

WANG

3111

**CUSTOMER ENGINEERING REPRINT
PRODUCT MAINTENANCE MANUAL**

**TANDON
TM602S AND TM603S
5-1/4" RIGID DISK DRIVES, 254 TPI**

NOTICE

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729-1188

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 5-1/4 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.

The following specifications are subject to change without notice.

2. **FUNCTIONAL CHARACTERISTICS**

DISK ROTATION

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

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.

START / STOP

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

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.

MEDIA

The media consists of two (2) or three (3) lubricated 5-1/4 inch platters, providing four (4) or six (6) recording surfaces, respectively.

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
CAPACITY, UNFORMATTED		
PER DRIVE	6.4 MB	9.6 MB
PER SURFACE	1.6 MB	1.6 MB
PER TRACK	10.4 KB	10.4 KB
NUMBER OF		
PLATTERS	2	3
ACTIVE DATA SURFACES	4	6
MAXIMUM FLUX REVERSAL DENSITY	7690 FRPI (303 FR/mm)	
TRACK DENSITY	254 TPI (10 TP/mm)	
CYLINDERS	153	
TRACKS	612	918
READ/WRITE HEADS	4	6
DATA TRANSFER RATE	5.0 MB/sec	5.0 MB/sec

ERROR RATES

SOFT AND HARD READ ERROR RATES

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 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 0 and on Track 1. There will be errors on no more than four (4) tracks per surface.

SEEK ERROR RATE

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

PHYSICAL CHARACTERISTICS

SIZE AND WEIGHT

Height: 3.25 in. (82.6 mm), excluding front panel

Width: 5.75 in. (146.1 mm), excluding front panel

Length: 8.00 in. (203.2 mm), excluding front panel

Weight: 6.5 lbs. (3.0 kg) maximum

ENVIRONMENTAL SPECIFICATIONS

Ambient Temperature

Operating: 41° F to 115°F (5°C to 46°C)

Nonoperating: -40°F to 140°F (-40°C to 60°C)

Temperature Gradient

Operating: 10.8°F/hr. (6°C/hr.)
Nonoperating: 18°F/hr. (10°C/hr.) maximum, noncondensing.

Relative Humidity: 8% to 80%

Relative Humidity Gradient

Operating: 20%/hr.
Nonoperating: Below that causing condensation.

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

Elevation

Operating: Density Altitude -1,500 ft. to 9,750 ft. (-457 m to 2,972 m)
Nonoperating: Sea level to 12,000 ft. (3,658 m)

Shock, Nonoperating: 5g for 5 mS, 3 axis

RELIABILITY

MTBF: 11,000 power-on hours

MTTR: 0.5 hour

3. **POWER REQUIREMENTS**

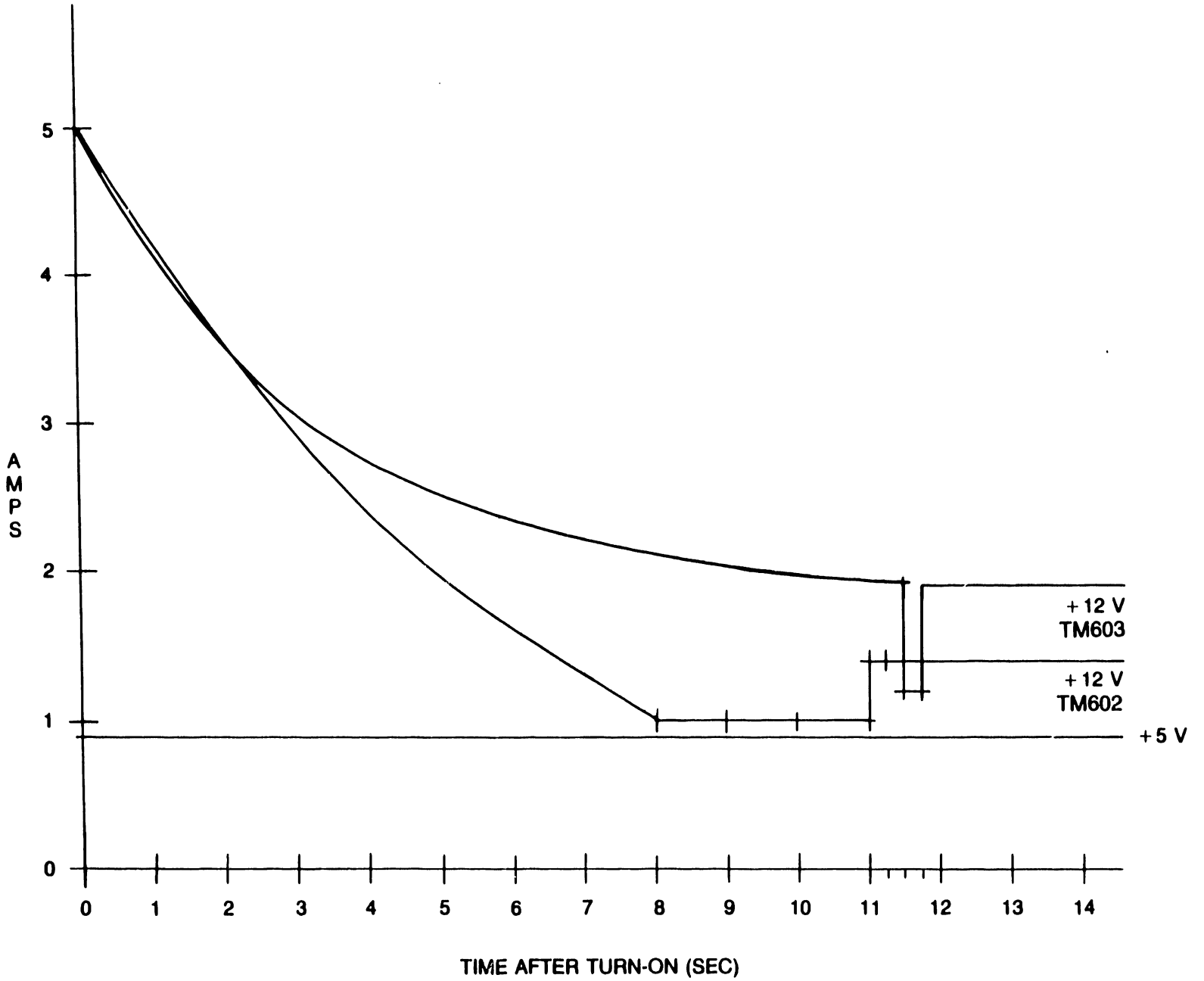
+12VDC \pm 5%, 1.5 amps typical, 5 amps during motor start-up (see Figure 1), not to exceed 12 seconds, 2.0 amps maximum running, with no more than 50 mV Periodic and Random Deviation (PARD).

+5VDC \pm 5%, 1.0 amp typical, 1.2 amps maximum running, with no more than 50 mV PARD.

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 2 for connector locations.

Figure 1
TM600 Typical Starting
Currents At Nominal Voltage



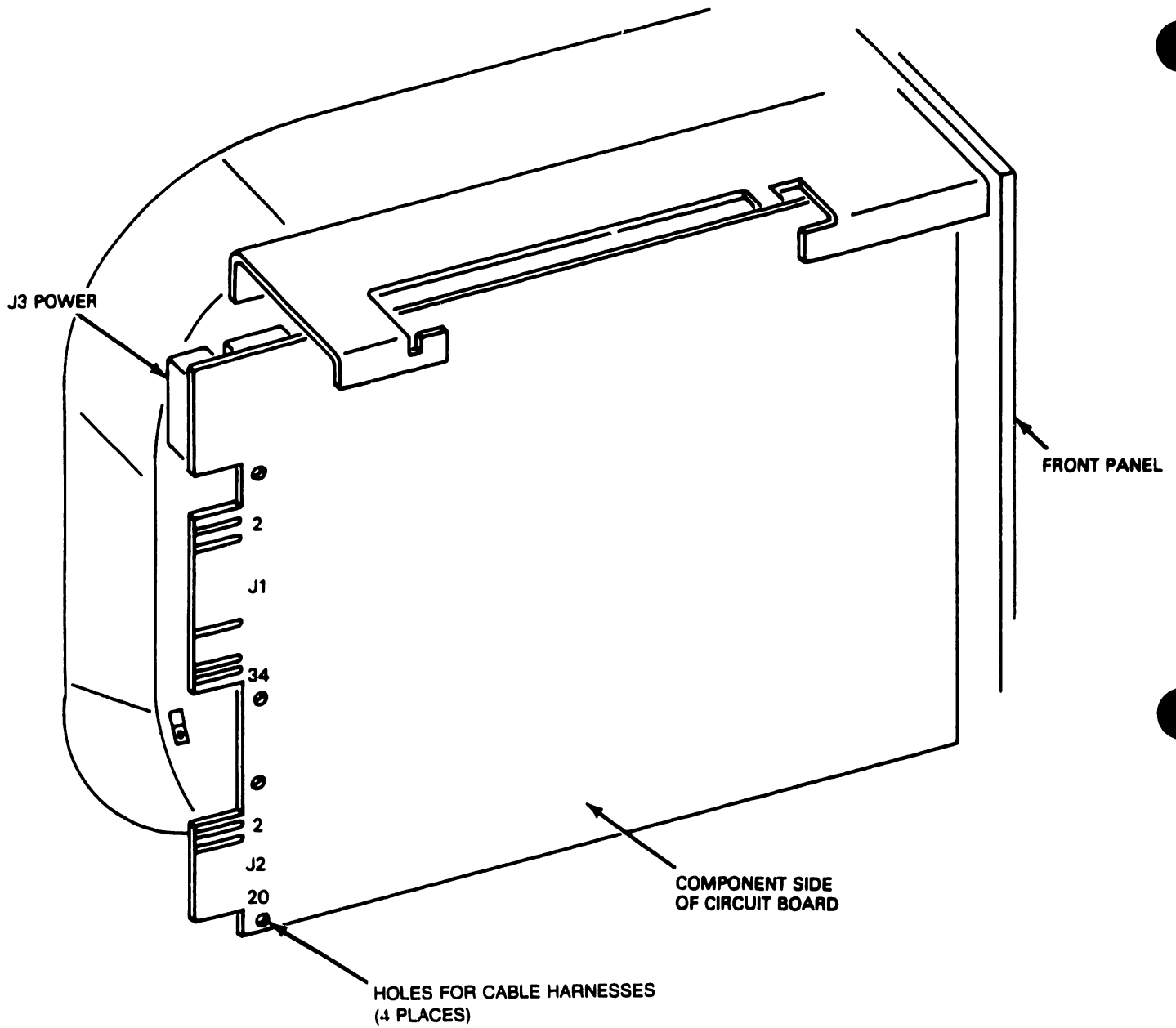


Figure 2
Interface Connector Locations

J1/P1 CONNECTOR

Connection to J1 is through a 34-pin circuit board connector. The dimensions for this connector are shown in Figure 3. 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 Pin 1 is 3M ribbon connector P/N 3463-0001, without ears.

J2/P2 CONNECTOR

Connection to J2 is through a 20-pin circuit board edge connector. The dimensions for the connector are shown in Figure 4. 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.

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 60617-4. J3 pins are labeled on the J3 connector (see Figure 5).

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 a 18 AWG, minimum, cable.

INTERFACE LINES AND PIN ASSIGNMENTS

The interface for the TM600 disk drive is available in one configuration. The TM600S 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.

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 6 contains the recommended circuit.

True: 0.0V D.C. to 0.4V D.C. @ I = -40 mA, maximum
False: 2.5V D.C. to 5.25V D.C. @ I_L = 250 uA, maximum

All input lines share a 220/330 ohm resistor pack for line termination.

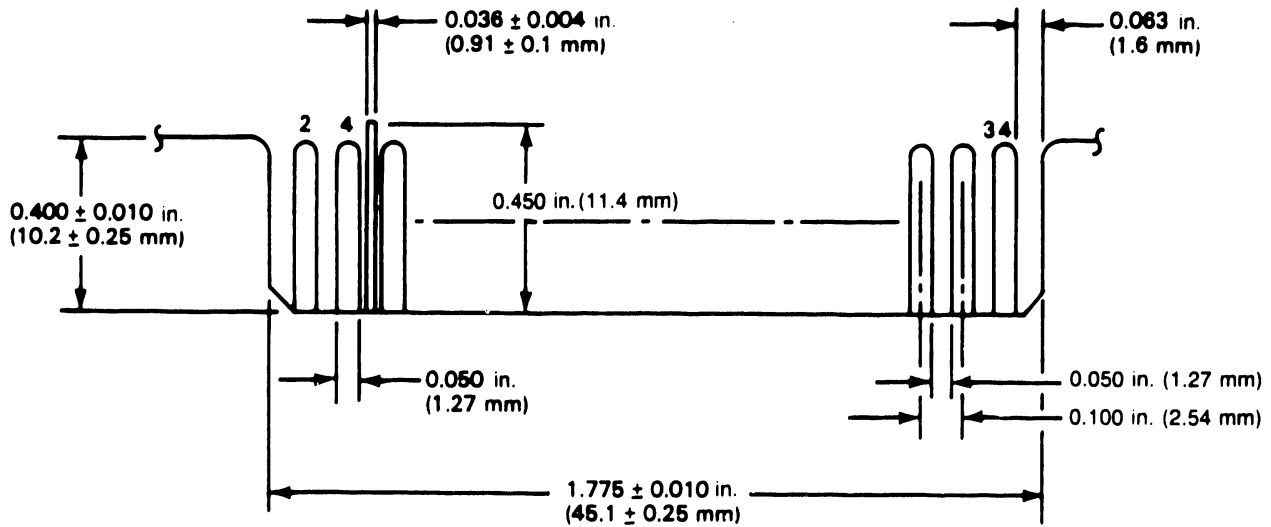


Figure 3
J1 Connector Dimensions

BOARD THICKNESS
0.062 ± 0.007 in.
(1.59 mm ± 0.18 mm)

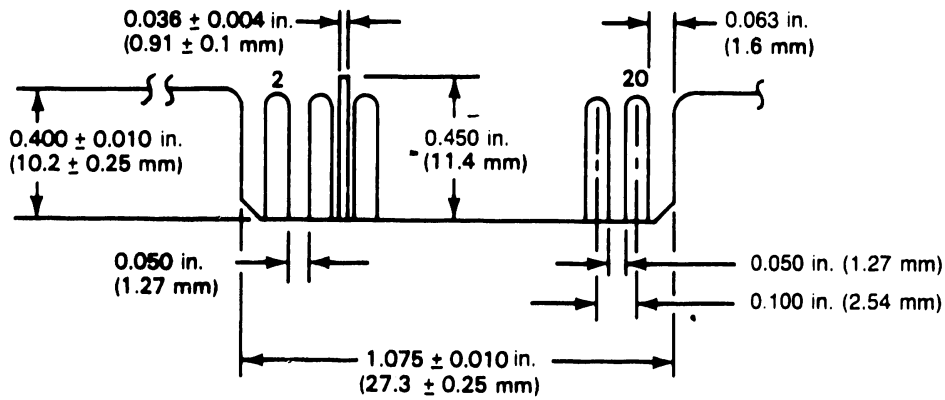
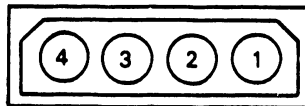


Figure 4
J2 Connector Dimensions



AS SEEN ON DRIVE CIRCUIT BOARD, SOLDER SIDE.

Figure 5
J3 Connector

TABLE 2
TM600S INTERFACE

Connector	INTERFACE:		TM600 Signal Type	I/O	Name of Signal
	Signal	Pin Number Ground			
P1 ↑ 34-Pin Ribbon Daisy Chain ↓ P1	2	(1)	S	I	Reduce Write I
	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	-	Reserved (+ 5V)
	5	(6)	-	-	Manufacturing 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 4-Pin Power 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				

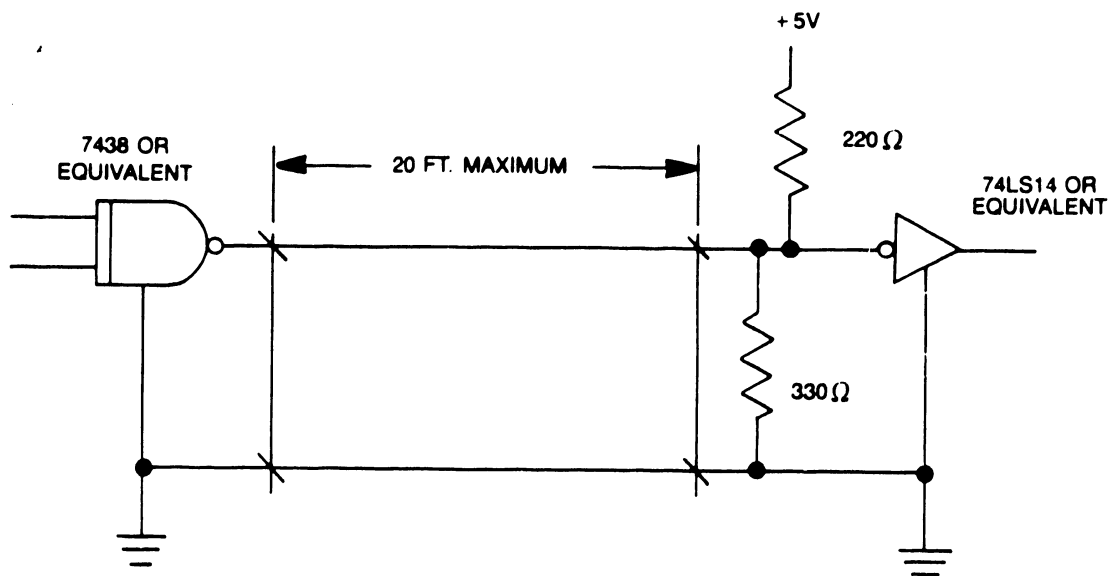


Figure 6
Control Signal/Driver Receiver Circuit Combination

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.

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 μ S 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 1.0uS. Figure 7 contains the step timing.

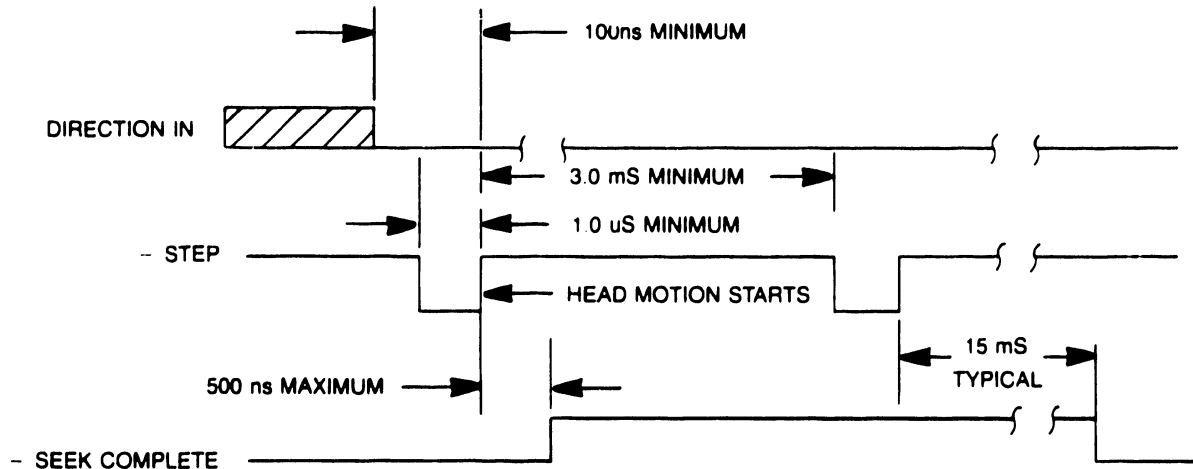


Figure 7
Step Mode Timing

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.

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

TO BE VALID, OF THE SIGNALS DRIVE SELECT 0, 1, 2, AND 3, A MAXIMUM OF ONE SIGNAL LINE MAY BE HELD LOGICALLY TRUE AT ANY ONE TIME.

OUTPUT LINES

The output control signals are driven with an open collector output stage capable of sinking a maximum of 40 mA in a logical true state, with a maximum voltage of 0.4V 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 uA.

All J1 output lines are enabled by the respective drive selected lines.

Figure 6 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:

When a recalibration sequence is initiated by drive logic at power on because the read/write heads are not over Track 0.

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

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 causes improper writing on the disk. When this line is true, further writing is inhibited at the drive until the condition is corrected.

The condition that exists is that D.C. voltages are grossly out of tolerance.

Index

This interface signal is provided by the drive once each revolution (16.7 mS 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 writing and seeking are inhibited.

The typical time after power on for Ready to be true is 15 seconds.

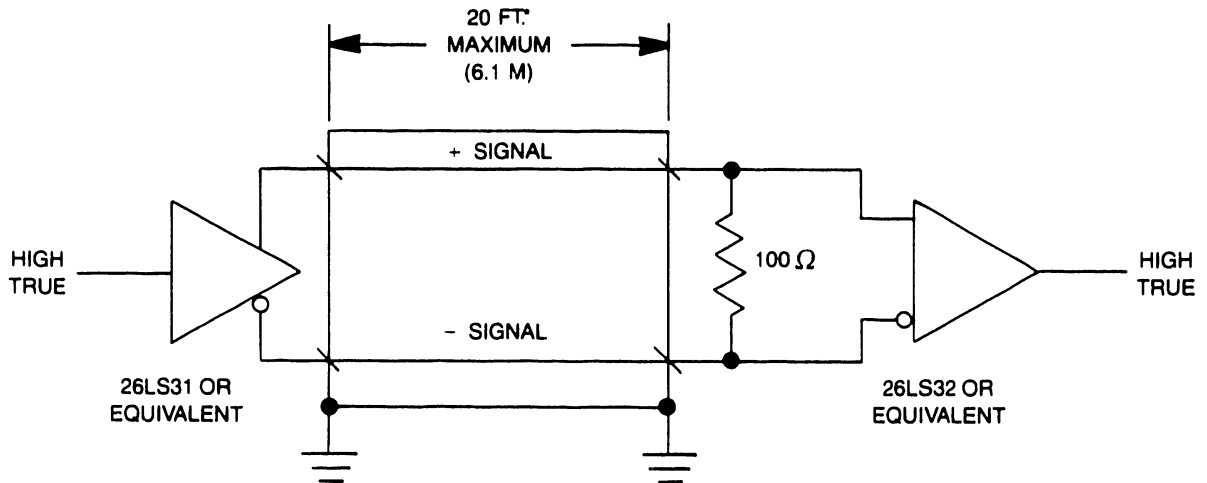
DATA TRANSFER LINES

All lines associated with the transfer of data between the drive and the host system are differential in nature and may be multiplexed. These lines are provided at the J2/P2 connector on all drives.

Two pairs of balanced signals are used for the transfer of data: MFM Write Data and MFM Read Data. Figure 8 contains the driver/receiver combination used with the TM600 drive for Data Transfer signals

MFM WRITE DATA

This is a differential pair that defines the transitions 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.



*Flat Ribbon or Twisted Pair Cable

Figure 8
Data Transfer Line Driver Receiver

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.

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 6). 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.

NOTE

ONLY ONE DRIVE MAY BE SELECTED AT A TIME.

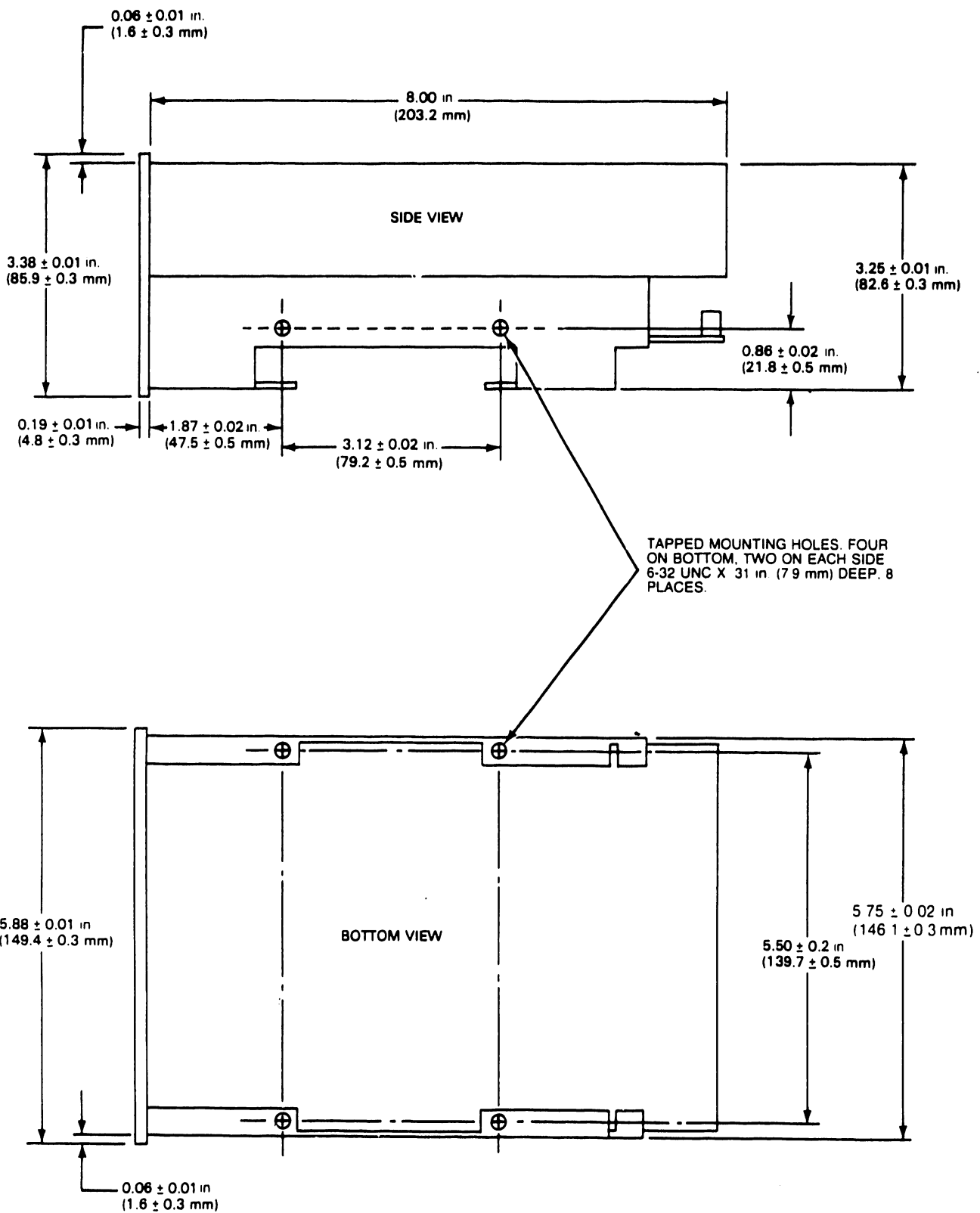
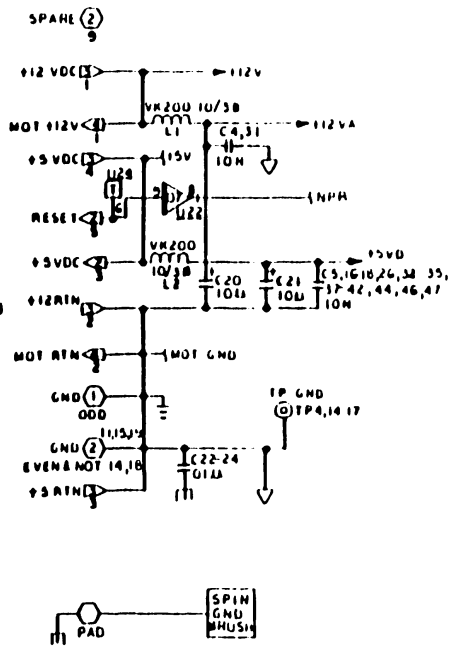
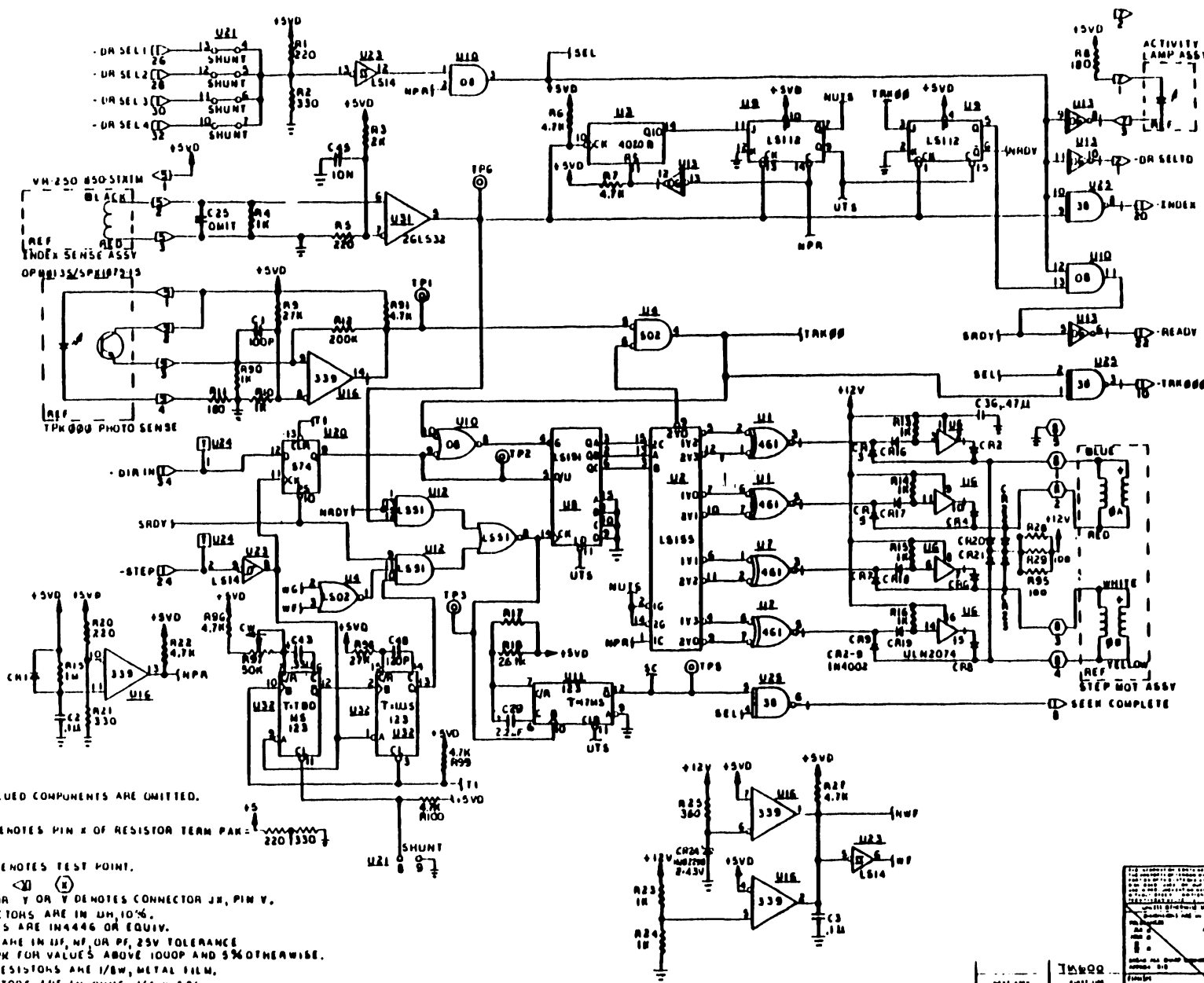
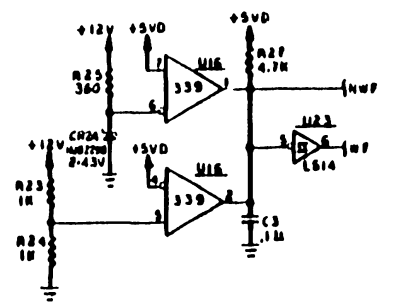


Figure 9
Disk Drive Dimensions and Mounting Holes

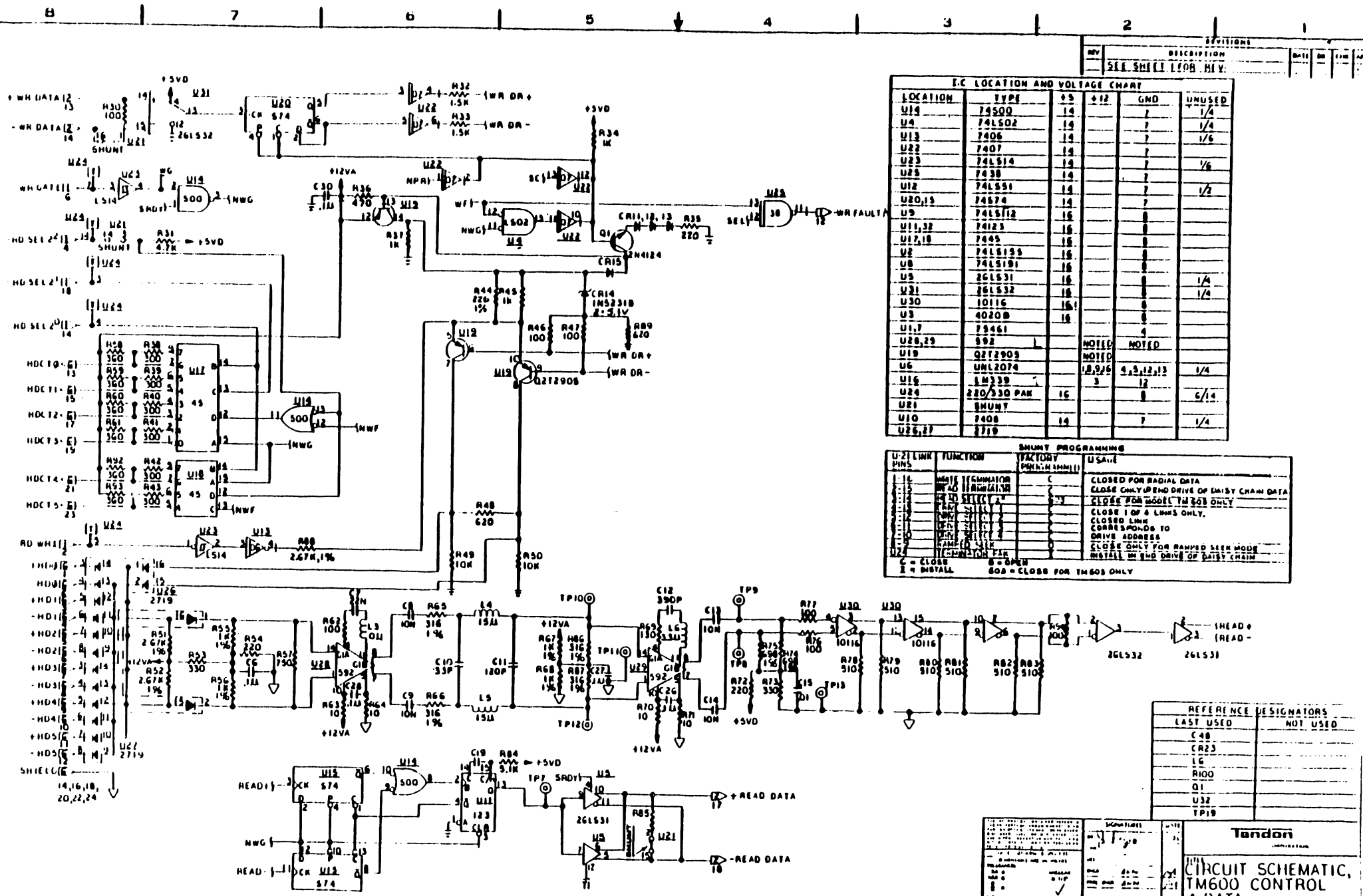
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2	REV PER 0	530067			
3	REV PER 0	530064			
4	REV PER 0	530055			
5	REV PER 0	530071			
6	REV PER 0	530076			
7	REV PER 0	530120			
8	REV PER 0	530156			



- 9 UNVALUED COMPONENTS ARE OMITTED.
 - 6 Y OR Y OR Y DENOTES CONNECTOR JN, PIN V.
 - 5 INDUCTORS ARE IN LH, 10%.
 - 4 DIODES ARE IN4446 OR EQUIV.
 - 3 CAPS ARE IN UF, WF, OR PF, 25V TOLERANCE
15 10% FOR VALUES ABOVE 100UF AND 5% OTHERWISE.
 - 2 1% RESISTORS ARE 1/8W, METAL FILM.
 - 1 RESISTORS ARE IN OHMS, 1/4 W, 5%.
- WIRE UNLESS OTHERWISE SPECIFIED



Tandon CORPORATION	
TITLE CIRCUIT SCHEMATIC TM600 CONTROL & DATA	DATE 11/15/71
PART NO. 187040-001	REV. 1



REV	DESCRIPTION	DATE	BY	CHK
1	SEE SHEET 1 FOR REV.			

LOCATION	TYPE	+5	+12	GND	UNUSED
U13	74LS00	14	7	1/4	
U4	74LS02	14	7	1/4	
U13	7406	14	7	1/6	
U22	7407	14	7		
U23	74LS14	14	7	1/6	
U25	7438	14	7		
U12	74LS51	14	7	1/2	
U20,19	74574	14	7		
U9	74LS112	16			
U11,32	74123	16			
U17,18	7445	16			
U2	74LS153	16			
U8	74LS151	16			
U5	26LS31	16			1/4
U31	26LS32	16			1/4
U30	10116	16			
U3	4020B	16			
U1,7	75461			4	
U20,29	922		NOTED	NOTED	
U19	Q2T2908		NOTED		
U6	UML2074	18,21,6	4,3,12,13		1/4
U16	LM339	3	12		
U24	220/330 PAK	16			6/14
U21	SHUNT				
U10	7408	14	7		1/4
U26,27	2719				

U-1 LINK PINS	FUNCTION	FACTORY (MOM/AMM/1)	USAGE
1-16	WRITE TERMINATOR	C	CLOSED FOR RADIAL DATA
1-17	READ TERMINATOR	C	CLOSE ONLY IF END DRIVE OF EMIST CHAIN DATA
1-18	EMIST SELECT	C	CLOSE FOR MODEL TM608 ONLY
1-19	DATA SELECT	C	CLOSE TOP 4 LINKS ONLY.
1-20	DATA SELECT	C	CLOSED LINKS CORRESPONDS TO DRIVE ADDRESS
1-21	DATA SELECT	C	CLOSE ONLY FOR RAMPED SEEK MODE
1-22	TERMINATOR PAK	O	INSTALL ON END DRIVE OF DATA CHAIN

C = CLOSE O = OPEN
I = INSTALL 608 = CLOSE FOR TM608 ONLY

LAST USED	NOT USED
C48	
CR23	
LG	
R100	
Q1	
U32	
TP19	

Tandon
CORPORATION

CIRCUIT SCHEMATIC, TM600 CONTROL & DATA

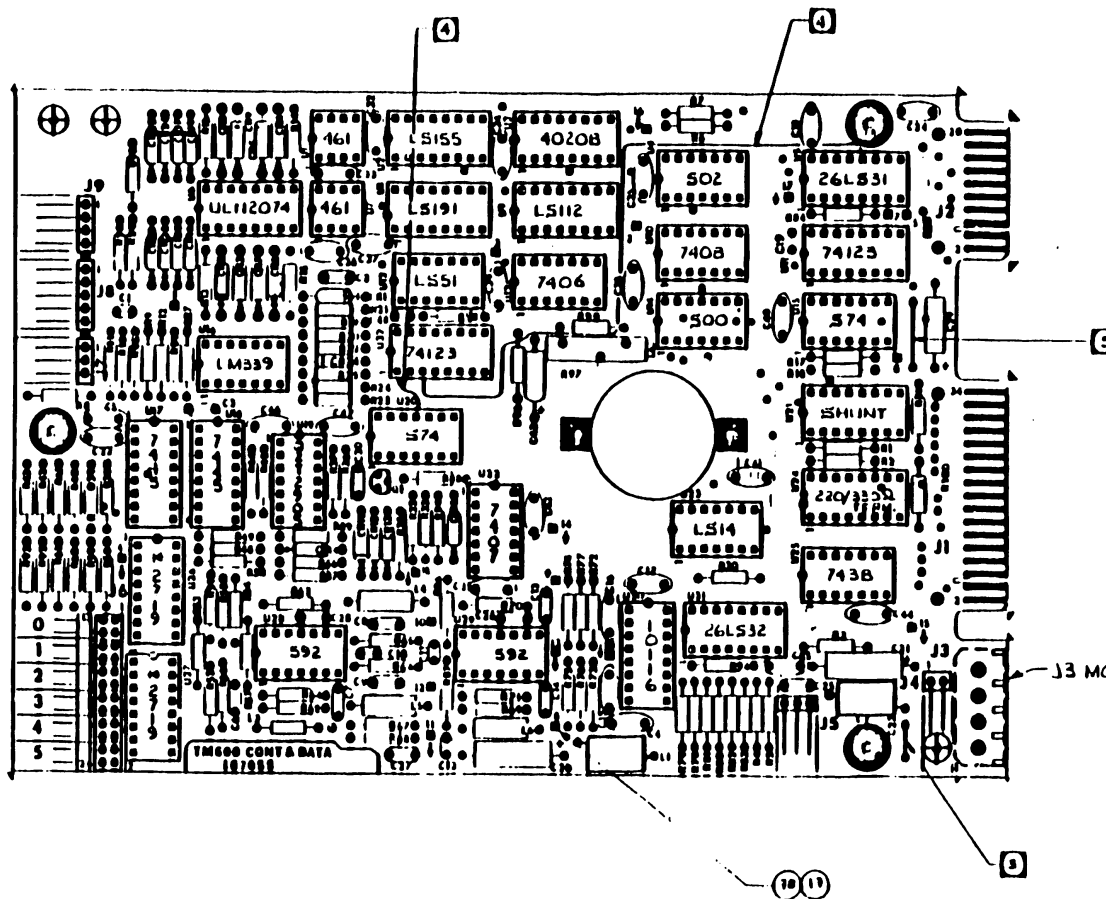
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NOTES: UNLESS OTHERWISE SPECIFIED

DATE: APPLICATION:

DESIGNED BY: CHECKED BY: APPROVED BY: DATE: 1/1/70

REVISIONS		DATE	BY	APP
REV	DESCRIPTION			
REV 7	PER E.O. 53007	10 11 71		
REV 6	PER E.O. 53007			
REV 5	PER E.O. 53007			
REV 4	PER E.O. 53007			
REV 3	PER E.O. 53007			
REV 2	PER E.O. 53007			
REV 1	PER E.O. 53007			



DESIGNATOR ASSEMBLY GUIDE		
LAST USED	MT	REVISION
C48	C19	C28-BUSS
C824	C810	
J4		
L4		L3-05
Q1		
R100	R17885	
TR19		
U32		

J3 MOUNTS ON FAR SIDE

9 JUMPER PER E.O. 53007.

4 JUMPER PER E.O. 530024.

3 SOLDER #24 AWG UNINSULATED TIN COATED SOLID COPPER WIRE. MAY SUBSTITUTE #24W RESISTOR LEAD WIRE.

2 REF DOCUMENT, 187040-001 - CIRCUIT SCHEMATIC
187041-001 - ARTWORK

1 SEE SHEET 1 THRU 3 FOR PART LIST

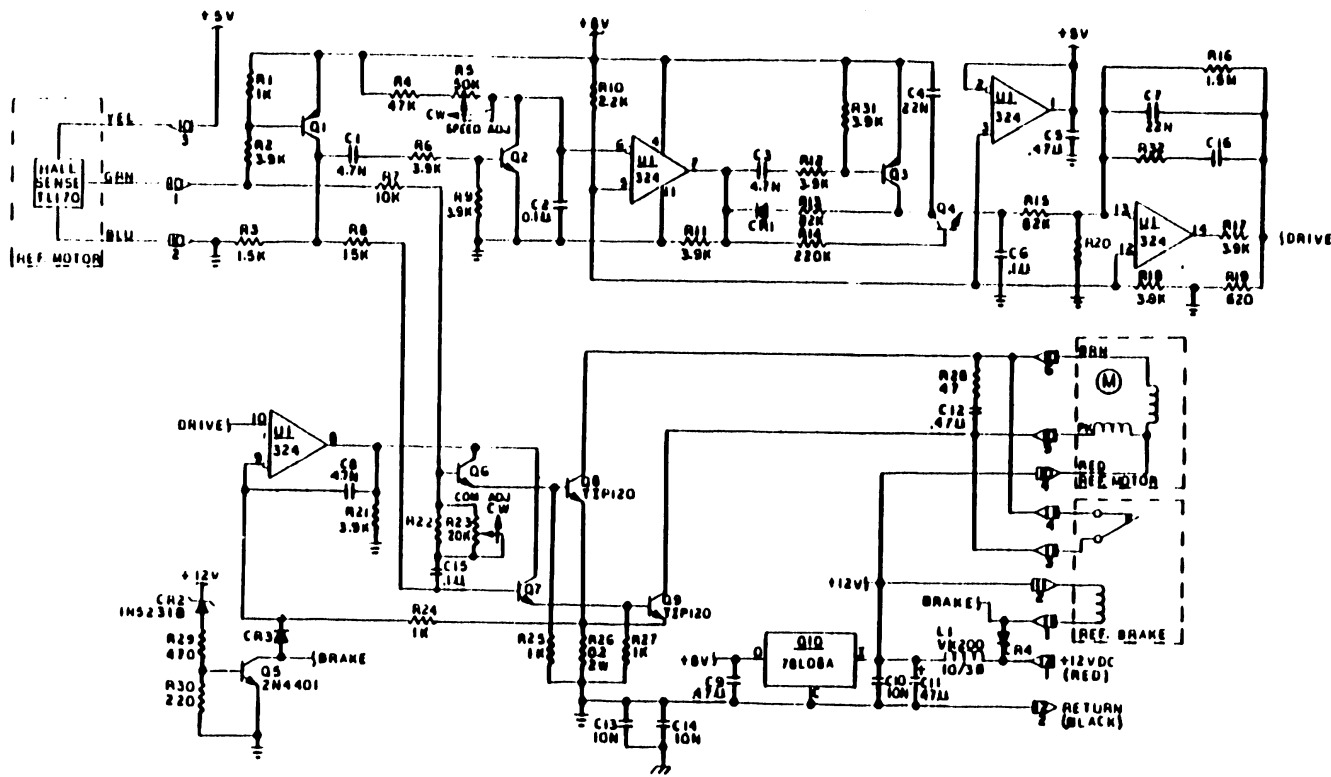
NOTES UNLESS OTHERWISE SPECIFIED

TM 600

APPLICATION

<p>DATE: 10/11/71</p> <p>BY: J. F. [Signature]</p> <p>APP: [Signature]</p>		<p>DATE: 10/11/71</p> <p>BY: [Signature]</p> <p>APP: [Signature]</p>	<p>Tandon</p> <p>TITLE: ASSEMBLY, TMECX CONTROL & DATA</p> <p>QTR: D</p> <p>NO: 187045-001</p>
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REVISIONS			
NO.	DESCRIPTION	DATE	BY
B	REV PER E O 11532		
C	REV PER E O 11532		
D	REV PER E O 51006		
E	REV PER E O 53043		



7. UNVALUED COMPONENTS ARE OMITTED.
 8. Y OR Y DENOTES CONNECTOR X, PIN Y.
 9. PNP TRANSISTORS ARE 2N4125.
 4. NPN TRANSISTORS ARE 2N4124.
 3. DIODES ARE 1N4446 OR EQUIV.
 2. CAPACITORS ARE 25V, 10%, PF, NF, OR UF.
 1. RESISTORS ARE IN OHMS, 1/4W, 5%.
- NOTES UNLESS OTHERWISE SPECIFIED

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CR4	
J3	
L1	
Q10	
R32	
U1	

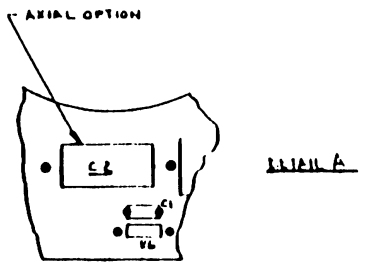
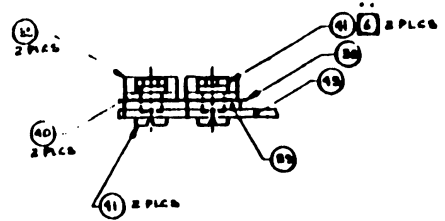
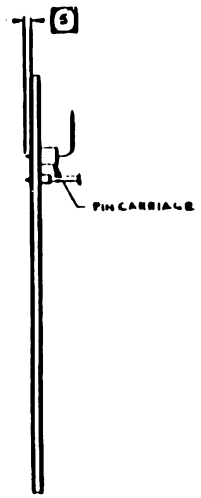
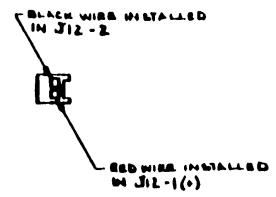
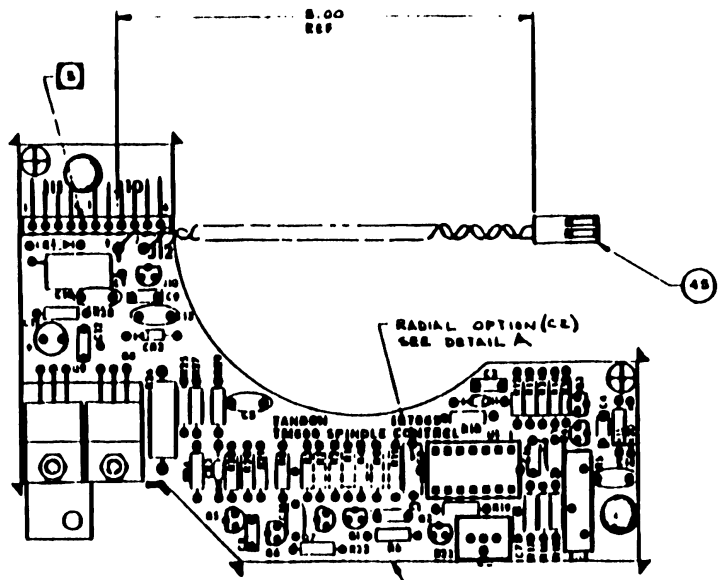
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CHECKED BY	DATE
APPROVED BY	DATE
APPLICATION	

Tandon
CORPORATION

TITLE
**CIRCUIT SCHEMATIC,
 TM600 SPINDLE
 CONTROL**

DATE: 187060-001

REV	DESCRIPTION	DATE	BY	CHK
B	REV PER E.O. 11225			
C	REV PER E.O. 11225			
D	REV PER E.O. 11225			
E	REV PER E.O. 11225			
F	REV PER E.O. 11225			



7. REF DOCUMENT : 18700-001 CIRCUIT SCHEMATIC
187002-001 ARTWORK
- 6 TORQUE 4 8 INCH LBS. NOMINAL
- 5 MAX LENGTH OF COMPONENT LEADS BELOW SOLDER SIDE BOARD AFTER ASSEMBLY & TRIMMING SHALL NOT EXCEED .08 INCH.
4. COMPONENT HEIGHT, EXCEPT C11, SHALL NOT EXCEED .45 INCH ABOVE BOARD. CAPACITOR C11, NOT TO EXCEED .50 INCH ABOVE BOARD.
- 3 CUT PIN TANGENT TO PIN CARRIAGE.
- 2 THIS ASSEMBLY SHALL BE MADE FROM P.C.B DETAIL 18700-001
1. ASSEMBLY PER STANDARD MANUFACTURING METHODS.

NOTES : UNLESS OTHERWISE SPECIFIED

USED ON TM 650

THE DESCRIPTION, QUANTITY, AND WEIGHT OF THIS PART SHALL BE CHECKED AGAINST THE PART LIST AND THE PART SHALL BE IDENTIFIED BY THE PART NUMBER AND THE DATE OF THE PART LIST. THE PART SHALL BE IDENTIFIED BY THE PART NUMBER AND THE DATE OF THE PART LIST. THE PART SHALL BE IDENTIFIED BY THE PART NUMBER AND THE DATE OF THE PART LIST.	DATE: 1/19/60 BY: JAG CHECKED: JAG APPROVED: JAG	Tandon CORPORATION TITLE: SPINDLE CONTROL ASSEMBLY TM 650
PART NO: 18700-001 QUANTITY: 1 WEIGHT: 0.117 MATERIAL: 18700-001	DATE: 1/19/60 BY: JAG CHECKED: JAG APPROVED: JAG	TITLE: SPINDLE CONTROL ASSEMBLY TM 650



LABORATORIES, INC.

ONE INDUSTRIAL AVENUE. LOWELL, MASSACHUSETTS 01851. TEL. (617) 459-5000. TWX 710 343-8769. TELEX 94-7421

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