APPENDIX B

HARD DISK REFERENCE MANUAL

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SECTION I

GENERAL INFORMATION

A. INTRODUCTION

The DISKOS 3350 is a random access storage device which employs advanced Winchester and microprocessor technologies. The microprocessor performs a self check of the drive's basic circuitry during each power-on sequence and if a fault is detected, the Ready status is inhibited. This microprocessor also monitors the drive's operational performance and indicates a Fault status if a malfunction should occur.

To ensure cleanliness, the head positioner voice coil, head carriage, read/write heads, disc and spindle mechanisms are assembled inside a contamination-resistant enclosure. An air flow system provides positive air pressure and continuous refiltration within this enclosure while the disc is rotating. The absolute filter in this air flow system does not require replacement during the normal lifespan of the disc drive.

The frame assembly holds the standard assemblies and provides mounting space for optional devices.

Data transfers, head positioning and status transfers are conducted over the PRIAM Standard interface. See the DISKOS 3350 Interface Specifications for detailed interface information.

B. STANDARD ASSEMBLIES AND OPTIONS

There are five standard assemblies.

1. Head Disc Assembly: A contamination-resistant enclosure which contains the disc, spindle assembly, voice coil actuator, head carriage, read/write heads and filter assemblies.

2. Main Circuit Board: Contains all the circuitry associated with read/write data transfers, interface transfers, head positioning and control.

3. Motor Control Assembly: Contains the circuitry associated with driving the spindle motor. In units shipped after October 1980, this circuitry receives an On/Off command from the Main Circuit Board and spindle rotational feedback from the Photocell Circuit Board. In units shipped prior to October 1980, this control circuitry is mounted on the Main Circuit Board.

4. Photocell Circuit Board: Contains three infrared light-emitting diodes and phototransistors; used to monitor and control spindle motor rotation.

5. Frame Assembly: Designed to contain the standard and optional assemblies of the disc drive.

6650-10

Standard options for the DISKOS 3350 are listed below:

1. Power Supply: An integrated supply that will operate from 50 or 60Hz, and at a selectable input voltage of 100VAC, 120VAC, 220VAC or 240VAC.

2. Terminator: A signal line terminator for the last drive connected to a controller.

3. Slides: The drive may be mounted in a standard 19" rack using these slides.

4. Cables: Lengths of 6, 15 or 25 feet of interface cables.

C. SPECIFICATIONS

The specifications for the DISKOS 3350 are given in Table I-1.

D. RELATED MANUALS

PRIAM provides the following related documents:

Product Specification Manual: Provides features, specifications, interface information and suggested data formats.

Interface Specification: Provides detailed information on interfacing the disc drive to a controller.

E. INQUIRIES

PRIAM provides full OEM product support. Contact your PRIAM sales representative for the location of the nearest product service center. The Customer Service manager may be contacted at PRIAM headquarters at 3096 Orchard Drive, San Jose, CA 95134, (408) 946-4600, TWX 910-338-0293.

104 SMART
203 SMART-E
BING GIBBS

Table I-1. DISKOS 3350 Specifications

OPERATIONAL CHARACTERISTICS	SPECIFICATION
Capacity (unformatted)	33.9 Megabytes
Number of discs	1
Number of data heads	3
Number of cylinders	561 (000-560)
Bytes per cylinders	60,480
Bytes per track	20,160
Track density	480 Tracks per inch
Recording density	6,430 Bits per inch
Data transfer rate	1.04 Megabytes per second
Recording code	MFM
Rotational speed	3,100 RPM
Rotational latency (average)	9.7 milliseconds
Rotational latency (maximum)	19.4 milliseconds
Positioning speed	
Single cylinder	8 milliseconds
Average	45 milliseconds
Maximum	85 milliseconds
Start time	30 seconds

POWER REQUIREMENTS

	Without Optional Power Supply	With Optional Power Supply
AC Power	Determined by system design	100VAC, 120VAC, 220VAC or 240VAC, 50 or 60Hz, 425 Watts Maximum
DC Power	+24VDC ± 5%, 7A + 5VDC ± 5%, 5A - 5VDC ± 5%, 2A -12VDC ± 5%, 0.7 A	Provided by optional Power Supply.

ENVIRONMENTAL SPECIFICATIONS

	(Operating)	(Non-Operating)
Temperature	10° to 40° C (50° to 104° F)	-40° to 60° C (-40° to 140° F)

Humidity - no condensation, maximum wet bulb temperature 26° C (78° F).

	20% to 80%	20% to 80%
Elevation	-1000 to +7000 feet MSL	-1000 to +40,000 feet MSL

RELIABILITY

Mean time between failures	8000 power-on hours
Mean time to repair	One-half hour (module swap)
Preventive maintenance	None required

SECTION II

INSTALLATION

A. INTRODUCTION

The disc drive is packaged to withstand normal handling in a reusable shipping container.

B. INSURANCE CLAIMS

It is the customer's responsibility to notify the carrier if shipping damage should occur to the drive. Any additional insurance protection is the customer's responsibility.

Examine the shipping container for obvious signs of shipping damage when the shipment is received. Most insurance adjusters will require an inspection of the damaged container. Notify the carrier and PRIAM Customer Service immediately after discovering shipping damage.

C. UNPACKING/REPACKING INSTRUCTIONS

There is an outer and inner carton. Open the outer carton by cutting the tape on the top side. Remove the inner carton and open it by cutting the tape.

Remove the disc drive and place it on a work surface. Remove the wrap. Visually inspect the drive for loose, bent or broken parts. Report any damage to the carrier and PRIAM's Customer Service.

Repacking is the reverse of the unpacking procedure. Prior to repacking the drive, ensure that the spindle and carriage locks are set to the locked positions. Contact PRIAM's Customer Service for a return authorization number prior to shipping a drive or assembly to PRIAM.

D. SPINDLE AND HEAD CARRIAGE LOCKS

The spindle lock and the head carriage lock are fully exposed on the bottom of the HDA, opposite the main circuit board. Place both levers in the required position, UNLOCK for operation or LOCK for shipment or movement of the disc drive.

> CAUTION: AVOID MANUAL ROTATION OF THE SPINDLE OR MOVEMENT OF THE CARRIAGE. DAMAGE TO THE DISC SURFACE MAY OCCUR IF THE HEADS ARE MOVED ACROSS A NON-ROTATING DISC SURFACE.

E. SWITCH SELECTIONS

Drive address, write protect and number of sector marks per track are switch selectable. Table II-1 defines the On position of the two 8-position DIP switches located on the main circuit board.

Table II-1. Switch Selection

Units after Oct. 1980

Switch 10N	Function when in the ON position
1	Select Drive Address Bit 1
2	Select Drive Address Bit 2
3	Select Drive Address Bit 4
4	Select Drive Address Bit 8
5	Skip Defect Write Enable
6	Write Protect, all heads
8	Write Clock Transmit Enable
7	Write Clock Phase Enable

Switch 12K	Function	Sector Size
1	Sector Marks per track 1	Bytes per Sector Mark 16
2	Sector Marks per track 2	Bytes per Sector Mark 32
3	Sector Marks per track 4	Bytes per Sector Mark 64
4	Sector Marks per track 8	Bytes per Sector Mark 128
5	Sector Marks per track 16	Bytes per Sector Mark 256
6	Sector Marks per track 32	Bytes per Sector Mark 512
7	Sector Marks per track 64	Bytes per Sector Mark1024
8	Select Switch-on	Select Switch-off

F. POWER CONNECTIONS

With the PRIAM optional power supply, check the AC voltage selection circuit board, prior to applying power. This board is adjacent to the AC input plug and is an integral part of the power supply. To select a voltage, extract the selection circuit board and reinsert it so that the proper AC voltage designation is visible (100, 120, 220 or 240). Check the fuse value. A 4 ampere fuse is used with 100 or 120VAC, a 2 ampere fuse is used with 220 or 240VAC. No modification is required for changing from a 60Hz power source to a 50 Hz power source.

Without the PRIAM optional power supply, DC power is applied to the drive through connector J3. See Paragraph IIH.1 and the Product Specification for additional information.

G. INTERFACE CONNECTION

Detailed interface information is given in the Interface Specification. Interface pin designations and signal names are given in Table II-2. Register Selection and Command summary are given in Table II-3. Status Register Bit definition is given in Table II-4.

Table II-2. Interface Connections

J1 and J2 Connector

Pin	Signal	Pin	Signal
1	Ground	26	Ground
2	+ DBUS 0	27	Ground
3	+ DBUS 1	28	+ 5 VOLTS DC (TERMINATOR POWER)
4	+ DBUS 2	29	(RESERVED)
5	+ DBUS 3	30	- HEAD SELECT 2
6	+ DBUS 4	31	- HEAD SELECT 1
7	+ DBUS 5	32	Ground
8	+ DBUS 6	33	- INDEX
9	+ DBUS 7	34	Ground
10	Ground	35	- READY
11	- READ GATE	36	Ground
12	Ground	37	- SECTOR MARK
13	- RESET	38	Ground
14	Ground	39	+ WRITE DATA
15	- WRITE GATE	40	- WRITE DATA
16	Ground	41	Ground
17	- RD	42	+ WRITE CLOCK
18	- WR	43	- WRITE CLOCK
19	+ AD 1	44	Ground
20	+ AD 0	45	+ READ/REFERENCE CLOCK
21	Ground	46	- READ/REFERENCE CLOCK
22	- DRIVE SELECT 1	47	Ground
23	- DRIVE SELECT 2	48	+ READ DATA
24	- DRIVE SELECT 3	49	- READ DATA
25	- DRIVE SELECT 4	50	Ground

Table II-3. Register Selection and Command Summary

REGISTER SELECTION

A1	A0	WR	RD	Selected Register
0	0	0	1	Status Register
0	0	1	0	Command Register
0	1	0	1	Current Address-Upper Byte
0	1	1	0	Target Address-Upper Byte
1	0	0	1	Current Address-Lower Byte
1	0	1	0	Target Address-Lower Byte

COMMAND SUMMARY

COMMAND	7	6	5	4	3	2	1	0
SEQUENCE UP	0	0	0	0	0	0	0	1
SEQUENCE DOWN	0	0	0	0	0	0	1	0
RESTORE	0	0	0	0	0	0	1	1
SEEK	0	0	0	0	0	1	0	0
FAULT RESET	0	0	0	0	0	1	0	1

TABLE II-4. Status Register Bit Definition

Bit	Name	Description
0	Ready	The drive is up to speed, servo system is locked onto a servo track, and the unit is in a state to read, write, or seek.
1	Seek Complete	This bit is set when seek operation is completed.
2	Seek Fault	A fault was detected during a seek operation.
3	Cylinder Zero	Access arm is set to Cylinder 0.
4	Busy	Drive is in process of executing a command.
5	Drive Fault	A fault was detected during a write operation or a drive unsafe condition was detected.
6	Write Protect	The head selected is write protected. Write protection is set by switches in the drive or when the drive is not sequenced up.
7	Command Reject	Control or Register Load command received while drive is not ready, or improper command received.

H. PERFORMANCE CHECK

1. Check DC voltage levels.

Voltage	Measured at J3	Tolerance
Ground	Pin 1	N/A
+24 VDC	Pin 2	± 5% running and + 5% -15% at spindle start-up
-5 VDC	Pin 3	± 5%
-12 VDC	Pin 4	± 5%
+5 VDC	Pin 5	± 5%
Ground	Pin 6	N/A

2. Check current demands, if voltage is outside specification.

Voltage	Maximum Current
-5VDC	2.0 amperes
+5VDC	4.0 amperes
-12VDC	0.7 amperes
+24VDC	7.0 amperes from start of spindle rotation until Ready (30 seconds). 5.0 amperes after Ready. 6.0 amperes after Ready with active seek operation.

3. Upon proper application of DC power and with the drive selected and a Sequence Up command applied, spindle rotation will begin.

4. If no faults are detected the drive will become Ready in about 30 seconds. If a fault is detected by the safety circuits within the drive, Ready will be inhibited and a fault condition will be issued.

   If a condition exists within the drive that prevents the microprocessor from sensing that the spindle is rotating at the specified speed within two minutes, Ready will be inhibited and spindle rotation will stop.

5. Check head positioning operation by issuing seek commands. One effective seek pattern is illustrated:

   From 000, to 001, to 000, to 002, to 000, to 003, to 000, to 004, to 000, ...to 560.

6. Average seek time can be checked for compliance to specification by performing a seek between cylinder 000 and 187 and measuring the interface signal - READY, which should be false for not more than 45 milliseconds.

7. Check data transfer operation by transferring data with each read/write head.

   CAUTION: Previously recorded data will be altered by a write operation. Most disc systems also require a formatted disc to allow data transfer to occur.

   A disc surface defect map is supplied by PRIAM with each drive. This map indicates the location of defects discovered in the manufacturing and test of the drive by the number of byte positions from Index Mark. See the DISKOS 3350 Product Description manual for additional surface defect information. Note: See Section IV for troubleshooting assistance.

SECTION III

PRODUCT DESCRIPTION

A. DISC FORMAT

There are three data heads, one servo head and one disc in the DISKOS 3350. Head 1 and Head 2 utilize the top surface, head 0 and the servo head utilize the bottom surface of the disc.

The heads are positioned in a landing zone during a power-on or power-off operation. When the disc is rotating, in the power-on sequence, the servo head senses its location and positions the data heads at cylinder 000.

The servo band information is recorded at the PRIAM factory. The controller determines the format on the data tracks.

For information on data formats and the interface, see the DISKOS 3350 Interface Specification manual.

The Servo tracks are precisely recorded with continuous position information. This information is used to derive Servo Clock, Index Mark and, in conjunction with the sector switches, Sector Marks. This information is also used by the servo circuits to determine head position and, during a seek operation, to determine a track crossing.

B. SERVO

The servo head, pre-amp and voice coil are located within the disc enclosure; all remaining servo circuits are contained on the main circuit board.

The servo operates in either an On Track or Move mode.

Move mode is active when the drive is commanded to move the heads. When the microprocessor receives a new seek address it will determine the number of cylinders of travel, set Move and the direction of travel.

When the servo is in the Move mode, a Digital to Analog Converter (DAC) places a velocity profile at the servo summing point. An electronic tachometer signal, which indicates the velocity of head motion, is also placed at the servo summing point.

The output from the summing point is the difference between the DAC signal and the electronic tachometer signal. This output is fed to the servo power amplifiers, which control the voice coil, and the heads are driven to the new cylinder address.

When the heads are within 100 microinches of the new cylinder address the On Track mode becomes active.

In the On Track mode, the heads are held precisely over the designated track. Any unintended head movement is detected by the electronic tachometer and fed to the summing point, causing the heads to remain at the designated location.

C. SERVO SAFETY CIRCUITS

Servo safety circuits will drive the heads to the landing zone upon detection of a low power condition or if both the On Track and the Move modes are detected. These circuits also monitor voice coil speed. If the specified speed is exceeded or if the continuous position information is lost, an Overspeed (-OS) signal is established and the servo power amplifiers are disabled. Seek Fault is set if this condition should develop.

D. WRITE DATA CIRCUITS

The controller initiates a write operation by supplying the disc drive with Head Select, Write Gate, Write Clock and NRZ Write Data. With the drive Selected and Ready and with Write Protect off, the write operation will begin. The write circuits will:

1. Encode the NRZ Write Data to MFM.

2. Synchronize the data to the Write Clock.

3. Record data transitions on the selected head and disc surface.

Safety circuits monitor the write operation. If a fault is detected during a write operation, Writing is inhibited, Fault is set and Ready is inhibited.

E. READ DATA CIRCUITS

To read from the selected disc drive, Read Gate is set true by the controller in a gap area which precedes a recorded field. Each gap area is recorded by the controller with zeros at the disc interface connector. These zeros are required to allow the data separation circuits to become synchronized to the recorded data.

The controller initiates a read operation by supplying the disc drive with Head Select and Read Gate. With the drive selected and in the Ready status, the read operation will begin.

When reading recorded data, voltage peaks of alternate polarities are induced in the selected head. A voltage peak occurs at each detected data transition. The functions performed by the read circuits are:

1. Amplify, differentiate and digitize the read signal.

2. Verify pulse width of the digital data and eliminate false zero crossings.

3. Separate the data pulses from the clock pulses.

4. Discard the detected clock pulses.

5. Transform the data pulses into NRZ format.

6. Develop a Read Clock signal to identify the beginning of each bit cell.

7. Transmit the NRZ format data and Read Clock to the controller.

A recoverable read error (soft error) may result from a transient condition and is usually corrected by re-reading the record. An error of this type is normally detected by cyclic redundancy checking (CRC) performed in the controller.

A non-recoverable error (hard error) is one which persists after several attempts to read the record. This may be a write error, in which case rewriting the record clears the error. This type of error may also be caused by a disc surface defect, in which case the error will likely persist even after the record is rewritten. See paragraph II-H.7 and the Product Description manual for additional information on surface defects.

F. SECTOR MARKS

The microprocessor sets the sector mark count during initialization by dividing 20,160 (number of bytes per track) by the setting in the sector switches. The last sector before Index will contain any remainder from the division and it will be longer in time than the other sectors by the value of this remainder.

Power to the drive must be removed and then applied to alter the selected number of sector marks per track. See the Product Description manual for additional Sector Mark information.

G. SPINDLE ROTATION

The spindle motor is a brushless (electronic commutating) permanent magnet DC motor. The speed of the motor is controlled by a closed loop optical position encoder and a comparator. In units shipped after October 1980 a crystal comparator is used. In units shipped prior to October 1980 a voltage comparator is used.

The position of the rotor with regard to the stator is encoded. Two 90° shutters are attached to the spindle motor rotor and three phototransistors, S1, S2 and S3 are attached to the photo cell circuit board. Each phototransistor will stop conducting when a shutter blocks its infrared LED light source. The phototransistors are mounted 30° apart.

All spindle rotation circuitry, with the exception of the phototransistors and the spindle motor, is located in the motor control assembly which is mounted to the frame assembly.

The microprocessor issues an OFF command to the motor control assembly to inhibit disc rotation. Upon completion of the power-on reset the microprocessor will set this OFF command false to allow spindle rotation. The microprocessor monitors the speed of spindle rotation and will set Fault true, restore the heads to cylinder 000 and inhibit spindle rotation if spindle rotation does not reach its specified speed within 45 seconds from completion of power-on reset or if, during normal operation, the microprocessor detects that spindle rotation is below specified speed.

SECTION IV

TROUBLESHOOTING

A. INTRODUCTION

All requests for maintenance assistance should be directed to PRIAM's Customer Service Department. PRIAM offers the following services:

1. Telephone Assistance: Service Representatives are available during PRIAM's normal working hours to assist customers with maintenance, interfacing and spare parts inquiries.

2. On-Site Assistance: PRIAM will provide a factory trained technician to assist the system technician in the test and repair of a PRIAM product.

3. Factory Repair: PRIAM maintains a repair facility at its factory for the convenience of its customers. An entire disc drive, or a reparable assembly, may be returned to PRIAM for repair. Contact PRIAM's Customer Service Department for a Return Authorization prior to returning any material to PRIAM.

B. ADJUSTMENTS AND PREVENTIVE MAINTENANCE

There are no field adjustments in the disc drive, and no preventive maintenance is required.

C. EQUIPMENT REQUIRED

Only standard hand tools are required for module replacement. Component level repair is not recommended.

D. REPLACEABLE MODULES

Replaceable modules, on a standard disc drive, are:

1. Main Circuit Board (main PCB): Mounted on the top of the frame. Replaced by unplugging the eight connectors and removing eight mounting bolts.

2. Motor Control Assembly (MCA): Mounted on the bottom of the frame. In units shipped prior to October 1980 this assembly is replaced by unplugging the two connectors and removing four mounting bolts. In units shipped after October 1980 the circuit board is replaced by unplugging the two connector, removing three bolts and releasing two retainers.

3. Photocell Assembly: Mounted on the bottom of the spindle. In units shipped prior to October 1980 this assembly is replaced by removing the fan guard, the connector and the two mounting bolts. In units shipped after October 1980 this assembly is replaced by removing the connector and two mounting bolts (access holes are provided in the fan guard). Installation of the replacement board will require locating the LEDs in exactly the same location with reference to the shutters.

4. Head Disc Assembly (HDA): Includes all moving parts in the disc drive. This is a sealed contamination-resistant enclosure and it should not be opened for any reason. If the HDA should fail replacement of the disc drive is recommended.

PRIAM supplied reparable optional items are:

Power Supply - Mounted on the bottom of the frame.

All optional items are fully exposed and easily replaced.

E. CONNECTORS

There are seven connectors on the main PCB.

1. J1 and J2: 50 position A cable connector (Controller and Terminator connector, or daisy chain cable connector from/to other disc drives in the system). J1 and J2 are connected pin to pin. See Table II-2 for pin designations.

2. J3: 6 position DC power connector.

Pin 1 - Ground	Pin 4 - -12 VDC
Pin 2 - +24 VDC	Pin 5 - +5 VDC
Pin 3 - -5 VDC	Pin 6 - Ground

3. J4: 8 position connector to corresponding pins on the Motor Control Assembly connector J2.

Pin 1 - Ground	Pin 5 - +5 VDC
Pin 2 - +24 VDC	Pin 6 - Ground
Pin 3 - Unused	Pin 7 - Unused
Pin 4 - +OFF signal to MCA	Pin 8 - Unused

4. J5: 16 pin IC connector to Voice Coil in HDA.
   Pins 1,2,3,14,15 and 16 - Ground
   Pins 4,5,6,12 and 13 - to one side of voice coil.
   Pins 7,8,9,10 and 11 - to one side of voice coil.

5. J6: 16 pin IC connector to Servo head and Data head 0.
   Pins 1,2,3,4,13,14,15 and 16 - Ground.
   Pin 5 - to one side of Servo head.
   Pin 6 - to one side of Servo head.
   Pins 7 and 8 - filtered +7 VDC to center tap of Servo head.
   Pins 9 and 10 - to center tap of Data head 0.
   Pin 11 - to one side of Data head 0.
   Pin 12 - to one side of Data head 0.

6. J7 - 16 pin IC connector to Data heads 1 and 2.
   Pins 1,2,3,4,13,14,15 and 16 - Ground.
   Pin 5 - to one side of Data head 2.
   Pin 6 - to one side of Data head 2.
   Pins 7 and 8 - to center tap of Data head 2.
   Pins 9 and 10 - to center tap of Data head 1.
   Pin 11 - to one side of Data head 1.
   Pin 12 - to one side of Data head 1.
   Pins 13 and 14 - unused.

F. SAFETY CIRCUITS/FAULT STATUS

Safety circuits enable Fault status, disable Ready and inhibit writing of data. The safety circuits monitor the following conditions.

1. Write Gate true with Write Protect Switch 10N-8 On.

   a. Check switch 10N-8 for correct setting and operation.

2. Act Unsafe, defined as Write Gate without Write Current or Write Current without Write Gate.

   a. With power off, check data head assembly for continuity if fault is isolated to an individual head assembly. If head assembly is faulty the HDA should be returned to the factory for repair.

   b. Check main PCB if fault occurs on all heads.

3. Multiple Heads selected (MultiSel), only one data head may be selected.

   a. Check center tap of all data heads, only one data head should have +7 VDC.

   b. Replace the main PCB if more than one data head center tap is at +7 VDC.

4. Write Gate and Read Gate both true at the same time will cause a Fault:

   a. Check the controller and the I/O cable for correct operation and connections.

   b. Replace the Main PCB.

5. A fault condition will be set by the microprocessor if the heads are not precisely located over the designated cylinder and Write Gate is true.

   a. Replace the main PCB.

   b. If replacement of the main PCB does not correct this type of fault the malfunction may be within the HDA. Replacement of the disc drive is recommended.

Note: The microprocessor will initiate a restore to cylinder 000 if condition 6 or 7 is detected.

6. Fault condition will be set by the microprocessor if head movement without a seek request is detected.

   a. Replace the main PCB.

   b. If replacement of the main PCB does not correct this type of fault the malfunction may be within the HDA. Replacement of the disc drive is recommended.

7. Fault condition will be set by the microprocessor if spindle rotation speed is outside of specifications.

   a. Check the Control Assembly for a defective component.

   b. Check the Photocell Assembly for a defective LED phototransistor, or connection.

   c. Check the power supply for a defective connection, DC voltage level or component.

   d. If the fault is not corrected by replacement of the Motor Control Assembly, Photocell Assembly and Power Supply, the fault may be within the HDA. Replacement of the disc drive is recommended.

Fault status is reset by:

1. Power On Reset - remove and reapply DC power.

2. Fault Clear - Tag 3 and Bit 4 on the interface A cable.

3. Ground potential at J8-2.

G. SEEK ERROR

Seek errors result when the head does not reach the correct track, which can be verified by reading a recorded track address. Whenever an error of this type occurs, the drive's track counter must be reset to zero by a Restore command to the drive, which will move the head back to cylinder 000. A new seek command may then be issued.

Seek incomplete occurs when the track following servo is unable to lock onto a track within the prescribed period of time. The microprocessor will detect this condition and issue an automatic Restore to move the head back to cylinder 000 and set Seek Error status.

H. TROUBLESHOOTING

The following troubleshooting techniques are designed to aid maintenance personnel in locating a drive fault to a replaceable module or to determine that the drive is not field reparable, in which case the drive must be repaired at a repair depot or factory.

As a general rule the following steps should be performed when the disc drive is suspected of being faulty:

1. Check spindle lock and carriage lock.
2. Check for proper voltages within the disc drive.
3. Check the fuse in the Power Supply.
4. Check the fuse in the Motor Control Assembly.
5. Check for correct setting of the device address write protect and sector mark switches, see Table II-1.
6. Visually check for component discoloration and loose or faulty connections.
7. Check and recheck all cable and controller connectors.

It may be useful to replace the disc drive or the main PCB with an operational spare if the disc drive is suspected of causing a malfunction. Replacement of the disc drive will confirm that the malfunction is elsewhere, if the malfunction persists. Replacement of the main PCB will confirm the performance level of approximately 85% of all electronic circuits in the disc drive.

Replacement of a faulty or suspected subassembly is normally the quickest and most economical means of restoring system operation. Reparable subassemblies can be returned to a repair depot for component level repair.

Functions performed by the disc drive can be classified as spindle rotation, command/status transfer, head positioning/servo, write data or read data. Various symptoms in each of these functions with possible causes for each symptom are given.

SPINDLE ROTATION TROUBLESHOOTING

Symptom	Possible Cause	Suggested Action
Rotation does not start.	Spindle lock	Place in Unlock position.
	Incorrect or missing voltage at Main PCB connector J4.	Check power supply.
	+ OFF signal (J4-4) is +5 VDC, should be 0 volts for rotation.	Check microprocessor reset signal on Main PCB: should be false. Check Power-on reset (POR): should be false. Check power reset (PRST): should be false.
	Defective Motor Control Assembly	Check J1-5 of Motor Control Assembly for + 12 volts (LED voltage). Check fuse in Motor Control Assembly.
	Defective Photocell Circuit Board	Check for open LED, defective connector or phototransistor.
	Defective Spindle Motor	Manually rotate spindle in clockwise direction only (viewed from bottom) to ensure motor is no binding. If motor is binding depot repair is required.
Spindle rotates and stops after about one minute.	Carriage Lock	Place in Unlock position.
	Defective Motor Control Assembly	Replace Motor Control Assembly.
	Defective Photocell Circuit Board	Replace Photocell circuit board.
	Speed Control not being sensed by Microprocessor.	Defective Main PCB.
	Spindle Motor has excessive drag.	Depot repair required.
Spindle rotates but unit does not come Ready, or Ready condition comes and goes.	Fault Condition being sensed.	Check Fault Status.
	Intermittent power supply failure.	Replace Power Supply.
	Defective Main PCB	Replace Main PCB.

SPINDLE ROTATION TROUBLESHOOTING (Cont'd)

Symptom	Possible Cause	Suggested Action
	Defective Motor Control Assembly	Replace Motor Control Assembly.
	Defective HDA	Depot repair required.

Comments: Upon completion of the Power On Reset (POR) the microprocessor disables the +OFF signal to the spindle motor. With +OFF at 0 volts the spindle motor should rotate to its specified speed (3100 RPM).

The microprocessor examines Index Marks for spindle speed. If specified spindle speed is not reached within 2 minutes the +OFF signal is enabled and spindle rotation is stopped.

Power to the disc drive must be cycled to allow the microprocessor to disable the +OFF signal.

Figure IV-1 diagrams the connections between the Main PCB, Motor Control Assembly, Spindle Motor, and Photocell circuit board.

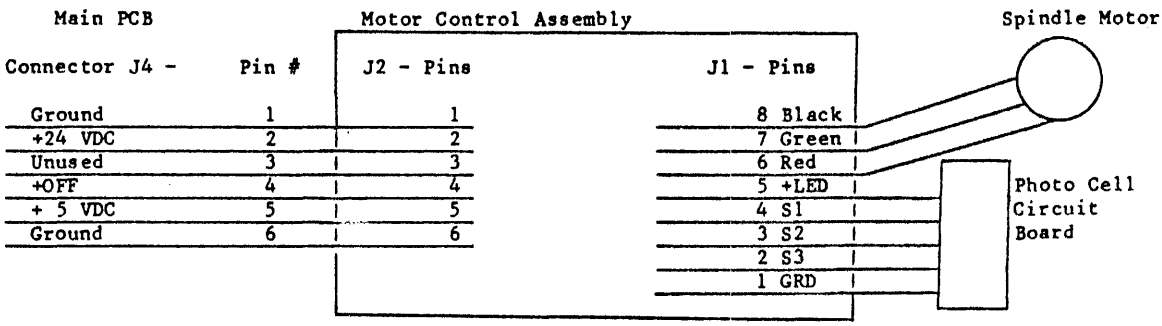

Figure IV-1

TROUBLESHOOTING COMMAND/STATUS TRANSFERS

Symptom	Possible Cause	Suggested Action
Incorrect state on Unit Selected (J9-17)	Device address select switch (10N)	Refer to Table II-1 for switch definition.
	Pick and Hold false (J1, J2 pins 57 and 58)	Check controller, cable and connectors.
	Open Cable Detect true (J1, J2 pin 28)	Check controller, cable and connectors.
	Unit Select Tag or Unit Address missing or mis-timed.	Check controller, cable and connectors.
Selected unit does not issue status.	Device Not Ready	See Spindle Rotation flow chart.
		Fault condition true, see Paragraph IV-F for definition of fault conditions.
		Replace Main PCB.
Selected unit does not accept commands.	Tag and bus data mal-function	Check controller, cable and connectors.
		Replace Main PCB.
Selected unit issues Fault	See paragraph 4-6 for causes of Fault	Suggested action for each monitored action that causes Fault is given in Paragraph IV-F.
Selected Unit issues Seek Error.	Defective servo action	See Head/Positioning/Servo.
Selected Unit fails to issue Index.	Defective circuit	Change Main PCB.
	Servo Head failed to READ.	See Head/Positioning/Servo.

Comments: Most circuit functions, within the servo and data write operations are monitored by the microprocessor. If Ready is true and Fault is false, it is a good indication that spindle speed, servo and data write circuitry are functioning in a normal manner and that the difficulty is elsewhere.

See Table II-2 for a listing of the interface connector pins and PRIAM's Interface Specification for additional interface information.

TROUBLESHOOTING HEAD POSITIONING/SERVO

Symptom	Possible Cause	Suggested Action
Fails to move to new address	Command transfer circuitry defect	See Paragraphs III-B, IV-G and Command/ Status Transfer in Paragraph IV-H.
Continuous Seek Error condition	Defective circuitry or connection	Defective servo circuitry on main circuit board. If fault continues with operational spare installed, and spindle speed and write circuits are not the source of the fault, replacement of the disc drive is recommended.
		Faulty connection to servo read head, check J6.
		Faulty connection to voice coil actuator, check J5.
		Incorrect voltage, check J3, see Paragraph II-H.
		Carriage locked, see Paragraph II-D.
Seeks to incorrect cylinder address	Defective circuitry or servo system	Defective signal from controller or fault in the interface cable.
		Defective circuitry on main circuit board. If symptom continues with operational spare installed, and controller and cable are not the source of the fault, replacement of the disc drive is recommended.
		Seek may be correct and method of checking for correct seek location may be defective. This could be caused by a read/write fault.

A large number of symptoms could be attributed to the servo circuitry. If the servo is suspected, replacement of the main circuit board with an operational spare is the recommended procedure. If the sealed enclosure is defective there is a high probability that non-servo related faults will also be evidenced, i.e., data errors, failure to come Ready, Fault status set true, etc.

TROUBLESHOOTING WRITE DATA TRANSFER

Symptom	Possible Cause	Suggested Action
Fault is set with each attempt to write data.	Incorrect switch setting or circuit defect.	See Paragraph IV-F for causes of Fault condition and troubleshooting description. Multiple heads selected can be checked at TP20 which will be high if more than one head is selected. Act Unsafe condition is checked at TP17 which will be high if there are no write transitions with Write Gate true or write transitions with Write Gate false.
Data is written incorrectly and fault does not Set.	Read data difficulty	See following section, Read Data Fault.

Read Data Transfer

Symptom	Possible Cause	Suggested Action
Reads header fields and data fields correctly, but will not read newly written data.	Defect in write operation.	See Write Data Transfer above and Paragraph IV-F if Fault is set during write operation.
Fails to read, but will perform a write operation without a Fault.	Defect in Read circuitry	Check all cable connections. Replace main circuit board. Replace terminator.
See suggested action column.		If read error persists after replace- ment of main circuit and terminator boards and if cable connections are correct, it is possible that the format being used is erroneous. If format is correct, replacement of the disc drive is recommended.

SECTION V

REPLACEMENT PARTS

A. INTRODUCTION

Replaceable subassembly part numbers are given below. Additional part number information and/or a bill of material listing, for customers establishing depot repair, is available from PRIAM's Customer Service Department.

B. DESCRIPTION OF PARTS

The replaceable standard modules in the DISKOS 3350 are listed below. These modules may be replaced using standard hand tools.

Description	Part Number
Main Circuit Board	200113
Head/Disc Assembly	330330
Motor Control Assembly	200083
Photocell Circuit Board	200053
Frame Asm.	330397

The replaceable optional items listed below, may also be replaced with standard hand tools.

Description	Part Number
Power Supply	330358
Power Cord	101116
Mounting Slides	330143
Terminator	200133

C. ORDERING INFORMATION

Orders for spare parts may be placed with your PRIAM Sales Representative or with the PRIAM Customer Service Department at the factory.