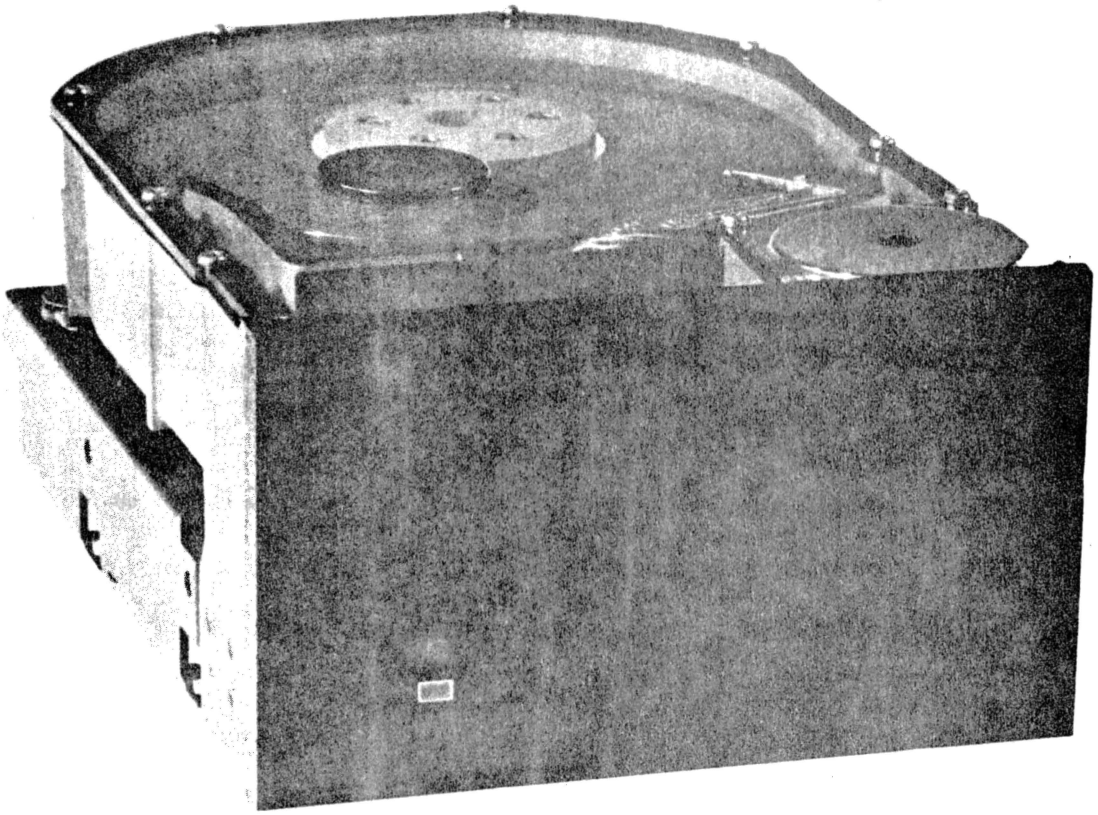


PRODUCT SPECIFICATION
5¼" RIGID DISK DRIVES
MODEL NUMBERS TM501, TM502, AND TM503
345 TRACKS PER INCH

1. PRODUCT DESCRIPTION

The TM500 family of disk drives are low cost, compact units that use a moving head, noncontact recording with standard Winchester technology on a 5¼-inch rigid media. The form factor and voltage requirements for the drive are identical to those of Tandon Corporation's TM100 series of flexible disk drives.

The storage media is contained within the drive in a fixed, nonoperator removable, configuration.

2. FUNCTIONAL CHARACTERISTICS

2.1 DISK ROTATION

The media is rotated at 3,600 RPM ± 1 percent by a direct drive brushless D.C. motor, giving and average latency of 8.3 milliseconds.

2.2 HEAD POSITIONING

Head positioning is by a split band, open loop, rotary positioning system. The track-to-track step time is two (2) milliseconds plus fifteen (15) milliseconds for head settling time after the last step of a seek. Heads automatically reposition to Track 000 at power up.

Multiple track access time can be reduced with the Buffered Seek microprocessor (see page 13).

2.3 START/STOP

The drive reaches its operating speed 15 seconds after power is applied to the drive circuitry. In addition, the disk stops rotating within 15 seconds after power is removed from the motor drive circuitry. A solenoid-operated, mechanical brake is provided for rapid spindle deceleration, and to preclude the possibility of head or disk damage during shipping.

2.4 AIR FILTRATION

A self-contained, recirculating air filtration system supplies clean air through a 0.3 micron filter. A secondary absolute filter is provided to allow pressure equalization with the ambient atmosphere without contamination. The entire head-disk-actuator compartment is maintained at a slightly positive pressure to further ensure an ultraclean environment.

2.5 MEDIA

The media consists of one (1), two (2), or three (3) lubricated 5¼-inch platters, providing two (2), four (4), or six (6) recording surfaces, respectively.

2.6 STORAGE CAPACITY

The storage capacities are listed in Table 1. Capacity is the maximum number of bytes that can be recorded irrespective of any gaps and formatting.

TABLE 1

STORAGE CAPACITIES

	MODEL NUMBER		
	TM501	TM502	TM503
At 32 sectors/track, 256 bytes/sector :	5 Meg	10 Meg	15 Meg
CAPACITY, UNFORMATTED			
PER DRIVE	6.38 MB	12.75 MB	19.14 MB
PER SURFACE	3.19 MB	3.19 MB	3.19 MB
PER TRACK	10.4 KB	10.4 KB	10.4 KB
NUMBER OF			
PLATTERS	1	2	3
ACTIVE DATA SURFACES	2	4	6
MAXIMUM FLUX REVERSAL DENSITY	9090 FRPI	9090 FRPI	9090 FRPI
TRACK DENSITY	345 TPI	345 TPI	345 TPI
CYLINDERS	306	306	306
TRACKS	612	1224	1836
READ/WRITE HEADS	2	4	6
DATA TRANSFER RATE	5.0 MBITS/ SECOND	5.0 MBITS/ SECOND	5.0 MBITS/ SECOND

2.7 ERROR RATES

SOFT AND HARD READ ERROR RATES, EXCLUSIVE OF MEDIA DEFECTS

When the drive is operated in the specified environment, the read error rates are:

For data that has been verified previously as error free, and when used in conjunction with a data separator and phase lock loop of good design, the recoverable (soft) read error rate for any subsequent read operation shall not exceed one error in $1X10^{10}$ bits transferred. A recoverable read error is an error that may be corrected within five attempts to reread the data.

The nonrecoverable (hard) read error rate shall not exceed one error in $1X10^{12}$ bits transferred. A nonrecoverable read error is an error that may not be corrected within five attempts to reread data, providing that the writing of the data previously had been verified as correct.

MEDIA DEFECTS

A media defect is a persistent, nonrecoverable error that occurs on the same track and at the same radial position.

The controller, not supplied, shall ensure that tracks or sectors which contain media defects are "skipped" and not used for storage of usable data or control information.

There will be no errors on Track 000. There will be errors on no more than three (3) tracks per surface, not to exceed eight (8) per drive.

SEEK ERROR RATE

The seek error rate is not to exceed one error in $1X10^6$ seeks.

2.8 PHYSICAL CHARACTERISTICS

SIZE AND WEIGHT

Height: 3.25 inches (82.6 millimeters), excluding front panel

Width: 5.75 inches (146.1 millimeters), excluding front panel

Length: 8.00 inches (203.2 millimeters), excluding front panel

Weight: 6.5 pounds (3.0 kilograms) maximum

MOUNTING

The disk drive may be mounted either vertically on either side or horizontally with the printed circuit board on the bottom.

Disk drive dimensions and mounting holes are shown in Figure 1.

ENVIRONMENTAL SPECIFICATIONS

Ambient Temperature

Operating: 39° F to 122° F (4° C to 50° C)
Nonoperating: −40° F to 140° F (−40° C to 60° C)

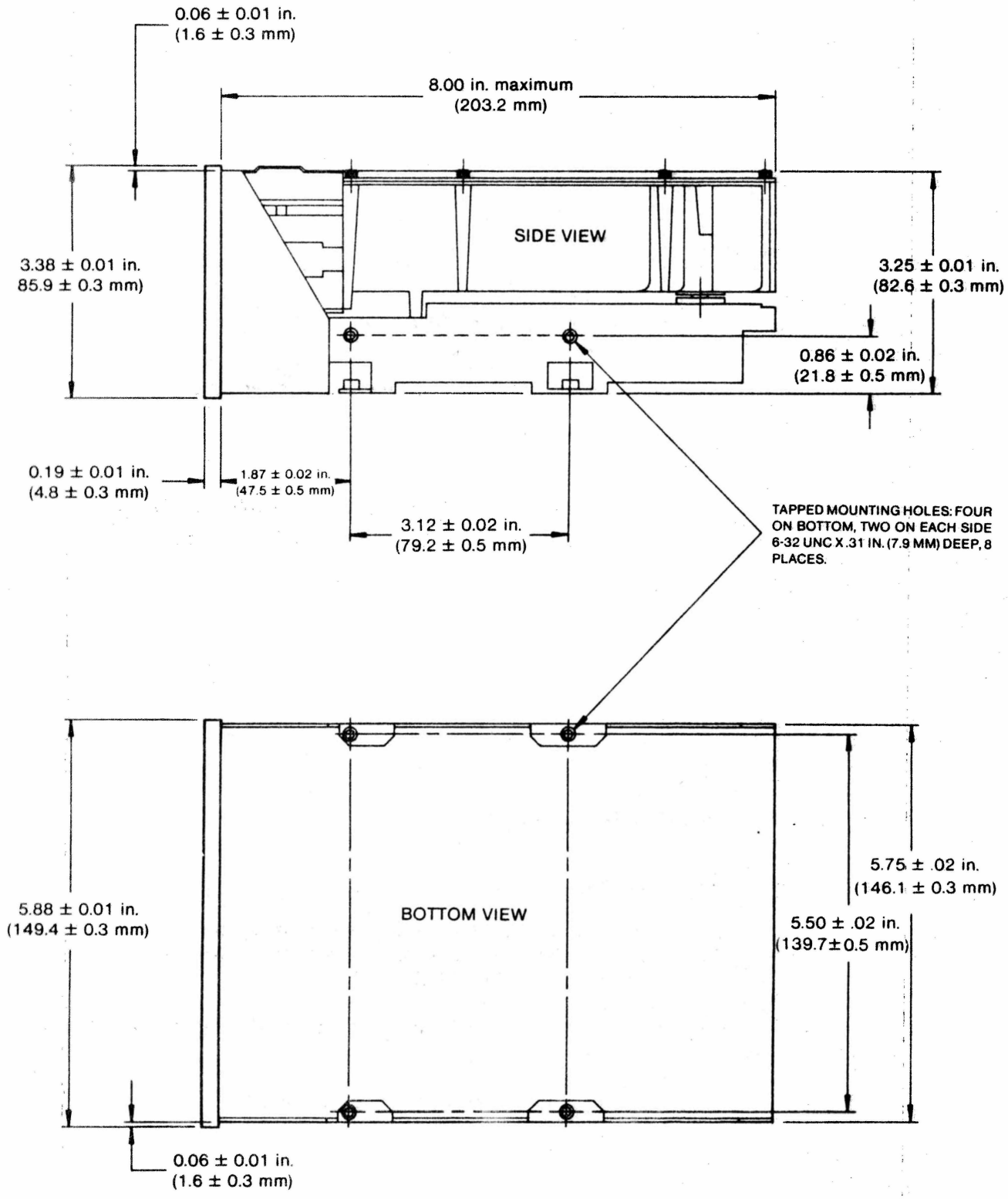


Figure 1
Disk Drive Dimensions and Mounting Holes

Temperature Gradient

Operating: 18° F per hour (10° C per hour)
Nonoperating: Below that causing condensation.

Relative Humidity: 8-to-80 percent (noncondensing)

Relative Humidity Gradient

Operating: 20 percent per hour
Nonoperating: Below that causing condensation.

Maximum Wet Bulb Temperature: 78.8° F (26° C) without condensation.

Elevation

Operating: Density-Altitude — 1500-to-9750 feet (-457-to-2972 meters)
Nonoperating: Sea Level-to-12000 feet (Sea Level-to-3650 meters)

2.9 RELIABILITY

MTBF: 11000 power-on hours

MTTR: 0.5 hour

Component Design Life: 5 years

Preventative Maintenance: Not required

3. POWER REQUIREMENTS

+ 12 volts D. C. ± 10 percent, 1.5 amps typical, 5 amps maximum during motor start-up (see Figure 2), not to exceed 12 seconds, 2.0 amps maximum running, with no more than 50 millivolts Periodic and Random Deviation (PARD).

+ 5 volts D. C. ± 5 percent, 0.8 amp typical, 1.2 amps maximum running, with no more than 50 millivolts PARD.

There are no restrictions in sequencing power supplies on or off.

4. PHYSICAL INTERFACE

The electrical interface between the TM501, TM502, or TM503 and the host system is via four connectors; J1 provides control signals for the drive; J2 provides for radial connection of read/write data signals; J3 provides for D. C. power; and J4 provides for frame ground. See Figure 2 for connector locations.

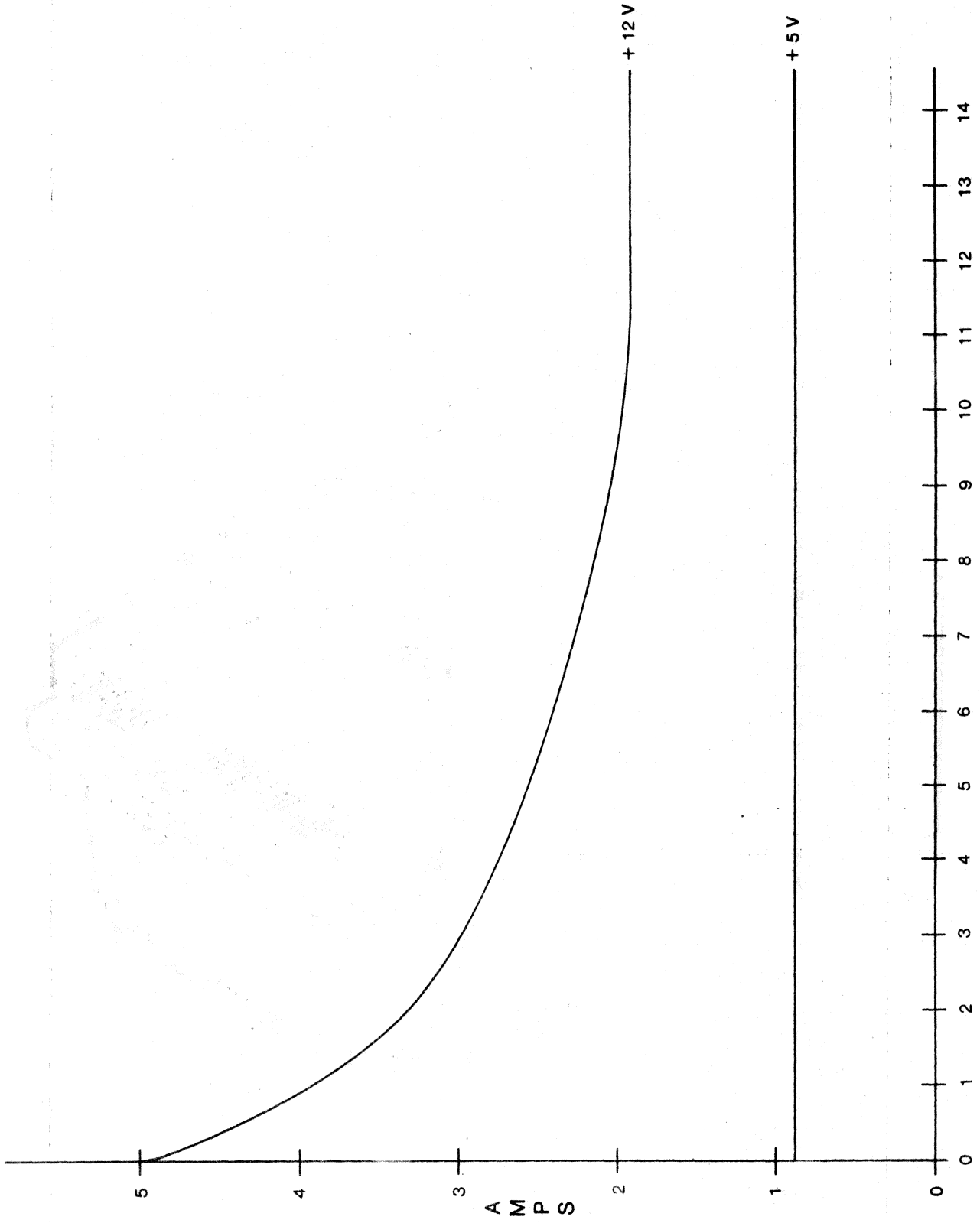


Figure 2
Typical Starting Current At Nominal Voltage

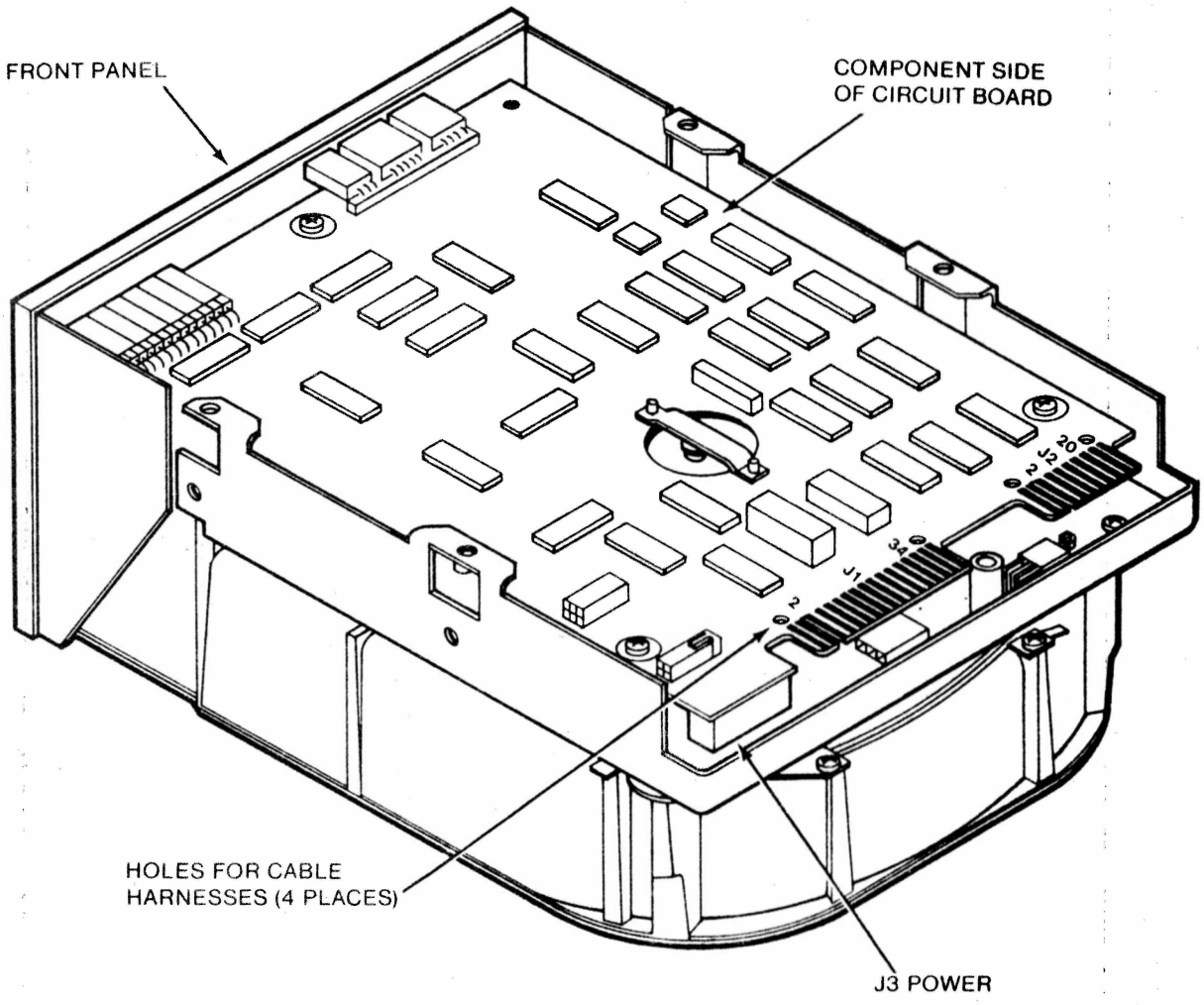


Figure 3
Interface Connector Locations

4.1 J1/P1 CONNECTOR

Connection to J1 is through a 34-pin circuit board connector. The dimensions for this connector are shown in Figure 4. The pins are numbered 1 through 34. The even pins are located on the component side of the circuit board. Pin 2 is located on the end of the circuit board connector closest to the D.C. power connector J3/P3, and is labeled. A key slot is provided between Pins 4 and 6. The recommended mating connector for P1 is 3M ribbon connector P/N 3463-0001, without ears.

4.2 J2/P2 CONNECTOR

Connection to J2 is through a 20-pin circuit board edge connector. The dimensions for the connector are shown in Figure 5. The pins are numbered 1 through 20. The even pins are located on the component side of the circuit board. The recommended mating connector for P2 is 3M ribbon connector P/N 3461-0001, without ears. A key slot is provided between Pins 4 and 6.

4.3 J3/P3 CONNECTOR

D.C. power connector J3 is a 4-pin AMP Mate-N-Lok connector, P/N 350211-1, mounted on the solder side of the circuit board. The recommended mating connector (P3) is AMP P/N 1-480424-0, utilizing AMP pins P/N 60619-4. J3 pins are labeled on the J3 connector (see Figure 6). J3 cabling must be 18 AWG, minimum.

4.4 J4/P4 FRAME GROUND CONNECTOR

The frame ground connector is Faston AMP P/N 61761-2. The recommended mating connector is AMP P/N 62187-1. To realize error rates, as specified in Section 2.7, J4 must be connected directly to the centrally located system ground via an 18 AWG, minimum, cable.

4.5 INTERFACE LINES AND PIN ASSIGNMENTS

The interface for the TM500 series drive is available in one configuration. It is compatible with industry standard drives. Compatiblity is using the same pin assignment where the signal and function are common. Table 2 contains pin assignments.

The interface may be connected in the Radial or Daisy Chain configuration.

INPUT CONTROL LINES

The input control signals are of two kinds: those to be multiplexed in a multiple drive system and those that do the multiplexing. The input control signals to be multiplexed are: Reduced Write Current, Write Gate, Head Select Line 2^0, Head Select Line 2^1, Head Select Line 2^2, Step, and Direction In. The signal to do the multiplexing is Drive Select 0, Drive Select 1, Drive Select 2 or Drive Select 3.

The input lines have the following electrical specifications as measured at the drive. Figure 7 contains the recommended circuit.

True: 0.0 volt D. C. to 0.4 volt D. C. @ I = −40 milliamperes, maximum

False: 2.5 volts D. C. to 5.25 volts D. C. @ I_L = 250 microamperes, maximum

All input lines share a 220/330 ohm resistor pack for line termination. Only the last drive in the chain should have the resistor pack installed.

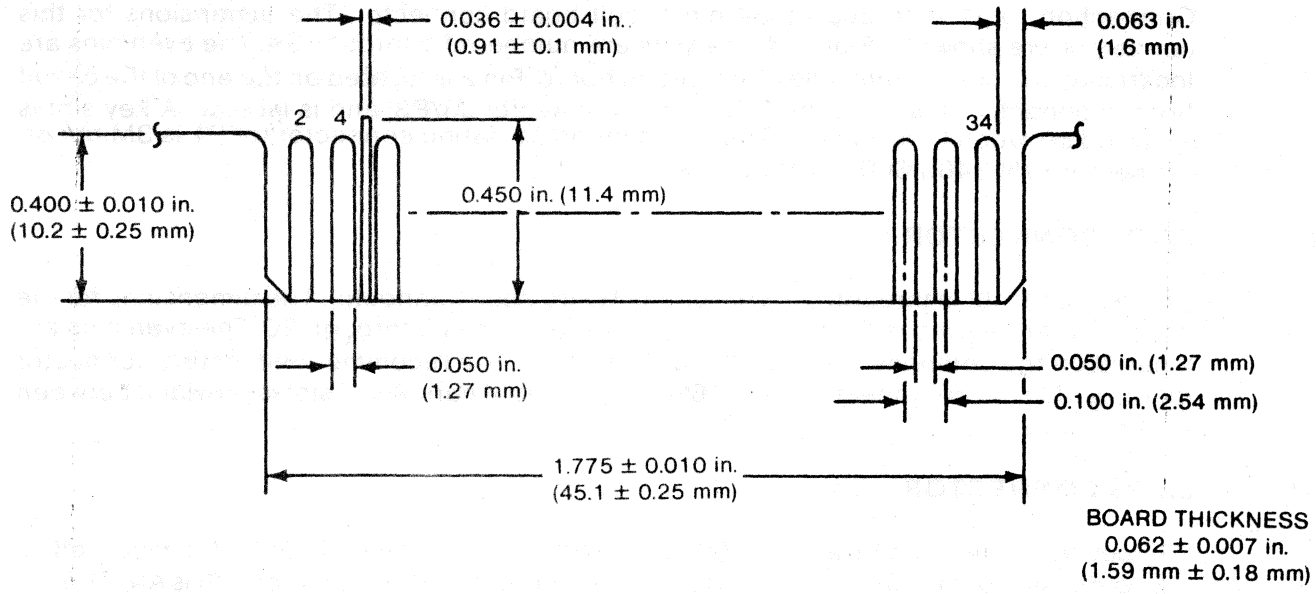


Figure 4
J1 Connector Dimensions

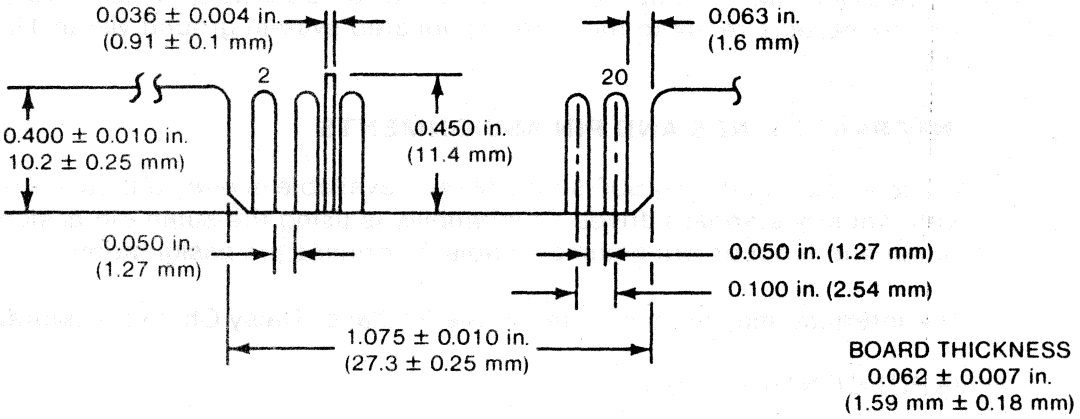
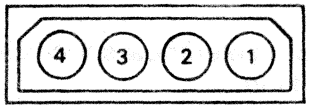


Figure 5
J2 Connector Dimensions



AS SEEN ON DRIVE CIRCUIT BOARD, SOLDER SIDE.

Figure 6
J3 Connector

TABLE 2

TM500 SERIES INTERFACE

Connector	Interface Pin Number Signal	Ground	Signal Type	I/O	Name of Signal
P1	2	(1)	S	I	Spare
↑	4	(3)	S	I	Head Select 2^2
	6	(5)	S	I	Write Gate
	8	(7)	S	O	Seek Complete
	10	(9)	S	O	Track 000
34-Pin	12	(11)	S	O	Fault
Ribbon	14	(13)	S	I	Head Select 2^0
Daisy	16	(15)	–	–	Reserved (To J2-7)
Chain	18	(17)	S	I	Head Select 2^1
↓	20	(19)	S	O	Index
	22	(21)	S	O	Ready
	24	(23)	S	I	Step
	26	(25)	S	I	Drive Select 0
	28	(27)	S	I	Drive Select 1
	30	(29)	S	I	Drive Select 2
	32	(31)	S	I	Drive Select 3
P1	34	(33)	S	I	Direction In
P2	1	(2)	S	O	Drive Selected
↑	3	(4)	S	–	Spare
	5	(6)	–	–	Reserved
	7	(8)	–	–	Reserved (To J1-16)
20-Pin	9	(10)	–	–	Spare
Ribbon	11	(12)	–	–	Ground
Radial	13		D	I	+ Write Data
	14		D	I	– Write Data
	15	(16)	–	–	Ground
	17		D	O	+ Read Data
↓	18		D	O	– Read Data
P2	19	(20)	–	–	Ground
P3	1			–	+ 12V D. C. In
↑	2			–	+ 12V D. C. Return
Radial	3			–	+ 5V D. C. Return
↓	4			–	+ 5V D. C. In
P3					

NOTES:

1. S—Single Ended
2. D—Differential
3. I —Drive Input
4. O—Drive Output

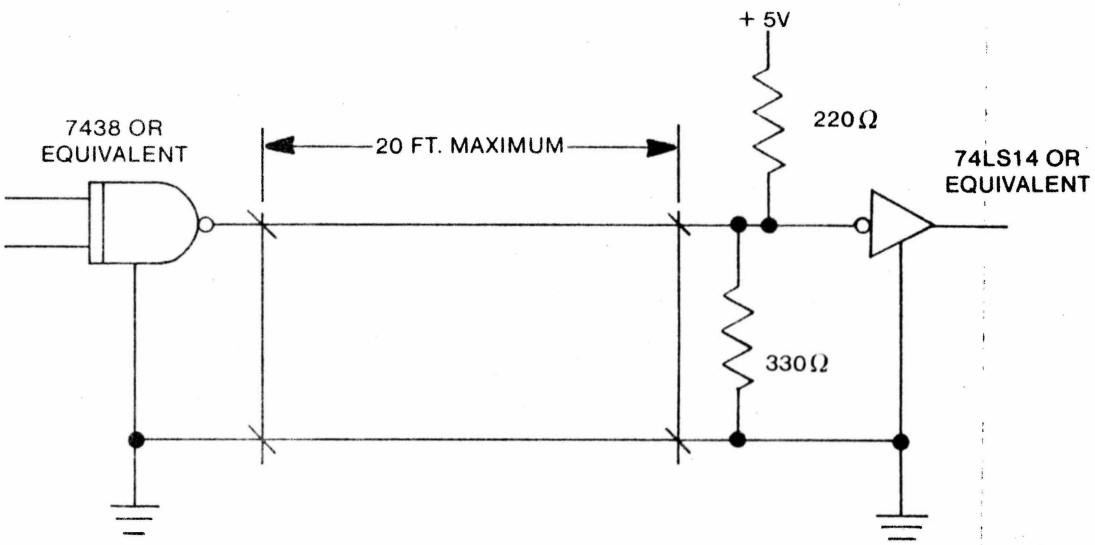


Figure 7
Control Signal/Driver Receiver Circuit Combination

Write Gate

The active state of this signal or logical zero level enables write data to be written on the disk. The inactive state of this signal enables the data to be transferred from the drive. In addition, the inactive state enables the step pulse to step the read/write actuator.

Head Select Lines 2^0, 2^1, 2^2

These three lines provide for the selection of each read/write head in a binary coded sequence. Head Select Line 2^0 is the least significant line. The heads are numbered 0 through 5. When all Head Select Lines are false, Head 0 is selected.

Head recovery time (Head-to-Head Select, Write-to-Read recovery, or Read-to-Write recovery) is 2.4 microseconds maximum.

Step

This interface line is a control signal that causes the read/write head to move with the direction of motion defined by the Direction In line.

The access motion is initiated at the logical true-to-logical false transition or the trailing edge of this signal pulse. Any change in the Direction In line must be made at least 100 nanoseconds before the leading edge of the step pulse. The quiescent state of this line should be held logically false.

The read/write head moves at the rate of the incoming step pulses. The minimum time between successive steps is 2.0 milliseconds, except during execution of a buffered seek. The minimum pulse width is 1.0 microseconds. Figure 8 contains the step timing.

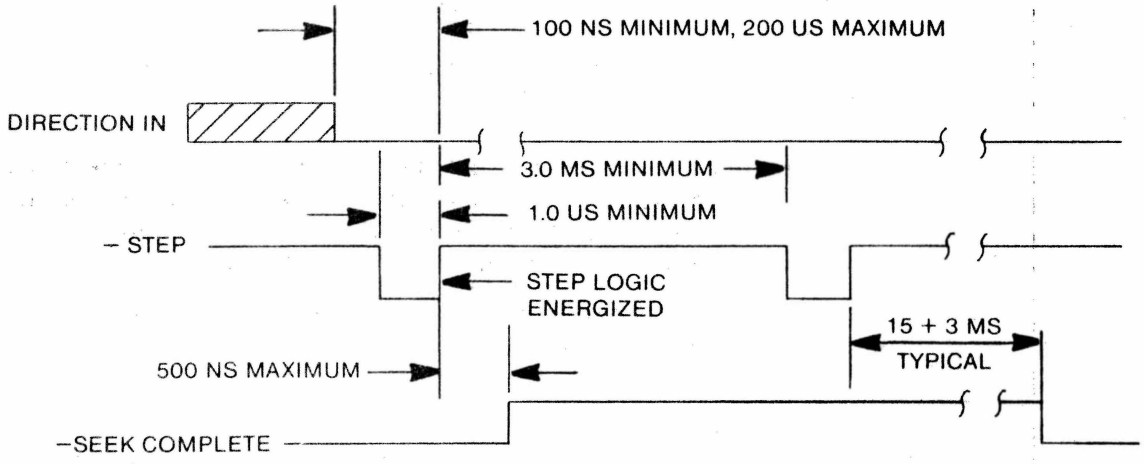


Figure 8
Step Mode Timing

Buffered Seek

The Buffered Seek utilizes an on-board microprocessor that calculates the most efficient seek algorithm for the user. The user need only issue step pulses in accordance with the timing shown below. Step pulses are issued in a 1:1 ratio to the cylinders moved. If more pulses are issued than there are cylinders left to move, the heads soft stop at the last cylinder.

The microprocessor switches reduced write current at cylinder 128 automatically. The reduced write current input lines has been terminated, and is immune to external switching. Figure 9 contains the buffered seek timing.

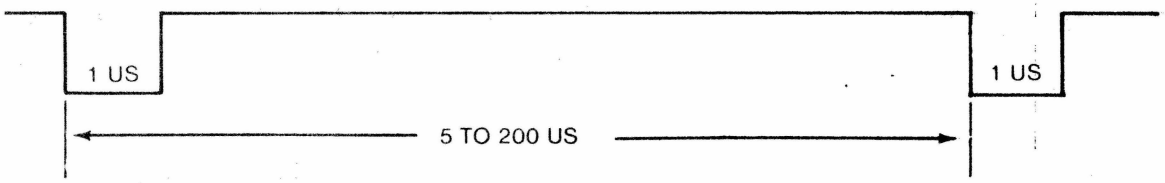


Figure 9
Buffered Seek Timing

Direction In

This signal defines the direction of motion of the read/write head when the Step line is pulsed. An open circuit or logical false defines the direction as "out". If a pulse is applied to the Step line, the read/write heads move away from the center of the disk. If this line is logical true, the direction is defined as "in", and the read/write heads move in toward the center of the disk.

Seek Complete must be true prior to changing directions and the application of additional step pulses.

Drive Select 0 Through Drive Select 3

These control signals enable the selected drive's input receivers and output drivers. When logically false, the output drivers are open circuits or logically false and the input receivers do not acknowledge signals presented to them.

Drive addresses are assigned via a programmable shunt. Selecting the appropriate shunt plug at W9 thorugh W12 determines which select line activates the drive.

NOTE

ONLY ONE DRIVE MAY BE SELECTED AT A TIME.

OUTPUT LINES

The output control signals are driven with an open collector output stage capable of sinking a maxmimum of 40 milliamperes in a logical true state, with a maximum voltage of 0.4 volt measured at the driver. When the line driver is in the logical false state, the driver transistor is off, and the collector cutoff is a maximum of 250 microamperes.

All J1 output lines are enabled by the respective Drive Select lines.

Figure 7 contains the recommended circuit.

Seek Complete

This line goes true when the read/write heads have settled on the final track at the end of a seek. Reading or writing should not be attempted when Seek Complete is false.

Seek Complete goes false:

1. When a recalibration sequence is initiated by drive logic at power on because the read/write heads are not over Track 000.

2. 500 nanoseconds (maximum) after the trailing edge of a step pulse or of a series of step pulses.

3. When power is momentarily lost, Seek Complete is false when power is restored and remains false until an automatic recalibration is completed.

Track 000

This interface signal indicates a true state only when the drive's read/write heads are positioned at Track 000, the outermost data track.

Fault

This signal is used to indicate that a condition exists at the drive that could cause improper writing on the disk. When this line is true, further writing is inhibited, as are other drive functions, until the condition is corrected.

This condition is caused by either the + 12 volt or + 5 volt supply being below the specified limits.

Index

This interface signal is provided by the drive once each revolution (16.7 milliseconds nominal) to indicate the beginning of the the track. Normally, this signal is logical false and makes the transition to logical true to indicate Index. Only the transition from logical false to logical true is valid.

Ready

When true, this interface signal together with Seek Complete, indicates that the drive is ready to read, write or seek, and that the I/O signals are valid. When this line is false, all controller-initiated functions are inhibited.

The typical time after power on for Ready to be true is 15 seconds. Track 000, Seek Complete, and Ready come true sequentially during power on.

Select Status

A status line is provided at the J2/P2 connector to inform the host system of the selection status of the drive.

The Drive Selected line is driven by a TTL open collector driver (see Figure 7). This signal goes active only when the drive is programmed as Drive X (X = 0, 1, 2, or 3) by programming the shunt on the drive, and the Drive Select X line at J1/P1 is activated by the host system.

4.6 DATA TRANSFER LINES

All lines associated with the transfer of data between the drive and the host system are differential in nature and may not be multiplexed. These lines are provided at the J2/P2 connector on all drives.

Signal levels are defined by RS-422A.

Two pairs of balanced lines are used for the transfer of data: MFM Write Data and MFM Read Data. Figure 10 contains the driver/receiver combination used with the drive for Data Transfer signals.

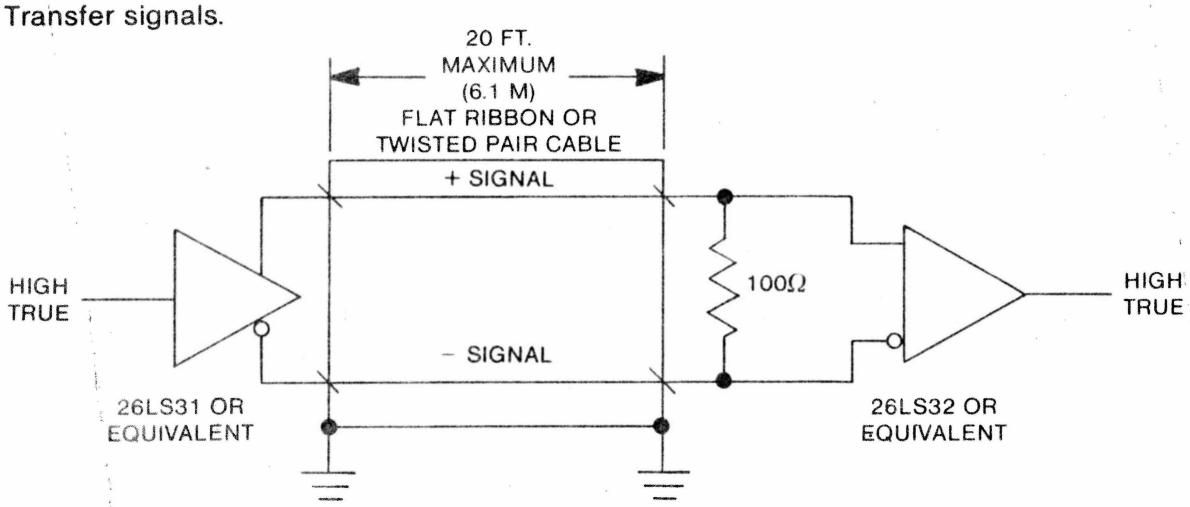


Figure 10
Data Transfer Line Driver Receiver

MFM WRITE DATA

This is a differential pair of lines that defines the flux transition to be written on the track. The transition of the + MFM Write Data line going more positive than the – MFM Write Data line causes a flux reversal on the track if the Write Gate is active. This signal must be driven to an inactive state (+ MFM Write Data more negative than – MFM Write Data) by the host system when in a read mode.

The delay from the leading edge of Write Gate to the Write Data pulse is 400 nanoseconds maximum.

MFM READ DATA

The data recovered by reading a prerecorded track is transmitted to the host system via the differential pair of MFM Read Data lines. The transition of the + MFM Read Data line going more positive than the – MFM Read Data line represents a flux reversal on the track of the selected head.

HARD DISK III

The Leading Edge® Hard Disk III is a 5¼" Winchester disk sub system which can be used on several popular microcomputers. Available in single or dual drive configurations, the Hard Disk III provides the user with storage capabilities of 5 to 30 megabytes. Since it is designed with ease of operation in mind, no user intervention is required (including power up), thus providing substantial additional time for user productivity.

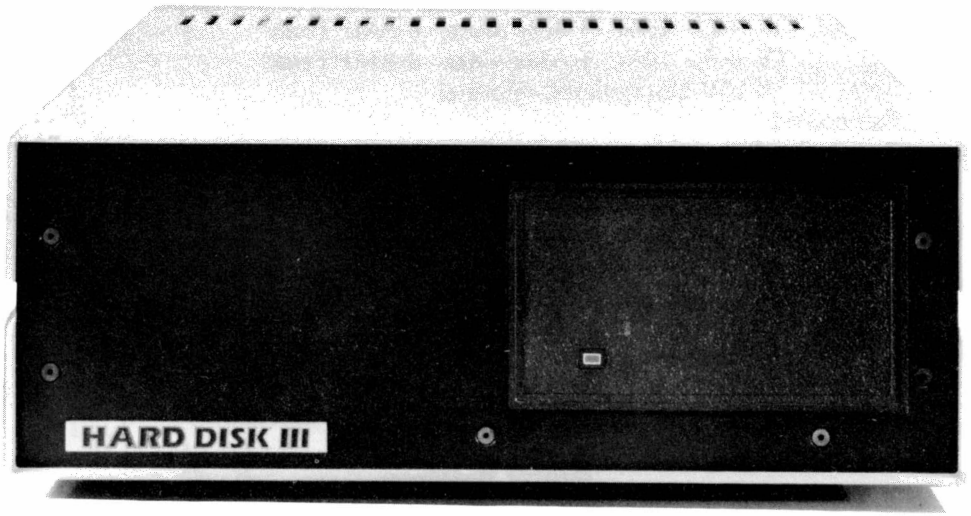
THE HARD DISK III IS COMPRISED OF 5 MAJOR COMPONENTS WHICH ARE AS FOLLOWS:

1. WINCHESTER DISK DRIVE

The 5¼" Winchester disk drive is the heart of the system and utilizes standard Winchester technology and 5¼" rigid media, contained in a sealed chamber with an air filtration system. Typically a drive will have 2 platters providing 4 writing surfaces. Each writing surface has 153 tracks and each track has 32 sectors with 256 bytes per sector providing 5 megabytes of usable storage. The read/write heads are positioned by a precision split band actuator with a track to track access time of 3MS. The 3600 RPM rotational speed of the media yields an average latency of only 8.34MS. MFM encoded data is transferred to and from the drive at a rate of 5 megabits per sec.

2. DISK CONTROLLER

The Hard Disk III features an intelligent disk controller with an on board (Z80A) microprocessor which provides the host system with 18 high level commands. Read sector, write sector, format drive, etc., are some examples of the high level commands which will free the host system for more important tasks. In the case of the read sector command, the host need only pass the number of the desired sector to the controller. The controller will then take care of positioning the heads, reading the sector and performing any required retries or error correction. Error correction is another feature not found in many hard disk systems. The controller will correct errors up to 11 bits in length and provide guaranteed detection of 22 bit burst errors. Also contained in the controller is a highly stable phase locked loop data separator. The data transfer rate between the controller and drive is at 5 megabits per second, while the controller to host system transfer rate is limited largely by the host processor. For example, on the TRS-80 Model III which has a 2 megaherz Z80 processor, the data rate is limited to 100K bytes per second. On the IBM PC computer's 5 megahertz 8088 processor the transfer rate can approach the 1 megabyte per second limit of the controller. This controller is a hard disk controller only, and is incapable of operating mini floppy disk drives, since it handles data transfers at a rate 20 to 40 times that of mini floppy disk drives.



HARD DISK III

HARD DISK III

3. POWER SUPPLY

The Hard Disk III power supply is a heavy duty linear supply which can provide more enough power for 2 Winchester disk drives. The supply will run on 50 or 60 hertz and is jumper selectable for 115 to 230 volt operation. Also a power line noise filter and solid state relay for auto power up are included.

4. HOST ADAPTER

The host adapter provides the interfacing and timing required between the controller and the I/O bus. It also contains the power sensing circuitry for the automatic power on feature of the Hard Disk III. The host adapter incorporates a gold edge card connector.

5. ENCLOSURE

The enclosure provides a smart housing for the Hard Disk III components. It is constructed entirely of heavy guage metal (3/32" aluminum) and features an integral 2 pass forced air cooling system. A black anodized faceplate and inner chassis are combined with a painted outer shell to match the host system.

SPECIFICATIONS

Hard Disk III

CONTROLLER

Microprocessor based Z80A — NO!
Full sector buffer 256 - 512 bytes
Hardware 32 bit ECC polynomial with 11 bit burst correction
Field proven data separator
ST 506 interface
Automatic retries on disk access
Internal diagnostics
High level command set
Variable sector interleave

POWER SUPPLY

200 VA MAX
Input voltage 115/230 (102-140/204-280)
Output 12V +/− 10% 5 AMP Com 8 AMP Peak
5V +/− 10% 5 AMP Com 8 AMP Peak
−16V Unregulated optional
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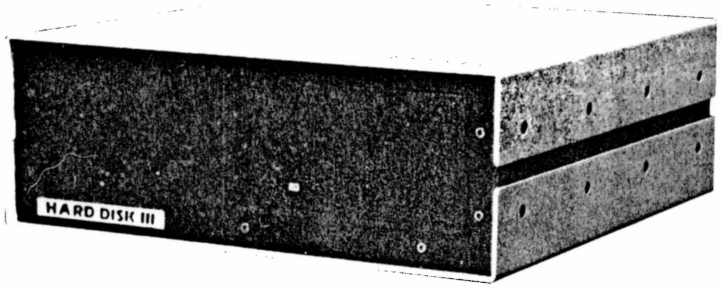

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