

PRODUCT SPECIFICATIONS
5-1/4" RIGID DISK DRIVES
MODEL NOS. TM602S, TM603S, AND TM603SE
255 TRACKS PER INCH

1. **PRODUCT DESCRIPTION**

The TM600 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 that of Tandon Corporation's TM100 family of flexible disk drives.

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

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2. **FUNCTIONAL CHARACTERISTICS**

2.1 **DISK ROTATION**

The media is rotated at 3,600 RPM \pm 1 percent by a direct drive brushless D. C. motor, giving an average latency of 8.3 milliseconds. Multiple track access time can be reduced with the use of a Ramped Seek algorithm.

2.2 **HEAD POSITIONING**

Head positioning is by a split band, open loop, rotary positioning system. The track-to-track step time is 3 milliseconds plus 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 use of a ramped seek algorithm. An optional Buffered Seek is available (see Section 4.7).

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 two (2) or three (3) lubricated 5¼-inch platters, providing 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 No. TM602S	Model No. TM603S	Model No. TM603SE
CAPACITY, UNFORMATTED			
PER DRIVE	6.4 MB	9.6 MB	14.4 MB
PER SURFACE	1.6 MB	1.6 MB	2.4 MB
PER TRACK	10.4 KB	10.4 KB	10.4 KB
NUMBER OF			
PLATTERS.....	2	3	3
ACTIVE DATA SURFACES	4	6	6
MAXIMUM FLUX REVERSAL DENSITY	7690 FRPI	7690 FRPI	9625 FRPI
	303 FR/MM	303 FR/MM	379 FR/MM
TRACK DENSITY	255 TPI	255 TPI	255 TPI
	10 TP/MM	10 TP/MM	10 TP/MM
CYLINDERS.....	153	153	153
TRACKS.....	612	918	1380
READ/WRITE HEADS.....	4	6	6
DATA TRANSFER RATE	5.0 MB/SEC.	5.0 MB/SEC.	5.0 MB/SEC.

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 1×10^{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 1×10^{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) tracks.

SEEK ERROR RATE

The seek error rate is not to exceed one error in 1×10^6 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)

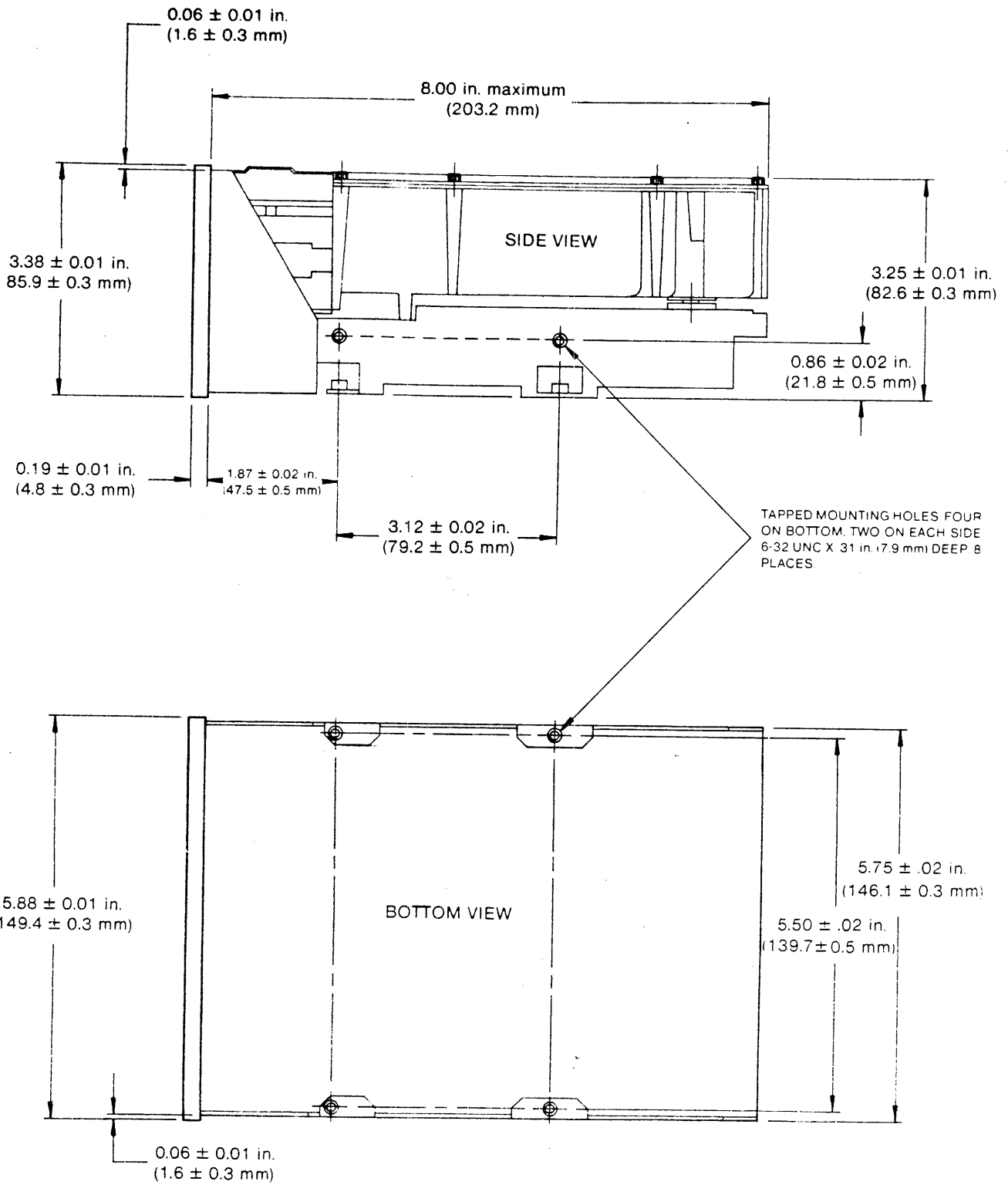


Figure 1
Disk Drive Dimensions and Mounting Holes

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 — 1,500-to-9,750 ft. (-457-to-2,972 m)
Nonoperating: — Sea Level-to-12,000 ft. (Sea Level-to-3,650 m)

Shock

Operating: 10 g's for 10 milliseconds, 3 axes (see Figure 2)
Nonoperating: 30 g's for 30 milliseconds, X and Y axes
20 g's for 30 milliseconds, Z axis

2.9 RELIABILITY

MTBF: 11,000 power-on hours

MTRR: 0.5 hour

Component Design Life: 5 years

Preventative Maintenance: Not required

3. POWER REQUIREMENTS

+ 12 volts D. C. \pm 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. \pm 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 TM600 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 3 for connector locations.

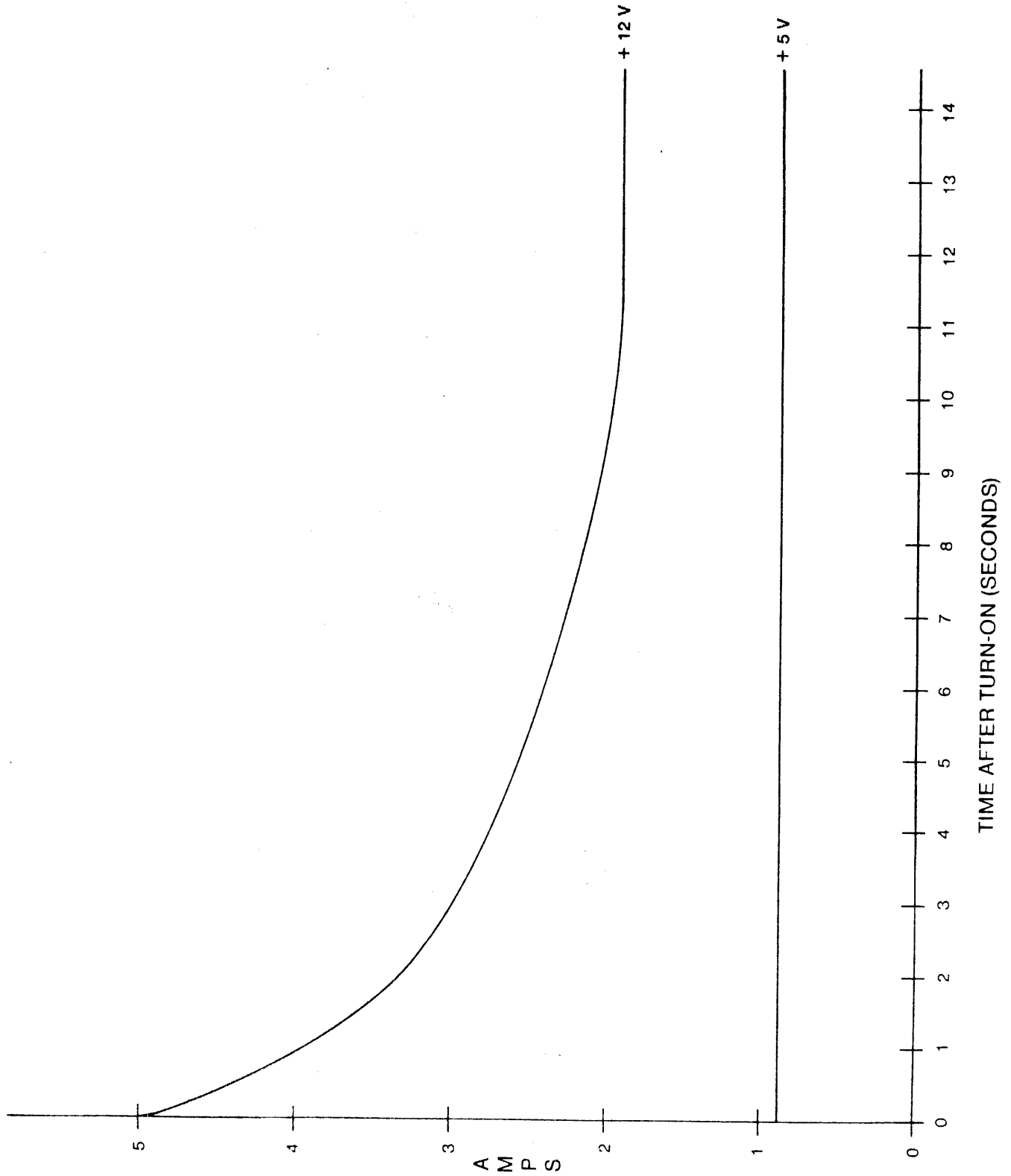


Figure 2
 TM600 Series Typical Starting Currents
 At Nominal Voltage

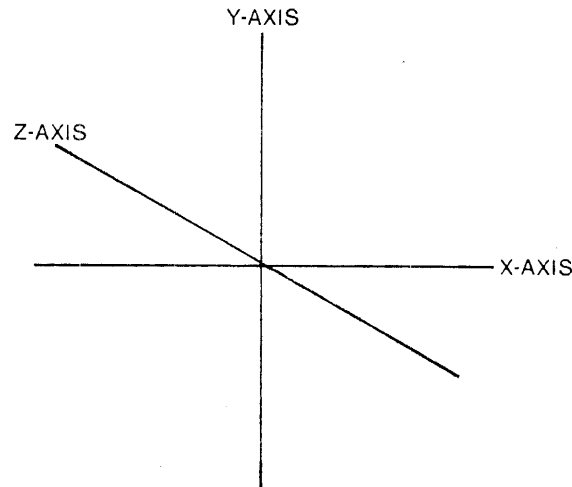
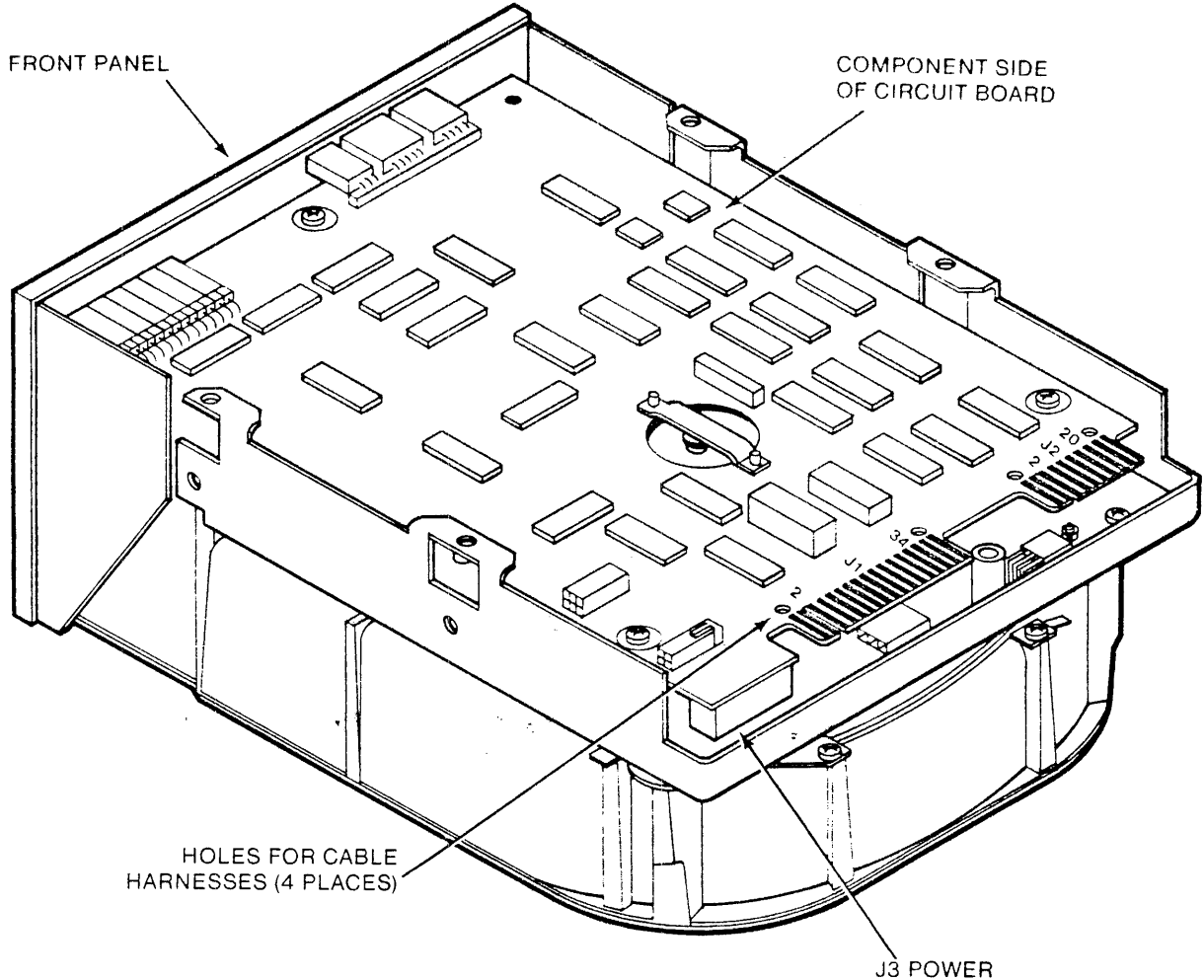


Figure 3
Interface Connector Locations

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 18AWG, 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 2.7.1, 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 TM600 series drive is available in one configuration. It is compatible with industry standard drives. Compatibility 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.

CONTROL INPUT LINES

The control input signals are of two kinds: those to be multiplexed in a multiple drive system and those that do the multiplexing. The control input signals to be multiplexed are: Reduced Write Current, Write Gate, Head Select Line 2⁰, Head Select Line 2¹, Head Select Line 2², 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 volts 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.

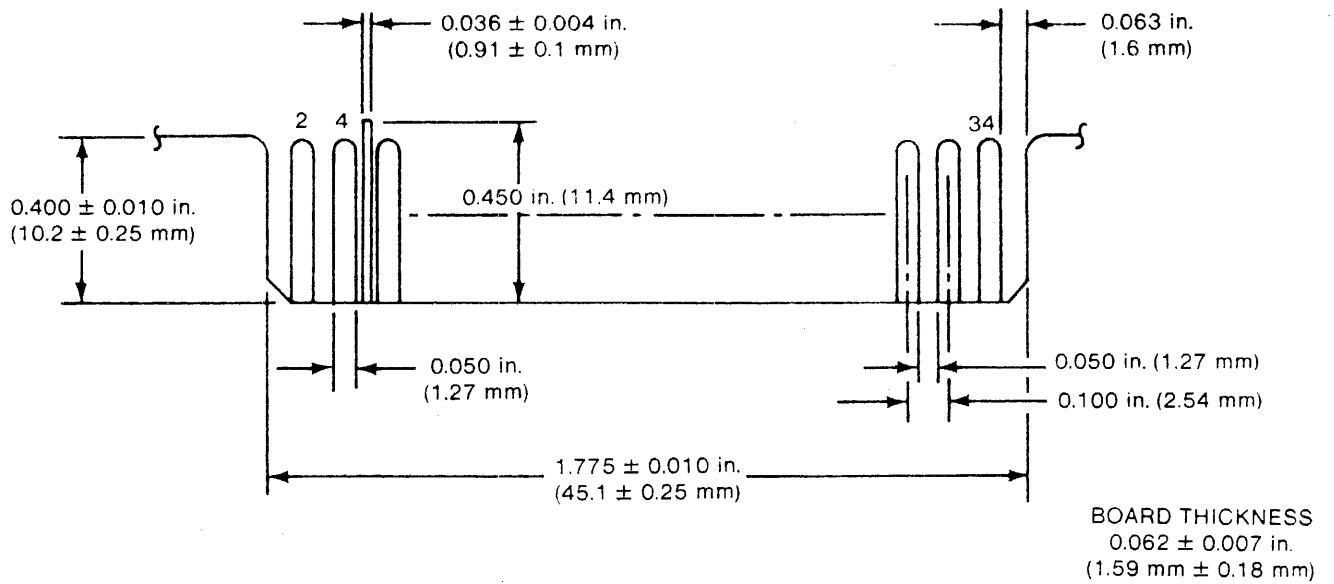


Figure 4
J1 Connector Dimensions

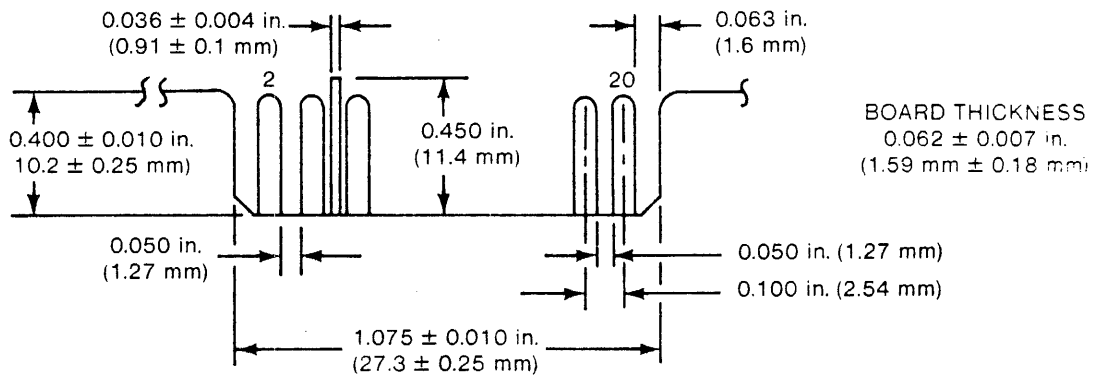
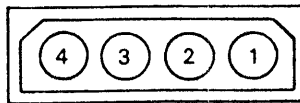


Figure 5
J2 Connector Dimensions



AS SEEN ON DRIVE CIRCUIT BOARD, SOLDER SIDE.

Figure 6
J3 Connector

TABLE 2
TM600 SERIES INTERFACE

Connector	Interface: Pin Number		Signal Type	I/O	Name of Signal
	Signal	Ground			
P1 ↑ 34-Pin Ribbon Daisy Chain ↓ P1	2	(1)	S	I	Reduce Write 1
	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
	12	(11)	S	O	Fault
	14	(13)	S	I	Head Select 2 ⁰
	16	(15)	—	—	Reserved (To J2-7)
	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	
34	(33)	S	I	Direction In	
.....					
P2 ↑ 20-Pin Ribbon Radial ↓ P2	1	(2)	S	O	Drive Selected
	3	(4)	S	—	+ 5V-Reserved
	5	(6)	—	—	Reset Test Point
	7	(8)	—	—	Reserved (To J1-16)
	9	(10)	—	—	Spare
	11	(12)	—	—	Ground
	13		D	I	+ Write Data
	14		D	I	- Write Data
	15	(16)	—	—	Ground
	17		D	O	+ Read Data
18		D	O	- Read Data	
19	(20)	—	—	Ground	
.....					
P3 ↑ Radial ↓ P3	1			—	+ 12V D. C. In
	2			—	+ 12V D. C. Return
	3			—	+ 5V D. C. Return
	4			—	+ 5V D. C. In

NOTES:

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

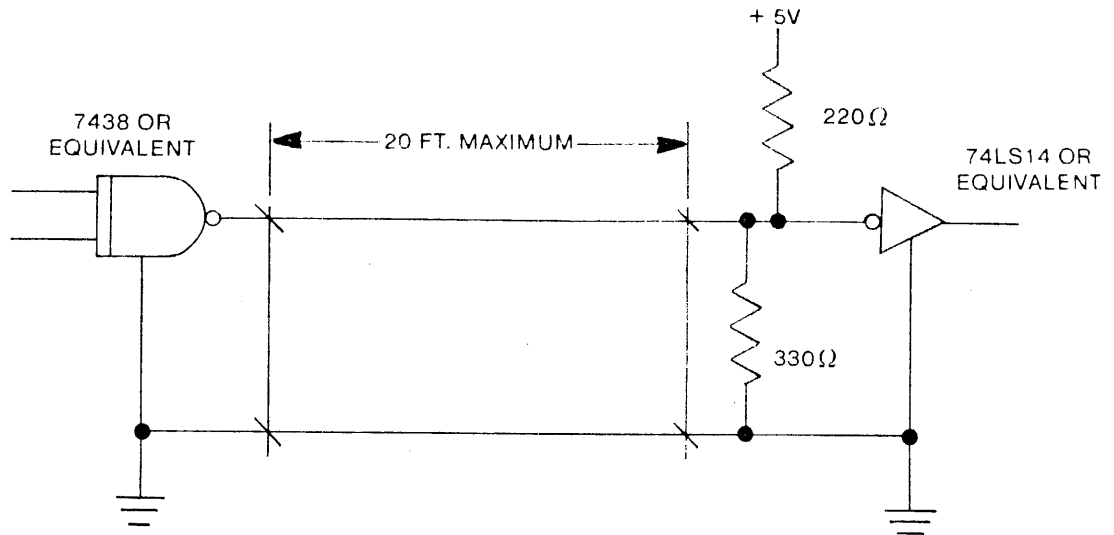


Figure 7
Control Signal/Driver Receiver Circuit Combination

Reduced Write Current

When active, this line, together with Write Gate, causes the write circuitry to write on the disk with a lower write current. It is recommended that this line be set true when writing is to be done on cylinders 128 and higher, and set false when writing is to be done on cylinders 0 through 127 of the TM602S and TM603S drives. The same is true for the TM603SE drive, except that the Reduced Write Current line is set false when writing is to be done on cylinders 0 through 191.

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.

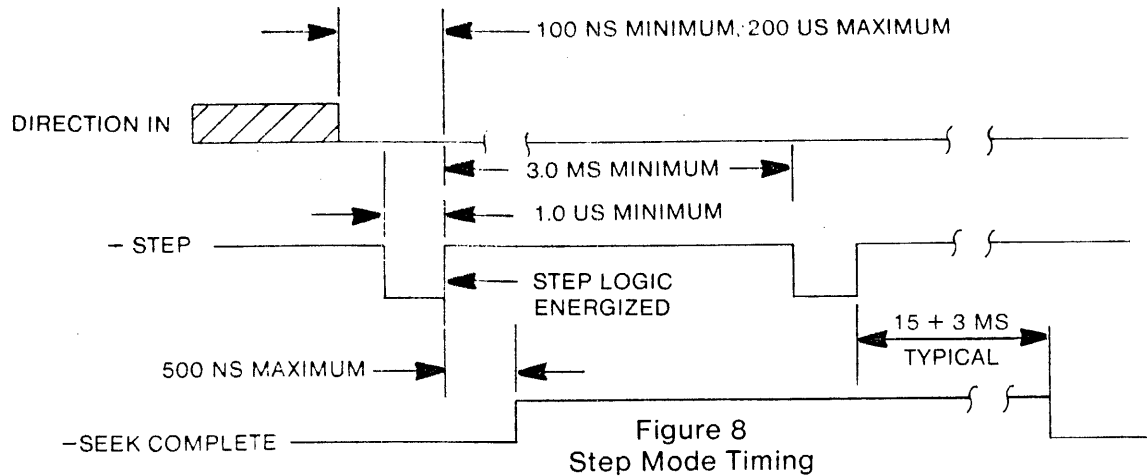
Head recovery time (Head-to-Head Select, Write-to-Read recovery, or Read-to-Write recovery) is 2.4 microseconds maximum.

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 3.0 milliseconds, except during execution of a ramped seek. The minimum pulse width is 1.0 microseconds. Figure 8 contains the step timing.



Buffered Seek Option

The Buffered Seek Option utilizes an on-board microprocessor that calculates the most 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 reduce 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.

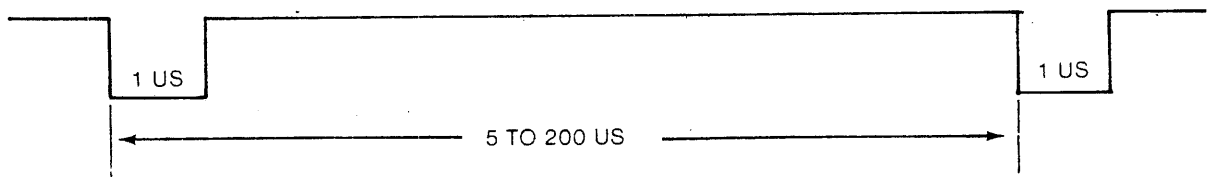


Figure 9
Buffered Seek Timing

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. Cutting the appropriate shunts at IC position U21 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 maximum of 40 milliamperes in a logical true state, with a maximum voltage of 0.4 volt measured at the driver. When the line drive 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 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.

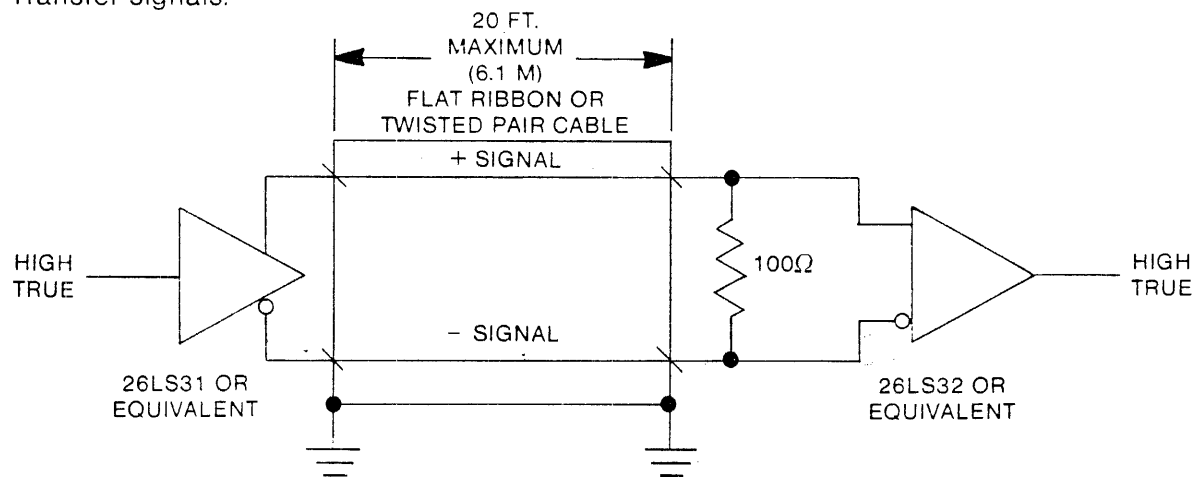


Figure 10
Data Transfer Line Driver Receiver

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.

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