

PRELIMINARY

TANDON OEM OPERATING AND SERVICE MANUAL
MODEL NUMBERS TM602S, TM603S, TM602E, AND TM603E
5.25" RIGID DISK DRIVE

MARCH 18, 1982

TANDON CORPORATION
20320 PRAIRIE STREET
CHATSWORTH CA 91311

TELEPHONE NUMBER: (213) 993-6644

TWX 910 493 5965

P/N 187275-003 Rev.A

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SECTION I--GENERAL INFORMATION

1.1 SCOPE

This manual contains information useful in the installation and operation of Tandon Corporation's TM600 family of 5.25" rigid disk drives. This manual also contains interface requirements and descriptions of signals. TM600 refers to Model Numbers TM602 and TM603, as appropriate.

1.2 INTRODUCTION

The Tandon TM600 family of 5.25" rigid disk drives are low-cost, random access memories that use moving head, noncontact recording techniques. There are both two- and three-platter models, which use standard Winchester technology and 130mm rigid media.

The Tandon 5.25" rigid disk drive consists of storage media that is contained within the drive in a fixed (nonoperator removable) configuration, read/write and control electronics, the drive mechanism, a read/write head, a precision split band positioning device, and an air filtration system.

Interface flexibility is provided by using an industry standard interface on the TM600 family of disk drives. The "S" version is compatible with larger capacity disk drives. Compatible is defined as using the same pin assignment where the signal and the function are common.

1.3 DISK DRIVE PERFORMANCE CHARACTERISTICS

The information contained in Table 1-1 pertains to all models of the Tandon TM600 family of disk drives.

1.4 DISK DRIVE MODEL SPECIFICATIONS

Table 1-2 contains a list of the Tandon 5.25" rigid disk drive models available and the number of platters each one has.

Table 1

Disk Drive Performance Characteristics

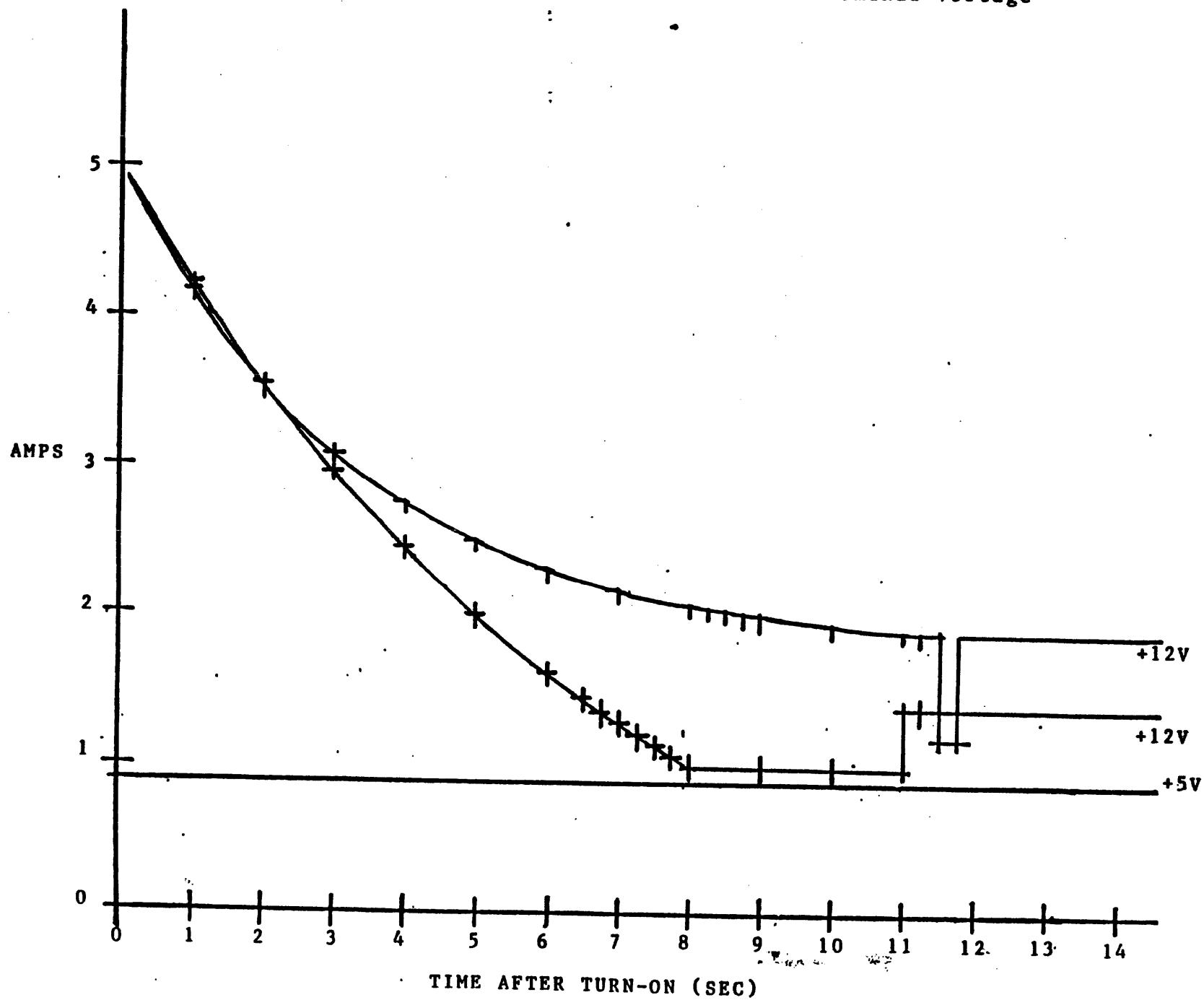
Model	TM602S	TM603S	TM603SE
Disks/Platters	2	3	3
Heads/Recording Surfaces	4	6	6
TPI.....	254 TPI.....	254 TPI.....	230
Cylinders	153	153	230
RPM.....	3600 RPM \pm 1 percent.....		
Recording Capacity,			
Unformatted:			
Per Drive	6.38 MBytes	9.57 MBytes	14.35 MBytes
Per Surface	1.59 MBytes	1.59 MBytes	2.39 MBytes
Per Track.....	10.40 KBytes.....		
Transfer Rate.....	5 Mbits per second.....		
Recording			
Density (BPI)	7690	7690	9625
Tracks	612	918	1380
Access Time			
Track-to-Track	3 milliseconds.....		
Average	153 ms, 99 ms	153 ms, 99 ms	210 ms, 137 ms
	ramped seek	ramped seek	ramped seek
Head Settling Time.....	15 milliseconds.....		
Average Latency.....	8.34 milliseconds.....		
Mechanical Dimensions			
Height.....	3.25 inch.....		
Width.....	5.75 inch.....		
Length.....	8.00 inch.....		
Error Rates			
Soft Read.....	1×10^{10} bits.....		
Hard Read.....	1×10^{12} bits.....		
Seek Errors.....	1×10^6 seeks.....		
Power			
+12V D. C. +/-	10% 1.5 amps typical, 5 amps maximum for 10 seconds with no more than 5 millivolts PARD* (see Figure 1).		
+5V D. C. +/-	5% .8 amps typical with no more than 50 millivolts PARD*		
Environmental			
Ambient			
Temperature:	Operating:	16°C to 46°C (50°F to 115°F)	
	Nonoperating:	-35.4°C to 60°C (-40°F to 140°F)	
Relative Humidity:	8% to 80%		
Maximum Wet Bulb Temperature:	26°C without condensation		

*Periodic and Random Deviation.

Specifications Subject To Change Without Notice.

Figure 1-1

Typical Starting Currents at Nominal Voltage



MicroScribe

Table 1-2

Disk Drive Model Specifications

<u>Model Number</u>	<u>Number of Platters</u>	<u>Kind of Interface</u>
TM602-E		
TM602-S	2	Standard
TM603-E		
TM603-S	3	Standard

1.5 PHYSICAL DIMENSIONS

The major physical dimensions of the TM600 family of disk drives are contained in Figure 1-2. These dimensions are given in English and in metric units.

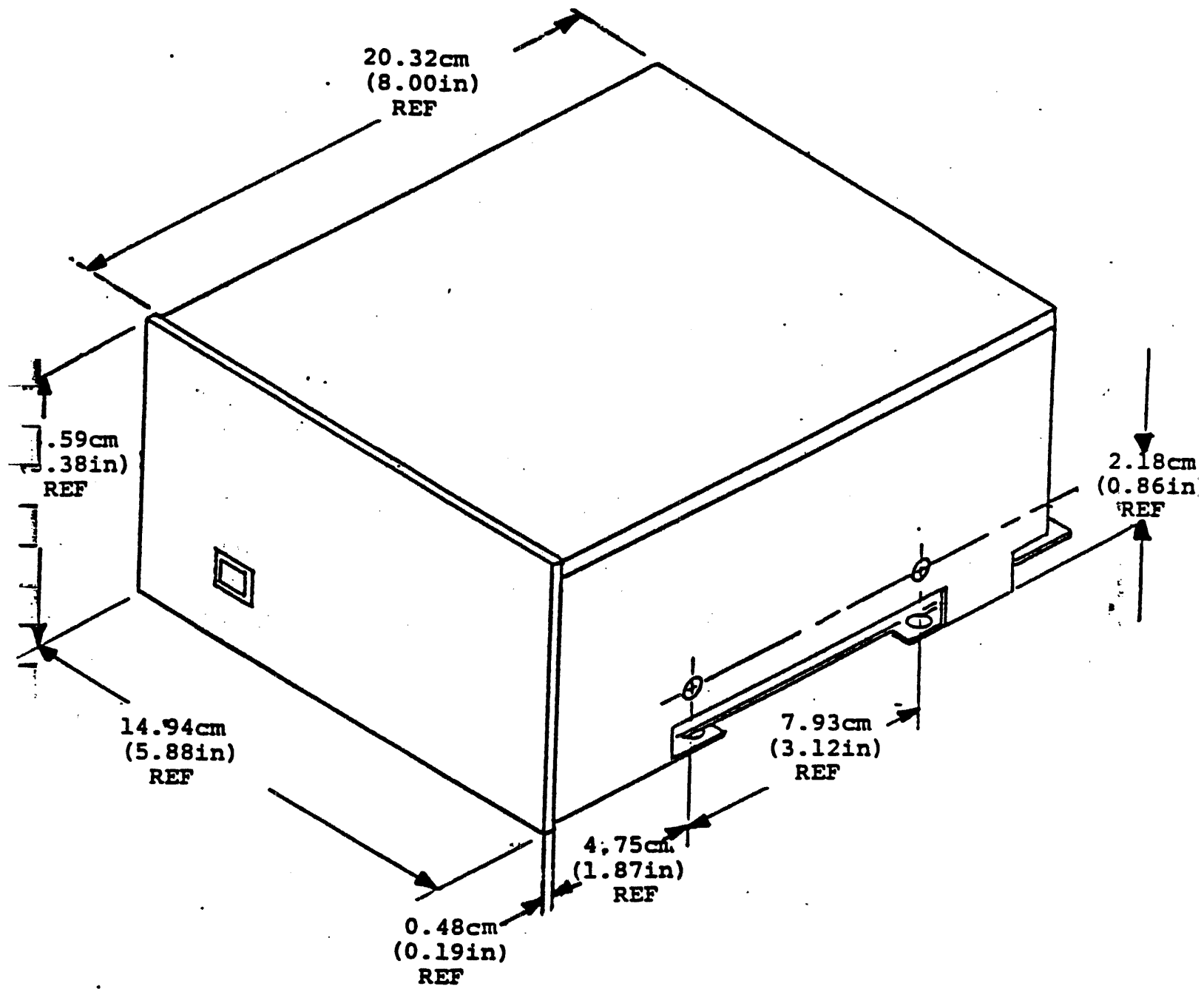


Figure 1-2
 Disk Drive Physical Dimensions

SECTION II--INSPECTION, INSTALLATION, AND INTERFACES

2.1 INTRODUCTION

This section contains information pertinent to the inspection, installation, and interfaces of the Tandon TM600 family of 5.25" rigid disk drives.

The electrical interface between the disk drive and the host system is via four connectors. J1 provides control signals for the drive. J2 provides for the radial connection of read/write data signals. J3 provides for D. C. power. J4 provides for frame ground. Figure 2-1 contains the locations of the interface connectors.

2.2 UNPACKING AND INSPECTION

The disk drive is shipped in a protective container which, when bulk packaged, minimizes the possibility of damage during shipment. The following procedure is the recommended method of uncrating the disk drive.

1. Place the shipping container on a flat work surface.
2. Remove the upper half of the inner container.
3. Remove the disk drive from the lower half of the inner container.
4. Check the model number and top assembly description against the packing slip.
5. Visually examine the contents of the shipping container for possible damage.
6. Notify the carrier immediately if any damage is found.
7. The inside chamber of the disk drive is a sealed compartment that must not be opened.

NOTE

REMOVAL OF THE COVER OF THE DISK DRIVE INVALIDATES THE WARRANTY.

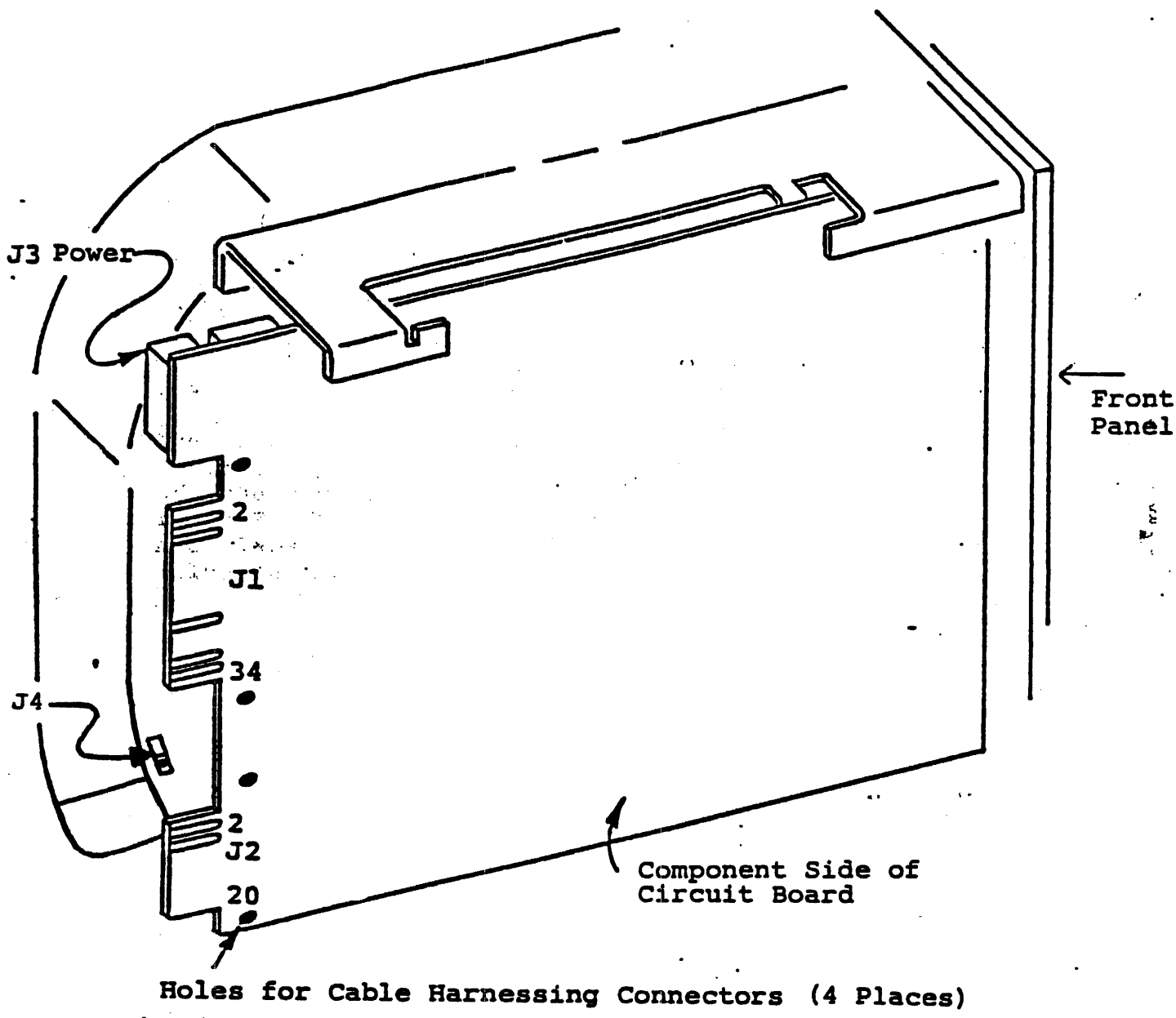


Figure 2-1
Locations of Interface Connectors

Before applying power to the disk drive, the following inspection procedure should be performed:

1. Check to ensure that the circuit boards are secure.
2. Check to ensure that the connectors are firmly seated.
3. Notify the carrier immediately if you find any damage.

2.3 MOUNTING CHARACTERISTICS

The mounting characteristics of the TM600 family of disk drives are contained in Figure 2-2. There are four 6-32, tapped mounting holes on the bottom of the disk drive, and two on each side of it.

2.4 POWER CABLING

The D.C. power connector, J3, is a four-pin AMP Mate-N-Lok device, P/N 350211-1, which is mounted on the solder side of the circuit board. The recommended mating connector, P3, is AMP P/N 1-480424-0, using AMP pins P/N 60617-4. J3 pins are labeled on the J3 connector. Figure 2-3 contains an illustration of the J3 connector.



AS SEEN ON DRIVE CIRCUIT BOARD, SOLDER SIDE

Figure 2-3

J3 Connector

The frame ground connector, J4 is the Faston AMP P/N 61761-2. The recommended mating connector is AMP P/N 62187-1.

2.5 STANDARD INTERFACE

The standard or "S" model interface is contained in Table 2-1. Connection to J1 is via a 34-pin circuit board edge connector. The dimensions of the J1 connector are found in Figure 2-4. The pins are numbered 1 through 34. The even numbered pins are located on the component side of the circuit board. Pin 2 located on the end of the circuit board connector closest to the D. C. power connector J3/P3, and it is labeled. A key slot is located between Pins 4 and 6.

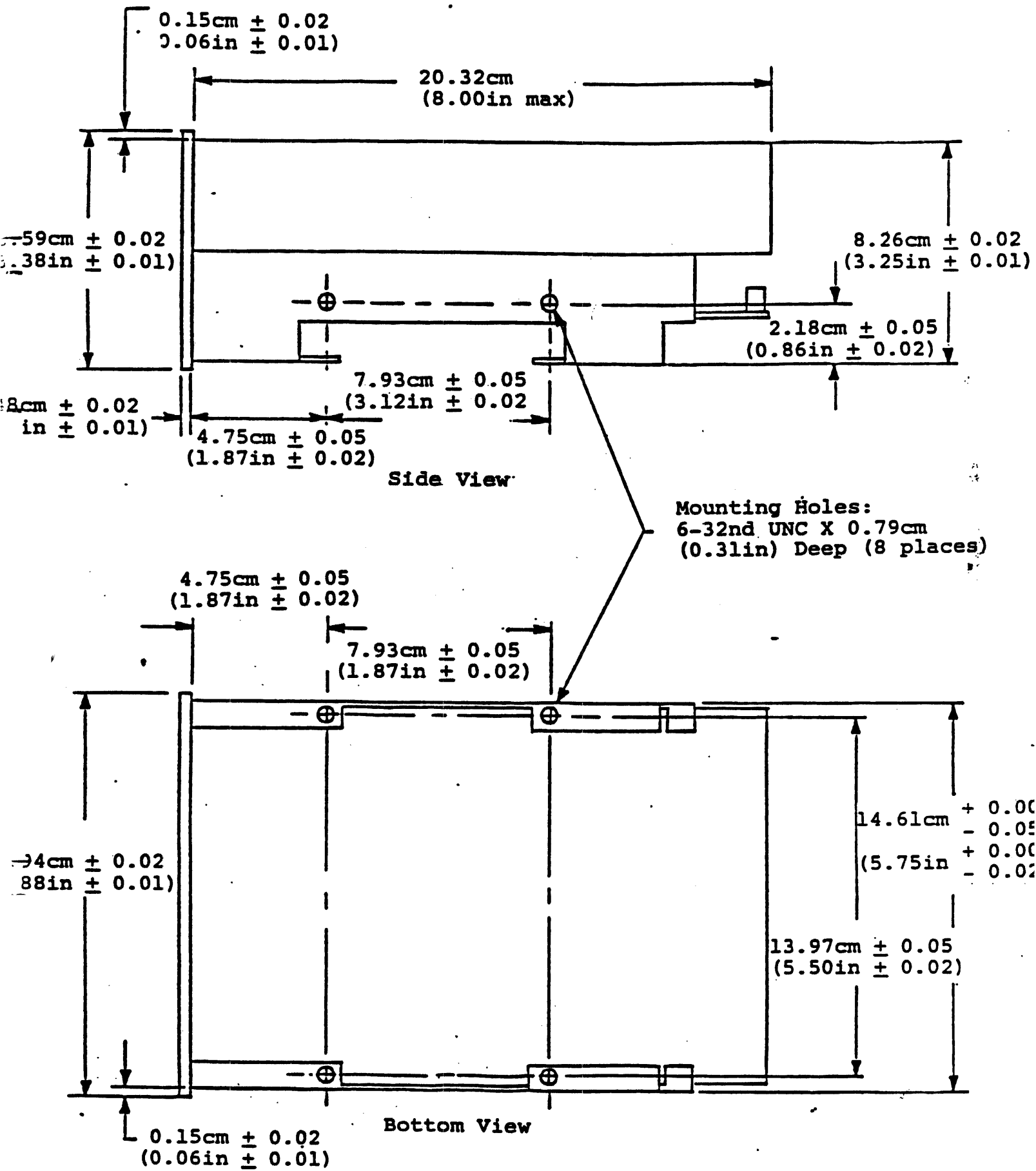


Figure 2-2
Disk Drive Mounting Characteristics

The recommended mating connector for P1 is a 3M ribbon connector, P/N 3463-0001, without ears.

Connection to J2 is via a 20-pin circuit board edge connector. The dimensions of the J2 connector are found in Figure 2-5. The pins are numbered 1 through 20. The even numbered pins are located on the component side of the circuit board. The recommended mating connector for P2 is a 3M ribbon connector, P/N 3461-0001, without ears. A key slot is located between Pins 4 and 6.

Table 2-1

Standard Interface

Connector	Pin Number	Signal (Gnd)	Signal Type	I/O	Signal Name
P1 ↑ 34-Pin Ribbon Daisy Chain ↓ P1	2	(1)	S	I	Reduce Write I
	4	(3)	S	-	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 Daisy Chain or Radial ↓ P2	1	(2)	S	O	Drive Selected
	3	(4)	S	-	Reserved (+5 V)
	5	(6)	S	I	Reset
	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		-	-	+12 V D. C. In
	2		-	-	12 V Return
	3		-	-	5 V Return
	4		-	-	+5 V D. C. In

Notes:

1. S - Single ended
2. D - Differential
3. I - Drive input
4. 0 - Drive output

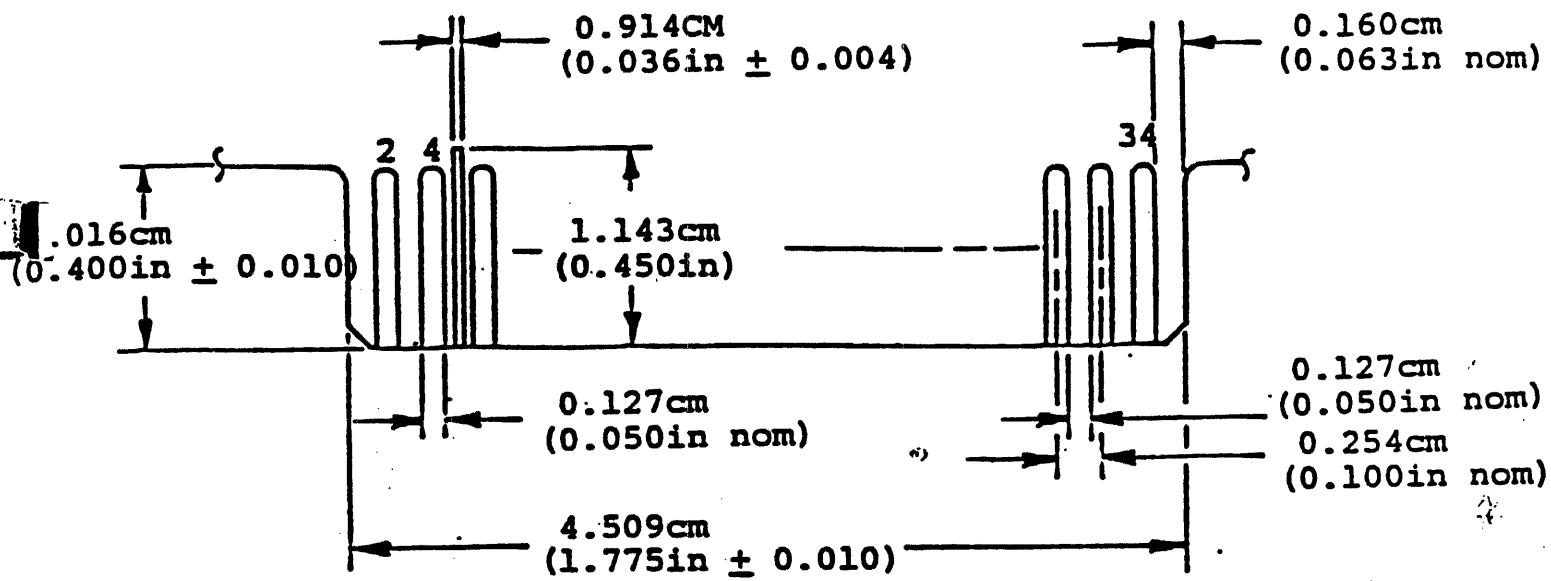


Figure 2-4
J1 Connector Dimensions

BOARD THICKNESS
- 0.157cm
($0.062\text{in} \pm 0.007$)

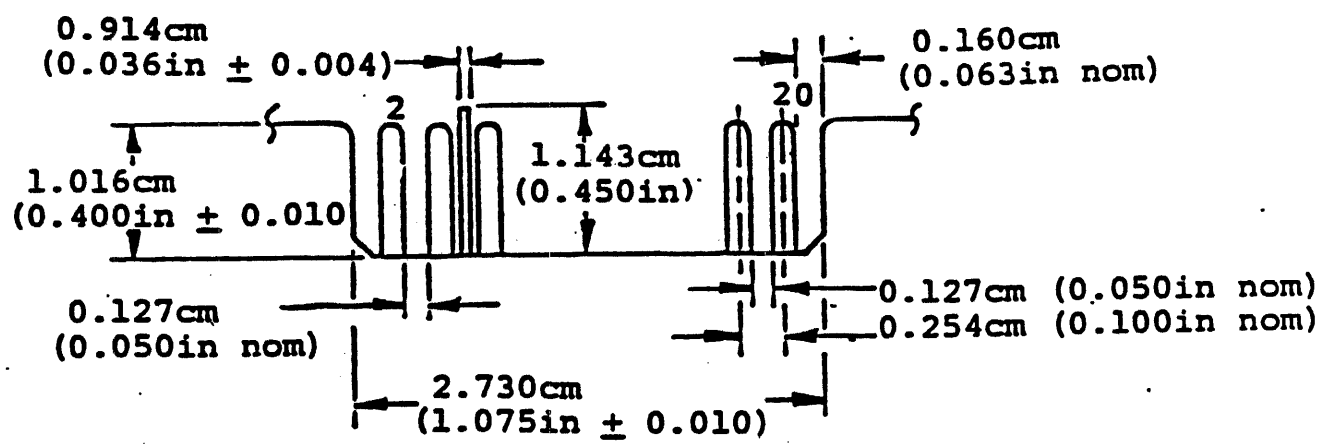


Figure 2-5
J2 Connector Dimensions

SECTION III--THEORY OF OPERATION

3.1 INTRODUCTION

There are three kinds of interface signals:

1. Input Control Lines
2. Output Control Lines
3. Data Transfer Lines

Signals on the Input Control lines are standard TTL levels. They have the following electrical specifications:

True: 0.0 V D. C. to 0.4 V D. C. @ I = 40 mA maximum

False: 2.5 V D. C. to 5.25 V D. C. @ I = 0 mA open

See Figure 3-1 for the recommended circuit.

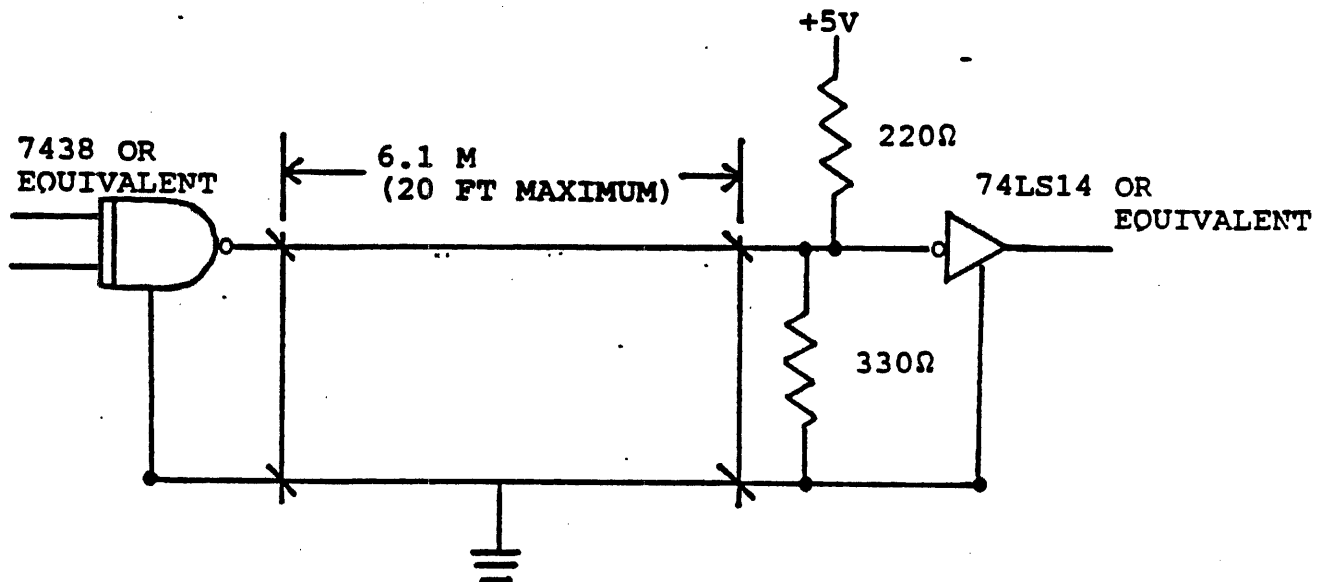


Figure 3-1

Control Signal Driver/Receiver Circuit Combination

3.2 INPUT CONTROL LINES

There are two kinds of Input Control lines, those that are multiplexed in a multiple drive system and those that do the multiplexing.

The Input Control lines that are multiplexed include:

1. Reduced Write Current
2. Write Gate
3. Head Select
4. Step Interface
5. Direction In

The Input Control lines that do the multiplexing are:

1. Drive Select 0
2. Drive Select 1
3. Drive Select 2
4. Drive Select 3

3.2.1 Reduced Write Current

When this Input Control line is activated low (true) in conjunction with the write gate, a lower value of write current is selected for writing on the disk. When the signal is set high (false), the higher value write current is selected. When writing on Tracks 0 through 127, it is recommended that this line be set false. For Tracks 128 and greater, the Reduced Write Current line should be set true.

A 220/230 ohm resistor pack allows the line to be terminated.

3.2.2 Write Gate

The Write Gate signal enables data to be written on the disk when it is activated or when the logical zero (true) level is reached. The ready line must be valid before write gate is activated. If a disk drive fault occurs, further writing on the disk is prohibited. In addition, the Seek Complete line should go true before you begin to write any information on the disk.

The inactive or logical high (false) level on the Write Gate line enables the step pulses to step the head arm actuator.

3.2.3 Head Select

There are three Head Select lines. They are used to select each read/write head--0, 1, or 2--in a binary coded sequence.

Head Select signals are logic low (true) levels. They must be activated in conjunction with the Drive Select lines. The heads are numbered 0 through 5. Head Select 0 is the least significant line. Table 3-1 contains information about the Head Select line sequence, disk drive model number, and numbers that may be selected.

Table 3-1

Head Select

Head Select Line Sequence			Model Number	
2^2	2^1	2^0	TM602	TM603
			Head Number Selected	
1	1	1	0	0
1	1	0	1	1
1	0	1	2	2
1	0	0	3	3
0	1	1		4
0	1	0		5

Legend: 1 = Logical High (False)
0 = Logical Low (True)

A 220/330 ohm resistor pack allows the line to be terminated.

3.2.4 Step Interface

When the Step Interface line is activated in conjunction with the Direction In line, the read/write heads move in the direction defined by the Direction In line. The motion is initiated by a logical zero to a logical one transition or by the trailing edge of the step pulse. Any change in the Direction In line must be made one hundred nanoseconds before the leading edge of the step pulse. The quiescent state of this line should be held logically high (false).

The heads move at the rate of the incoming step pulses. Figure 3-2 contains the sequence and the requirements for step timing.

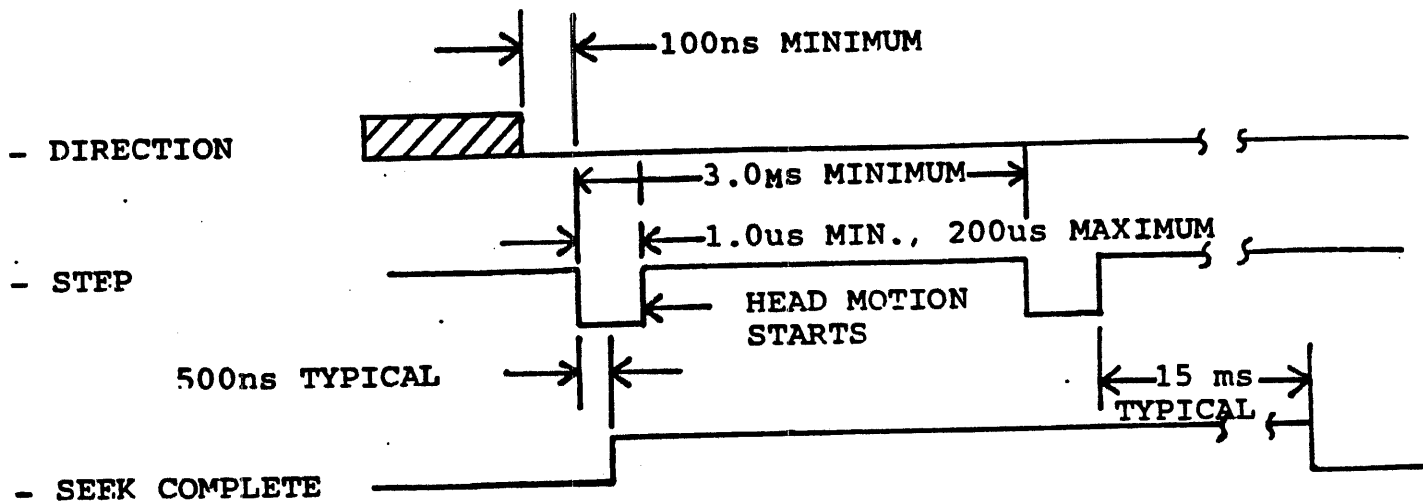


Figure 3-2

TIMING DIAGRAM

3.2.5 Direction In

The Direction In line determines the motion of the read/write heads when a step pulse is issued. The motion is toward the center of the disk if the Direction In line is in the true (low) state when a step pulse occurs. The direction of the motion is away from the center of the disk if the Direction In line is in the false (high) state when a step pulse occurs.

A 220/330 ohm resistor pack allows the line to be terminated.

3.2.6 Drive Select

Drive Select lines 0 through 3 provide a means of selecting and deselecting a disk drive. These four lines select one of four drives that are daisy chained to the controller.

The disk drive address is determined by a select shunt on the Signal circuit board. Drive Select lines 0 through 3 provide a means of daisy changing a maximum of four drives to a controller.

When logically high (false), the output drivers are open circuits or logically high (false), and the drive receivers do not acknowledge signals presented to them. A Drive Select line must remain stable in the true (low) state until a Step or Read/Write command is executed.

Only one line can be true (low) at a time. An undefined operation might result if two or more units are assigned the same address or if two or more Drive Select lines are in the true (low) state simultaneously.

3.3 OUTPUT CONTROL LINES

The Output Control lines are enabled by their respective Drive Select line. They send status information to the controller, such as: drive selected, seek complete, Track 000 fault, and line ready. In addition, the Index line is provided as an output to the controller for timing information.

The Output Control lines use an open collector gate that is capable of sinking a maximum of forty milliamperes in a logical low (true) level, with a maximum voltage of 0.4 volt measured at the driver. When the gate is off or logically high (false), the collector cutoff is a maximum of 250 u amps. See Figure 3-1 for the recommended circuit.

3.3.1 Drive Selected

When the Drive Selected lines coincide with the selected jumper on the shunt pack, the Select Status line goes logically low (true). This line informs the host system of the selection status of the disk drive.

NOTE

ONLY ONE DRIVE MAY BE SELECTED AT A TIME.

3.3.2 Seek Complete

The Seek Complete line indicates that the read/write heads have settled on the selected track at the end of a seek sequence. This status line is set logically zero (true) at the end of a normal seek. It is set logically high (false) in two cases:

1. A recalibration sequence is initiated by drive logic at power on because the heads are not over Track 000.
2. Five hundred nanoseconds, typical, after the leading edge of a step pulse of a series of step pulses.

Reading or writing should not be attempted in either of these cases since Seek Complete is false.

3.3.3 Track 000

The Track 000 line indicates to the host system that the read/write heads are positioned on Track 000. The Track 000

line goes logically low (true) only when the heads are positioned on Track 000. It remains low until the heads are moved away from Track 000, the outermost data track.

3.3.4 Fault

The Fault line indicates to the host system that a condition exists on the disk drive that is going to cause improper writing on the disk. When this line is logically low (true), Write Data is inhibited and further writing on the disk is prohibited until the condition is corrected. The condition under which the Fault line goes true is that D.C. voltages are grossly out of tolerance.

3.3.5 Line Ready

In conjunction with the Seek Complete line, the Line Ready line indicates to the host system that the disk drive can read, write or seek, and that all I/O signals are valid. The Line Ready line goes logically low (true) approximately 15 seconds after power on. The Line Ready line goes logically high (false) if the drive is not selected or if the speed of the motor is too slow. When this line is false, all writing and seeking is inhibited.

3.3.6 Index

An index pulse is provided once every revolution (16.67 ms nominal) to indicate the beginning of a track to the controller. The transition from logically high (false) to logically low (true) is the only valid transition. The leading edge of the pulse must be used to ensure accurate timing.

3.4 DATA TRANSFER LINES

The Data Transfer lines transfer information between the host system and the disk drive when the drive is selected. These lines are differential in nature. They may be multiplexed when using Drive Select.

The MFM Write Data pair of lines and the MFM Read Data pair of lines are provided for the transfer of data. Figure 3-3 contains a typical driver/receiver circuit combination used for data transfer signals.

3.4.1 MFM Write Data

The MFM Write Data lines are the differential pair that provide the data to be stored on the track. A flux reversal on the track to be written is caused when the plus (+) MFM

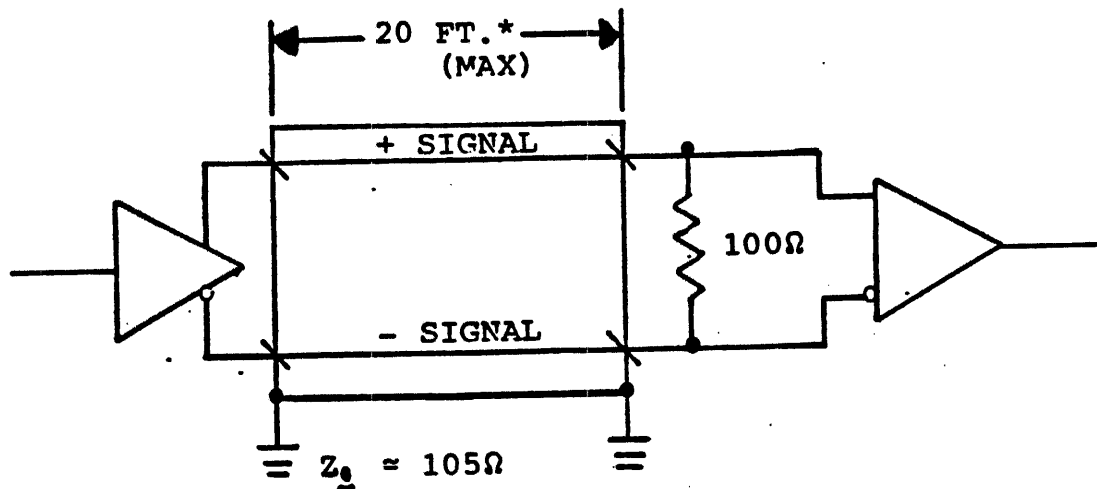


Figure 3-3

Data Line Driver/Receiver Circuit

Write Data line goes more positive than the minus (-) MFM Write Data line, provided that the Write Data line is logically low (true). When the disk drive is in a Read mode, the host system must ensure that the MFM write data signals are in the inactive state. The inactive state can be attained by making the plus MFM Write Data line more negative than the minus MFM Write Data line.

3.4.2 MFM Read Data

These lines are a differential pair that recover the data previously written on a track. A flux reversal on the track to be read is caused when the plus MFM Read Data line goes more positive than the minus MFM Read Data line. Subsequently, the differential pair signal is transmitted to the host system via the MFM Read Data lines.

SECTION 4

TROUBLESHOOTING GUIDE AND REPLACEMENT PROCEDURE

INTRODUCTION

This section is designed to help locate and correct failures related to the drive. Table 4-2 is a troubleshooting guide outlining the problem, its possible cause, and the recommended action. This section also contains parts removal, replacement, and adjustment procedures.

In all cases, the power supply voltages should be checked before proceeding.

4.1 TROUBLESHOOTING GUIDE

TEST EQUIPMENT

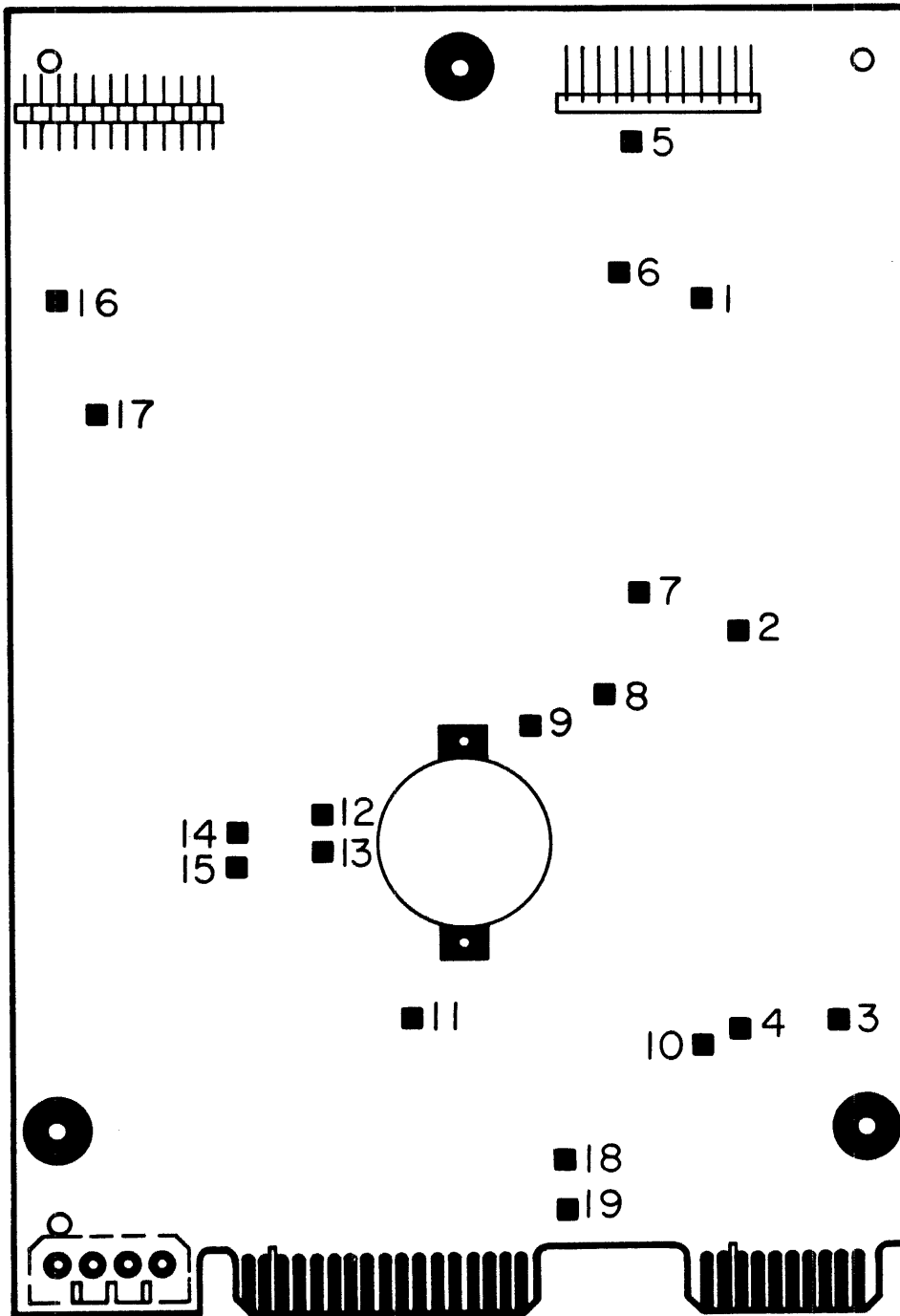
The following test equipment, or its equivalent, is recommended:

1. Oscilloscope, Tektronix 465—vertical and horizontal sensitivity plus three percent specified accuracy—with three 10X probes, each with individual ground leads.
2. Counter Timer, Monsanto Model 100B.
3. Digital Voltmeter (DVM), John Fluke Model 800A.

TEST POINTS

Table 4-1 contains each test point by function name. All test points referred to are on the logic board. Figure 4-1 illustrates their locations.

TABLE 4-1 TEST POINTS	
Test Point	Signal
1, 4, 9, 11, 12, 13, 16, 17.....	Logic Ground
2.....	Direction
3.....	Index
5.....	Photo Sensor, Track 0
6.....	Track 0
7.....	Step
8.....	Seek Complete
10.....	Pulse Read Data
14.....	- Analog Read Data
15.....	+ Analog Read Data
18.....	Reserved + 5 volts D. C.
19.....	Cable Detect + 5 volts D. C.



**FIGURE 4-1
TEST POINT LOCATIONS**

**TABLE 4-2
TROUBLESHOOTING GUIDE**

Problem	Possible Cause	Recommended Action
No activity lamp.	Not selected. Lamp not plugged in. Lamp faulty. Logic board faulty.	Check for correct drive select jumper. Check Connector P-7. Replace lamp. Replace logic board.
No index.	Not selected. Index sensor not plugged in. Index sensor misadjusted. Index sensor faulty. Logic board faulty.	Check drive select jumper. Check Connector P-5 Readjust Index sensor. Replace sensor. Replace logic board.
No Track 0.	Not selected. Track 0 sensor not plugged in. Track 0 sensor misadjusted. Track 0 sensor faulty. Logic board faulty.	Check drive select jumper. Check Connector P-9. Readjust Track 0 sensor. Replace Track 0 sensor. Replace logic board.
Drive not ready.	Not selected. No index. No Track 0. Motor not up to speed or not turning. Drive does not seek. Drive does not restore.	Check drive select jumper. See "No index." See "No Track 0." See "Motor not up to speed, not turning." See "Drive does not seek or restore."

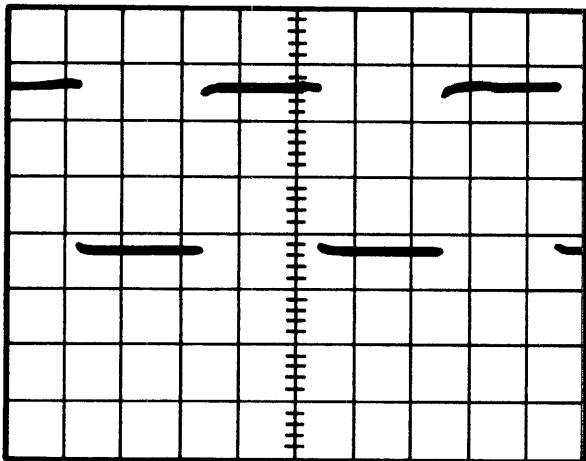
**TABLE 4-2 (CONTINUED)
TROUBLESHOOTING GUIDE**

Problem	Possible Cause	Recommended Action
<p>Drive does not seek or restore.</p>	<p>Drive not selected.</p> <p>Stepper motor not plugged in.</p> <p>Logic board faulty.</p> <p>Spindle motor speed misadjusted.</p> <p>Stepper motor faulty.</p> <p>Foreign object interfering with positioning arm or damper.</p>	<p>Check drive select jumper.</p> <p>Check Connector P-8.</p> <p>Replace logic board.</p> <p>Readjust spindle motor's speed.</p> <p>Return to factory for repair.</p> <p>Remove foreign object.</p>
<p>Motor not up to speed, not turning.</p>	<p>Spindle circuit board not plugged in.</p> <p>Spindle motor not plugged in.</p> <p>Faulty Spindle circuit board (see Figure 4-2).</p> <p>Motor not up to speed.</p> <p>Motor faulty.</p> <p>Brake misadjusted.</p>	<p>Check Connector P-12.</p> <p>Check Connectors P-10 and P-11.</p> <p>Replace circuit board.</p> <p>Adjust spindle speed.</p> <p>Return to factory for repair.</p> <p>Readjust brake.</p>
<p>Does not read.</p>	<p>Not selected.</p> <p>Heads not selected.</p> <p>Head cable not plugged in.</p> <p>Logic board faulty (see Figure 4-3).</p> <p>Defective head.</p>	<p>Check drive select jumper.</p> <p>Check head select interface lines.</p> <p>Check jumper 3P W13, installed for Model Number TM503 (see Table 3-2, page 3-10).</p> <p>Check Connector P-6.</p> <p>Replace logic board.</p> <p>Return to factory for repair.</p>

**TABLE 4-2 (CONTINUED)
TROUBLESHOOTING GUIDE**

Problem	Possible Cause	Recommended Action
Does not read.	Improper position. Drive not ready.	See "Drive does not seek or restore." See "Drive not ready."
Does not write.	No Write Gate for writing. Not selected. Heads not selected. Head cable not plugged in. Logic board faulty. Defective head. Drive not ready.	Check Write Gate interface line. Check drive select jumper. See "Does not read." Check Connector P-6. Replace logic board. Return to factory for repair. See "Drive not ready."

**VOLTAGE SCALE
2 VOLTS PER DIVISION**



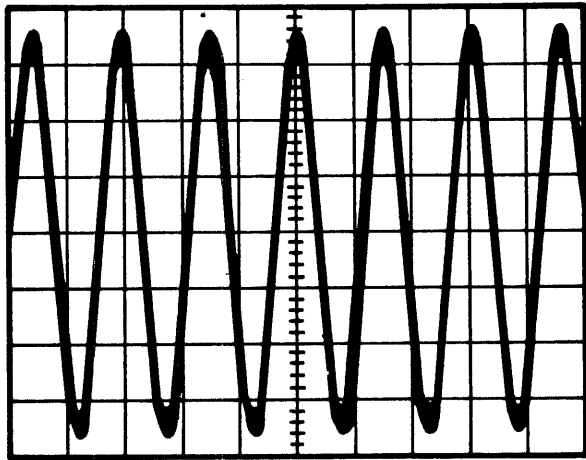
**TIME SCALE: 2 MILLISECONDS PER DIVISION
HALL SENSE
LOCATION P10-1**

**VOLTAGE SCALE
5 VOLTS PER DIVISION**

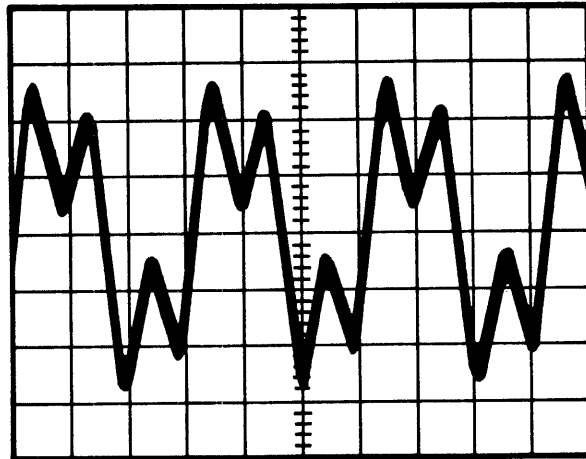


**TIME SCALE: 2 MILLISECONDS PER DIVISION
SPINDLE MOTOR WINDINGS
LOCATION P10-6**

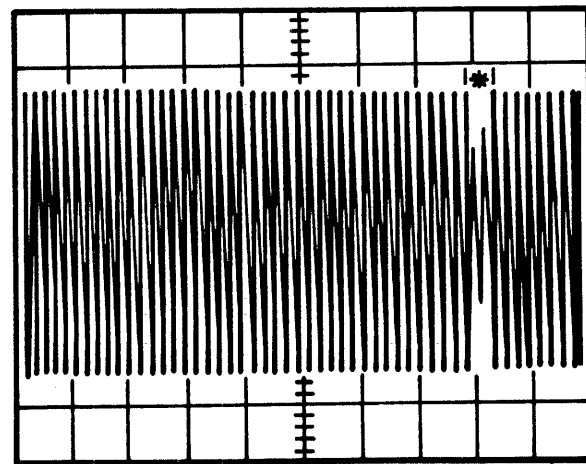
**FIGURE 4-2
SPINDLE MOTOR CIRCUIT BOARD WAVEFORMS**



ALL ZERO PATTERN



ALTERNATING ONES AND ZEROS



*BIT DROPOUT CAUSED BY MEDIA DEFECT

FIGURE 4-3
READ DATA WAVEFORMS 15 TPR + AND 14 TPR -

4.2 REPLACEMENT PROCEDURES

Do not rotate spindle motor or head positioning mechanism. Damage to heads and/or media may occur.

Remove power prior to replacing parts.

The following assemblies may be replaced:

Control and Data Circuit Board Assembly
Front Panel L.E.D. Assembly
Linear Brake Assembly
Front Panel
Index Assembly
Spindle Control Circuit Board Assembly
Frame Assembly
Track 0 Sensor Assembly

TOOLS REQUIRED

Number 2 Phillips screwdriver
3/16" nut driver
5/16" nut driver
.008" or .010" feeler gauge

CONTROL AND DATA CIRCUIT BOARD ASSEMBLY

REMOVAL

To remove the Control and Data Circuit Board Assembly:

1. Remove the three screws that attach the circuit board to the chassis.
2. Remove the Connectors J4 and J5 from the circuit board.
3. Slide the circuit board toward the side of the frame, lift up on the free side of it, and remove remaining connectors.

REPLACEMENT

To replace this assembly, reverse Steps 1 through 3.

FRONT PANEL L.E.D. ASSEMBLY

REMOVAL

To remove the Front Panel L.E.D. Assembly:

1. Remove the Control and Data Circuit Board Assembly.
2. Remove the L.E.D. Assembly by pressing the center of the Front Panel L.E.D. Assembly with a blunt tool.

NOTE

Press from the inside to the outside of the panel.

3. Remove the square retainer from the assembly.

REPLACEMENT

To replace this assembly, reverse Steps 1 through 3.

LINEAR BRAKE ASSEMBLY

REMOVAL

To remove the Linear Brake Assembly:

1. Remove the Control and Data Circuit Board Assembly.
2. Remove Connector J11 from the Spindle Control circuit board.
3. Remove the 5/16-inch nut and washer from the mounting stud.
4. Remove the Linear Brake Assembly.

REPLACEMENT

To replace the assembly, reverse Steps 1 through 4.

ADJUSTMENT

To adjust the Linear Brake Assembly:

1. Loosen the 5/16-inch mounting nut.
2. Set the feeler gauge, adjusted to 0.014 inches, between the brake pad and the spindle drive motor rotor.
3. Push the brake pad up against the feeler gauge.
4. Align the brake shoe with the Spindle Drive Motor rotor.
5. Tighten the 5/16-inch mounting nut.
6. Remove the feeler gauge.

INDEX ASSEMBLY

REMOVAL

To remove the Index Assembly:

1. Remove the Control and Data Circuit Board Assembly.

2. Loosen the lock nut on the Index Assembly bracket.
3. Unscrew the Index Assembly, and remove.

REPLACEMENT

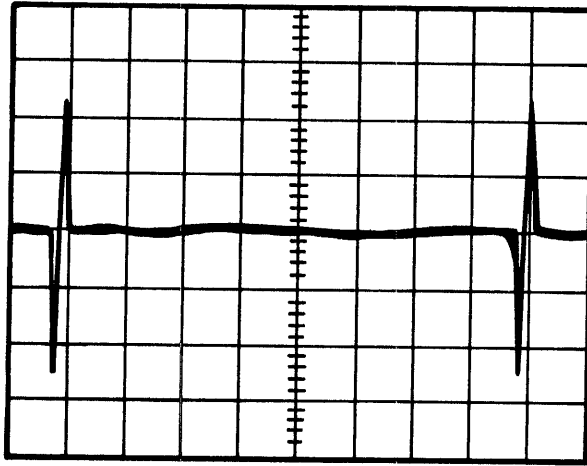
To replace the Index Assembly, reverse Steps 1 through 3.

ADJUSTMENT

To adjust the Index Assembly:

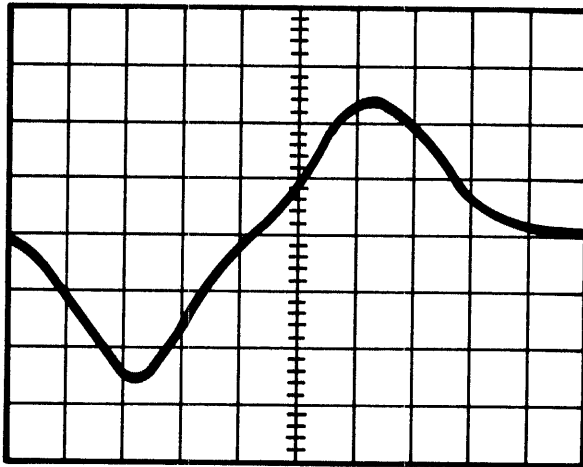
1. Loosen the 3/8-inch locking nut.
2. Adjust the Index Assembly to between 0.008 and 0.010 inches from the motor rotor.
3. Use a 100 megahertz or greater bandwidth oscilloscope.
4. Verify the A. C. signal as seen at U9, Pin 6, is greater than one volt peak to peak (see Figure 4-4).
5. There must not be more than 100 millivolts peak ripple on the base line.

VOLTAGE SCALE
1 VOLT PER DIVISION



TIME SCALE: 2 MILLISECONDS PER DIVISION
LOCATION U9-6

VOLTAGE SCALE
1 VOLT PER DIVISION



TIME SCALE: 50 MICROSECONDS PER DIVISION
LOCATION U9-6

FIGURE 4-4
INDEX SENSOR

FRONT PANEL

REMOVAL

To remove the front panel:

1. Wedge a taper shim 0.030 inch under the edge of the front panel.
2. Remove the front panel from the drive frame.
3. Clean the front panel thoroughly with solvent.

REPLACEMENT

To replace the front panel, apply new double back tape, and fit the panel over the drive frame.

SPINDLE CONTROL CIRCUIT BOARD ASSEMBLY

REMOVAL

To remove the Spindle Control Circuit Board Assembly:

1. Remove the Control and Data Circuit Board Assembly.
2. Remove Connectors J10 and J11 from the Spindle Control circuit board.
3. Remove the three screws that attach the board to the chassis.
4. Lift the board straight up and out.

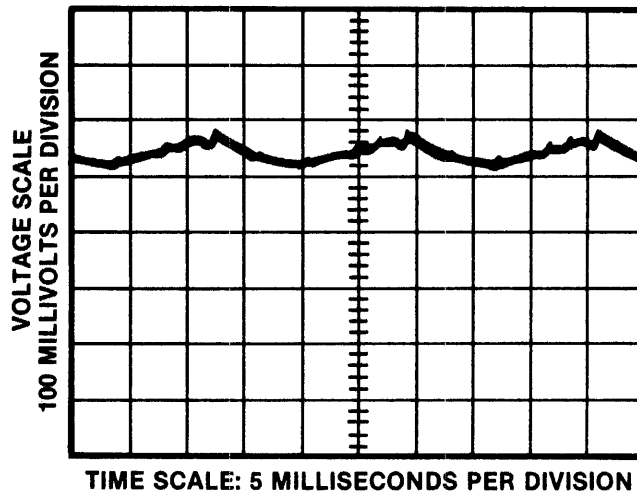
REPLACEMENT

To replace the board, reverse Steps 2 through 4. When replacing connectors, ensure the proper pin orientation.

ADJUSTMENT

To adjust the Spindle Control circuit board:

1. Set potentiometer R23 (closest to interface connectors, single turn) to its approximate center position.
2. Using a dual channel oscilloscope, connect one channel to R26 (resistor lead closest to the power transistor leads on Spindle Control Circuit Board), and set scope to 100 millivolts per division. Connect the other channel of the scope to test point three on the logic board (index), and set the voltage scale at one volt per division and the time base at two milliseconds per division.
3. Apply power to the drive and wait 15 seconds for the spindle motor to come up to speed.
4. While the scope is triggered on index, adjust the speed control potentiometer R5 on the spindle control board (10 turn pot closest to the front of the drive), so the time between index pulses is between 16 and 17 milliseconds.
5. Trigger the scope to the line frequency (60 Hertz). Adjust R5 so index pulses are stationary on the scope screen.
6. Adjust R23 so voltage spikes, both positive and negative going, across R26 are minimal (see Figure 4-5).
7. Repeat Steps 5 and 6 until no further improvement can be made.



**FIGURE 4-5
VOLTAGE SPIKES**

FRAME ASSEMBLY

REMOVAL

To remove the Frame Assembly:

1. Remove the Control and Data circuit board.
2. Remove the Spindle Control circuit board.
3. Remove the three frame nuts and the six washers.
4. Remove the Frame Assembly.

REPLACEMENT

To replace the Frame Assembly, reverse Steps 1 through 4 above.

TRACK 0 SENSOR ASSEMBLY

Do not move the positioning mechanism or Track 0 stop.

REMOVAL

To remove the Track 0 Sensor Assembly:

1. Remove the Circuit Board Assembly.
2. Loosen the screw on the Track 0 Sensor Assembly mount.
3. Swing the mount clear, and remove the screw that holds the Track 0 Sensor Assembly.

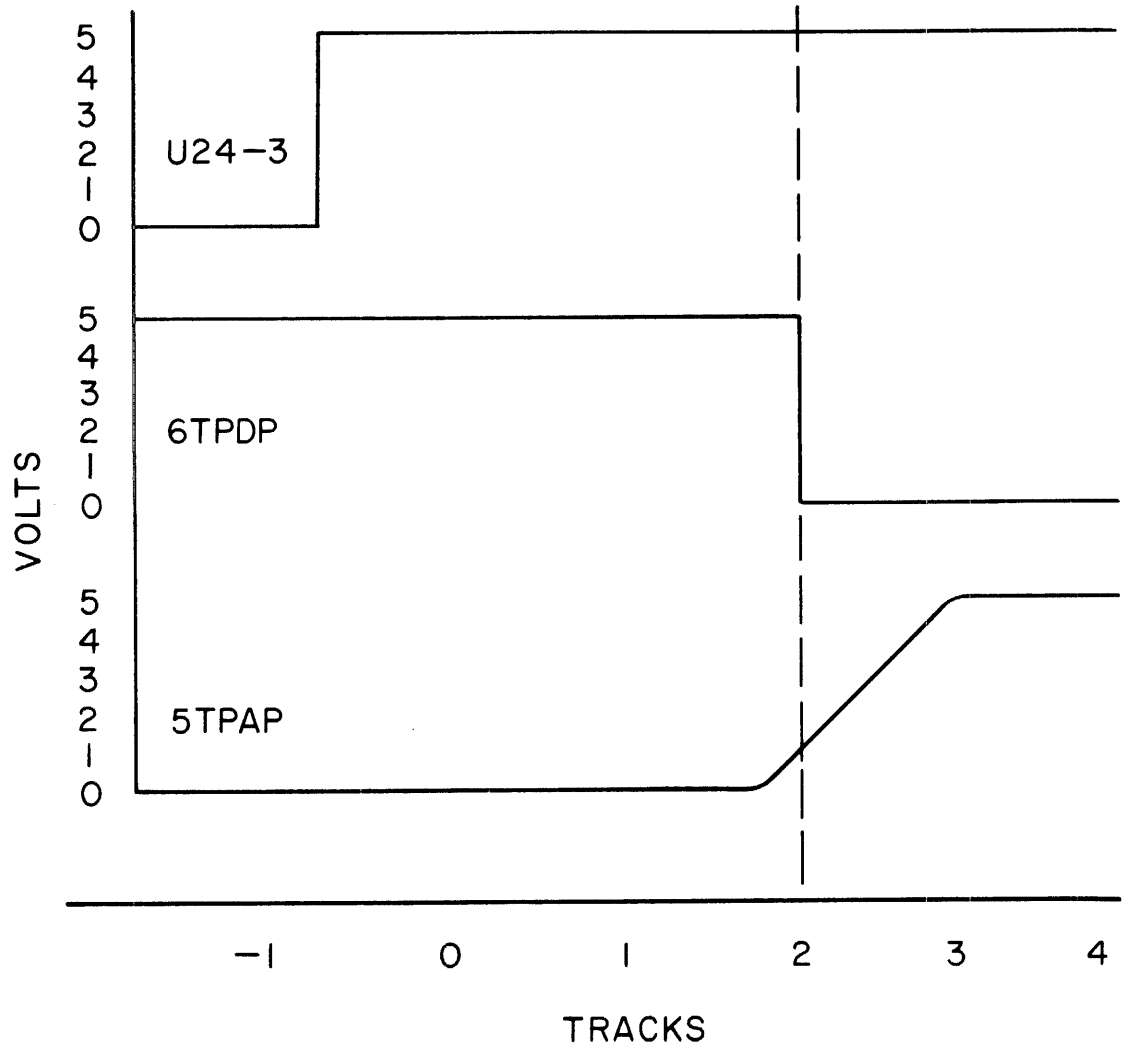
REPLACEMENT

To replace the Track 0 Sensor Assembly, reverse Steps 1 through 3 above.

ADJUSTMENT

To adjust the Track 0 Sensor Assembly:

1. Loosen the screw.
2. Adjust the sensor so that it is 2.5 ± 1 volt at Test Point 5, while stepping out from Track 5 to Track 0, and the positioner is on Track 2 plus or minus one track.
3. Verify that Test Point 6 changes logic level at Track 2, plus or minus one track (see Figure 4-6).



**FIGURE 4-6
TRACK 0 ADJUSTMENT**

APPENDIX A
CUSTOMER INFORMATION BULLETINS

CUSTOMER INFORMATION BULLETIN

NO. _____

SUBJECT: TM600 RIGID DISK DRIVE

RAMPED SEEK MODE

Tandon uses a Customer Information Bulletin to inform our customers of changes to and improvements in our products. The following information is an option on Tandon TM602 and TM603 rigid disk drives that may be of interest in your application.

Our current production TM600 series disk drives are designed to operate at a minimum time between steps of 3 milliseconds. Given 18 milliseconds for last step and settling time, this step rate results in an average seek time of 170 milliseconds for the 153 cylinder drive.

Customer requirements may necessitate a reduction in average seek time. By using the ramped seek mode and giving correct step pulse timing, the present drive's average access time can be improved.

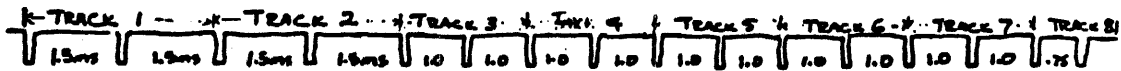
- A. In order to utilize a ramped seek, four major conditions must be met:
1. The disk drive must have a Control and Data printed circuit board, P/N 187045-001.
 2. Pin 8 and 9 programming shunt of the Control and Data printed circuit board must be closed (shorted).
 3. The viscous damper, available from Tandon, must be mounted to the stepper motor.
 4. The controller must issue step pulses in accordance with the algorithm below. Note: two pulses per track are required in ramped seek.
- B. The pulse timing for single-track to nine-track seek is:

Two pulses separated by 1.5 milliseconds for each track, i.e., one track seek = two pulses, seven track seek = 14 pulses.

BY _____ DATE _____

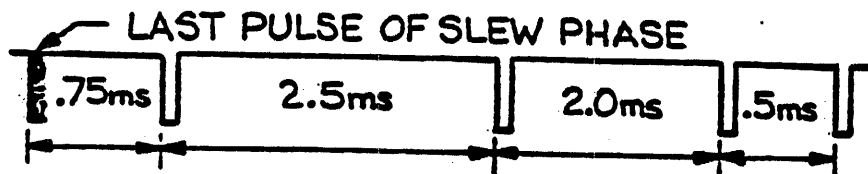
C. Pulse timing for an 10 track seek or greater.

1. Acceleration Phase:



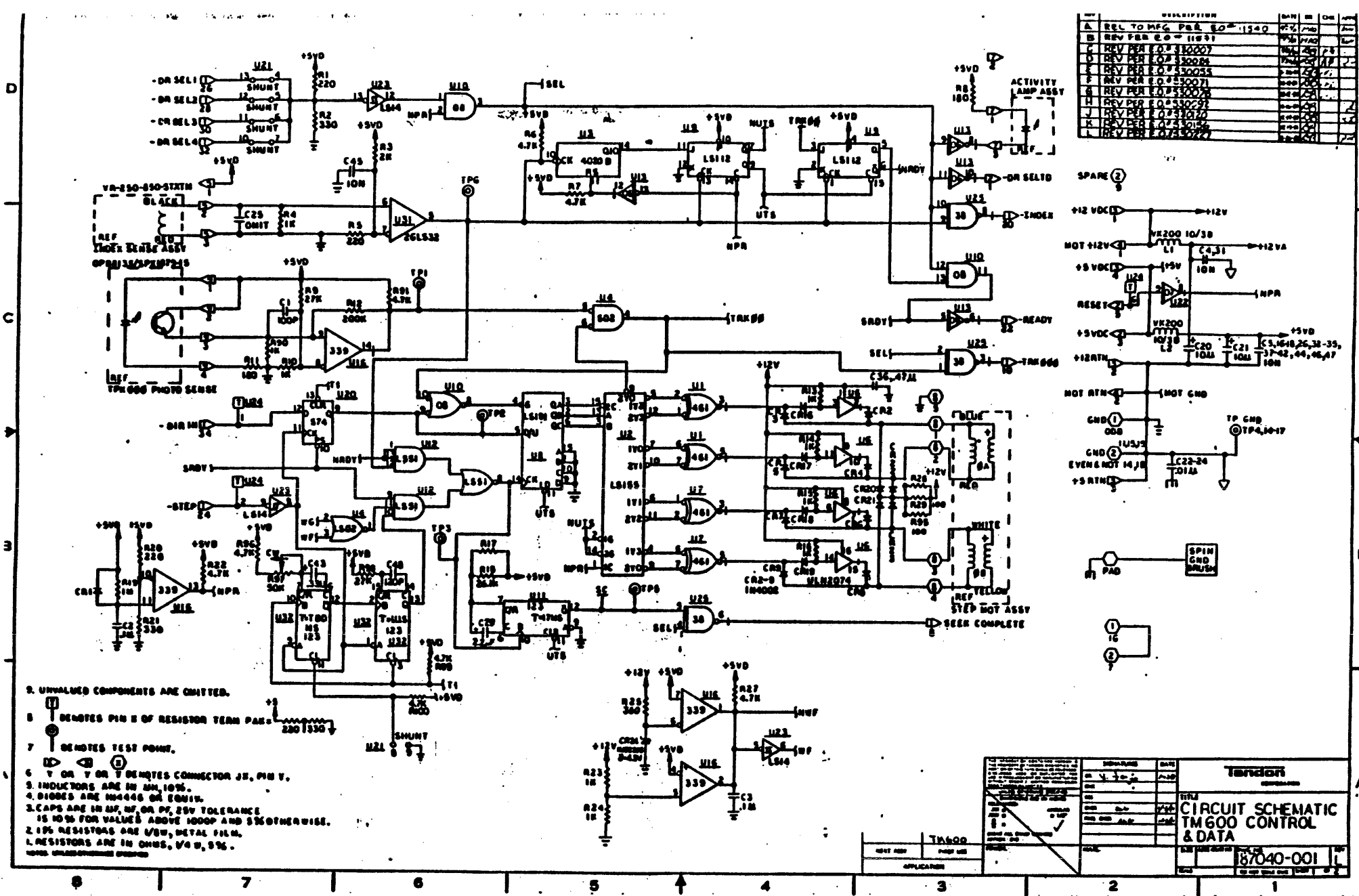
2. Slew Phase: two pulses separated by .75 milliseconds for each track.

3. Deceleration Phase: last two tracks or seek.



If you have any questions or need additional information, please do not hesitate to contact me.

APPENDIX B
SCHEMATICS



REV	DESCRIPTION	DATE	BY	CHK
A	REL TO MFG P&R EO-11540	11/27/50	WAC	WAC
B	REV PER EO-11531	11/27/50	WAC	WAC
C	REV PER EO-11500	11/27/50	WAC	WAC
D	REV PER EO-11500	11/27/50	WAC	WAC
E	REV PER EO-11500	11/27/50	WAC	WAC
F	REV PER EO-11500	11/27/50	WAC	WAC
G	REV PER EO-11500	11/27/50	WAC	WAC
H	REV PER EO-11500	11/27/50	WAC	WAC
I	REV PER EO-11500	11/27/50	WAC	WAC
J	REV PER EO-11500	11/27/50	WAC	WAC
K	REV PER EO-11500	11/27/50	WAC	WAC
L	REV PER EO-11500	11/27/50	WAC	WAC

- 9. UNVALUED COMPONENTS ARE OMITTED.
- 10. DENOTES PIN # OF RESISTOR TERM PAIR.
- 7 DENOTES TEST POINT.
- Y OR Y OR Y DENOTES CONNECTOR J#, PIN #.
- 5. INDUCTORS ARE IN MH, 10%.
- 4. DIODES ARE 1N4466 OR EQUIV.
- 3. CAPS ARE IN MF, UF, OR PF, 20% TOLERANCE IS 10% FOR VALUES ABOVE 1000P AND 5% OTHERWISE.
- 2. 1% RESISTORS ARE 1/8W, METAL FILM.
- 1. RESISTORS ARE IN OHMS, 1/4 W, 5%.

TANARD		TANARD	
CIRCUIT SCHEMATIC		TM 600 CONTROL & DATA	
187040-001		1	

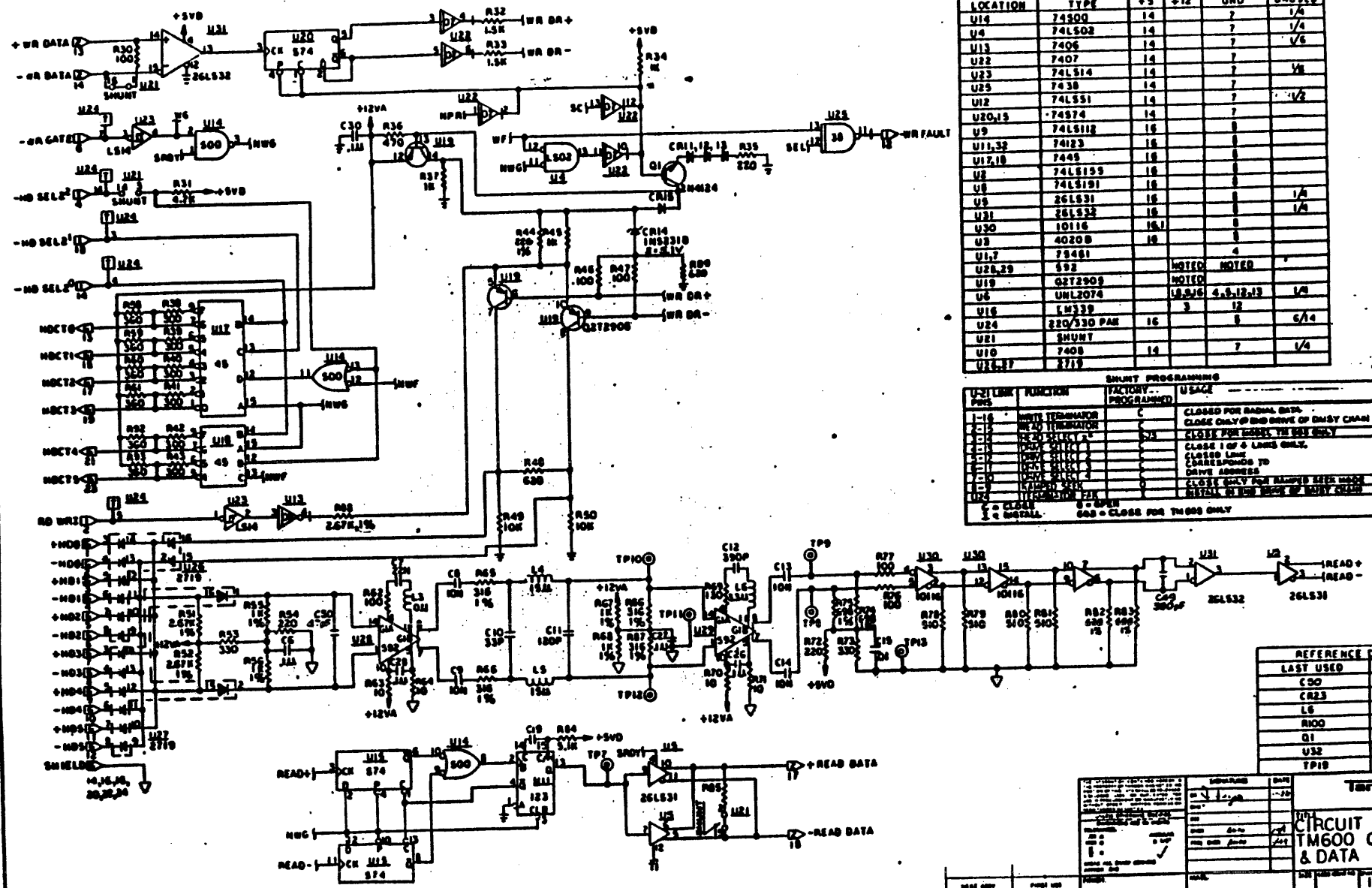
SEE SHEET FOR REV.

IC LOCATION AND VOLTAGE CHART					
LOCATION	TYPE	+3	+12	GND	UNUSED
U14	74500	14		7	1/4
U4	74LS02	14		7	1/4
U13	7406	14		7	1/4
U22	7407	14		7	
U23	74LS14	14		7	1/4
U25	7438	14		7	
U12	74LS51	14		7	1/2
U20,15	74974	14		7	
U9	74LS112	16			
U11,32	74123	16			
U17,18	7443	16			
U2	74LS155	16			
U8	74LS191	16			1/4
U5	26LS31	16			1/4
U31	26LS32	16			1/4
U30	10116	16			
U3	4020B	16			
U17	79481			4	
U28,29	555	NOTED	NOTED		
U19	02T2909	NOTED			
U6	UNL2074	16,2/6	4,5,12,13		1/4
U16	LM339	3	12		
U24	220/330 PAF	16	6		6/4
U10	7408	14		7	1/4
U16,17	8719				

SMURT PROGRAMMING			
U21 LINK POS	FUNCTION	FACTORY PROGRAMMED	USAGE
1-16	WRITE TERMINATOR	C	CLOSED FOR RADIAL DRUM - CLOSE ONLY ON DRIVE OF DRUM DATA
2-11	READ TERMINATOR	C	CLOSE ONLY ON DRIVE OF DRUM DATA
3-11	READ SELECT 1	3-11	CLOSE FOR READS TO THE ONLY
4-11	READ SELECT 2		CLOSE 1 of 4 LINKS ONLY.
5-11	READ SELECT 3		CLOSE LINK
6-11	READ SELECT 4		CLOSE RESPOND TO DRIVE ADDRESS
7-11	WRITE SELECT		CLOSE ONLY FOR RADIAL DRUM
8-11	INTERLOCK		INSTALL ON THE BACK OF DRUM CHASSIS
U22	INTERLOCK LINK		

C = CLOSE S = OPEN
 1 = INSTALL 60B = CLOSE FOR TM600 ONLY

REFERENCE DESIGNATORS	
LAST USED	NOT USED
C50	
CR23	
L6	
R100	
Q1	
U32	
TP12	

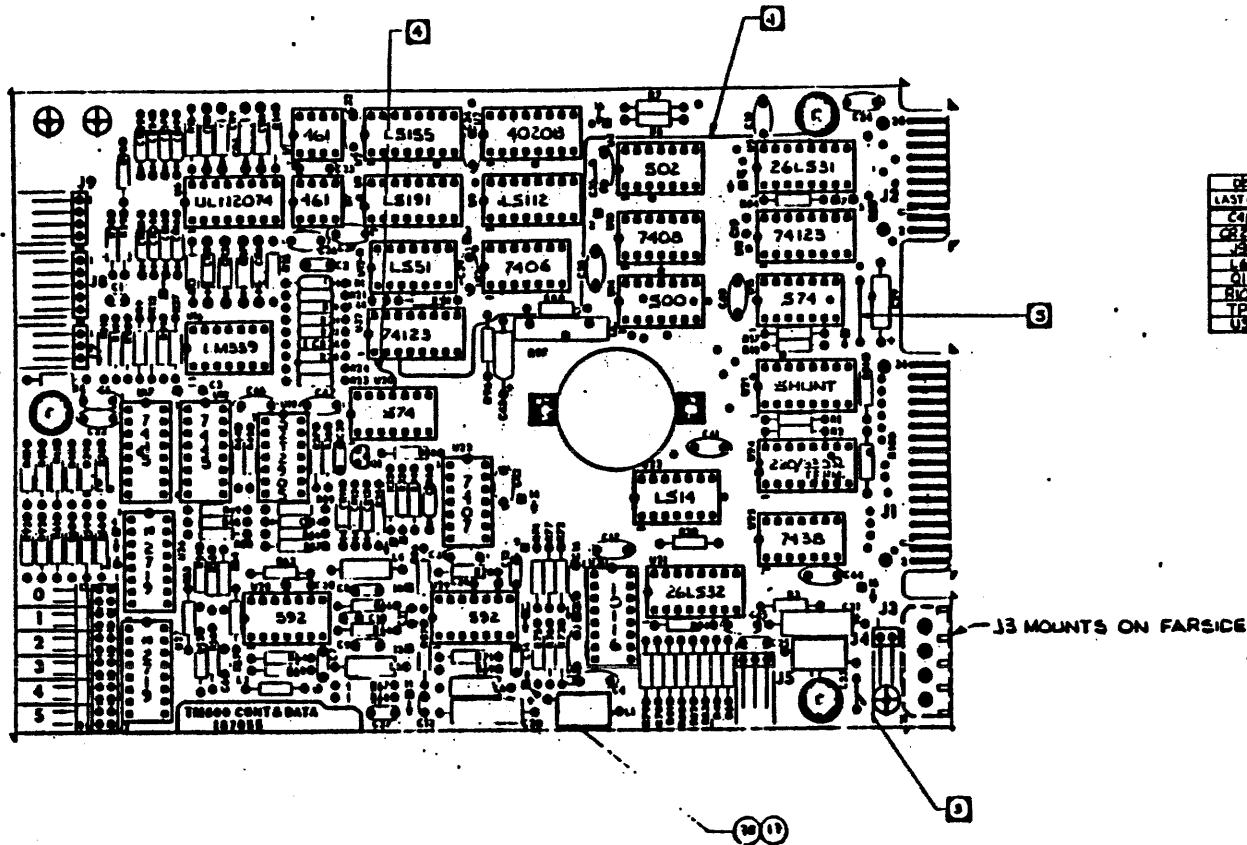


Tandon CORPORATION	
CIRCUIT SCHEMATIC, TM600 CONTROL & DATA	
DATE: 12-78 DRAWN: J. L. JONES CHECKED: J. L. JONES APPROVED: J. L. JONES	PART NO: 187040-001 REV: 1

8 7 6 5 4 3 2 1
 A

REVISIONS			
REV	DESCRIPTION	DATE	BY
B	REV PER E.O. 33007	11/2/71	JG
C	REV PER E.O. 33007	11/2/71	JG
D	REV PER E.O. 33007	11/2/71	JG
E	REV PER E.O. 33007	11/2/71	JG
F	REV PER E.O. 33007	11/2/71	JG
G	REV PER E.O. 33007	11/2/71	JG
J	REV PER E.O. 33007	11/2/71	JG
K	REV PER E.O. 33007	11/2/71	JG
L	REV PER E.O. 33007	11/2/71	JG
M	REV PER E.O. 33007	11/2/71	JG

DESIGNATOR ASSEMBLY SHOP		
LAST USED	DATE	BY
CR74	CR19	CR18-044
JS		
LA		LS-02
R100	R17885	
TRD		
USA		



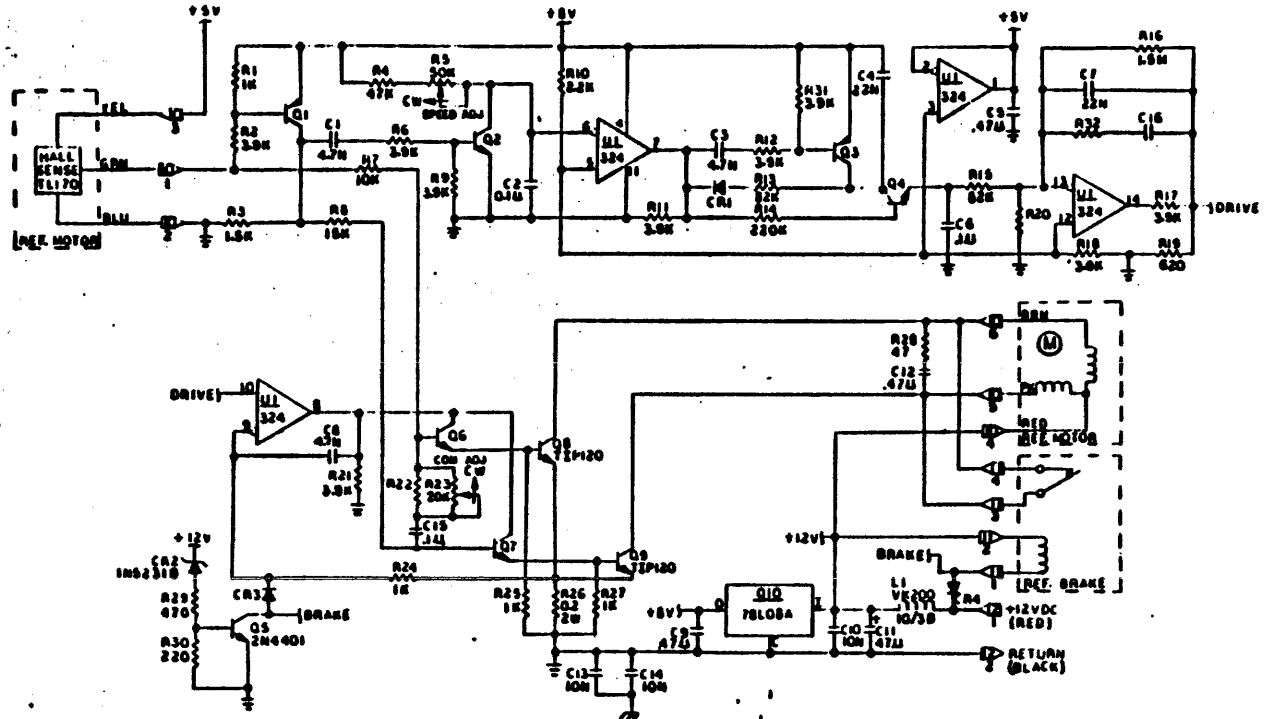
- ⑨ REFER PER E.O. 33007.
- ④ REFER PER E.O. 33007.
- ① SOLDER #20 AND UNINSULATED TIN COATED SOLID COPPER WIRE. MAY SUBSTITUTE #20 BONDOR LEAD WIRE.
- 2. SEE DOCUMENT 1 187045-001 - CIRCUIT SCHEMATIC
187045-002 - ASSEMBLY
- 3. SEE TABLE 1 THROUGH 5 FOR PART LIST

TP600
REV 1.0
DATE 11/2/71

		Tandon 187045-001 ASSEMBLY, TM600 CONTROL & DATA	
D 11/2/71	JG	187045-001	M

8 7 6 5 4 3 2 1

REVISIONS					
REV	DESCRIPTION	DATE	BY	CHKD	APP
E	REV P&B EQ 53-543				
D	REV P&B EQ 53-543				
C	REV P&B EQ 53-543				
B	REV P&B EQ 53-543				
A	REV P&B EQ 53-543				

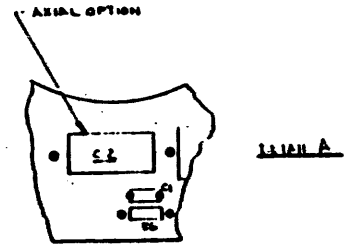
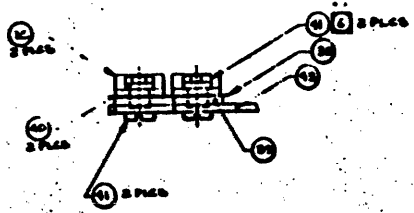
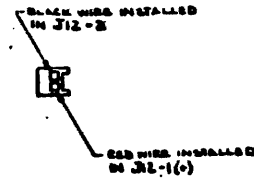
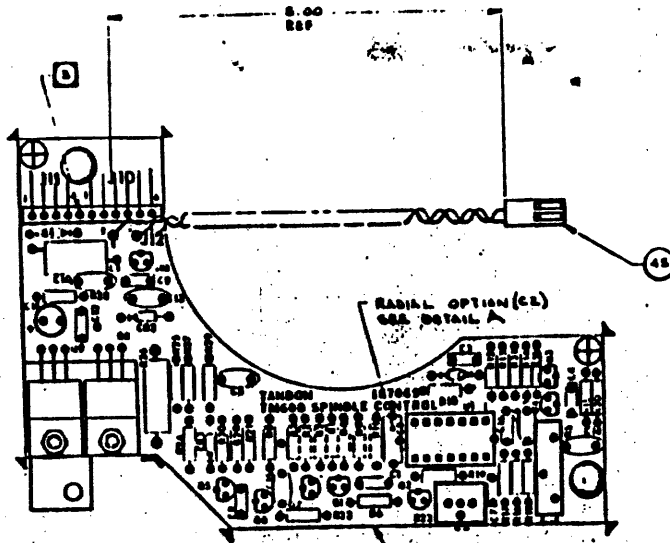


- 2 UNLABLED COMPONENTS ARE OMITTED.
 C T OR Y DENOTES CONNECTOR T, PIN Y.
 3 PNP TRANSISTORS ARE 2N4123.
 4 NPN TRANSISTORS ARE 2N4124.
 3 DIODES ARE 1N4446 OR EQUIV.
 2 CAPACITORS ARE 25V, 10%, PP, NP, OR MF.
 1 RESISTORS ARE IN OHMS, 1/4W, 5%.

REFERENCE DESIGNATORS	
LAST USED	NOT USED
C16	
CR4	
J3	
L1	
Q10	
R32	
U1	

<p>DATE: _____</p> <p>APP. CAT. NO. _____</p>		<p>REV. _____</p> <p>DATE: _____</p>	<p>REV. _____</p> <p>DATE: _____</p>	<p>REV. _____</p> <p>DATE: _____</p>	<p>REV. _____</p> <p>DATE: _____</p>
<p>Tandon</p> <p>COMMUNICATIONS</p>					
<p>CIRCUIT SCHEMATIC,</p> <p>TM60 SPINDLE</p> <p>CONTROL</p>					
<p>FIG. NO. _____</p> <p>REV. _____</p>				<p>187060-001</p>	

REVISIONS				
REV	DESCRIPTION	DATE	BY	CHK
C	REV PER E.O. 11291			
D	REV PER E.O. 11291			
D	REV PER E.O. 11291			
E	REV PER E.O. 11291			



- 2. REF DOCUMENT: INSTALLATION SCHEMATIC
- 3. THIS IS A 4.0 MICRON BOARD.
- 4. COMPONENT HEIGHT, EXCEPT CH, SHALL NOT EXCEED .63 INCH ABOVE BOARD.
- 5. COMPONENT HEIGHT, EXCEPT CH, SHALL NOT EXCEED .63 INCH ABOVE BOARD.
- 6. CUT PIN TAIL TO PIN CARRIAGE.
- 7. THIS ASSEMBLY SHALL BE MADE FROM P.C.B. DETAIL 0750-001.
- 8. ASSEMBLY PER STANDARD MANUFACTURING METHOD.

NOTES: UNLESS OTHERWISE SPECIFIED

USED ON TM 500		DATE		BY		CHK	
Tandon		1970-05-01		E		E	
SPINDLE CONTROL ASSY		TM 500		187005-001		E	

APPENDIX A

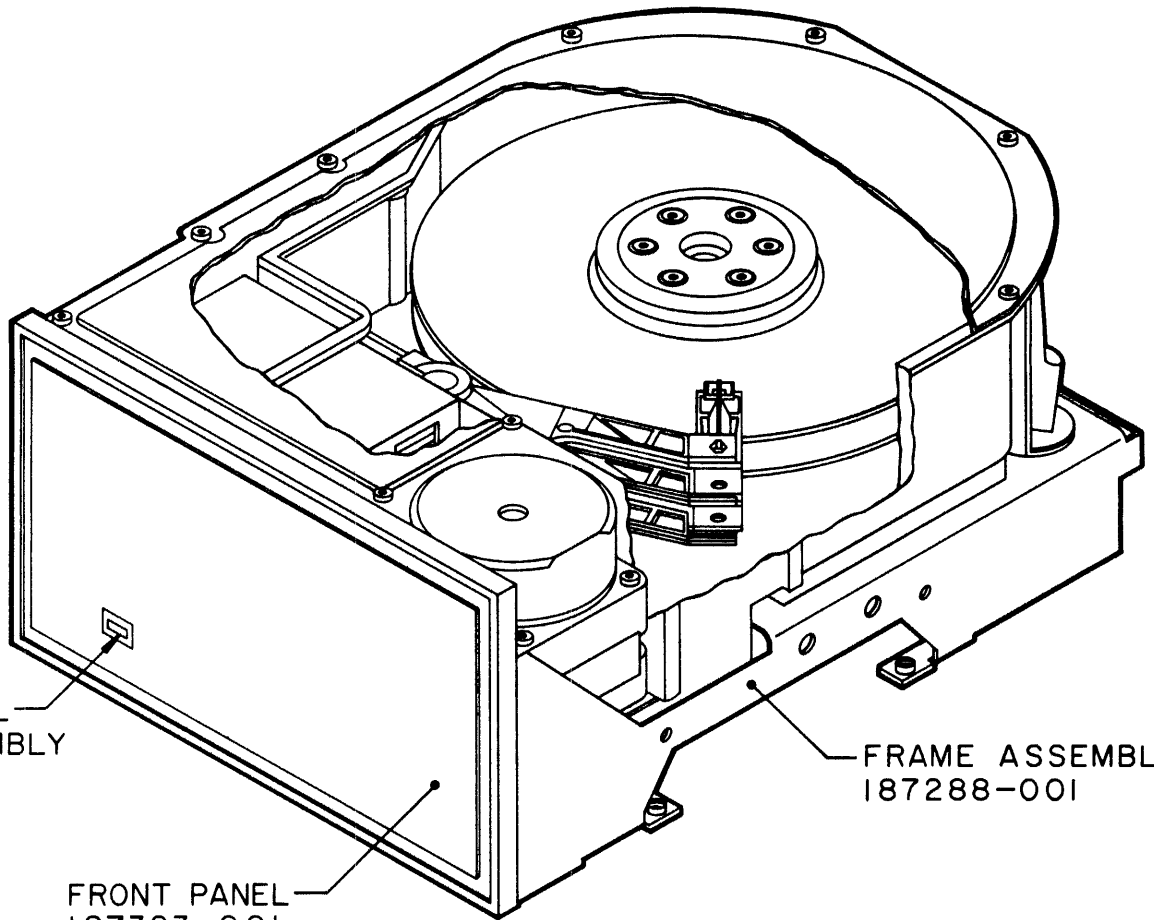
RECOMMENDED SPARE PARTS LIST AND MAJOR ASSEMBLIES

All assemblies with part numbers are available for purchase as spare replacement parts. The items without alpha designators on the drawings are for reference only, and cannot be purchased as spare replacement parts.

If an assembly has been determined faulty, and is not listed as a spare replacement, the drive must be returned to the manufacturer for repair.

RECOMMENDED SPARE PARTS LIST

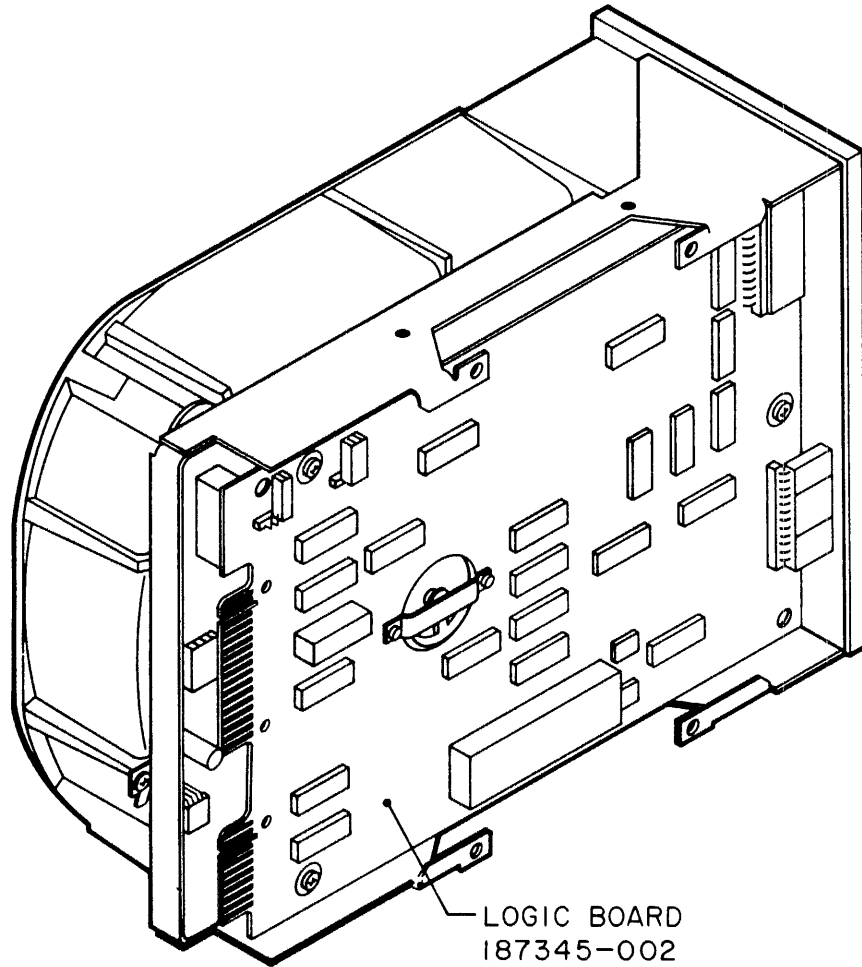
Description	Part Number
Brake Assembly.....	962010-001
Index Assembly.....	187010-001
Track 0 Assembly.....	187174-001
Frame Assembly.....	187288-001
Front Panel.....	187323-001
Spindle Control Board.....	187065-001
Logic Board.....	187345-002
Front Panel L.E.D. Assembly.....	187018-001
Single Pack Shipping Container.....	187125-001 (Not Shown)
Four Pack Shipping Container.....	187125-002 (Not Shown)

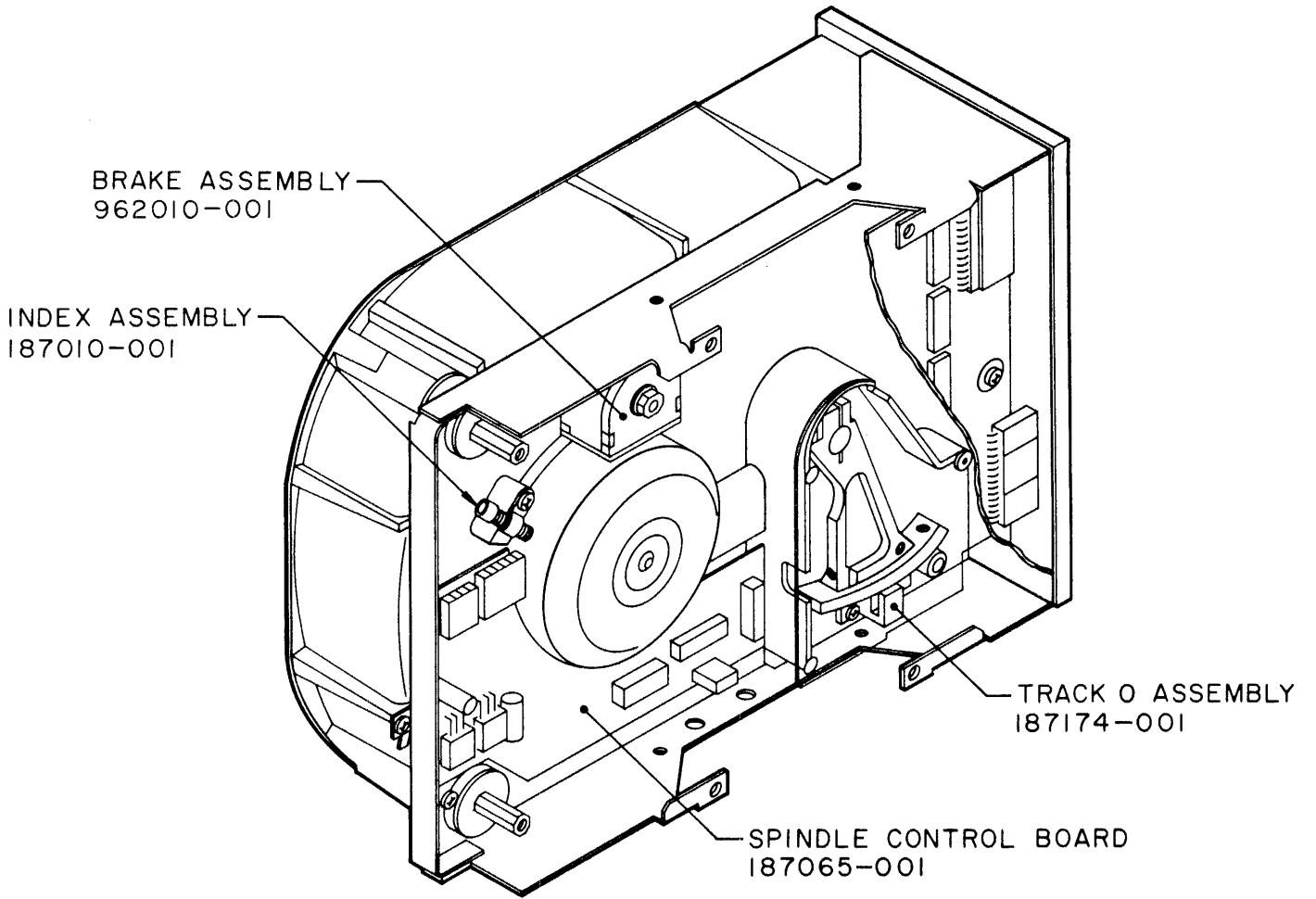


FRONT PANEL
L.E.D. ASSEMBLY
187018-001

FRAME ASSEMBLY
187288-001

FRONT PANEL
187323-001



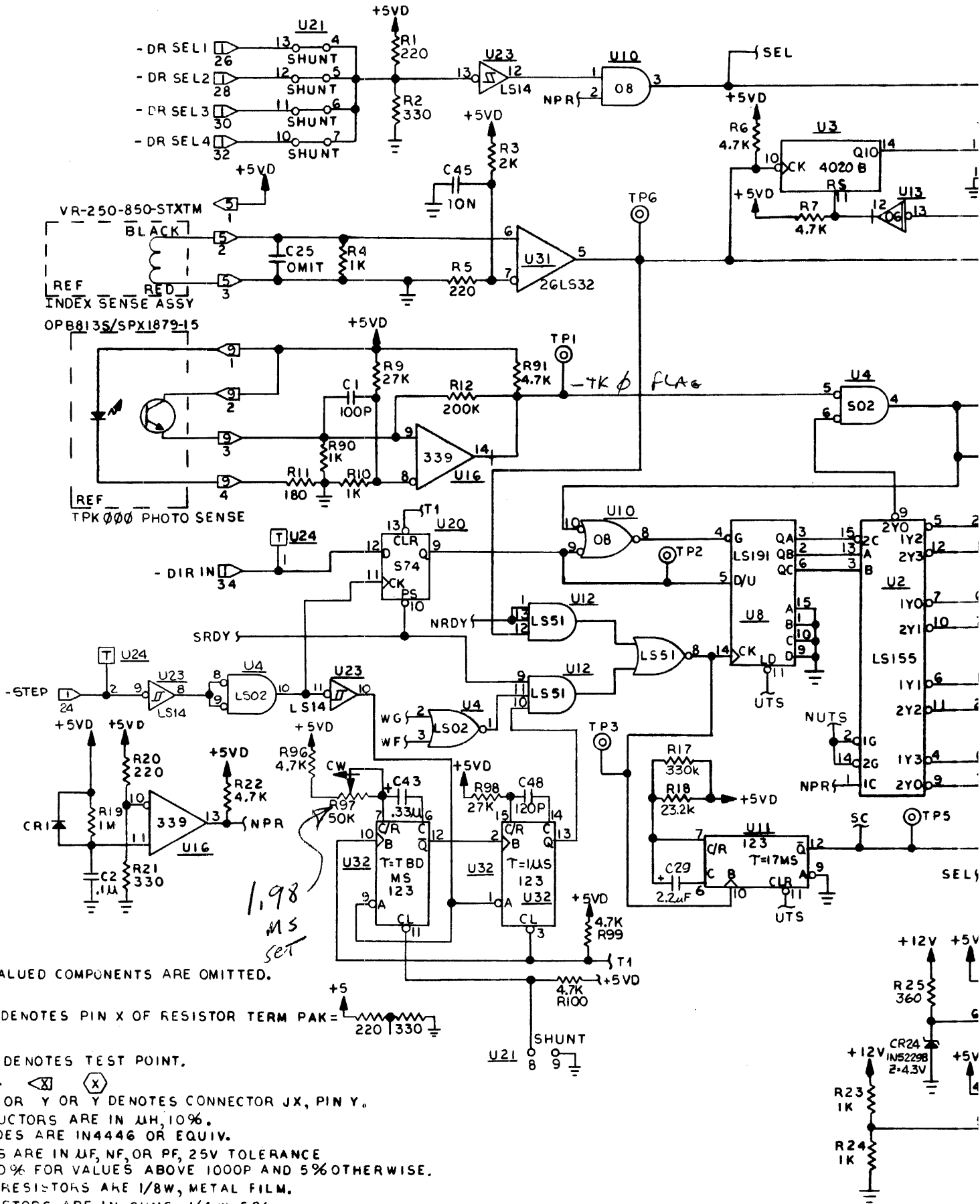


APPENDIX B

CIRCUIT BOARD SCHEMATICS AND ASSEMBLY DRAWINGS

This appendix contains the current circuit board schematics and assembly drawings for the TM500 series of disk drives.

Drawing Number	Title	Page Number
187340-001 REV L	Control and Data Circuit Board Schematic	B-2, B-3, B-4
187345-001 REV S	Control and Data Circuit Board Assembly	B-5
187065-001 REV J	Spindle Control Circuit Board Assembly	B-6
187060-001 REV E	Spindle Control Circuit Board Assembly	B-7



9. UNVALUED COMPONENTS ARE OMITTED.

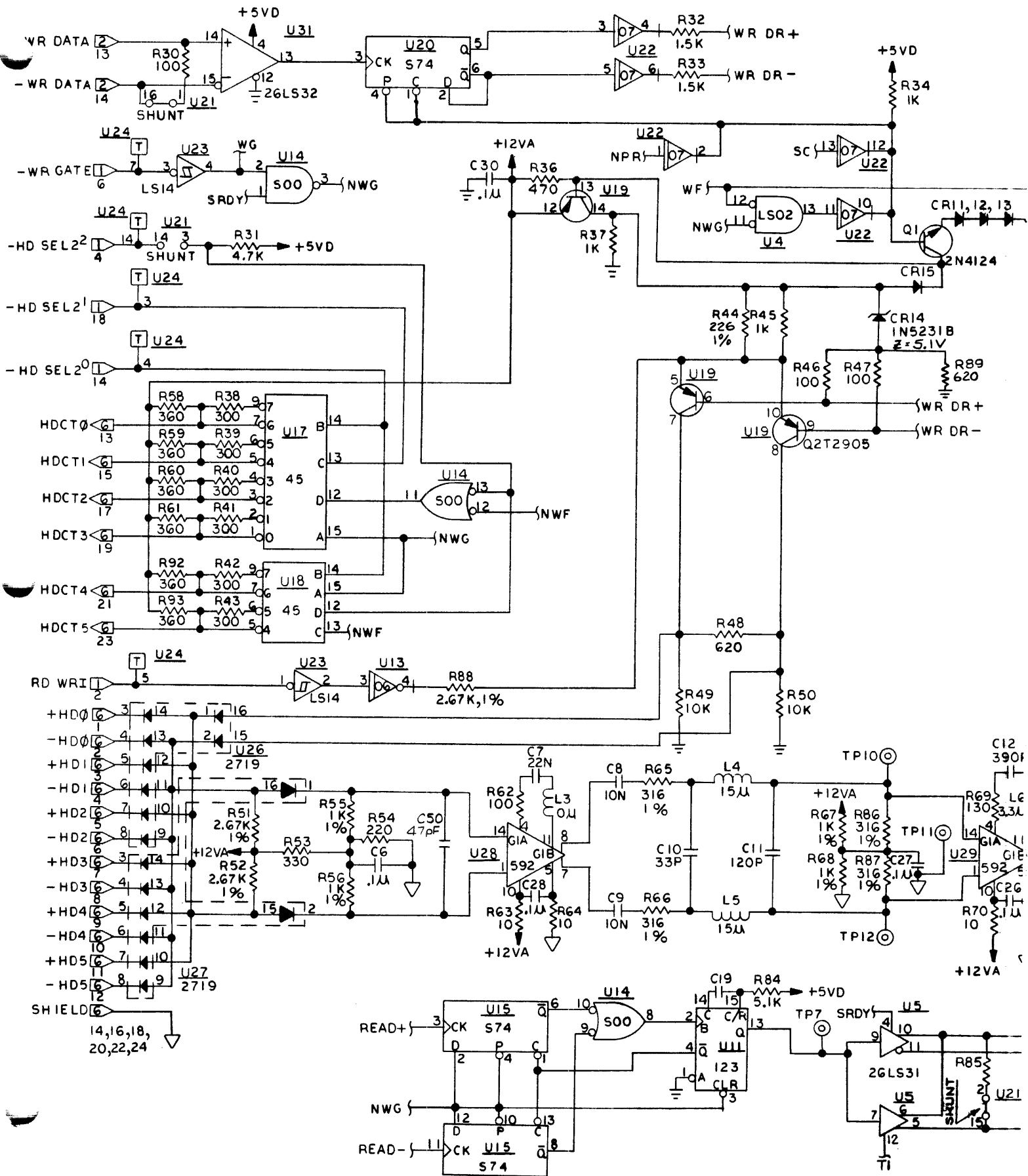
8. DENOTES PIN X OF RESISTOR TERM PAK = $\frac{220}{330}$

7. DENOTES TEST POINT.

Y OR Y OR Y DENOTES CONNECTOR JX, PIN Y.

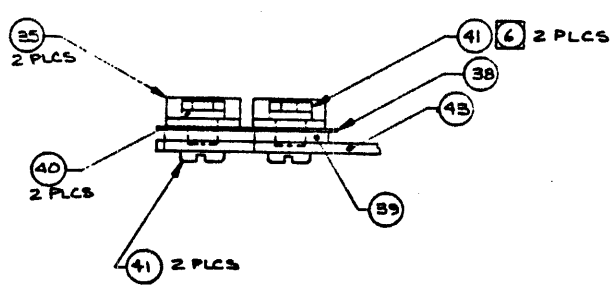
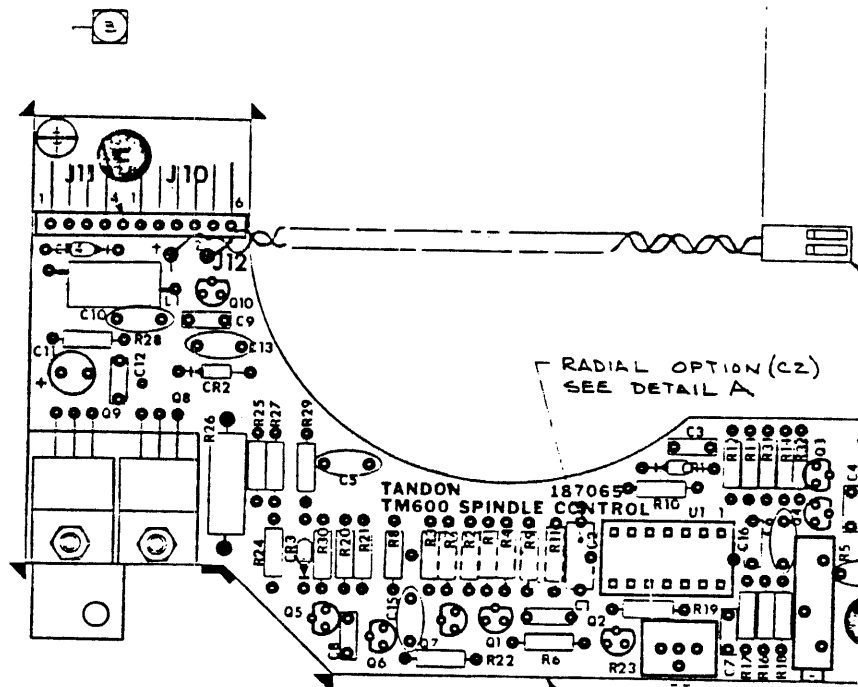
INDUCTORS ARE IN μ H, 10%.
 4. DIODES ARE IN4446 OR EQUIV.
 3. CAPS ARE IN μ F, NF, OR PF, 25V TOLERANCE
 IS 10% FOR VALUES ABOVE 1000P AND 5% OTHERWISE.
 2. 1% RESISTORS ARE 1/8W, METAL FILM.
 1. RESISTORS ARE IN OHMS, 1/4 W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED



D
C
B
A

5.00 REF



- 7. REF DOCUMENT : 187060-001 -CIRCUIT SCHEMATIC
187061-001 - ARTWORK
- 6 TORQUE 4.5 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 187060-001
- 1. ASSEMBLY PER STANDARD MANUFACTURING METHODS.

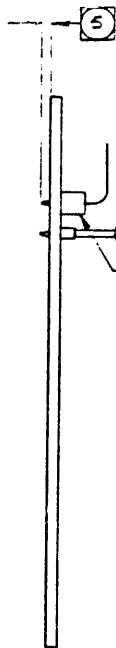
NOTES : UNLESS OTHERWISE SPECIFIED

REVISIONS				
REV	DESCRIPTION	DATE	DR	CHK
E1	REV PER E.O. 11633	11-27-61	ASB	ASB
C	REV PER EC-11561	11-27-61	ASB	ASB
D	REV PER E.O. S30006	11-27-61	ASB	ASB
E	REV PER E.O. S30043	9-28-61	ASB	ASB
F	REV PER E.O. S30201	4-2-62	ASB	ASB

BLACK WIRE INSTALLED
IN J12-2



RED WIRE INSTALLED
IN J12-1(+)

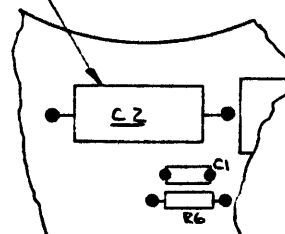


PIN CARRIAGE

45



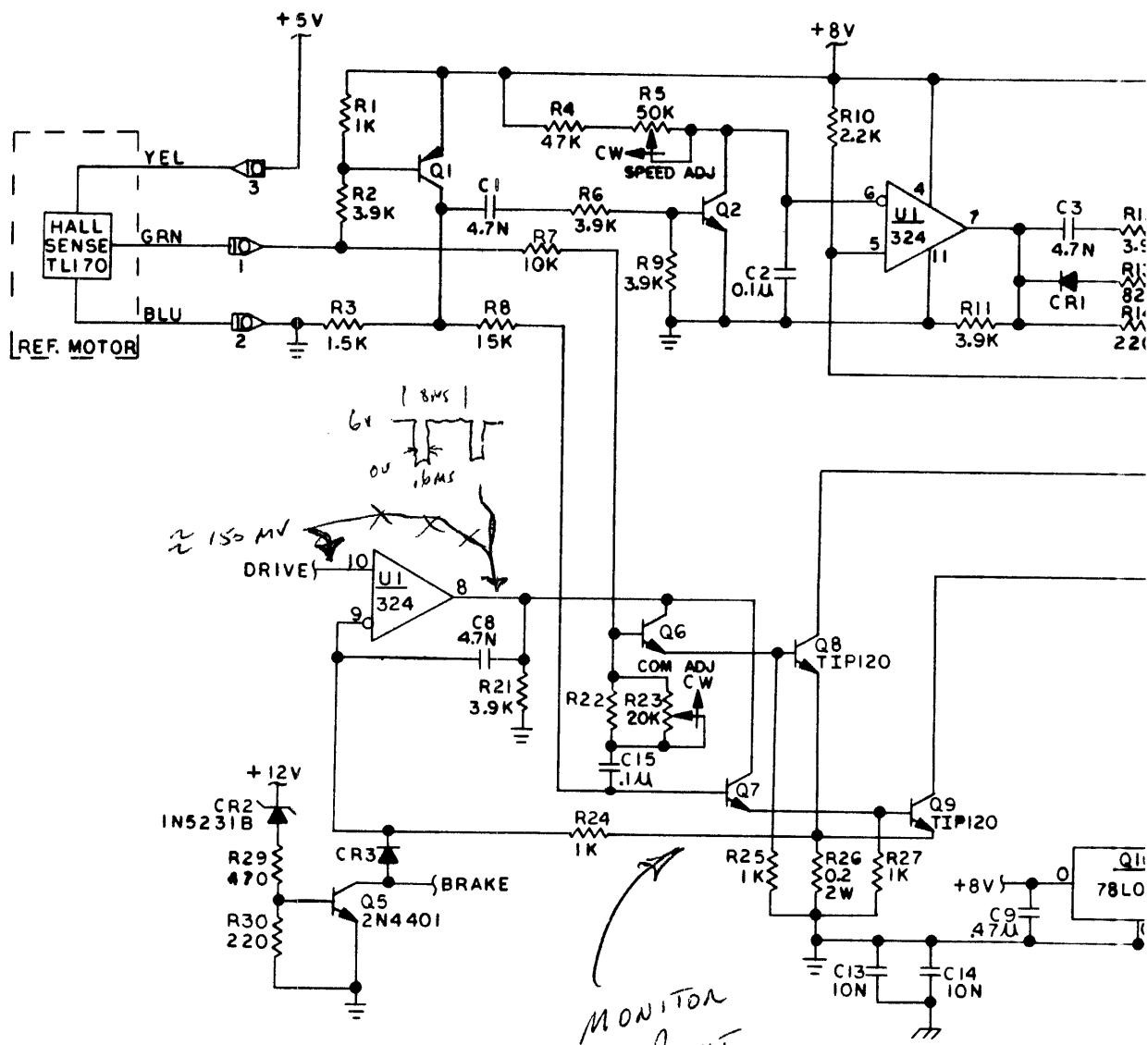
AXIAL OPTION



DETAIL A

USED ON TM600

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<small>UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.</small>		DE: ENGR:		TITLE SPINDLE CONTROL ASSY TM600	
TOLERANCES SURF ± .005 HOLE ± .005 ANGULAR ± 1/2° BREAK ALL SHARP CORNERS APPROX .015		PROJ: ENGR <i>[Signature]</i> DATE:		SIZE CODE IDENT NO DWG NO D 1E7065-001	
FINISH		MATL		SCALE DO NOT SCALE DWG SHEET 3 OF 3	



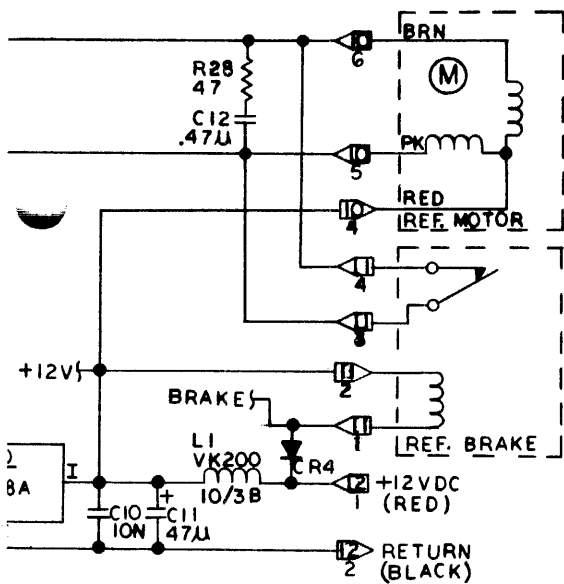
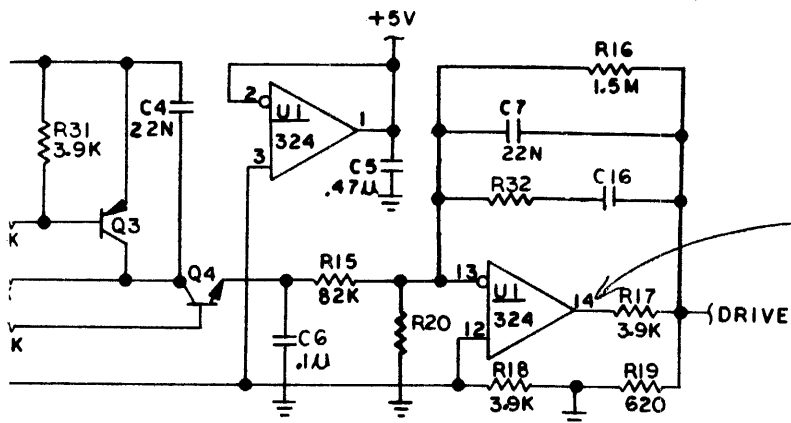
Handwritten notes:
 6V | 8MS |
 0V | 16MS |
 ~ 150 MV
 DRIVE

MONITOR THIS POINT FOR COM ADJ.

- 7. UNVALUED COMPONENTS ARE OMITTED.
- Y OR Y DENOTES CONNECTOR X, PIN Y.
- NP TRANSISTORS ARE 2N4125.
- 4, NPN TRANSISTORS ARE 2N4124.
- 3, DIODES ARE IN4446 OR EQUIV.
- 2, CAPACITORS ARE 25V, 10%, PF, NF, OR UF.
- 1, RESISTORS ARE IN OHMS, 1/4W, 5%.

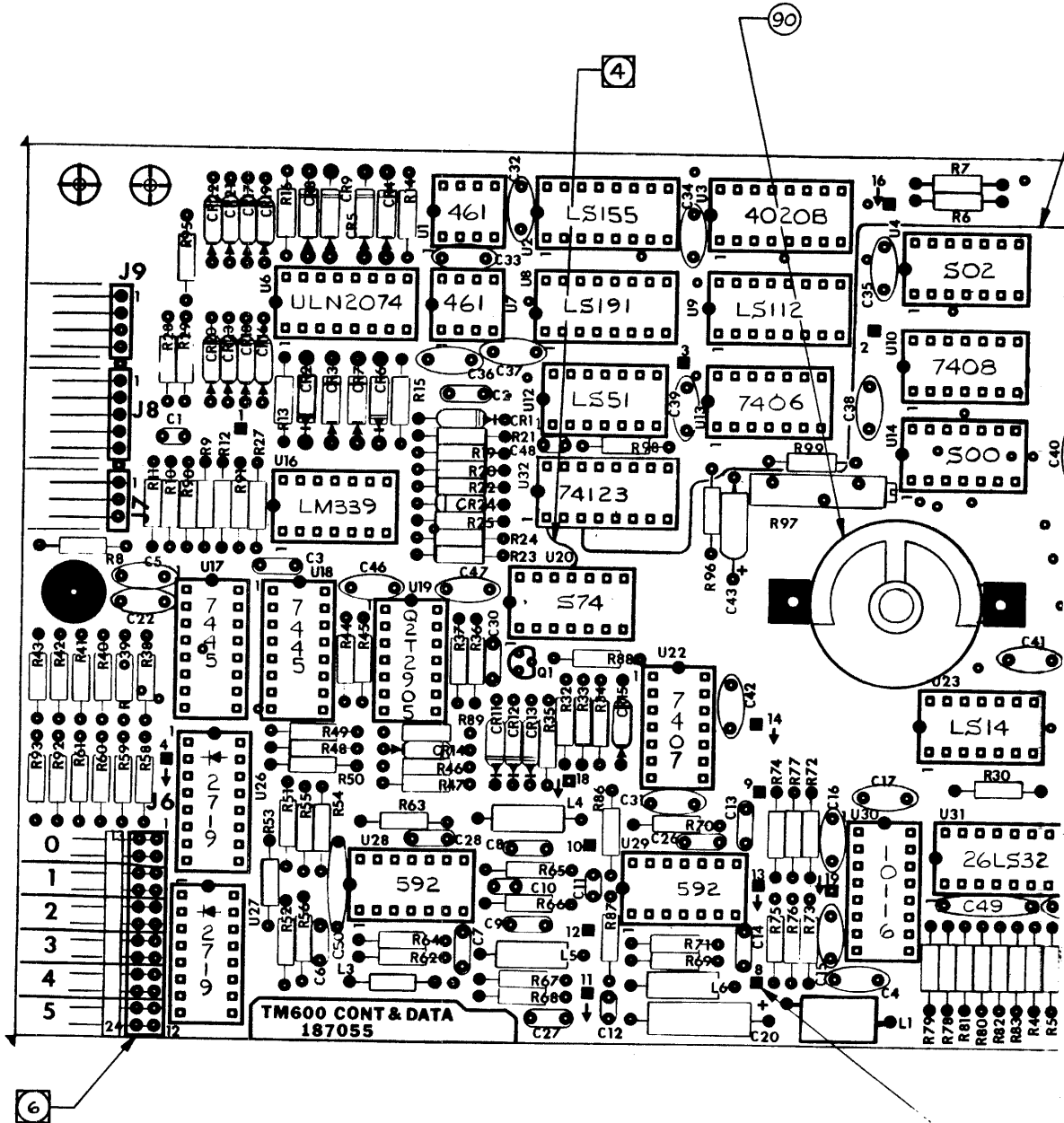
NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS					
REV	DESCRIPTION	DATE	DR	CHK	BY
B	REV PER E.O. # 11539	4/24/61	MAZ		A
C	REV PER E.O. # 11558	7/20/61	MAZ		A
D	REV PER E.O. 530006	7/14/61	ASB		A
E	REV PER E.O. 530043	8-23-61	ASB		A



REFERENCE DESIGNATORS	
LAST USED	NOT USED
C16	
CR4	
J3	
L1	
Q10	
R32	
U1	

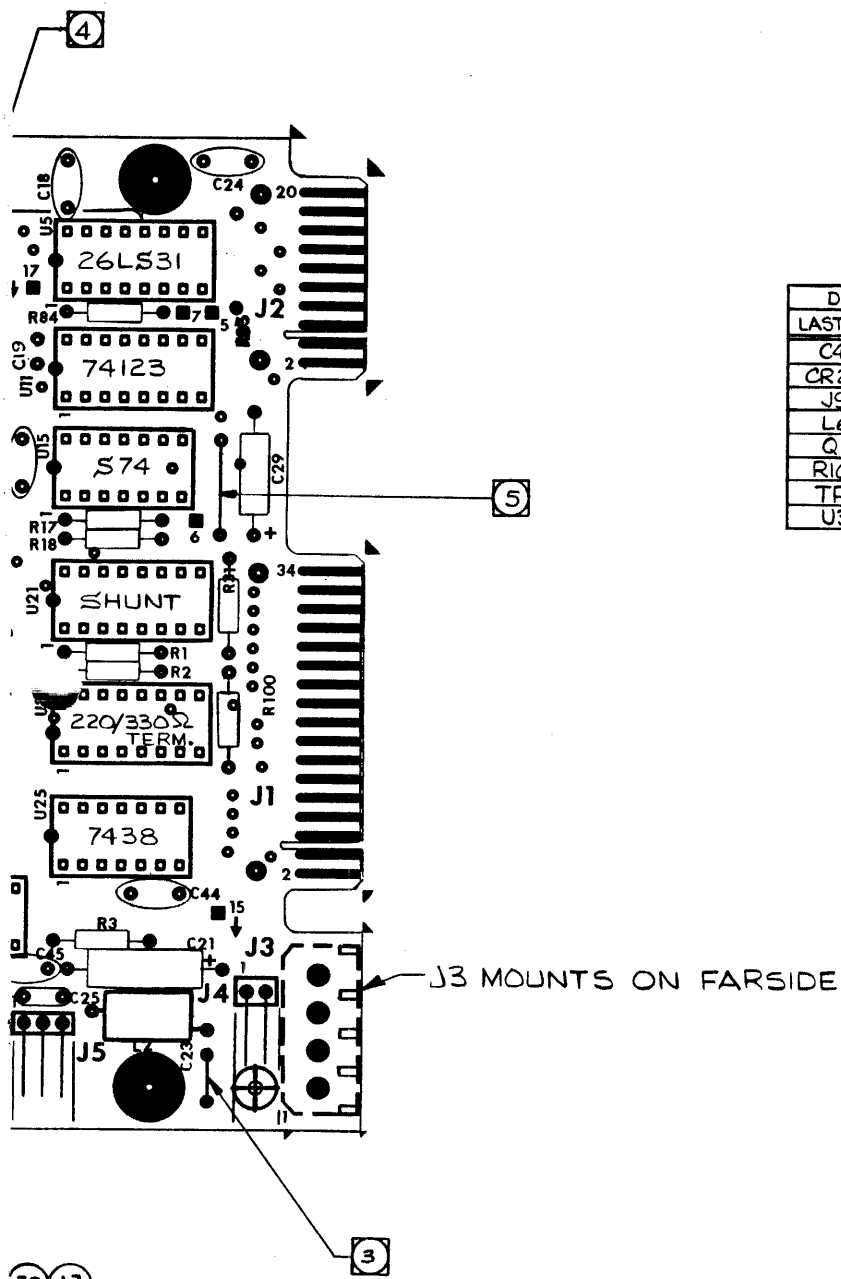
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<small>UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES</small>		TITILE CIRCUIT SCHEMATIC, TM600 SPINDLE CONTROL		SCALE NIP N.E. DO NOT SCALE DWG. SHEET 1 OF 1
<small>TOLERANCES: JOK ± JOKK ± X ± X ±</small>		<small>ANGULAR ± 1/2°</small>		SIZE D
<small>BREAK ALL SHARP CORNERS APPROX. .010</small>		FINISH:		CODE IDENT NO. 187060-001
APPLICATION		MATL:		DO NOT SCALE DWG



- 6 RAISE CONNECTOR J6 TO .035 INCHES ABOVE SURFACE PER E.O. S30395.
 - 5 JUMPER PER E.O. S30156.
 - 4 JUMPER PER E.O. S30024.
 - 3 SOLDER #24 AWG UNINSULATED TIN COATED SOLID COPPER WIRE. MAY SUBSTITUTE 1/4W RESISTOR LEAD WIRE.
2. REF DOCUMENT: 187040-001 - CIRCUIT SCHEMATIC
187042-001 - ARTWORK
1. SEE SHEET 1 THRU 3 FOR PART LIST

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS						
REV	DESCRIPTION	DATE	DR	CHK	APP	
B	REV & REDRAWN PER E.O.# 11571	5/1/81	MAQ			
C	REV PER E.O.S30007	7/8/81	OB			
D	REV PER E.O.S30024	7/30/81	OB			
E	REV PER E.O.S30055	8-28-81	OB			
F	REV PER E.O.S30071	7-30-81	J.T			
G	REV PER E.O.S30075	7-30-81	J.E			
J	REV PER E.O.S30092	1-4-82	OB			
K	REV PER E.O.S30120	1-4-82	OB			
L	REV PER E.O.S30156	1-4-82	OB			
M	REV PER E.O.S30167	1-11-82	OB			
N	REV PER E.O.S30227	5-7-82	OB			
P	REV PER E.O.S30250	5-7-82	OB			
Q	REV PER E.O.S30318	8-4-82	OB			
R	REV PER E.O.S30329	8-4-82	OB			
S	REV PER E.O.S30331	8-5-82	OB			
T	REV PER E.O.S30346	8-6-82	OB			
U	REV PER E.O.S30367	10-8-82	OB			
V	REV PER E.O.S30395	10-8-82	OB			



DESIGNATOR ASSEMBLY GUIDE		
LAST USED	NOT USED (OMIT)	EXCEPTIONS (DESIGNATOR-INSERT)
C48	C19	C23-BUSS
CR24	CR10	
J9		
L6		L3-05
Q1		
R100	R17,R85	
TP19		
U32		

J3 MOUNTS ON FAR SIDE

78 17

TM600
NEXT ASSY FIRST USE APPLICATION

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	DR. J. RAJIC	8/28/81
	CHK	
	DES	
	ENGR	
PROJ. ENGR	AWW	5/7/81

Tandon
CORPORATION

TITLE
ASSEMBLY, TM600 CONTROL & DATA

SIZE CODE IDENT NO DWG NO. REV
D 187045-001 V

SCALE 2/1 DO NOT SCALE DWG SHEET 4 OF 4