6	5	Spare
8	7	Reserved
	9,10	Spare
12	11	Gnd
	13	+Write Data
	14	-Write Data
16	15	Gnd
	17	+Read Data
	18	-Read Data
20	19	Gnd

Table 3-3. J3/P3 DC Power Connector Pin Assignments

Pin No.	Voltage Level
1	+12 VDC
2	+12 V Return
3	+5 V Return
4	+5 VDC

component side of the PCB. The recommended mating connector for P2 is a Scotchflex ribbon connector P/N 3461-0001 or AMP ribbon connector P/N 88373-6. A key slot is provided between pins 4 and 6. Figure 3-4 shows the dimensions for the connector.

3.1.3 J3/P3 DC POWER CONNECTOR

The DC power connector, J3, is mounted on the component side of the PCB. J3 is a four-pin AMP Mate-N-Loc connector P/N 641737. The recommended mating connector is AMP P/N 1-480424-0 utilizing AMP pins P/N 61473-1. Pin 1 is on the component side of the PCB and is labeled. Wire used should be No. 18 AWG. Figure 3-5 illustrates the J3 connector as seen from the rear of the drive.

3.1.4 SYSTEM GROUND CONNECTOR

To ensure that electrical noise does not create random read/write errors, it is important that a good ground exists between the HDA and the host system. A 0.187 by 0.020 inch thick slip-on tab has been provided for this purpose (AMP P/N 60920-2). Any AMP FASTON 187 series receptacle for 0.020 tabs (AMP 62137-1, 42617-1, etc.) or any equivalent may be used as a mating connector. A wire gauge of 16-18 AWG should be used.

3.2 CONTROL INPUT SIGNAL OPERATION

3.2.1 DRIVE ADDRESS SELECT

Drive selection is accomplished in EVOTEK drives by an electrical signal match between the preset drive address jumper and one of the host's drive select signal lines (Drive Select 1, Drive Select 2, Drive Select 3, or Drive Select 4). Only after these signals match is the drive able to receive the host's control input signals: Write Gate, Head Select 2^0, Head Select 2^1, Head Select 2^2, Step, and Direction In.

Refer to Figure 2-7 for address configurations.

The electrical signal level specifications listed below are low active true logic state, and high active false logic state.

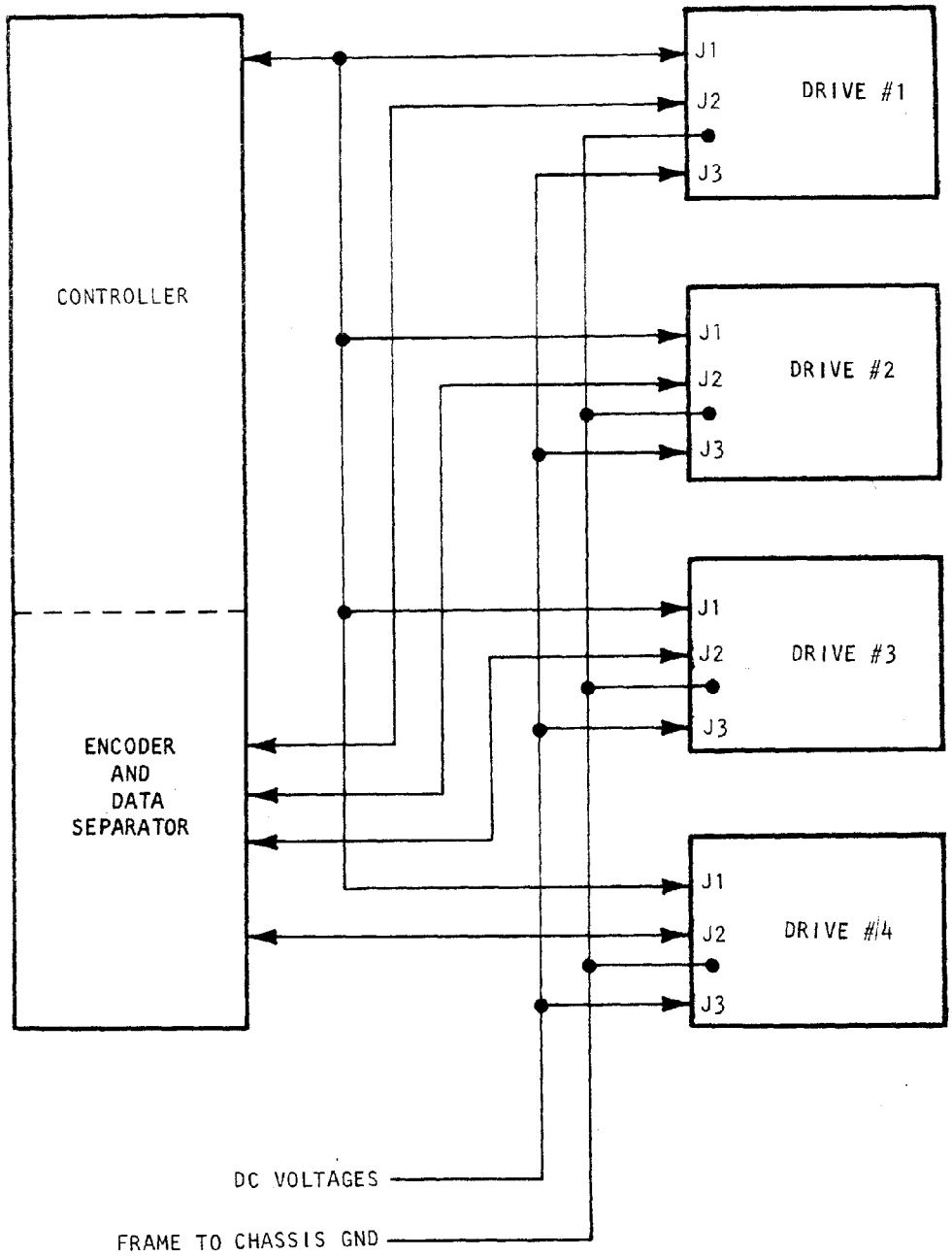


Figure 3-6. Typical Connection, 4 Drive System

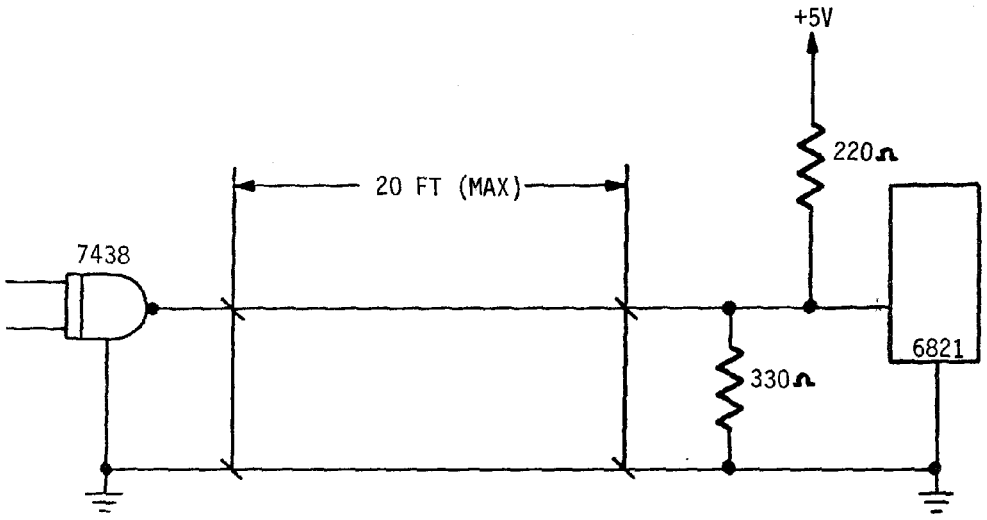


Figure 3-7. Recommended Control Signal Driver/Receiver Conbination

TRUE: 0.0 to 0.4 VDC @ -40 mA (max.)
FALSE: 2.5 to 5.25 VDC @ +250 μA (open)

3.2.2 REDUCED WRITE CURRENT

Because of the magnetic saturation characteristics of EVOTEK's plated media, only a single level write current is required for all cylinders. Consequently, the interface variable-write-current function (J1/P1, Pin 2) is not active. To ensure compatibility with existing controller designs, the signal line may be activated with no adverse impact in the drive.

3.2.3 WRITE GATE

When in the low active state, Write Gate will enable data to be written on the disks. Whenever this signal is true (low active), any attempt to reposition the head actuator assembly with the Step signal will be ignored. The false logic (high active) state of this signal allows read data to be transferred from the drive and enables the movement capability of the head actuator. A 220/330 ohm resistor pack is used for line termination.

3.2.4 HEAD SELECT 2^0, 2^1, AND 2^2

A binary coded sequence placed on these lines allows any one of up to eight read/write heads to be selected at a time. Head Select 2^0 is the least significant bit and the heads are numbered from 0 to 7. See Figure 2-10 for an illustration and cross reference guide to the disk surface-to-head interface. A 220/330 ohm resistor pack is used for line termination.

3.2.5 DIRECTION IN

When a step pulse is received, the direction in which the head actuator moves is determined by the logic level of the -Direction In line. (Remember that Write Gate must be false for any movement to occur.) If the Direction In line is true (low active), the actuator will move the heads in towards the center of the disk to a higher numbered cylinder. Whenever this signal is false (high active) the heads will be moved towards the outer edge of the disk and a lower numbered cylinder. Any change in direction must comply with the timing requirements in Figure 2-8. A 220/330 ohm resistor pack is used for termination.

Note

The direction signal must not change during a step pulse.

3.2.6 STEP

A pulse on the step line will cause the actuator to move the heads in the direction indicated by the Direction In line. It is recommended

that seek operations be performed in the Buffered Seek mode to meet the stated access times. For a more detailed operational description of how this is accomplished, consult the theory of operations in Section 2.3.4 of this manual, and Figure 2-8 for the recommended timing chart. A 220/330 ohm resistor pack is used for line termination.

3.2.7 DRIVE SELECT 1-4

When the appropriate Drive Select signal is true (low active) and matches up with the disk address select jumper configuration, the input control lines are connected to the disk drive interface. Refer to the theory of operations in Section 2.3.2 of this manual and Figure 2-7 for Drive Address selection.

3.3 CONTROL OUTPUT SIGNAL OPERATION

The control output signals from the EVOTEK drive are tri-state driven, digital TTL signals. They are in a true logic state with a maximum of 0.4 VDC at the driver. This output stage is capable of sinking 40 mA at true logic. Whenever the driver is in the false logic state, the output driver transistor is turned off, and the maximum collector cutoff current is rated at 250 μA. All of the control output signal drivers are enabled the entire time that the specific disk is selected by the Drive Select line. See Figure 3-4 for the recommended circuit.

3.3.1 SEEK COMPLETE

Drive control logic will cause this line to go true (low active) only after the R/W heads have settled on track at the end of a seek operation. Users should always check the status of this line prior to attempting read or write operations. If the Seek Complete line is false, no operations should be attempted.

Seek Complete will go false under the following conditions:

a. A Seek operation is initiated or in progress.

b. Momentary loss of +5 or +12 VDC power.

c. A power-up sequence initiates a recalibration.

If a read or write operation is attempted while Seek Complete is false, the EVOTEK microprocessor will inhibit these operations. Seek Complete is true only after the heads have arrived at an on-track position, the controller need not delay before beginning a read/write operation.

3.3.2 TRACK 0

This signal from the disk will be true (low active) only when the R/W heads are located over Cylinder 0.

3.3.3 WRITE FAULT

A true Write Fault signal indicates that the drive is unable to properly write the presented data. This signal requires action to be taken at the drive to clear the faulty condition. Any stepping or writing operation is inhibited until the problem is corrected.

Write Fault can be caused by the following conditions:

a. Loss of voltage, or improper DC voltages present

b. Improper head selection or multiple heads selected

c. Write Gate without Write Current when drive is selected

d. Write Current without Write Gate

3.3.4 INDEX

To indicate the beginning of a track, the Index signal from the drive is low active once each revolution (every 16.67 ms) for a period of 110 microseconds. Only the transition from logical one to logical zero is valid (see Figure 3-8).

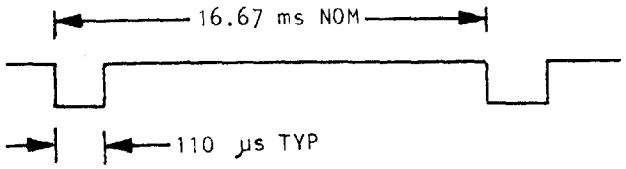


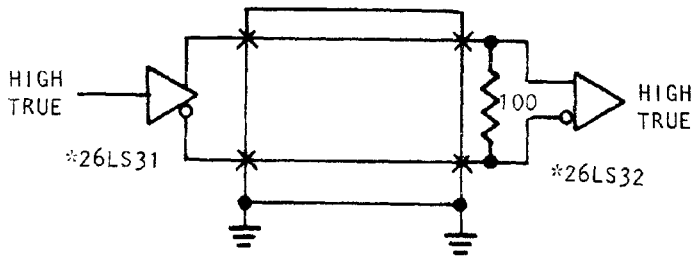
Figure 3-8. Index Timing

3.3.5 READY

The Ready line will be true (low active) from 6 to 15 sec after power-up, depending on the number of disks. An active Ready line indicates that the drive has proper DC voltages and is up to speed. An indicator LED will be lit on the drive bezel whenever this line is active. A combination of Ready in a true (low active) state and Seek Complete in a true (low active) state indicates that the drive is ready to seek, read, or write, and I/O signals are valid.

3.4 DATA CABLE SIGNAL OPERATION

The disk drive data cable contains one, tri-state TTL signal, Drive Selected, with the same electrical characteristics as the other output signals previously discussed in Section 3.2. All signal lines associated with data transfers to and from the disk are differential, and, as a result, must be presented in a serial fashion. These signals are presented in balanced pairs for both Write Data and Read Data. See Figure 3-9 for an illustration of the differential driver/receiver combination used in the ET-5000 disk drives.



*Note: Any RS-422 Driver/Receiver Pair will interface.

Figure 3-9. Data Differential Driver/Receiver Combination

3.4.1 WRITE DATA

Write Data defines the balanced pair of differential signal transitions to be written on the disk. Whenever Write Gate is low active, and the +Write Data line goes more positive than the -Write Data line, a flux reversal will occur on the track. In order for a read operation to be valid and accurate, the host system must drive the +Write Data line to an inactive state with a logic level lower (more negative) than the -Write Data line.

3.4.2 READ DATA

The differential pair of signal lines labeled Read Data becomes active whenever the drive is selected and ready with Write Gate inactive. When reading from the drive to the host, if the +Read Data line goes more positive than the -Read Data line, this represents a flux change under the selected head on the disk surface.

3.4.3 DRIVE SELECTED

This signal output line from the drive to the host is a status line. It informs the host through the connector J2/P2 that the active Drive Select line matches the drive address code that has been selected on the PCB. The characteristics of this signal are identical to the output signals described in Figure 3-7.

3.4.4 READ/WRITE TIMING

In order for data to be read or written in an EVOTEK disk drive, control signals must be activated in the proper sequence for the desired operation. Care must also be taken not to violate any of the applicable timing restrictions. The data recovered by reading a pre-recorded track is transmitted to the host system via the differential pair of Read Data lines. This condition of the +Read Data line going more positive than -Read Data line represents a flux reversal on the track under the selected head while Write Gate is inactive. For examples of proper timing relationships, see Figures 3-10 and 3-11.

3.5 **MOUNTING**

The ET-5000 family of drives may be mounted in any orientation in all three dimensions, as long as the three shock mounts can move freely. Temperature specifications should be considered when mounting the drive within an enclosure.

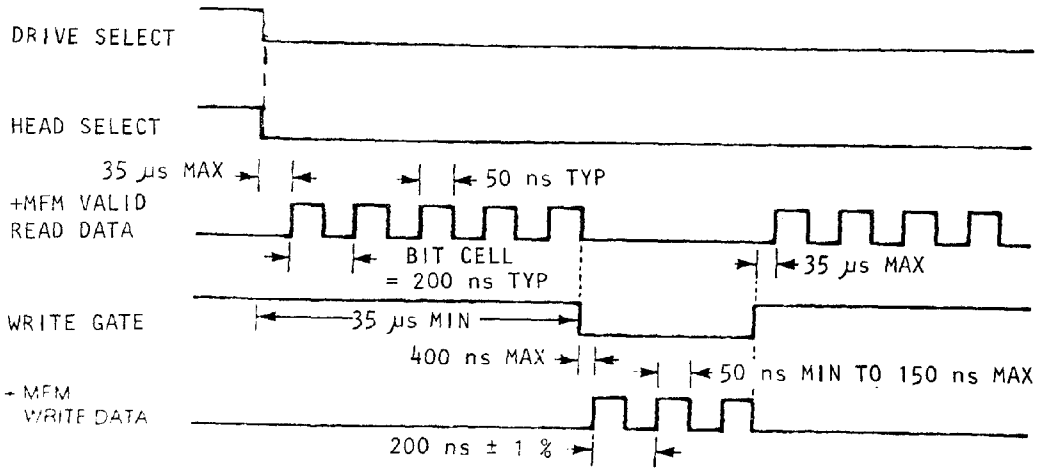


Figure 3-10. ET-5500 Read/Write Data Timing

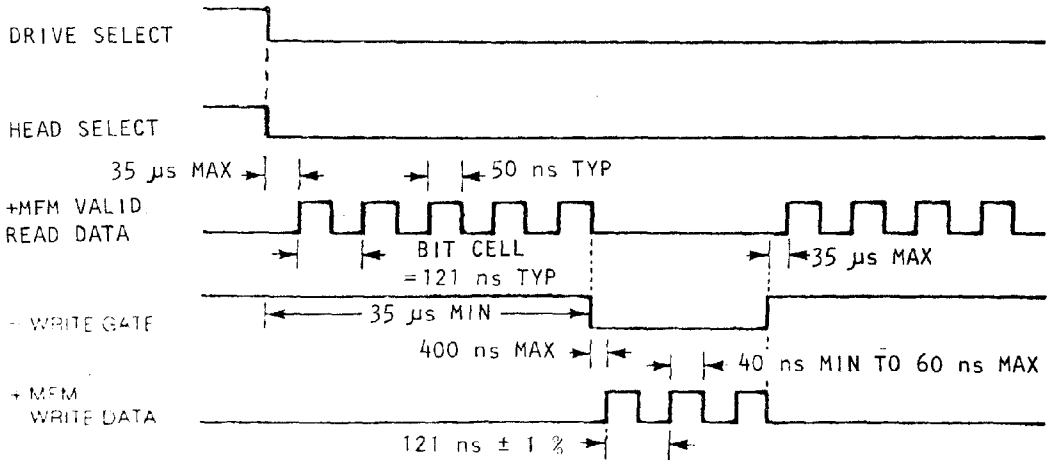


Figure 3-11. ET-5800 Read/Write Data Timing

Section 4

MAINTENANCE

4.1 GENERAL MAINTENANCE

The EVOTEK Family of drives requires no preventive maintenance. The internal HEPA filter assembly and the spindle brake have been designed to last for the expected life of the drive.

All EVOTEK drives have been designed and engineered for installation in an office or business computer system and standard computer safety precautions should be observed. These precautions include:

a. The disk drive should not be subjected to overvoltage or power surges.

b. Keep strong magnetic and x-ray devices away from the unit.

c. Proper ventilation should be maintained to ensure temperatures of the electrical components do not reach damaging levels.

d. Whenever the drive is to be moved, the heads should be accessed to the ship zone located at cylinder 412.

e. Never subject the disk drive to excessive shock or vibration.

f. Prior to sequencing down the drive, execute a seek to cylinder 412.

EVOTEK warrants each drive for conformance to published specification for the specified warranty period.

4.1.1 MAINTENANCE DIAGNOSTICS

For user convenience, cylinders 377 and 378 on all ET-5000 drives have been reserved for loading diagnostic and reliability programs. The test routines are loaded and executed by the host controller and are not supplied by EVOTEK who assumes no responsibility for maintenance program operation other than warranting that the drives will meet criteria published on the data sheets.

4.2 FIELD REPLACEABLE UNITS

Part	Part Number
HDA	*(listed below by model number)
Subframe	100077
Bezel	100118
Shock Mounts	100088
PCB	100261
Spindle Brake Kit	300001

*Model Number	Part Number	*Model Number	Part Number
ET-5510	100130	ET-5810	100134
ET-5520	100131	ET-5820	100135
ET-5530	100132	ET-5830	100136
ET-5540	100133	ET-5840	100137

4.3 REPLACEMENT PROCEDURES

4.3.1 BEZEL

The bezel is designed to lock securely to the subframe at the front of the drive, allowing the READY LED to be visible. If the bezel should become damaged, no tools are required for replacement. To remove the bezel proceed as follows:

a. Remove the two PCB clips and slide the PCB rearward approximately $\frac{1}{4}$-inch.

b. Carefully flex the bottom of the bezel forward and lift up, sliding it free from the mounting slot.

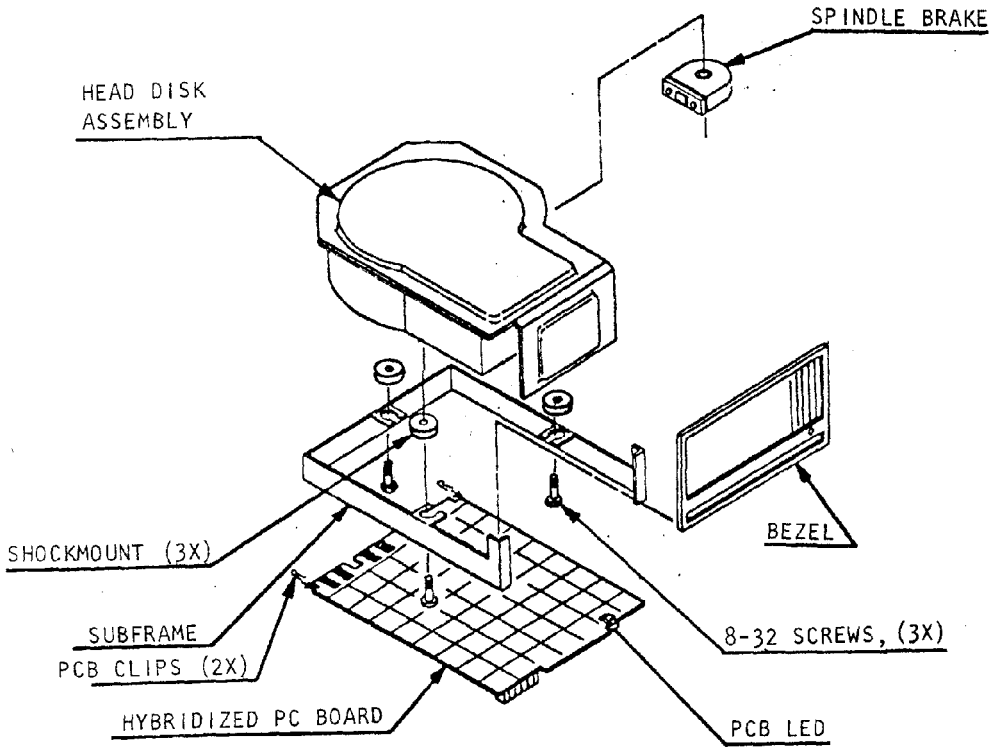


Figure 4-1. Field Replaceable Parts

The new bezel should be installed in the reverse manner. If the PCB is not properly retracted during bezel removal and replacement, the LED may be damaged.

4.3.2 PCB

To remove the PCB proceed as follows:

a. Remove the control, data, and power cables from their respective connectors.

b. Locate the two clips which hold the PCB in place.

c. Remove the clips and carefully unplug the spindle motor cable plug, stepper motor cable plug, brake plug, PCB ground strap, and head cable connector. Refer to Figure 2-12 for connector location.

d. Lift the spindle ground button spring and slide the PCB out of the subframe.

No special tools are needed. The replacement PCB is installed in the reverse sequence.

> Note
> Replacement of the following field replaceable units assumes that the PCB and bezel have been removed in the above manner first.

4.3.3 SHOCK MOUNTS

To replace the shock mounts the subframe must first be removed. See 4.3.4. Remove old shock mounts from subframe by removing brass ferrule from rubber shock mounts and then sliding rubber mounts out of subframe. Install new shock mounts in reverse of removal.

4.3.4 SUBFRAME

A screw driver is required to remove the subframe. Proceed as follows:

a. Remove PCB (4.3.2) and bezel (4.3.1)

b. Remove and save the three 8-32 screws shown in Figure 4-1.

> Note
> At this point, the HDA can be removed.

c. Remove the three shock mounts from the old subframe and install the new subframe.

d. Align the new subframe to the head disk assembly (HDA) casting, and insert the three screws.

4.3.5 SPINDLE BRAKE

The spindle brake is fastened to the base of the HDA casting with a single 6-32 screw. It is unlikely that the brake will ever need to be replaced. If it does, the task should be handled by a competent technician, because the brake must be carefully adjusted to ensure proper operation. To remove the spindle brake, proceed as follows:

a. Remove the defective brake by disconnecting connector P7 and removing the single 6-32 mounting screw.

b. Install the new brake by loosely screwing brake to the base casting.

c. Insert a 0.010-inch shim (supplied with the brake replacement kit) between the brake body and the brake armature (see Figure 4-2).

d. Firmly press the brake against the spindle rotor and tighten the mounting screw. Ensure that the brake body remains perpendicular to the rotor while doing so.

e. Remove the 0.010-inch shim and reconnect electrical connector P7.

4.3.6 HEAD DISK ASSEMBLY

HDAs shipped as spare parts are unformatted. No attempt should be made to open the sealed HDA enclosure or to remove any part from the enclosure that would expose the inside to unfiltered air. Such an exposure will contaminate the head/disk environment and cause a head crash. **If the HDA is opened, the warranty is void.**

If replacement of the previously listed parts fails to correct the problem, EVOTEK customer service should be contacted for instructions.

Remember to contact EVOTEK prior to returning any parts, assemblies, or units for repair or replacement.

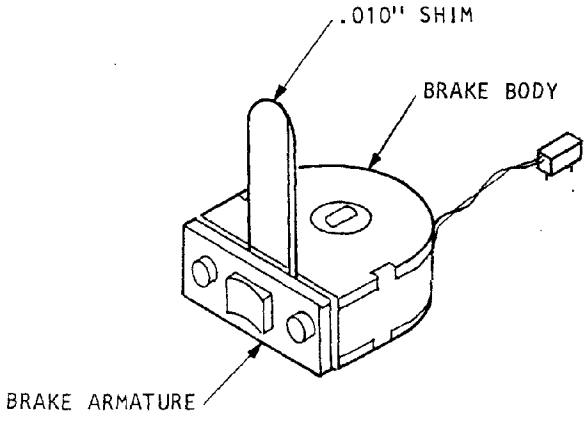


Figure 4-2. Brake Replacement Procedure

Appendix A

INSTALLATION INSTRUCTIONS

A.1 UNPACKING

Inspect the shipping container for damage. Check to insure there are no puncture marks, severe indentations, grossly flattened corners, or discolorations. If any of the above conditions are visible, note them before signing the waybill for acceptance.

Note

Retain the container, as most claim officers will want to inspect the reported damage.

The customer is responsible for settling any transportation damage claims with the carrier. All disk drives will be shipped to customer F.O.B., EVOTEK. EVOTEK will be responsible for ensuring that drives and containers are free of the defects listed above before leaving their facility.

Once the shipping container has been inspected and any damage noted, remove the disk drive from its shipping container. Remove the protective padding, again making note of any loose or damaged components.

The customer is responsible for retaining an adequate supply of shipping containers, so that any physically damaged or functionally faulty disk drive can be properly packaged and returned back to EVOTEK for service.

EVOTEK will, at its option, repair or replace any faulty module, at no charge during the warranty period. Physical damage is outside the scope of the warranty and will be handled and billed on a case-by-case basis.

Notify EVOTEK field personnel prior to returning any product to the factory for service.

A.2 INSPECTION

With the disk drive out of the shipping container examine it carefully and make note of any loose or damaged parts.

a. Ensure that the bezel is securely snapped in place and the LED is visible and firmly attached to the primary PCB.

b. Make sure the PCB is secured by its mounting clips and no damage has been inflicted to the connector extrusions at the back side (opposite end from the bezel).

c. Check that the stepper motor and the top cover assembly are both securely mounted to the HDA and that no damage is visible in either area.

After the above steps have been completed successfully, the customer is ready to proceed with operational testing of the disk drive.

d. Before connecting any cables, carefully remove the detented plastic shipping restraint collar from the end of the stepper motor shaft. Ensure that the device address select jumper is positioned for the desired configuration (see Section 2.3.2 for details).

e. Connect the 34-pin control cable to edge connector J1. Ensure that pin 1 on the edge connector is mated to pin 1 of the cable connector. Secondly, connect the 20-pin data cable to edge connector J2. Again ensure proper pin orientation and that the seating of both control and data cables is secure.

f. Before connecting the four-pin DC power cable a meter should be used to verify the voltage levels are within proper limitations as posted in specifications. Carefully check that the voltage pin orientation is in accordance with the power connector pin assignments in Table 3-3.

g. If all the power connections are proper at the cable end, cut off power to the cable and attach the power cable to connector J3 on the primary PCB ensuring that it is seated completely. You may now bring up system power and energize the disk drive for testing (see Section 2 for expected results).

The EVOTEK disk drive will automatically initiate a rezero sequence upon application of DC power. Depending upon the number of disks in your drive, the spindle will reach operational speed in 6 to 15 seconds. As soon as it does, the heads will be retracted from the shipping position and lock over track 000. Within 125 ms from the start of the rezero sequence, the output drivers for Ready, Track 0, and Seek Complete will be enabled.