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# **MAGNETIC TAPE UNIT (75 IPS Family)**

**MTU 9105 / 9110 / 9113 / 9115  
9117 / 9119 / 9121 / 9123**

## **GENERAL DESCRIPTION OPERATION THEORY OF OPERATION**

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## PREFACE

This manual describes the STC 1750 Series Magnetic Tape Unit prepared for Honeywell Information Systems, Inc. The tape unit is a 10 1/2-inch reel, dual vacuum column, digital magnetic tape unit that reads and writes ANSI and IBM compatible formats using either non-return-to-zero (NRZI) or phase encoded (PE) methods. All references in this manual to the Datapoint 2750 Series Magnetic Tape Unit are equivalent to the STC 1750 Series Magnetic Tape Unit.

The manual is divided into six chapters as follows:

- Chapter 1 - General Information
- Chapter 2 - Installation and Checkout
- Chapter 3 - Operation and Interface
- Chapter 4 - Theory of Operation
- Chapter 5 - Maintenance
- Chapter 6 - Drawings and Parts Lists

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# Chapter 1

## GENERAL INFORMATION

### 1-1 INTRODUCTION

This chapter describes and illustrates the 2750 Series Magnetic Tape Unit (figure 1-1) and its major components. This chapter also defines interface capabilities and describes the optional equipment and accessories available with the unit. Performance specifications and equipment characteristics are listed at the end of the chapter.

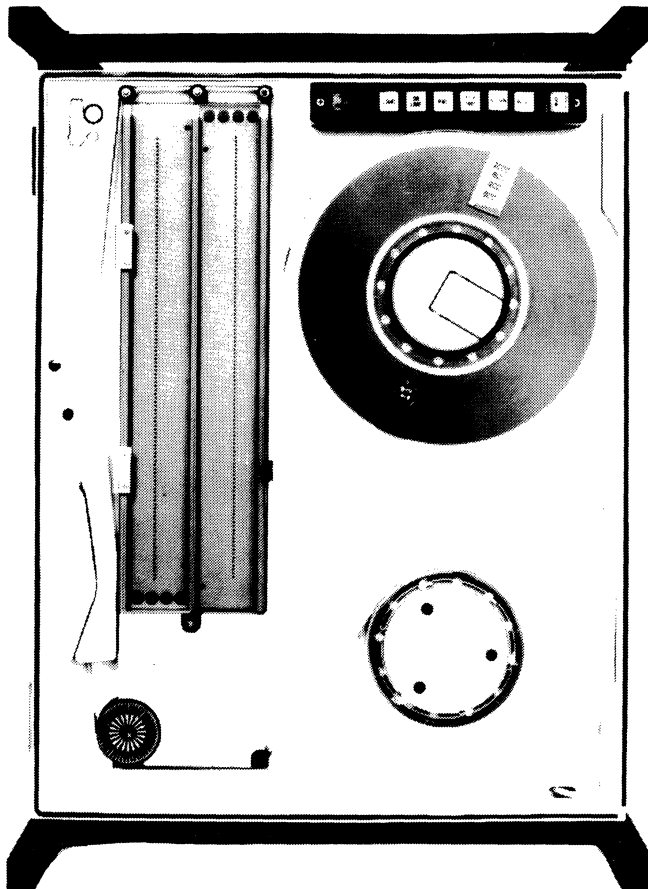


Figure 1-1. 2750 Series Magnetic Tape Unit

### 1-2 FUNCTIONAL DESCRIPTION

The 2750 is a highly reliable, dual vacuum column, digital magnetic tape drive which reads and writes data in ANSI and IBM compatible formats using either NRZI or phase encoded (PE) methods. Data may be recorded on 7- or 9-track tapes at 25, 37.5, 45, or 75 inches per second (ips). The 2750 can read 7- or 9-track tapes recorded on

any other ANSI or IBM compatible tape unit; conversely, any such unit can read tapes recorded on the 2750. Up to four tape units can be daisy-chained and individually addressed by the same external controller.

The magnetic tape unit may be equipped with a single gap read/write head or a dual gap, simultaneous read and write head. A separate crase head is mounted ahead of the write head except on read-only tape units.

The tape unit is designed specifically for remote control of the read, write, forward, reverse, rewind, and packing density select functions. Available options are described in paragraph 1-4.

The tape unit uses dual column vacuum chambers which maintain tape tension within ANSI specifications. The position of the tape in a vacuum column is sensed by a tape position sensor covering the length of each column. The tape position sensor is driven by an oscillator and is sensed by an amplifier and a synchronous detector circuit located on the tape control board. Since the tape position sensor is the length of the column, the output of the detector is a voltage linearly related to the position of the tape.

To prevent damage to the tape, two holes located in each vacuum chamber limit the range of the tape loop. When the tape is properly tensioned, the upper hole on the supply vacuum column is at atmospheric pressure while the lower hole is at vacuum. The two holes are connected through tubing to opposite sides of a pressure switch. The contacts of the pressure switch are closed when vacuum and atmospheric pressure are across the switch. For example, if the supply tape loop drops below the lower hole in the vacuum column, the hole no longer is at vacuum, but at atmospheric pressure, causing the pressure switch contacts to open. Alternately, if the tape loop rises above the upper hole in the vacuum column, the hole no longer is at atmospheric pressure, but is at vacuum. The pressure switch contacts open, the servos are immediately disconnected from the motors, the vacuum motor turns off and write current is removed from the data board. All tape motion stops and the write electronics is prevented from erasing data.

Each tape unit contains a tape control circuit board, and a data circuit board. (More than one data circuit board may be included depending on the optional configuration selected.) The tape unit also contains a power supply module and power supply regulator circuits.

The data board provides the data reading and writing functions. Write data signals enter by an edge connector on one end of the board. They are buffered by a register which drives the write head. The write and read head connections are made through two connectors in the center of the board. The signals from the read head are amplified, differentiated, and compared to a threshold. For PE data boards, the signals are driven directly to the interface lines. For NRZI data boards, the signals are buffered and strobed out with a read strobe. The read signals are connected to the interface by an edge connector at the other end of the board.

The tape control board receives control signals from the external controller and uses these signals to drive the reel servo amplifiers, ramp generators, capstan servo, and BOT/EOT amplifiers in controlling tape movement. The tape control board also contains the voltage regulators which receive unregulated +17 and -17 Vdc from the power supply module and provide regulated +5, +10, -5, and -10 Vdc to the tape unit circuitry.

The power supply module receives 115 Vac line power and provides unregulated +17 and -17 Vdc to the voltage regulator circuits, and unregulated +17, -17, +36, and -36 Vdc to the reel and capstan servo circuits.

The tape unit logic circuitry uses negative logic; that is, logic 1 is negative relative to logic 0. The input logic levels must be compatible with this logic in order for the tape unit to operate properly. Input levels required are logic 1 = 0.0 to +0.4 Vdc; logic 0 = +2.5 to +5.0 Vdc.

### 1-3 PHYSICAL DESCRIPTION

The magnetic tape unit mounts in a standard 19-inch wide electrical equipment rack and requires 24 inches of vertical rack space. The tape handling components, heads, and operator controls and indicators are mounted on the front panel. A dust cover protects the tape and tape handling components from contaminants during operation.

The critical components of the tape unit (figure 1-2) are mounted on a precision machined tape unit baseplate. The capstan motor, reel servo motors, and other mechanical and electromechanical components are mounted on the back of the tape unit baseplate.

The control and data electronics are mounted on circuit boards attached to a frame which is hinged to the back of the tape unit baseplate. If the dual data board option is selected, a second data board is mounted to an additional hinged frame attached to the back of the tape unit baseplate. The power transistors are mounted on an air cooled heatsink. All external control and signal cables connect directly to the edge connectors of the circuit boards.

Each tape unit contains a minimum of two printed circuit boards: the tape control and data circuit boards. The tape control board contains the tape control logic, the reel servo amplifiers, ramp generators, capstan servo, BOT/EOT amplifier, and voltage regulators. All other mounted components, except the read/write head, also plug directly into the tape control circuit board. Options can be changed by simply changing jumpers in Molex option plugs on the board. Interface lines are connected to the control board by an edge connector.

Environmental conditions, weight, and physical dimensions are contained in table 1-2.

### 1-4 OPTIONAL CONFIGURATIONS

#### 1-5 CONFIGURATION IDENTIFICATION

Since the magnetic tape unit is available in a variety of configurations depending on choice of number of tracks, type of head, packing density and recording method, and tape speed, it is necessary to refer to the model number to determine the exact configuration of a particular unit. The model number is a hyphenated seven digit number located on the identifying tag attached to the back of the tape unit. The model number is composed of three base digits and four variable digits. In the example below, letters of the alphabet are used to indicate variable digits. The applicable numbers for specific configurations are listed in table 1-1.

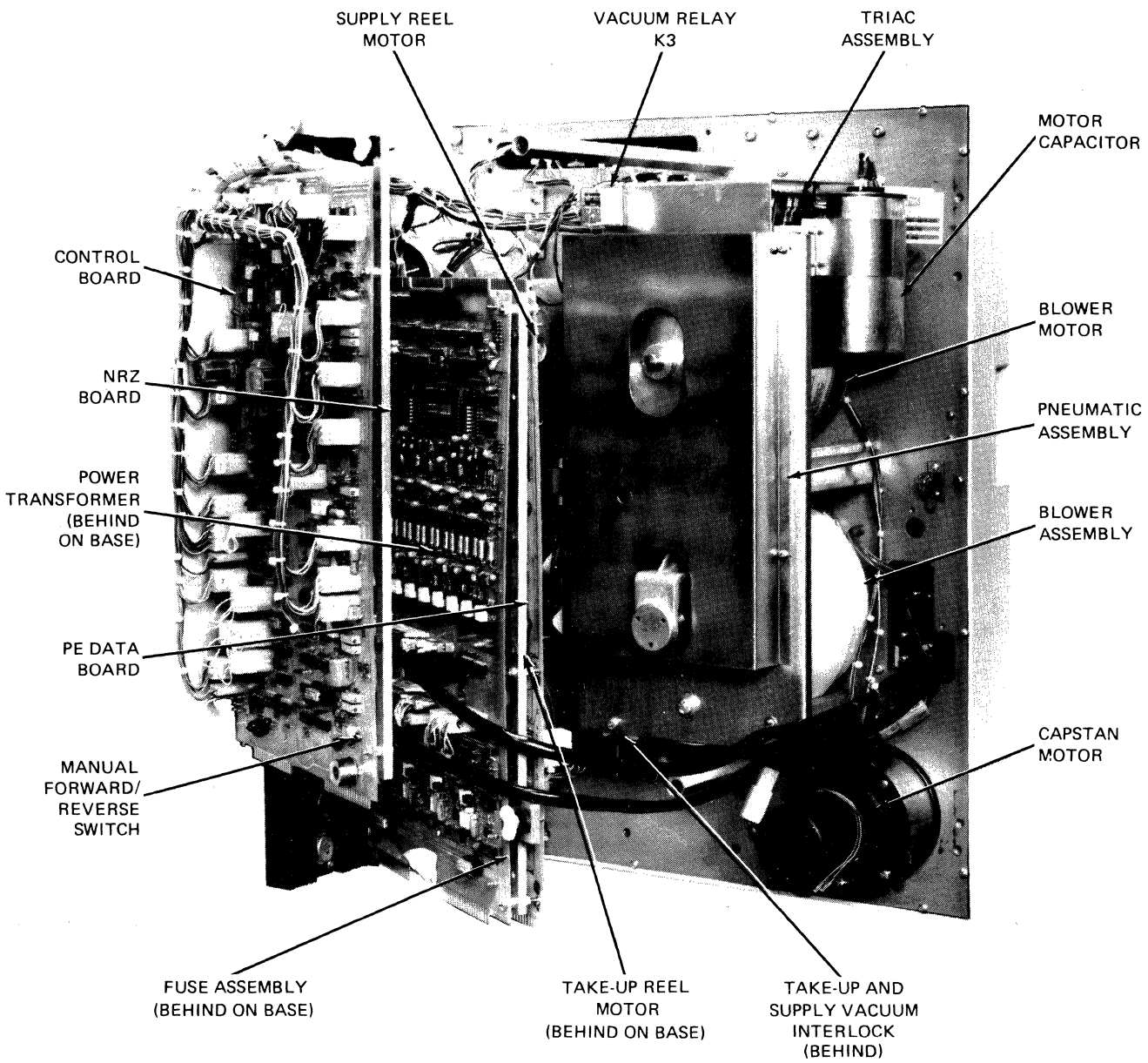
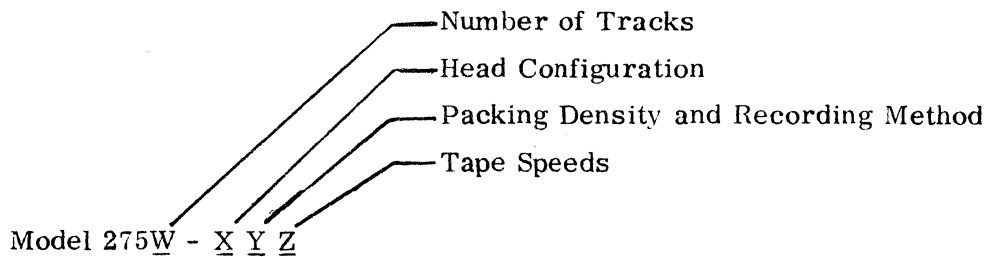


Figure 1-2. Open View of 2750 Series Magnetic Tape Unit





A "U" prefix to the model number indicates the optional UL-recognized version of the magnetic tape unit. The letter "A" after the "W" reference letter defines the current harnessing and subassembly configuration.

TABLE 1-1. OPTIONAL CONFIGURATION IDENTIFICATION LIST

Reference Letter	Characteristic	Config. Number	Configuration
W	Number of tracks	7	seven-track head
		8	seven-track/nine-track head, read only
		9	nine-track head
X	Head configuration	1	dual-gap head
		2	single-gap head
Y	Packing density and recording method		<u>Single Density</u>
		8	800 BPI (NRZI, 7- or 9-track)
		6	1600 BPI (PE, 9-track)
			<u>Dual Density</u>
		7	800/1600 PBI (NRZI and PE, 9-track)
		5	800/556 BPI (NRZI, 7-track)
		4	556/200 BPI (NRZI, 7-track)
		3	800/200 BPI (NRZI, 7-track)
			<u>Quad Density</u>
		3	1600/800 BPI (PE and PRZI, 9-track) 800/556 PBI (NRZI, 7-track)
Z	Tape Speeds (ips)	2	1600/800 BPI (PE and NRZI, 9-track) 800/200 BPI (NRZI, 7-track)
		1	1600/800 BPI (PE and NRZI, 9-track) 556/200 PBI (NRZI, 7-track)
		1	75
		2	75/37.5
		3	75/45
		4	75/56.5

1-6 ADDITIONAL OPTIONS AND ACCESSORIES

In addition to the standard options listed in table 1-1, the following options are available.

1. Address Select Switch - a four-position thumbwheel switch, located on the front of the tape unit, for selecting the device address of a tape unit in installations where up to four tape units are daisy chained.
2. File Protect/Write-Enable - every tape unit is equipped with write protect circuits, but the front panel indicator can be selected to read FILE PROTECT or WRITE ENABLE. The indicator will be illuminated during the condition that corresponds to the name that appears on the indicator.
3. Density Select Interface Line - allows the bit density or speed to be selected via the interface.
4. Status Lines Enable (Opt. 1) - allows the status lines (rewinding, file protect, BOT, and ready) to be enabled while the tape unit is off line, but the device address line (SELECT) is asserted (selected).
5. Status Lines Enable (Opt. 2) - allows all status lines to be enabled when the tape unit is selected and off line.
6. Status Lines Enable (Opt. 3) - allows the status lines (rewinding file, protect, BOT, ready, EOT, high density, and on line) to be enabled when the tape unit is not selected or on line.
7. EOT Status (EOTS) - an interface line that is asserted when the EOT tab passes the tab sensor. This line remains asserted until the tape is rewound or passes the EOT tab in reverse.
8. Single or Double Load - two different tape loading modes. On tape units equipped with single load circuits, the tape is tensioned and advanced to the BOT marker all in one continuous sequence when load switch is pressed. With double load circuits, the tape is tensioned first, then the operator must press LOAD to cause the tape to advance to the BOT marker. The double load sequence allows the operator to verify that the tape has been threaded and seated in the tape guides properly, before the tape is advanced to the BOT marker.
9. Automatic Load/On Line - an optional circuit that automatically places the tape unit on line after the tape has been loaded (single or double load) and the tape reaches the BOT marker, provided that a rewind operation has not been initiated.
10. Rewind and Unload - allows a tape unloading sequence to be initiated from a remote controller.
11. Front Panel Disable - allows front panel switches to be disabled when the tape unit is selected and on line.

There are numerous other detail configurations of interfacing, control and data signals that can be specified for different applications.

PERFORMANCE SPECIFICATIONS AND EQUIPMENT CHARACTERISTICS

Table 1-2 describes the electrical, environmental and mechanical specifications pertaining to the magnetic tape unit.

TABLE 1-2. PERFORMANCE SPECIFICATIONS AND EQUIPMENT CHARACTERISTICS

CHARACTERISTIC	VALUE
Type of Tape Storage	Vacuum chamber - linear servo driven
Recording mode	NRZI or Phase Encoded - IBM and ANSI compatible
Number of Tracks	7 or 9
Head Configuration	Single or Dual Gap
Bit Density	200, 556, 800, 1600 BPI
Tape Speed	Various speeds in range of 25 to 75 ips
Rewind Speed	250 ips.
Data Transfer Rate	120,000 characters per second, max
Speed Variation:	
Instantaneous	$\pm 3\%$
Average	$\pm 1\%$
Start/Stop Time (milliseconds)	375/tape speed (ips)
Start/Stop Displacement	0.190 ( $\pm 0.02$ ) inches
Skew:	
Write (NRZI)	Electronically compensated
Read	100 $\mu$ inches, maximum
Dynamic	75 $\mu$ inches, maximum
Tape Tension	7 to 10 oz.
Reel Size	10.5 in. , maximum
Tape Type (IBM P/N457892 or equivalent):	Computer Grade
width	0.5 inches
thickness	1.5 mil
Beginning of Tape (BOT) and End of Tape (EOT) Detectors	Photoelectric, IBM compatible spacing

TABLE 1-2. PERFORMANCE SPECIFICATIONS AND EQUIPMENT CHARACTERISTICS (CONT.)

CHARACTERISTIC	FUNCTION
Tape Cleaner	Perforated Plate type
Read Thresholds	NRZI: 12%, 25%, and 45%
	PE: 8%, 22%, and 26%
NRZI Deskew Window	50% of character time in Read mode. 40% of character time in Write mode.
Output Signal Parameters	
Asserted (True)	40 mA max. current sink
Not Asserted (False)	open collector
Power Requirements	
Line Frequency	48 to 52 Hz, 58 to 62 Hz (in 2 steps)
Line Voltage	95 - 125 Vac $\pm 10\%$ (in 5 steps) 190 - 250 Vac $\pm 10\%$ (in 10 steps).
Energy Consumption Rate	800 Watts maximum
Environment	
Temperature, Operating	30 <sup>o</sup> F to 122 <sup>o</sup> F
Storage	-50 <sup>o</sup> F to 160 <sup>o</sup> F
Humidity	15% to 95% without condensation
Altitude	0 to 8,000 feet (in 3 steps)
Dimensions	
Height	24 inches
Width	19 inches
Depth, overall	15.4 inches
Depth, from mounts	12.0 inches
Weight	120 lbs. , maximum
Daisy Chaining	Built-in provision

## Chapter 2

# INSTALLATION AND CHECKOUT

### 2-1 INTRODUCTION

This chapter contains installation instructions for the 2750 Series Magnetic Tape Unit. These instructions include information for installation planning, unpacking and inspection, installation, and checkout of the magnetic tape unit. Upon completion of the procedures contained in this chapter, the tape unit is ready for normal operation.

### 2-2 INSTALLATION PLANNING

### 2-3 EQUIPMENT LOCATION

The magnetic tape unit may be located adjacent to any other electronic data processing equipment provided the temperature, humidity, and other environmental characteristics are within the limits specified in table 1-2. The tape unit should not be located in a strong magnetic field because the recording head assemblies and other components can become magnetized, causing interference with the read/write operation. To obtain optimum performance from the tape unit, the ambient temperature fluctuation should be kept as small as possible and a reasonably clean and dust free environment should be provided. It is also important that a free flow of air is provided around the tape unit and through the rack in which the tape unit is mounted.

The magnetic tape unit mounts in a 19-inch electronic equipment rack cabinet and requires 24 inches of vertical rack space. When the tape unit is mounted, the rack should be located on a firm, vibration-free surface.

### 2-4 CABLING CONSIDERATIONS

Each magnetic tape unit is shipped with all internal interconnect cabling completed and with three data and control cable connectors provided in the shipping kit. The data and control cabling from the formatter to the tape unit and external interconnect cabling required for daisy-chaining tape units may be ordered as an option from STC or fabricated prior to installation. Specific cabling and power requirements are discussed in paragraphs 2-5 through 2-7; cable fabrication instructions are given in paragraph 2-8.

The data and control cabling from the external formatter to the tape unit normally consists of single cable with one connector at the formatter end and three connectors at the tape unit end. The data input and output lines connect to edge connectors J301 and J201, respectively, of the data board. The control lines connect to connector J101 of the tape control board. Figures 2-1 through 2-3 show typical cabling diagrams for single data board, dual data board, and quad density options.

### 2-6 Cabling for Daisy-Chained Configurations

Figure 2-4 shows the cabling for four tape units connected in a daisy-chained configuration. The additional cable connectors must be ordered and external cables must be fabricated, or purchased as an option. The total length of all sets of data or control cables from the formatter to the last tape unit cannot exceed 50 feet. Table 2-1 lists the various lengths of the I/O cable to a Model 2000 Formatter and the interconnection cable between the tape units in the daisy chain. All tape units have the data and control signal output connectors (circuit card edge connectors), so that no equipment modifications need be performed; however, the signal line terminating resistors, normally installed on all units at the factory, must be removed on all except the last unit in the daisy chain. These resistor networks are 220/330 DIP type located as shown in figure 2-4. Figure 2-5 shows the schematic of the resistor networks.

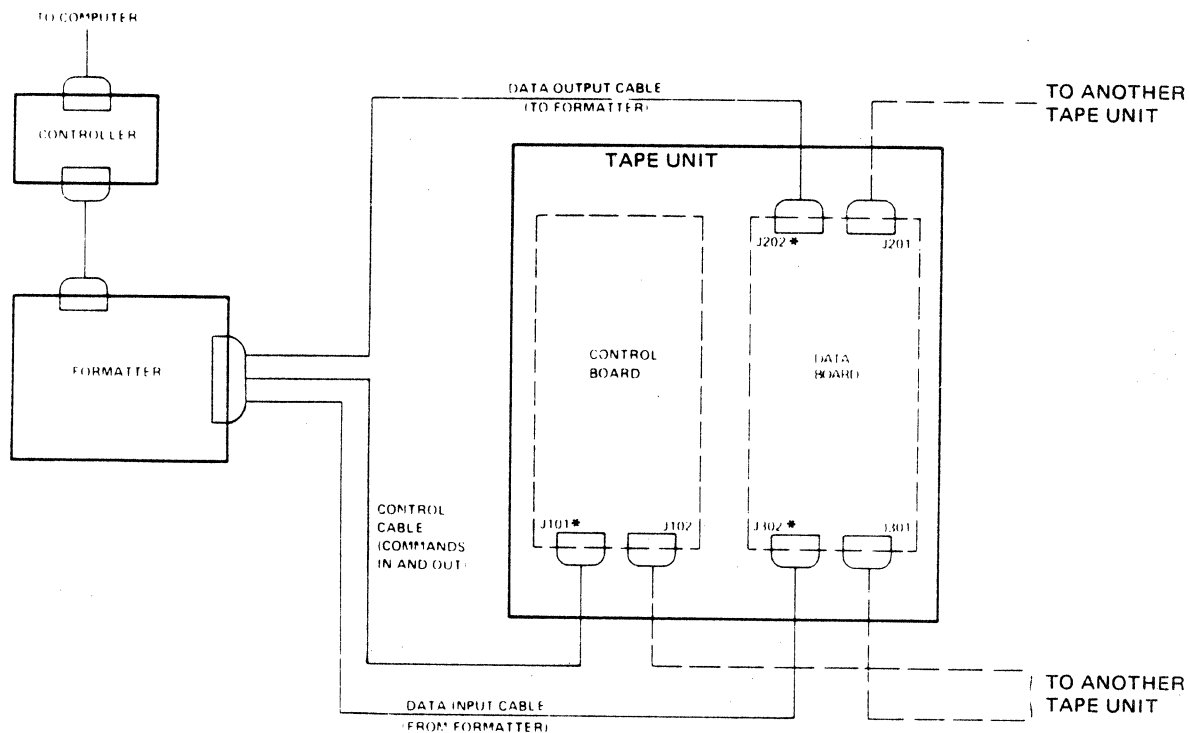


Figure 2-1. Typical Cabling Diagram, Single Data Board Option

TABLE 2-1. CABLE LENGTH OPTIONS

AMCOMP CABLE PN	LENGTH (In Feet)
<u>I/O to Formatter</u>	
1060129-01	4
1060129-02	8
1060129-03	12
1060129-04	16
1060129-05	20
1060129-06	6
<u>Tape Interconnection</u>	
9060116-01*	3.5 in.
9060116-02	6
9060116-03	12
9060116-04**	2
*Card interconnection cable	
**Quad density	

2-7 Primary AC Power Connections

Prior to application of power to magnetic tape unit, the primary ac input power must be checked for proper connection. The connection requirements are given in

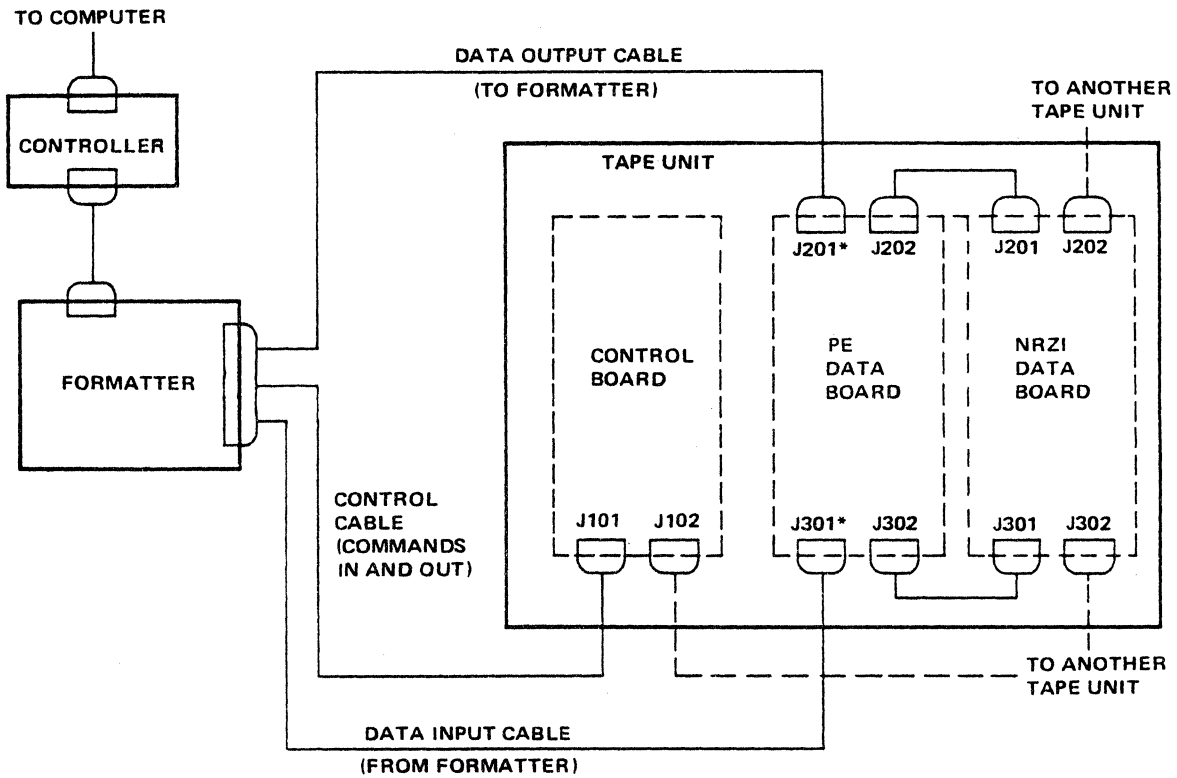
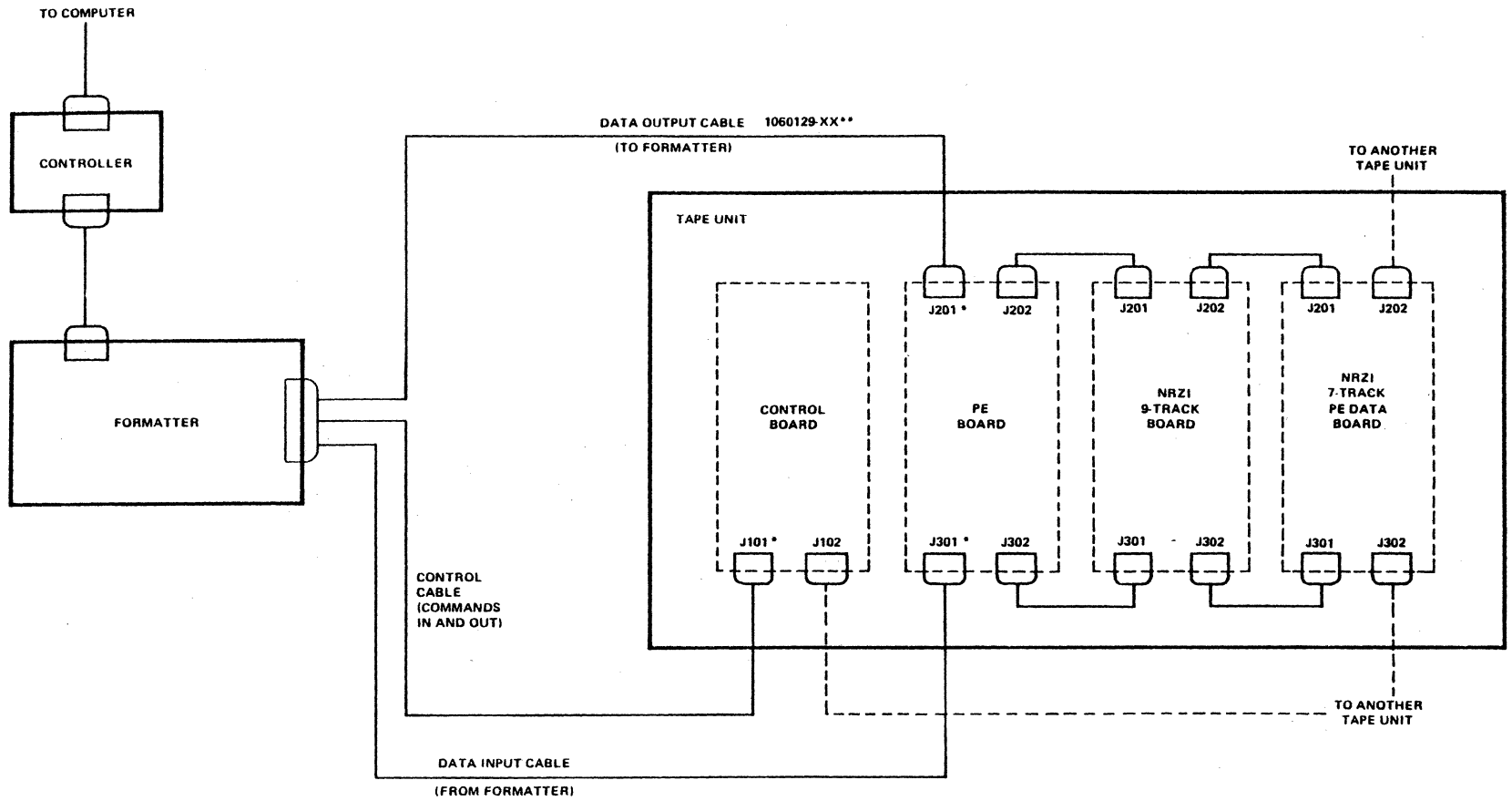


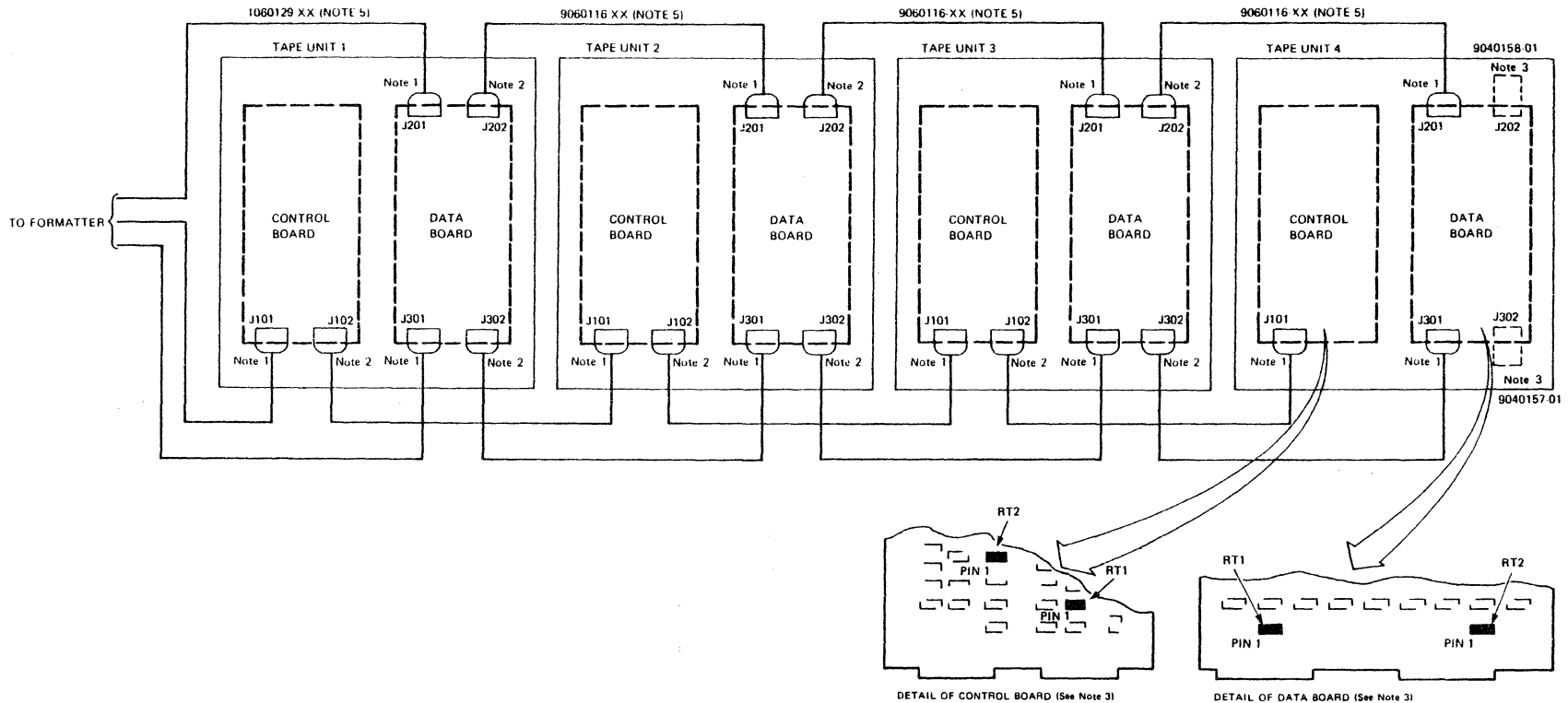
Figure 2-2. Typical Cabling Diagram, Dual Data Board Option



\*CABLE CONNECTOR (P/N 07120007-01) IS SUPPLIED.  
\*\*FOR CABLE LENGTH OPTIONS, SEE TABLE 2.1.

Figure 2-3. Typical Cabling Diagrams, Quad Density Option





- NOTES:
1. CABLE CONNECTOR (P/N 07120007-01) IS SUPPLIED.
  2. CABLE CONNECTOR - SAME AS NOTE 1, BUT NOT SUPPLIED.
  3. TERMINATING RESISTOR NETWORKS ARE TO BE REMOVED FROM ALL EXCEPT THE LAST TAPE UNIT IN THE DAISY CHAIN. TERMINATING RESISTOR NETWORKS (P/N 04600001-02) ARE USED FOR NRZI DATA BOARD ONLY. TERMINATOR BOARDS (P/N 9040157-01 AND P/N 9040158-01) ARE USED FOR PE DATA BOARD ONLY.
  4. UP TO FOUR TAPE UNITS MAY BE DAISY-CHAINED.
  5. FOR CABLE LENGTH OPTIONS, SEE TABLE 2-1.
  6. AC POWER TO THE TAPE UNIT WITH TERMINATORS (LAST UNIT) MUST BE ON WHILE THE OTHER TAPE UNITS ARE IN OPERATION.

Figure 2-4. Typical Cabling Diagram, Daisy-Chained Configuration

figure 2-6. The ground lead in the primary ac power input cable provides sufficient grounding; no external grounding straps or other grounding devices are required.

## 2-8 CABLE FABRICATION

The interface is designed for twisted pair cables with returns grounded. The wire should be 26 AWG with thin insulation and twisted about 20 turns per foot. The maximum length can be 50 feet. The twisted pairs should be grounded within a few inches of the receiver.

The mating connector is AMCOMP PN 07120007-01 (STC PN 10041652) or equivalent. All connector pin assignments are contained in tables 2-2, 2-3 and 2-4.

## 2-9 INTERFACE CIRCUITS

The tape unit data board drivers and receivers are shown in figure 2-5. The interface must be compatible with these circuits in order for the tape unit to function correctly.

### Logic Levels:

Logic 1 (true)	0.0 to +0.4 Vdc
Logic 0 (false)	+2.5 to +5.0 Vdc

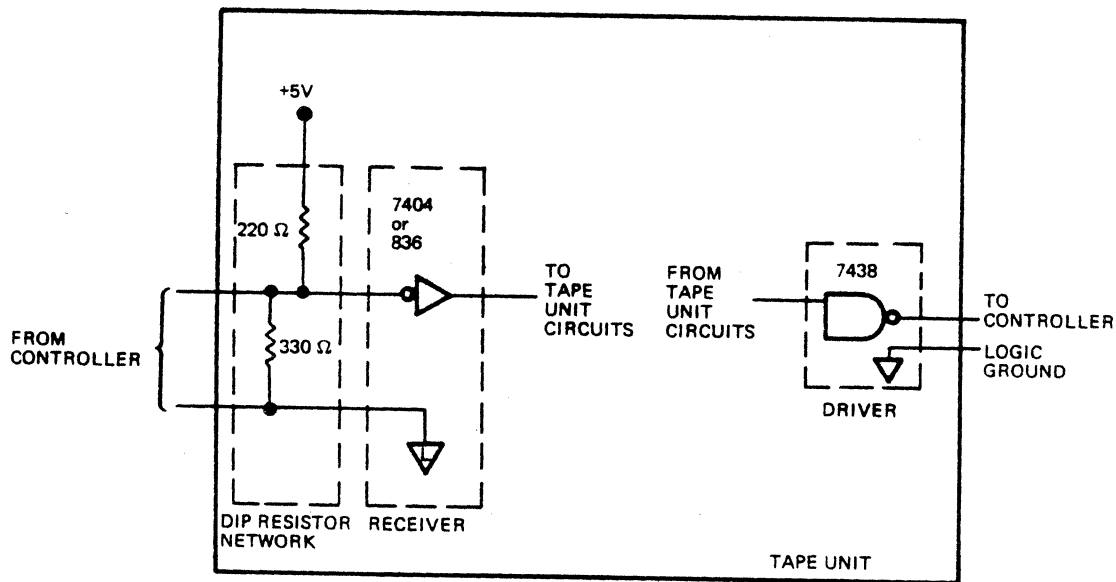


Figure 2-5. Tape Unit Interface Circuits

TABLE 2-2. TAPE UNIT CONTROL AND STATUS CONNECTIONS (J101, J102)

SIGNAL CONNECTOR PIN	GROUND CONNECTOR PIN	SIGNAL NOMENCLATURE
		<u>COMMAND INPUTS</u>
J	8	ISELECT 0
A	8	ISELECT 1
18	8	ISELECT 2
V	8	ISELECT 3
C	3	ISFC (Forward)
E	5	ISRC (Reverse)
H	7	IREW (Rewind)
L	10	* IREU (Rewind and Unload)
K	9	ISWRT (Set Write)
B	2	IOVW (Overwrite)
D	4	* IDDS (Density Select)
		<u>STATUS OUTPUTS</u>
T	16	IRDY (Ready)
M	11	IONL (On Line)
N	12	IRWD (Rewinding)
U	17	IEOT (EOT)
R	14	IBOT (BOT)
P	13	IFPT (File Protect)
F	6	IDDI (High Density)
S		* + 5 Volts

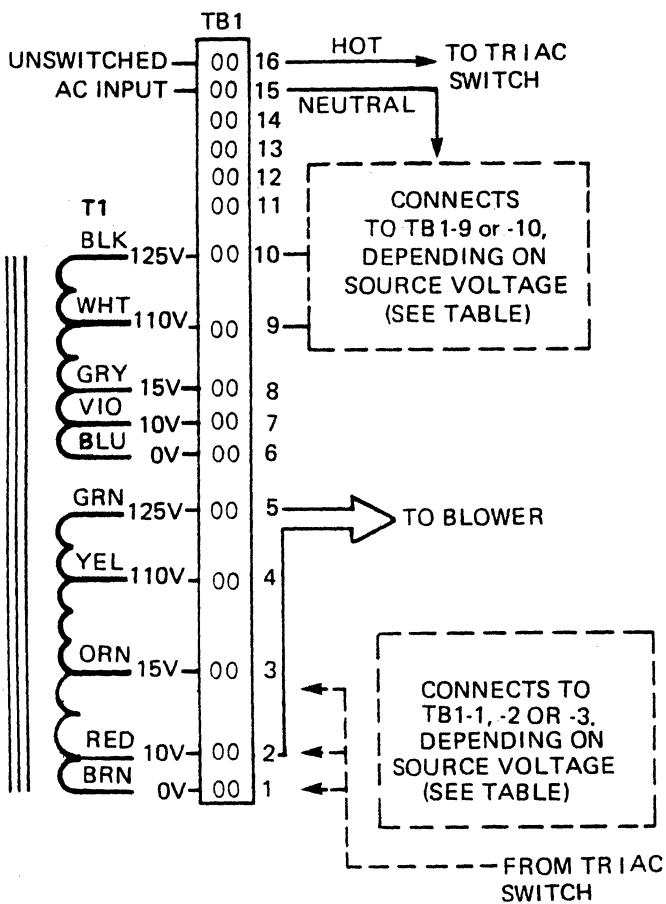
\* indicates tape unit option

TABLE 2-3. TAPE UNIT DATA OUTPUT CONNECTIONS (J201, J202)

SIGNAL CONNECTOR PIN	GROUND CONNECTOR PIN	SIGNAL NOMENCLATURE
<u>DATA OUTPUTS</u>		
2	B	Read Data Strobe
1	A	Read Data Parity
3	C	Read Data 0
4	D	Read Data 1
8	J	Read Data 2
9	K	Read Data 3
14	R	Read Data 4
15	S	Read Data 5
17	W	Read Data 6
18	V	Read Data 7
11	M	*Seven Track
12	N	*Single Stack
10	L	*NRZ
13	P	*Speed
<p>NOTE: Read Data 0 and 1 are not used on seven-track tape units.</p> <p>* indicates tape unit option</p>		

TABLE 2-4. TAPE UNIT DATA INPUT CONNECTIONS (J301, J302)

SIGNAL CONNECTOR PIN	GROUND CONNECTOR PIN	SIGNAL NOMENCLATURE
<u>DATA INPUTS</u>		
E	5	Read Threshold 1
F	6	Read Threshold 2
A	1	Data Ready
C	3	LRC Strobe
L	10	Write Data Parity
M	11	Write Data 0
N	12	Write Data 1
P	13	Write Data 2
R	14	Write Data 3
S	15	Write Data 4
T	16	Write Data 5
U	17	Write Data 6
V	18	Write Data 7
NOTE: Write Data 0 and 1 are not used on seven-track tape units.		



TERMINAL BOARD 1				
If Source Voltage (RMS) is:	AC DISTRIB.		JUMPERS	
	From Triac SW To:	From TB1-15 To:	Jump Between	Jump Between
95	3	9	3 & 8	4 & 9
100	2	9	2 & 7	4 & 9
110	1	9	1 & 6	4 & 9
115	2	10	2 & 7	5 & 10
125	1	10	1 & 6	5 & 10
190	3	9	4 & 8	-
200	2	9	4 & 7	-
210	2	9	4 & 6	-
215	2	10	4 & 7	-
220	1	9	4 & 6	-
225	1	10	4 & 7	-
230	2	10	5 & 7	-
235	1	10	4 & 6	-
240	2	10	5 & 6	-
250	1	10	5 & 6	-

Figure 2-6. Input Power Transformer Primary Winding Diagram

2-10 INSTALLATION

2-11 UNPACKING AND INSPECTION

The tape unit is shipped in a special double packing case, which should be saved if reshipment of the equipment is planned. Within the packing case the tape unit is attached to a shipping frame which can be used to hold the tape unit upright when the unit is removed from the packing case and placed on a level surface. There is also a separate shipping kit contained in the packing case. The shipping kit contains the rack mounting hardware for the tape unit and other necessary parts.

As the equipment is unpacked, care should be exercised to prevent damage to the finished surfaces of the tape unit and all parts should be inspected for evidence of damage during shipment. If the packing case or any tape unit parts are damaged, advise manufacturer and file a claim with the transfer company. The following procedure should be followed for unpacking and inspecting the tape unit:

- a. Inspect the packing case for evidence of in-transit damage. Contact the transfer company and manufacturer if damage is evident. Specify nature and extent of damage.

#### WARNING

The tape unit on shipping frame weighs over 100 pounds. To prevent personal injury or damage to the equipment, the tape unit should be lifted by two people.

- b. Open the outer and inner packing case and remove the contents. Check items against the shipping list to verify packing case contents. Contact manufacturer in the event of a packing shortage.
- c. Remove any additional packing material and verify that the serial number of the unit corresponds to that shown on the shipping invoice.
- d. Visually inspect the exterior of the tape unit for evidence of physical damage that may have occurred in transit.
- e. Check major component assemblies to determine if any assemblies or screws have been loosened. Tighten any loose screws or mounting hardware. Inspect all Molex connectors.

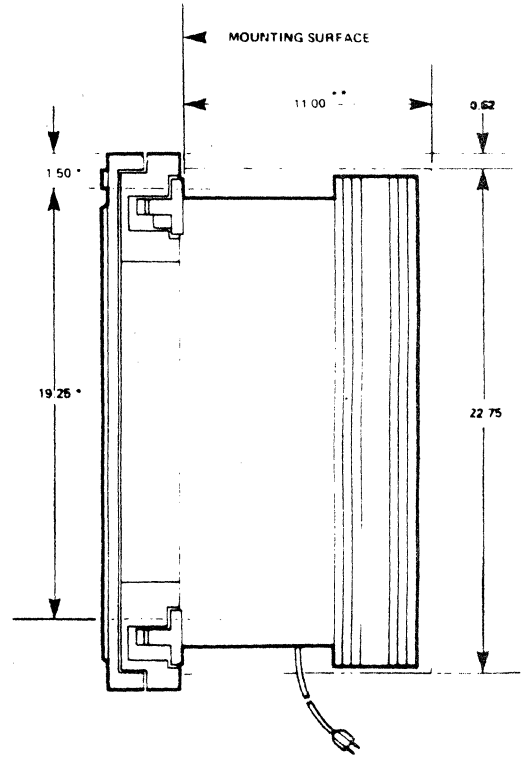
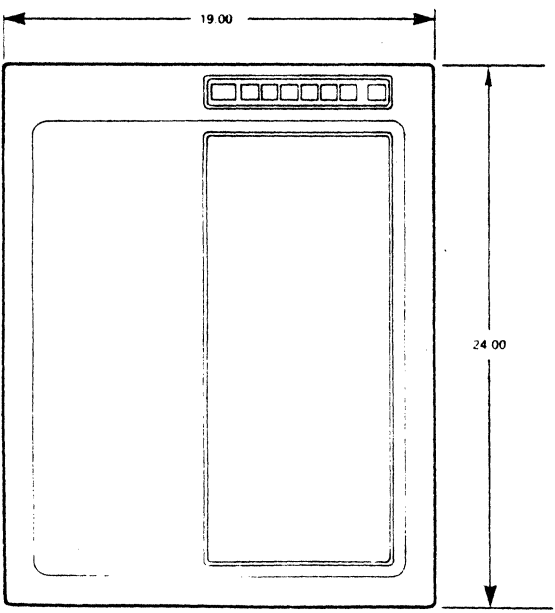
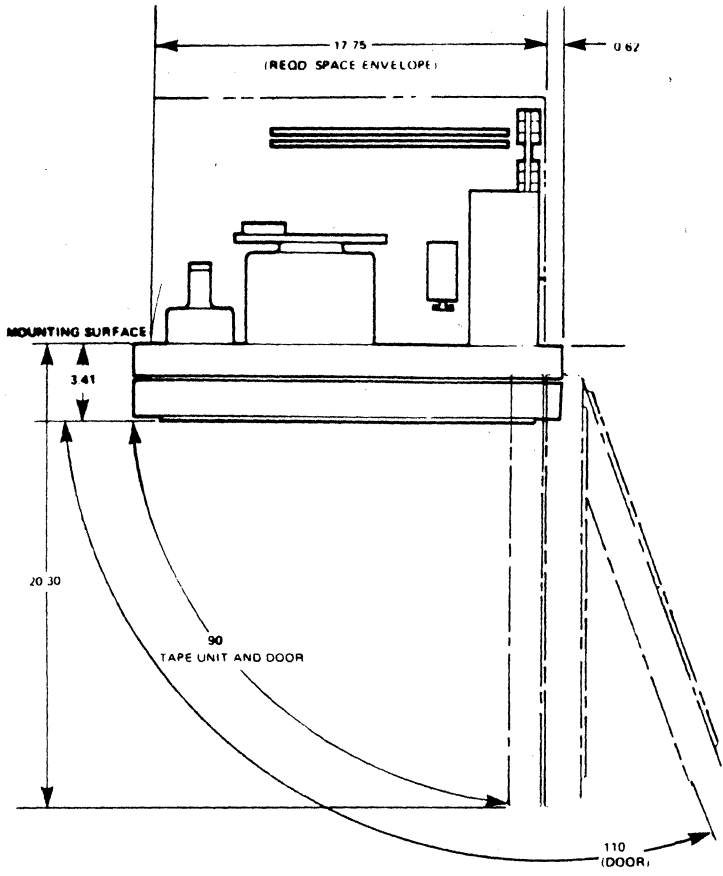
#### 2-12 MOUNTING

To mount the tape unit, refer to figure 2-7 and proceed as follows:

- a. Remove the two hinge bases from the shipping kit and mount them on the rack cabinet 19.25 inches apart.
- b. Place the tape unit on a level surface face up and remove the three screws that hold the unit to the shipping frame.
- c. Lift the tape unit and set it on the hinges in the 90-degree open position (figure 2-7). The tape unit is now mounted in place and can be swung to closed position and latched.

#### NOTE:

The safety blocks should be installed if the tape unit and the rack cabinet are to be tipped over on side or back. The safety blocks keep the tape unit from slipping off the hinge bases.



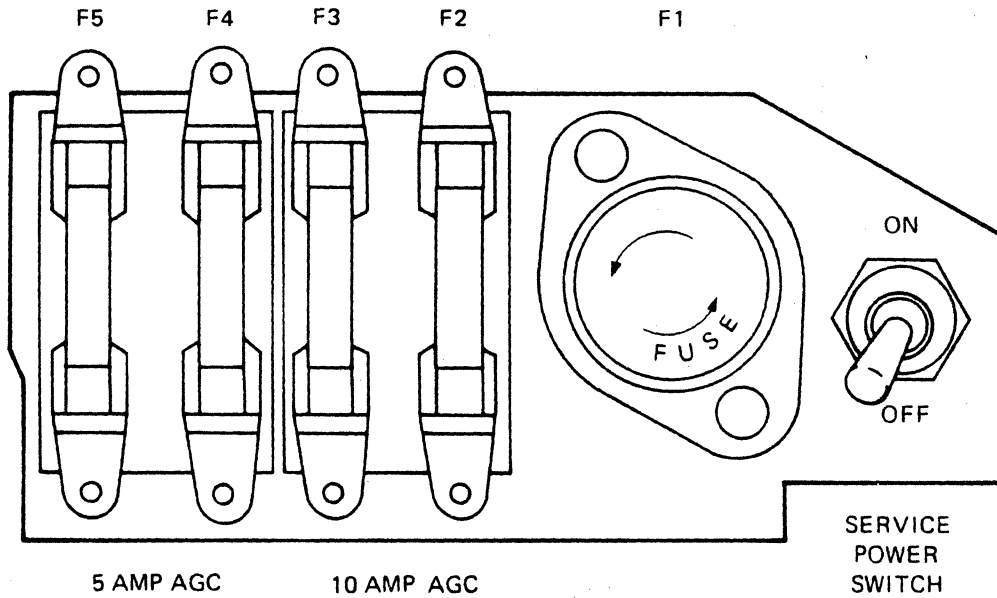
• HINGE MOUNTING DIMENSIONS  
 •• 14.5 INCHES ON DUAL DENSITY  
 NRZ/PE AND QUAD DENSITY

Figure 2-7. Installation Mounting Dimensions for the 2750 Tape Unit



- a. After the tape unit is installed in place, check again for any damage and missing or loose components. Check also for the following items:
  - Loose relays.
  - Loose connectors or terminal connections on circuit boards and other assemblies.
- b. Check and verify that the input power terminal strip is connected correctly to supply the primary power voltage from which the tape unit is to be operated (figure 2-6).
- c. The pulley supplied is the correct one for the line frequency specified on the factory label. To adjust for high altitude, or to change power frequency, see figure 2-9 and table 2-5.
- d. Check the five fuses located at the lower left corner on the back of the tape unit. These fuses are identified in figure 2-8.
- e. Refer to Chapter 3 to become familiar with tape unit controls and operating procedures before applying power to tape unit.
- f. Plug in the primary power cable and turn on equipment power with the ON/OFF switch on the front of the tape unit, and the service power switch at the rear of the tape unit. Verify that tape unit power comes on.
- g. Load a reel of tape on the tape unit according to the procedure in paragraph 3-4. This will verify that the tape unit can move tape and can execute the loading sequence properly.
- h. Use the forward/reverse toggle switch on the tape control logic board to move the tape first in the forward and then in the reverse direction. This will verify that the tape unit operates properly in both directions.
- i. Press the RWD pushbutton to verify that the tape properly rewinds (at 200 ips) and stops at the BOT marker.
- j. Press the RWD pushbutton again to verify that the tape unit unloads tape properly.

The magnetic tape unit is now ready for normal operation. Refer to Chapter 3 for information pertaining to the operation of the tape unit.



- NOTES: 1. For 90V/125V line voltage, F1 is 10-amp fuse, type FNM, slow-blow.  
 2. For 190V/250V line voltage, F1 is 5-amp fuse, type FNM, slow-blow.

Figure 2-8. Tape Unit Fuses

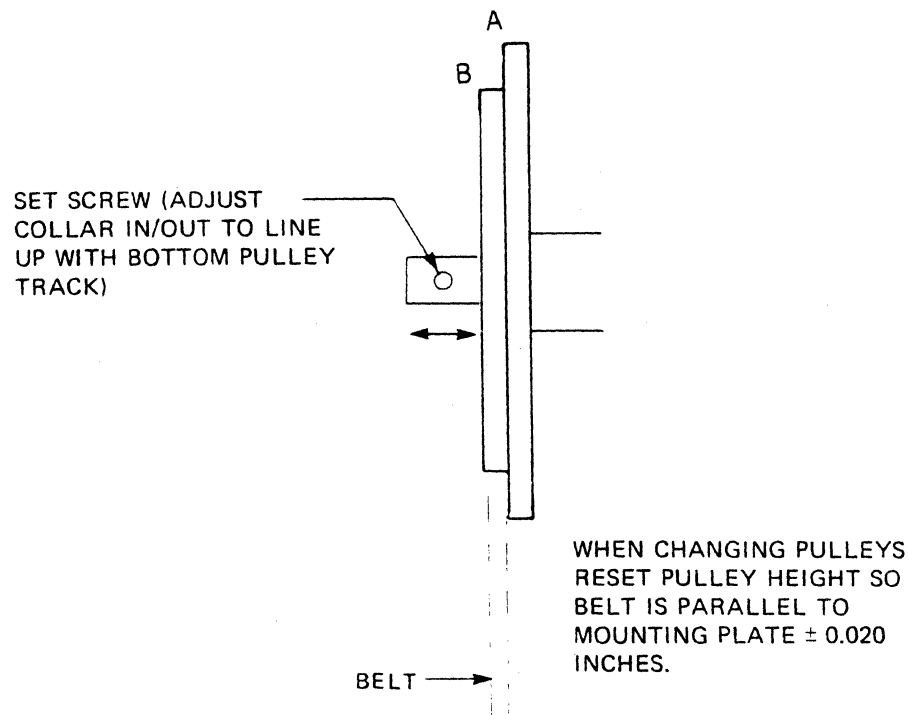


Figure 2-9. Blower Motor Pulley/Belt Positioning

TABLE 2-5. PULLEY AND BELT POSITIONING

FREQ (Hz)	ALTITUDE (Feet)	AMCOMP PULLEY PN	STC PULLEY PN	PULLEY STEP	AMCOMP BELT PN	STC BELT PN	BELT LTH (Inches)
50	0-2000	9210796-01	4008433-01	B	32000101-04	10307031	25.5
	2000-4000	9210796-01	4008433-01	A	32000101-04	10307031	25.5
	4000-6000	9210796-02	4008433-02	B	32000101-09		27.0
	6000-8000	9210796-02	4008433-02	A	32000101-09		27.0
60	0-2000	9210796-03	NA	B	32000101-08	10307032	23.5
	2000-4000	9210796-03	NA	A	32000101-08	10307032	23.5
	4000-6000	9210796-04	4008433-04	B	32000101-04	10307031	25.5
	6000-8000	9210796-04	4008433-04	A	32000101-04	10307031	25.5



## Chapter 3

# OPERATION AND INTERFACE

### 3-1 INTRODUCTION

This chapter provides operating instructions and interface information for the 2750 Series Magnetic Tape Unit. Operator controls and indicators are illustrated and described and step-by-step instructions for operation of the tape unit are included. Paragraph 3-6 presents I/O interface information, including signal definitions and logic levels.

### 3-2 CONTROLS AND INDICATORS

The basic operation controls and indicators of the tape unit are located on the front of the unit, accessible through an opening in the cover door. Several of these controls operate in conjunction with the interface command lines so that the function of a front panel control or indicator may be affected by the status of a command line between the interface and the tape unit. Normally, manual operation of the tape unit is performed only until the unit is placed on line. Operation is then transferred to an external formatter under software control. It is then necessary to take the tape unit off line only to change tape. The front panel controls are described in table 3-1 and shown in figure 3-1.

Forward/reverse switch SW1 and service power switch S2 are not located on the front panel. These switches are shown in figure 1-2. The forward/reverse switch is located on the lower edge of the tape control board and the service power switch is located below the primary power fuse on the rear panel.

The forward/reverse switch is a three-position toggle switch used in the off-line mode to move tape between the BOT and EOT tabs. Switch positions: up = forward; down = reverse; center = off.

The service power switch controls the application of ac line power to the tape unit. Switch positions: up = power on; down = power off.

Alternate controls and indicators may be supplied depending upon the equipment options selected. These controls and indicators are not illustrated but are described in table 3-2.

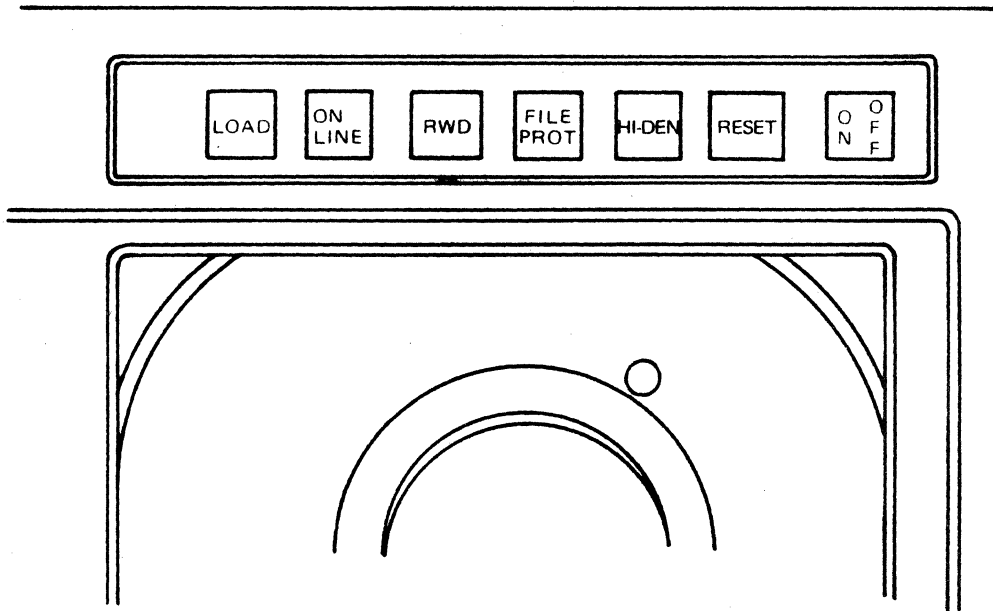


Figure 3-1. Tape Unit Front Panel Controls and Indicators

TABLE 3-1. CONTROLS AND INDICATORS

NAME	FUNCTION
LOAD	A backlighted pushbutton used in loading tape. After threading tape, press LOAD pushbutton to tension tape and advance it to the BOT tab. On double-load tape units, the pushbutton must be pressed twice. The pushbutton lights when the tape is tensioned and advanced to the BOT tab. Light goes out when the BOT tab moves off the sensor.

TABLE 3-1. CONTROLS AND INDICATORS (Continued)

NAME	FUNCTION
ON LINE	A backlighted pushbutton that is used to place the tape unit under remote control (on line). It can also be used to place the tape unit under local control (off line), but in this respect it operates in parallel both with the RESET pushbutton and the IREU interface command line; either can place the tape unit off line and extinguish the pushbutton light, but cannot place the tape unit on line. The ON LINE pushbutton lights to indicate that the tape unit is on line. Note, however, that it can be depressed and lit also when the tape unit is not selected (RESET pushbutton indicator not lit); in this case the tape unit is on line, but is not under remote control until selected.
RWD	A pushbutton used to rewind tape when the tape unit is off line. The tape will rewind past the BOT tab, then reverse and advance to the BOT tab and stop. If the tape is at the BOT tab and the RWD button is pressed, the tape will rewind slowly off the take-up reel.
FILE PROT	An indicator that lights when a write protected file reel is installed on the tape unit. This light is meaningful only after the tape has been tensioned.
HI-DEN	An alternate action indicator switch pressed to select packing density. When the switch is lit, the higher density is selected. The switch is functional in dual density NRZI/PE, or dual speed tape units, and operates in parallel with the IDDS command input line. This switch is not operational in the single density versions of the tape unit.
RESET	A backlighted pushbutton used to stop and reverse forward tape motion, and place the unit off line. The indicator light is on when the tape unit is selected by the formatter. Optionally, the indicator light can be wired so that it lights only when the tape unit is selected and on line.
ON/OFF	A pivot switch that controls power to the tape unit. The switch is lit in the ON position by the -5 volt regulator.

TABLE 3-2. OPTIONAL CONTROLS AND INDICATORS

NAME	FUNCTION
1600 BPI	Alternate action indicator switch which replaces the HI-DEN switch on the optional NRZI and PE combination tape units. This switch is illuminated when 1600 bpi Phase Encoded operation is selected.
7/9 TRACK	On the optional 7-track and 9-track combination, this alternate action indicator switch replaces the HI-DEN or FILE PROT switches. This switch is illuminated when 9-track operation is selected.
ADDRESS SELECT	A rotary thumb switch whose first four positions (0, 1, 2, and 3) are used to select the active address for the tape unit. This switch operates in conjunction with the ISELECT 0-3 command input lines from the formatter. If the tape unit is not equipped with this switch, its address (select code) is zero. Switch position should be changed only while the tape unit is off line.

3-3 OPERATING PROCEDURES

3-4 LOADING TAPE

Verify that service power switch S2 is in the on (up) position and proceed as follows:

- a. Press the ON side of the power ON/OFF switch on the front panel.

NOTE:

The ON indicator should light. Other indicators which may light are RESET (if the tape unit is selected by the formatter), HI-DEN, and FILE PROT. No other indicators should be lighted.

- b. Lift the upper reel hub loading latch, place a loaded reel on the hub and push it until seated. Lower the reel hub loading latch.
- c. Install an empty reel on the lower reel hub.
- d. Refer to the tape threading diagram inside the front cover or to figure 3-2 and thread the tape as shown.



- e. Hold the tape end on the takeup reel by placing a finger through the hole in the flange. Rotate the takeup reel clockwise until the tape is on securely and the amount is enough to tension the tape.
- f. Tension the tape by turning the supply reel, then press the LOAD pushbutton to activate tension arms and tension the tape. A double-load unit will stop at this point; go to step g. A single-load unit automatically advances to the BOT tab where the unit stops and the LOAD pushbutton lights; go to step h.
- g. Check that the tape is properly positioned on the guides, then press the LOAD pushbutton. The tape advances to the BOT tab and stops. The LOAD indicator lights and will remain lighted until the tape is moved forward of BOT by a remote command or by manual use of the forward/reverse switch.
- h. Verify that the address select thumb switch is set to the correct address.
- i. If the tape unit is equipped with AUTO LOAD/ON LINE option, the tape unit will be on line when BOT is reached. Otherwise, press the ON LINE switch to enable the formatter to assume control by asserting the ISELECT address line. When the tape unit is on line, the operator should not interfere with its operation except to return it to off line status by pressing the RESET pushbutton. On units equipped with the front panel disable tion, the RESET switch is used to disable the operator switches.

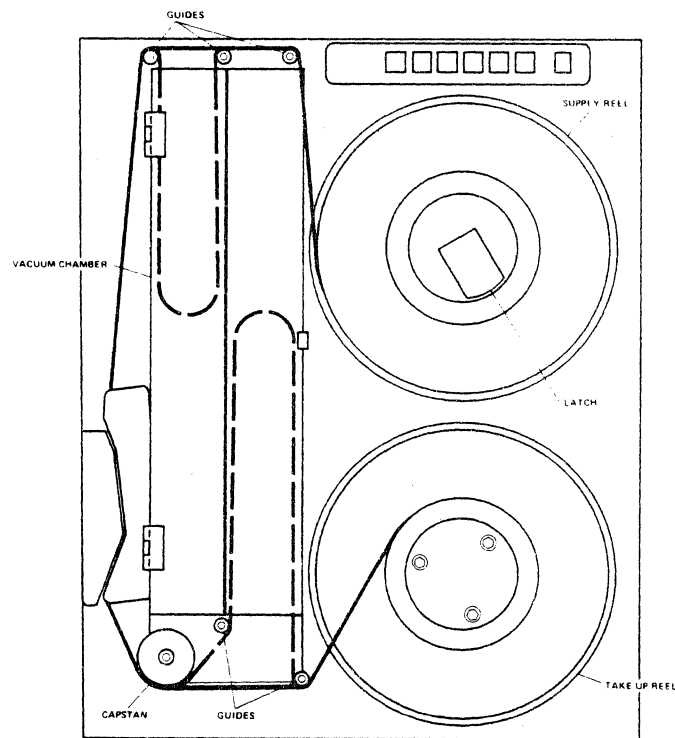


Figure 3-2. Tape Threading Path

### 3-5 UNLOADING TAPE

To unload tape proceed as follows:

- a. Press RESET or ON LINE pushbutton to place unit off line.
- b. If the tape is at BOT, press RWD pushbutton. The tape will reverse at low speed until wound on upper reel, then stop.
- c. If the tape is forward of BOT, press RWD pushbutton to rewind tape to BOT. The tape will stop at BOT; press RWD pushbutton again to wind remaining tape on upper reel.
- d. Lift upper reel hub latch and remove reel. Lower reel hub latch.

### 3-6 INTERFACE

#### 3-7 DATA AND COMMAND INPUT AND OUTPUT SIGNALS

The tape unit has four categories of input and output lines:

- a. Data Inputs - the data and parity lines, data ready line, and LRC strobe.
- b. Data Outputs - data and parity lines, data strobe line, and several status lines.
- c. Command Inputs - lines that select the tape unit, initiate tape motion, enable a read or write operation, and generally control operation of the tape unit.
- d. Command Outputs - lines that generally indicate the status of the tape unit, the position of the tape (at BOT or EOT), and other similar information.

Descriptions of the functions and typical examples of use of these lines are listed in tables 3-2 through 3-5 and the following paragraphs. All logic levels are negative true; that is, when a signal line is asserted, its logic level is 0 to +0.4V, and when it is not asserted (cleared) the logic level is +2.5 to +5.0V. It is also important to note that several of the input/output lines operate in parallel with, or in some other way interact with, the front panel controls and indicators of the tape unit.

#### 3-8 Data Inputs

The data input lines are used for entry of data into the tape unit from the formatter, as well as for determining the read threshold voltages. Refer to figure 4-52 for typical timing interrelationships between these lines.

TABLE 3-3. TAPE UNIT DATA INPUT LINES

NAME	FUNCTION																
DATA READY	<p>This line must be asserted for a minimum of 1 microsecond during the time a data or CRC character is recorded. The tape speed and the frequency of these pulses determines the record density. For NRZI the frequency is equal to the data rate, but for PE the frequency of data ready pulses is twice the data rate. The frequency stability should be 0.25%. The write data lines should not change for 0.5 microsecond before or after DATA READY.</p>																
WRITE DATA (7 or 9 Lines)	<p>For recording NRZI data, any of these lines must be asserted each time a logic 1 bit is to be recorded on that track. The leading edge of the DATA READY pulse transfers the data into the tape unit write register.</p> <p>For recording PE data the WRITE DATA lines must present data in the format described in paragraph 4-52. The data will be transferred into the write register on the trailing edge of DATA READY.</p>																
LRC STROBE	<p>This signal must be asserted for a minimum of 1 microsecond at the end of a record of file of NRZI data. The pulse must occur four character times after the last data ready in each record of data.</p> <p>The signal is not used during recording PE data, except during an over-write operation, the pulse must occur after the last DATA READY to clear the over-write function in the tape unit.</p>																
IRDT 1, 2 (Read Threshold 1 and 2)	<p>The status of these lines defines the read amplifier output voltage level which is recognized as a logic level change. For example, if 25% of the maximum voltage change is recognized as a change from one level to the other, the read threshold is 25%. The function of these lines depends on the configuration of the tape unit. For a tape unit with a single gap head:</p> <table border="1" data-bbox="592 1575 1323 1795"> <thead> <tr> <th data-bbox="592 1638 722 1669">IRDT 1</th> <th data-bbox="738 1638 868 1669">IRDT 2</th> <th data-bbox="901 1575 1096 1669">READ THRESHOLD (NRZI)</th> <th data-bbox="1128 1575 1323 1669">READ THRESHOLD (PE)</th> </tr> </thead> <tbody> <tr> <td data-bbox="592 1701 673 1732">false</td> <td data-bbox="738 1701 820 1732">false</td> <td data-bbox="982 1701 1047 1732">25%</td> <td data-bbox="1209 1701 1274 1732">22%</td> </tr> <tr> <td data-bbox="592 1732 673 1764">true</td> <td data-bbox="738 1732 820 1764">false</td> <td data-bbox="982 1732 1047 1764">45%</td> <td data-bbox="1209 1732 1274 1764">26%</td> </tr> <tr> <td data-bbox="592 1764 673 1795">false</td> <td data-bbox="738 1764 820 1795">true</td> <td data-bbox="982 1764 1047 1795">12%</td> <td data-bbox="1209 1764 1274 1795">8%</td> </tr> </tbody> </table>	IRDT 1	IRDT 2	READ THRESHOLD (NRZI)	READ THRESHOLD (PE)	false	false	25%	22%	true	false	45%	26%	false	true	12%	8%
IRDT 1	IRDT 2	READ THRESHOLD (NRZI)	READ THRESHOLD (PE)														
false	false	25%	22%														
true	false	45%	26%														
false	true	12%	8%														

TABLE 3-3. TAPE UNIT DATA INPUT LINES (Continued)

NAME	FUNCTION
	For tape units with a dual-gap head, the high threshold (45% or 26%) is selected automatically whenever the tape unit is in write mode. The middle threshold (25% or 22%) is selected automatically during read, but the assertion of IRDT2 line will select the low threshold (12% or 8%) instead.

3-9 Data Outputs

The data output lines are used for supplying data and data format information from the tape unit to the formatter.

TABLE 3-4. TAPE UNIT DATA OUTPUT LINES

NAME	FUNCTION
READ DATA 9 or 7 Lines (NRZI)	On these lines the read character is output in parallel form. Each bit is at the correct logic level at the trailing edge of the READ DATA STROBE. These lines are active whenever the ISFC or ISRC command lines have been asserted.
READ DATA 9 Lines (PE)	The signals on these lines are the outputs of each peak detector, gated by the envelope detector associated with the channel. These signals are replicas of the write data input signals. These lines are active whenever the ISFC or ISRC command lines have been asserted.
READ DATA STROBE (NRZI)	Asserted for a minimum of 1 microsecond for each data character, whenever the read data lines are active. NRZI data is to be sampled with the trailing edge of this strobe. The READ STROBE is not used during the reading of PE data.
SEVEN TRACK	A status line asserted to indicate that the tape unit has a seven-track configuration. It is not asserted for a nine-track unit.
SINGLE GAP	A status line asserted for tape units with a single gap head. It is not asserted for dual head gap units.
NRZI	A status line asserted for NRZI tape units; it is not asserted for PE tape units. This line is operative in the optional NRZI and PE combination tape units.

TABLE 3-4. TAPE UNIT DATA OUTPUT LINES (Continued)

NAME	FUNCTION
SPEED	This line may be used in installations in which two tape units of different operating speeds are connected to the same formatter. The line is asserted on the tape unit which has the lower of the two tape speeds.

3-10 Command Inputs

Functions of command inputs to the tape unit are listed in table 3-4; except for ISELECT, the command inputs are functional only when the tape unit is on line. Figure 4-49 shows typical timing interrelationships between these lines.

TABLE 3-5. TAPE UNIT COMMAND INPUT SIGNALS

NAME	FUNCTION
ILOL (Load and On Line)	An optional line which allows remote restart after power fails.
ISELECT 0-3	Four address select lines that are used for selecting a tape unit. These lines function in conjunction with the front panel Address Select thumbwheel so that if the front panel switch is in 0 position and ISELECT 0 line is asserted, the tape unit is selected. Likewise, switch position 1 corresponds to ISELECT 1, etc.
ISFC (Forward)	When asserted, will cause the selected unit to accelerate to synchronous speed in the forward direction. The tape unit will automatically begin to read and output data, but tape motion will stop when this line is not asserted.
ISRC (Reverse)	When asserted, will cause the selected tape unit to accelerate to synchronous speed in the reverse direction and begin to read and output data. The ISRC command is not recognized if the IBOT command output is asserted. The tape unit will stop when this line is not asserted.
IREU (Rewind and Unload)	Must be asserted for at least 1 $\mu$ sec to place tape unit off line and initiate a rewind and unload operation. The tape unit ON LINE indicator will go out. If the tape is not at BOT the tape will be rewound to BOT and then will unload onto the file reel at low speed. If the tape is at BOT the tape will unload onto the file reel at low speed.

TABLE 3-5. TAPE UNIT COMMAND INPUT SIGNALS (Continued)

NAME	FUNCTION
ISWRT (Set Write)	Asserted for at least 10 $\mu$ sec with ISFC to place the tape unit in write mode. Note that ISWRT must be asserted before the leading edge of ISFC.
IOVW (Over Write)	Asserted for at least 10 $\mu$ sec with ISFC and ISWRT to overwrite (update) an isolated record. Overwrite is terminated by assertion of the LRC Strobe at the end of the record. Note that the LRC Strobe must be asserted also during PE overwrite.
IREW (Rewind)	When this line is asserted for a minimum of 1 $\mu$ sec, the tape will be rewound to BOT. When the tape is at BOT, this line is inhibited.
IDDS (Density Select)	<p>Optional on 7 track tape units. Asserted to cause the tape unit to read the higher density data. This functions the same as the HI DEN switch described in table 3-1, but on any tape unit either the interface line or the switch is functional, but not both.</p> <p>This line may also be used on the optional NRZI and PE combination tape unit and asserted to cause the unit to operate in the 1600 bpi phase encoded mode. The function in this case is the same as the 1600 bpi switch described in table 3-2, but the interface line must be specified. Otherwise, the switch is functional. On dual speed tape units assertion of the IDDS line also causes the tape unit to move tape at the lower of the two speeds.</p>

3-11 Command Outputs

The command output lines reflect status of the selected tape unit. The functions are listed in table 3-6 and are available on the interface whenever the tape unit is selected.

TABLE 3-6. TAPE UNIT COMMAND OUTPUT SIGNALS

NAME	FUNCTION
IRDY (Ready)	<p>Asserted to indicate that:</p> <ol style="list-style-type: none"> <li>1. Tape is tensioned</li> <li>2. Tape is at or forward of BOT</li> <li>3. Tape unit is on line</li> <li>4. Tape unit is not rewinding</li> </ol> <p>When IRDY is asserted, the tape unit can accept a command.</p>

TABLE 3-6. TAPE UNIT COMMAND OUTPUT SIGNALS (Continued)

NAME	FUNCTION
IONL (Online)	<p>Asserted to state that the tape unit is on line (under remote control) with tape under tension.</p> <p>IONL will be cleared by any one of the following:</p> <ol style="list-style-type: none"> <li>1. A remote IREU assertion</li> <li>2. Pressing the tape unit RESET pushbutton</li> <li>3. Pressing the ON LINE pushbutton</li> <li>4. Loss of tape tension</li> <li>5. A remote IREU assertion</li> </ol>
IRWD	<p>Asserted to state that the tape unit is rewinding tape. IRWD is cleared when the tape motion stops and tape is positioned at BOT. As an option, the IRWD line can be enabled for an unselected unit.</p>
IBOT (BOT)	<p>Asserted to state that the tape unit has stopped motion and tape is positioned at the BOT tab.</p>
IEOT (EOT)	<p>Asserted to state that the tape unit is positioned at the EOT tab. Optionally, the tape unit may be wired so that this signal is asserted by passing the EOT tab and remains on until reset by passing of the EOT tab in reverse direction of tape movement.</p>
IFPT (File Protect)	<p>Asserted to state that the selected tape unit has a write protected tape file mounted on it.</p>
IDDI (High Density)	<p>Asserted to state that the tape unit has been commanded to read the higher of two densities. In the optional NRZI and PE combination tape units this line is asserted to indicate that the unit is operating in the phase encoded mode. On dual speed tape units this also indicates that the tape unit is operating at the lower speed.</p>





## Chapter 4

# THEORY OF OPERATION

### 4-1 INTRODUCTION

This chapter provides the theory of operation for the 2750 Series Magnetic Tape Unit. The theory is presented from the functional block diagram level, supported by later detailed circuit descriptions. Included in this chapter are signal mnemonics and definitions, theory of operation of data boards, tape control board, and primary power circuitry, and tape track layout and formats. The material in this chapter should be read and understood by maintenance personnel prior to performing maintenance described in Chapter 5.

Generally, logic symbology used in this manual is drawn in accordance with MIL-STD-806C. Chapter 6 contains an explanation of drawing symbology and notation, as well as the applicable assembly drawings, schematics, and logic diagrams pertaining to the tape unit.

### 4-2 SIGNAL MNEMONICS AND DEFINITIONS

Table 4-1 contains a complete list of signal mnemonics and definitions used for the magnetic tape unit.

TABLE 4-1. SIGNAL MNEMONICS AND DEFINITIONS

MNEMONIC	DESCRIPTION	FUNCTION
ADDR SELECT	Address Select	Asserted when tape unit address is selected.
BOTA & $\overline{\text{BOTA}}$	Beginning-of-tape	Asserted when beginning-of-tape is detected.
BOT & $\overline{\text{BOT}}$	Beginning-of-tape	Asserted when beginning-of-tape is detected, but not during a rewind, load or detection of EOT tab.
DATA READY	Data Ready	Strobes write data from interface into write register.

TABLE 4-1. SIGNAL MNEMONICS DEFINITIONS (Continued)

MNEMONICS	DESCRIPTION	FUNCTION
EOTA & $\overline{EOTA}$	End-of-tape	Asserted when end-of-tape tab is detected.
EOT & $\overline{EOT}$	End-of-tape	Asserted when end-of-tape tab is detected, but not during rewind or detection of BOT tab.
FORWARD & $\overline{FORWARD}$	Forward command	Asserted when tape unit is selected, ready and on line.
HID & $\overline{HID}$	High density	Asserted when tape selected at high density by either front panel switch or interface signal.
$\overline{HI DEN}$	High density	High density command to data board.
HOLD		Delay during which K1 is held on until interlock switch close.
IBOT		Interface beginning-of-tape signal.
IDDI		Interface density status.
IDDS		Interface density select command.
IEOT		Interface end-of-tape signal status.
IFPT		Interface file protect signal.
IOVW		Interface overwrite command.
ILOL		Interface load and on line.
INTLA	Interlock A	Asserted when K1 relay and interlock switches are closed.
INTL & $\overline{INTL}$	Interlock	Asserted when K1 relay and interlock switches are closed.
IONL		Interface on line status.

TABLE 4-1. SIGNAL MNEMONICS DEFINITIONS (Continued)

MNEMONICS	DESCRIPTION	FUNCTION
IRDY		Interface ready status.
IREU		Interface rewind and unload command.
IREW		Interface rewind command.
IRWD		Interface rewind status.
ISELECT 0-3		Interface select commands.
ISFC		Interface synchronous forward command.
ISRC		Interface synchronous reverse command.
ISWRT		Interface set write command.
LDA & $\overline{\text{LDA}}$	Load flip-flop A	Asserted to tension tape
LDB & $\overline{\text{LDB}}$	Load flip-flop B	Asserted to move tape to BOT.
$\overline{\text{LDRDY}}$	Load ready	Sets reel motors in motion during a load operation.
LG	Logic ground	Controls operation of some front panel switches for front panel disable option.
I WRT CNTRL	High current boost	Sets write current amplitude to NRZI level when switching to write mode.
$\overline{\text{GAP}}$		Clears write data flip-flop when motion stops.
WRT PWR SW	Write power switched	+5 volts to write circuitry when write enable and hi-density are true.
ENV PWR	Envelope power	Applies power to envelope detector circuitry.
ERASE ERROR		Set when erase current failure is detected.

TABLE 4-1. SIGNAL MNEMONICS DEFINITIONS (Continued)

MNEMONICS	DESCRIPTION	FUNCTION
LOL	Load and on line	Sets offset to take up servo during a load and on line operation.
LOLSTR	Load and on line strobe	Sets on line flip-flop at end of load and on line operation.
LON & $\overline{\text{LON}}$	Load once flip-flop	Set when tape unit has completed a load operation.
LRC & $\overline{\text{LRC}}$	Longitudinal redundancy character strobes	Writes LRC and resets write enable during overwrite.
LRC STROBE	Longitudinal redundancy character strobes	Interface input line for longitudinal redundancy character strobes
MFWD & $\overline{\text{MFWD}}$	Manual forward or maintenance forward	Asserted when using maintenance switch to move tape in forward direction.
$\overline{\text{MINTL}}$	Momentary interlock	Momentarily energizes K1 during load sequence.
MOTION & $\overline{\text{MOTION}}$		When either forward or reverse commands are asserted, MOTION is high.
MREV & $\overline{\text{MREV}}$	Manual reverse or maintenance reverse	Asserted when using maintenance switch to move tape in reverse direction.
VTH	Voltage threshold	Dynamically switched threshold voltage reference applied to envelope detector.
ENV P, $\emptyset$ , 1...7	Envelope output	Envelope output flip-flop is set when read data is detected.
SUM DATA		Read data sum output.

TABLE 4-1. SIGNAL MNEMONICS DEFINITIONS (Continued)

MNEMONICS	DESCRIPTION	FUNCTION
NRZ or NRZI	Non-return-to-zero	Interface line used to indicate recording method.
ONL & $\overline{\text{ONL}}$	On line flip-flop	Set to allow the tape unit to accept commands.
OPR POS & $\overline{\text{OPR POS}}$	Operating position	Asserted when the tension arms are in the operating position.
ORS	On line ready selected	Indicates when tape unit is ready to accept a command.
$\overline{\text{PSET}}$	Power reset	Resets the control logic when power is turned on and when power fails.
RD THRESHOLD	Read threshold	Voltage used to detect data.
RDY & $\overline{\text{RDY}}$	Ready	Indicates the tape unit is ready to accept a command i.e., tape unit is loaded and not rewinding.
RDYA	Ready	Indicates tape unit is not rewinding and is loaded.
RDYNOL	Ready and not on line	Indicates tape unit is loaded, not rewinding and not on line.
READ DATA PARITY, 0, 1, . . . , 7.	Read data lines	Interface lines for either NRZI or PE data.
READ DATA STROBE		Interface line strobe used to load read data into formatter.
IRDT	Read Threshold 1	Interface threshold command.
IRDT	Read Threshold 2	Interface threshold command.
$\overline{\text{RESET}}$		Asserted when reset front panel switch is pressed. Resets selected flip-flop.
REU	Rewind and unload	Asserted by interface command line (IREU) input to initiate rewind and unload operation.

TABLE 4-1. SIGNAL MNEMONICS DEFINITIONS (Continued)

MNEMONICS	DESCRIPTION	FUNCTION
REVERSE & $\overline{\text{REVERSE}}$		Asserted when tape unit is on line, ready and selected.
REWD & $\overline{\text{REWD}}$	Rewind	Asserted when capstan is rewinding.
REWDL	Rewind delay	Delays the starting of the capstan and energizing of K2 relay during a rewind operation.
$\overline{\text{RST}}$	Reset	Resets unload (UNL) and load A (LDA) flip-flops when power is turned on and tape is not threaded through tape path (TPC) and load fault (LDFLT) signal is asserted.
$\overline{\text{RSTA}}$	Reset A	Resets rewind A (RWDA) and rewind B (RWDB) flip-flops during completion of rewind sequence or when RSTB is asserted.
$\overline{\text{RSTB}}$	Reset B	Resets load B (LDB) flip-flop and generates RSTA during load sequence or when $\overline{\text{RSTC}}$ is asserted.
$\overline{\text{RSTC}}$	Reset C	Resets on line flip-flop, asserts ready (RDY) low, and generates RSTB during unload sequence or when RSTD is asserted.
RSTD	Reset D	Asserted by RESET pushbutton or INTL not asserted generates RSTC.
RUL	Rewind and unload flip-flop	Output asserted during rewind and unload operation.
RWDA & $\overline{\text{RWDA}}$	Rewind A	Set during rewind operation.
$\overline{\text{RWDAB}}$	Rewind A & B	Indicates rewind flip-flop A set and rewind flip-flop B not set.

TABLE 4-1. SIGNAL MNEMONICS DEFINITIONS (Continued)

MNEMONICS	DESCRIPTION	FUNCTION
RWDC	Rewind C	Generated by $\overline{RWDA}$ . This signal turns on the rewind lamp and high gain to the reel servo circuits.
RWDL	Rewind delay	Delays start of the capstan for a rewind operation.
$\overline{RWRD}$	Rewind ramp	Input signal that generates the rewind ramp to capstan. Asserted after rewind delay and when RWDA is set and RWDB is not set.
SELECT		Asserted when the tape unit is selected.
SETHOLD & $\overline{SETHOLD}$		Asserted when HOLD signal times out resetting LDA flip-flop.
SG		Single gap, see Single Gap.
SINGLE GAP		Status signal output from the NRZI and PE boards signifying a single gap head configuration.
SLTA & $\overline{SLTA}$	Select A	Select gated with on line when this signal is asserted, the command inputs ILOL, IREU and the internally used signal ORS are qualified.
SLTB	Select B	Qualifies the command outputs (status) IEOT, IDDI and IONL.
SLTC	Select C	Qualifies command outputs IBOT, IFPT, IRWD and IRDY.
SPEED		Data PWBA status output; signifies a low speed tape unit is selected when asserted low. This is used when two different speed tape units are daisy-chained together to a signal formatter.
$\overline{SPD}$	Low speed	When asserted low, the tape unit will operate at the lower speed. (Used on dual speed units only.)

TABLE 4-1. SIGNAL MNEMONICS AND DEFINITIONS (Continued)

MNEMONICS	DESCRIPTION	FUNCTION
SUPPLY DET	Supply detector	Supply vacuum column detector output.
SWRT	Set write flip-flop output	This flip-flop is set to start a write operation.
TAKE UP DET		Take-up detector circuit output.
TPC	Tape path complete	Asserted when BOT or EOT signals are not asserted.
UNL	Unload flip-flop	Asserted during unload sequence.
VACUNL	Vacuum unload	Asserted when unload flip-flop is set and interlock switches are open. This signal initiates the circuits to allow reel servos to perform an unload operation.
VINTL	Vacuum interlock	Asserted when vacuum interlock switch is closed.
WRTA	Write A	Asserted when write lockout switch is closed. Generates signal to solenoid lamp driver (file protect).
WRT DATA PARITY, 0, 1, ... 7		Write data interface lines.
$\overline{\text{WRT ENA}}$	Write enable	See $\overline{\text{WRT ENABLE}}$ .
$\overline{\text{WRT ENABLE}}$	Write enable	Asserted when write flip-flop is set and tape motion is true. The write electronics is enabled.
WRT PWR	Write power	+5 volts applied to write electronics when interlock switches are closed. K1 relay is energized and write lockout switch is closed.
7 TRK or SEVEN TRACK	Seven track status	Interface line asserted
9 TRK or 9 TRACK	9 track	Interface line asserted when a nine track tape unit is selected.



#### 4-3 FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

Figure 4-1 shows a functional block diagram of the magnetic tape unit. The tape unit functions may be considered to consist basically of three general areas: data read/write, control and status, and power. Circuitry for these functions is contained on the tape control board, the data board, the power supply module, and other deck-mounted components that plug into the boards. The following paragraphs contain a brief discussion of the circuit boards. Detailed circuit descriptions are contained in paragraph 4-7.

#### 4-4 Tape Control Board

The tape control board contains most of the circuitry necessary to implement the status and control functions. Tape control logic processes the control signals from the external formatter or controller and reports tape unit status to the formatter. The control signals are routed to the data boards for use in read/write operation and to the tape drive circuits on the tape control board for electromechanical operation of the tape unit. The tape control board also contains the voltage regulator circuitry to furnish regulated power to the tape unit. Detailed circuit descriptions are contained in paragraph 4-8.

#### 4-5 Data Board

The data board provides the data read/write functions. Write data signals enter the board by an edge connector on one side of the board. They are buffered by a register which drives the write head. The write and read head connections are made through two connectors in the center of the board. The signals from the read head are amplified, differentiated and compared to a threshold voltage. For PE data boards the signals are driven directly on the interface lines. For NRZI data boards the signals are buffered and strobed out with a read strobe. The read signals are connected to the interface by an edge connector at the other end of the board. Data board control signals are received from the formatter via the tape control board. Detailed circuit descriptions are contained in paragraph 4-28.

#### 4-6 Primary Power Circuits

The primary power circuits consist of a power supply module mounted on the tape unit baseplate and the power supply regulator circuits located on the tape control board. The power supply module supplies unregulated  $\pm 36$  volts to the reel servos, and unregulated  $\pm 17$  volts to the reel servos, the capstan servos and the power supply regulator circuits. The power supply regulator circuits on the tape control board consist of four separate regulator circuits which supply +10 volt, +5 volt, -10 volt and -5 volt outputs. In addition, the power supply regulator circuits also provide a reset (PSET) signal to the tape unit control circuits. Detailed circuit descriptions are contained in paragraph 4-40.

#### 4-7 DETAILED CIRCUIT DESCRIPTIONS

#### 4-8 TAPE CONTROL BOARD ELECTRONICS

The following paragraphs describe the operation of the circuits contained on the tape control board. These circuits consist of the load logic, reel servo, capstan servo, on line/off line logic, addressing logic, and the tape control circuits. A complete schematic diagram of the tape control board is contained in Chapter 6. Simplified

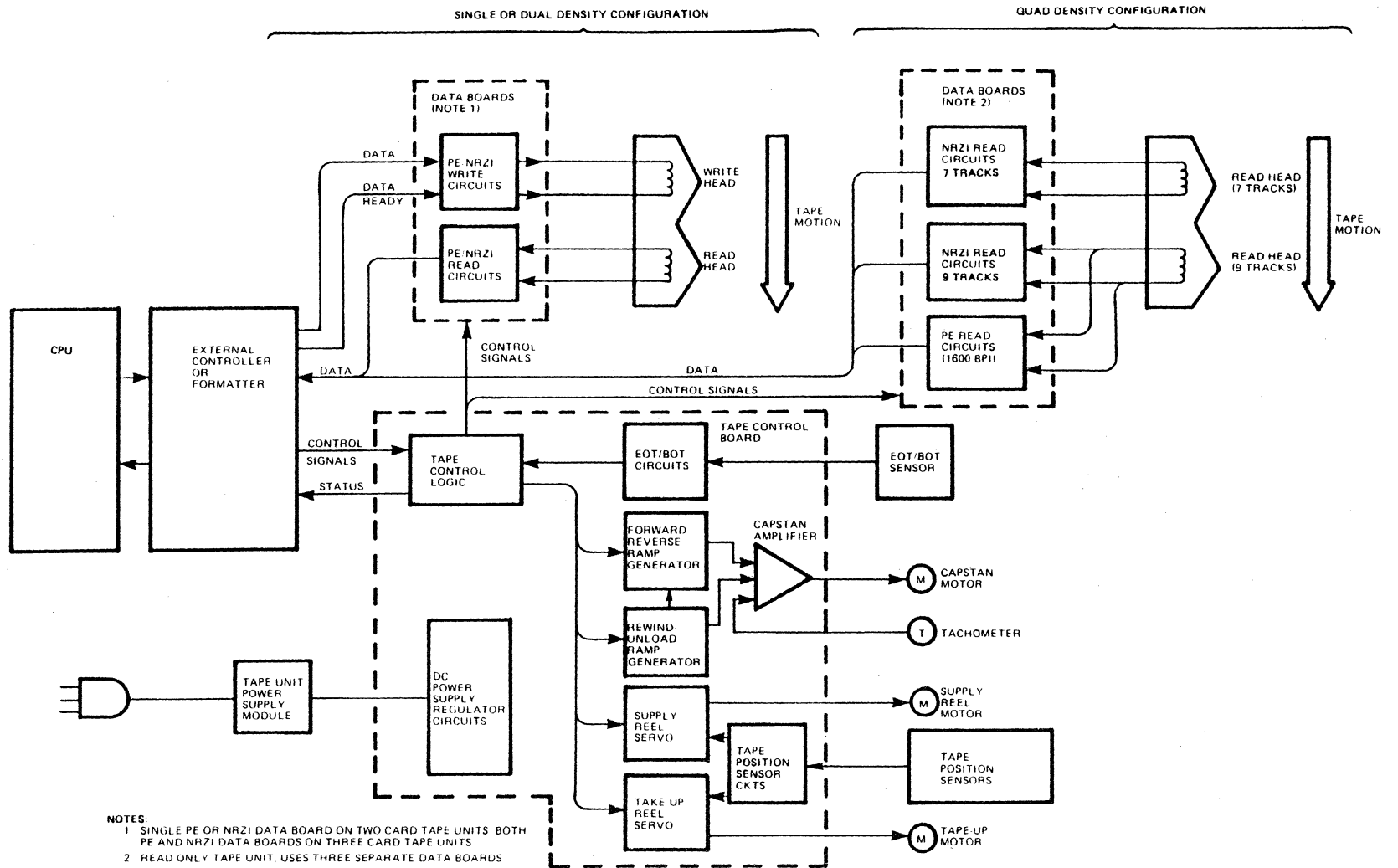


Figure 4-1. Magnetic Tape Unit Functional Block Diagram

schematics of the various tape control board circuits are contained in the following paragraphs where necessary for clarity of explanation.

#### 4-9 Load Logic Circuits

The load logic circuits have differences depending on whether the single load or double load option is in use. The following paragraphs discuss both the single and double load options.

#### 4-10 Vacuum Column Load Sequence

Figure 4-2 shows the simplified schematic for a vacuum column load sequence with the double-load option. Pressing the LOAD switch and releasing it causes a positive pulse output from flip-flop U26-8 which sets flip-flop U27-3 (LDA). LDB flip-flop U27-5 is not set since RSTD is low until INTL goes high. This occurs when relay K1 is energized.

LDA is connected to gate U43-3 which applies a low at relay driver U38-7. A low at either input to U38 energizes relay K3 and turns on the vacuum motor. LDA is also an input to NAND gate U15-6 with INTL at U15-1 and LDLY at U15-4. INTL is high until relay K1 is energized and LDLY is the output of a load delay circuit.

The input to the load delay circuit is  $\overline{\text{LDA}}$ .  $\overline{\text{LDA}}$  is connected to Q3 through R31 and when LDA is high Q3 conducts at saturation. U1-7 is at ground potential and is less than the voltage at U1-6. The voltage divider of R36 and R37 sets the U1-6 voltage at 3.5 volts. The output of U1 is at -10 volts and is connected to R40. LDLY is clamped by CR5 to approximately -0.5 volt. When LDA is set low, Q3 is turned off. This allows the voltage at U1-7 to increase with the time constant of R35 and C8. When the voltage is increased to greater than 3.5 volts the output of U1 and LDLY goes high and LDRDY at U15-6 goes low. LDRDY low saturates Q5 and 2N6058 in the reel servo circuits applying -17 volts through a resistor to the reel motors. Current through the reel motors creates a torque that allows the tape to enter the vacuum chamber.

LDRDY is also an input to the load fault circuits at U2-12. When LDRDY goes low U2-11 allows C48 to charge toward +5 volts at U1-4. The voltage at U1-4 increases with the time constant of C48 and R74. If the voltage at U1-4 increases above the voltage at U1-5 before the interlock is set, U1-2 and LDFLT go low. This causes RST at U35-12 to go low at U31-1, resetting LDA flip-flop U27 and stopping the load sequence. If the interlock is set before the voltage at U1-4 increases above the voltage at U1-5, INTL goes low at U15-1. This causes LDRDY to go high and U2-11 goes low causing C48 to discharge through R72. LDFLT will remain high allowing the load sequence to complete.

When the tape is in the vacuum columns, the vacuum interlock switches close making VINTL high. With LDA at U33-1 and VINTL at U33-2 high, MINTL goes low triggering HOLD single shot U37. MINTL also applies a low at U35-4. Any low at relay driver U45 energizes relay K1 connecting the reel and capstan motors to their amplifiers. The tape is now positioned by the reel motors to the center of the vacuum columns. The vacuum interlock switches stay closed as long as the tape loop stays in the operating range. When relay K1 is energized and the interlock switches are closed, INTL and INTLA also go high. INTLA at U39-9 is gated with PSET at U39-10 causing U39-8 to go low and keeps relay K1 energized until PSET goes low or either interlock switch is opened.

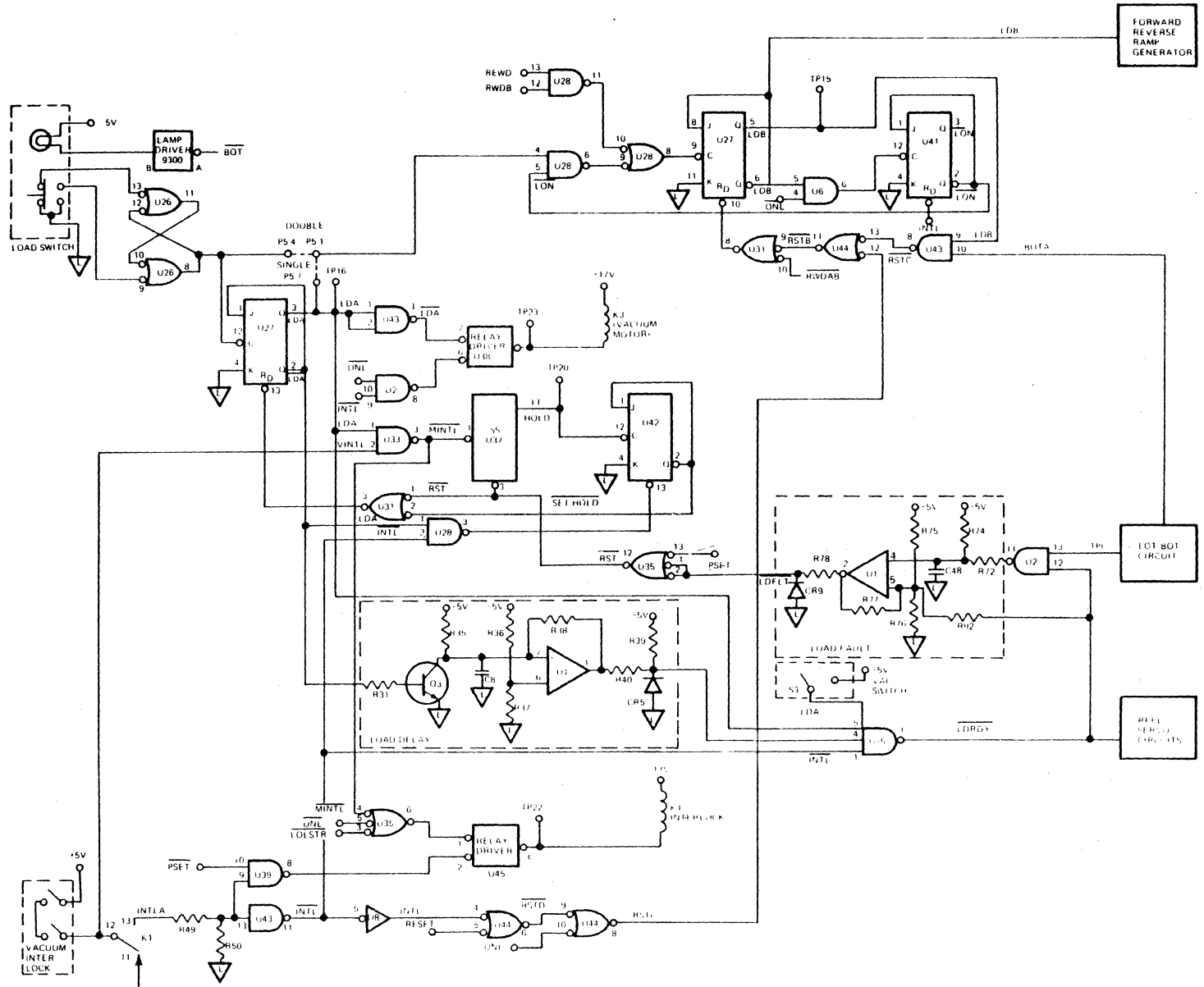


Figure 4-2. Vacuum Chamber/Double Load Logic Simplified Diagram

When HOLD single-shot U37-13 times out, it sets flip-flop U42-3 (SET HOLD). SET HOLD is an input at U31-2 which resets LDA flip-flop U27. Therefore, if the vacuum interlock switches are not closed, relay K1 will be deenergized.

For the single-load option, LDA at U28-4 is gated with  $\overline{\text{LON}}$  at U28-5. Since LON is high until the tape unit has been loaded, the reset of LDA sets flip-flops U27-5 (LDB) and flip-flop U41-3 (LON). LDB is an input to the forward ramp generator which causes the capstan to move the tape forward. When the BOT sensor detects a BOT marker, the BOTA signal at U25-6 goes high. BOTA at U43-10 and LDB at U43-9 are gated at U43-8 applying a low at U44-13. A low input to U44-13 makes RSTB go low at U44-11. RSTB is an input to U31-8 which resets LDB at U27-10 stopping tape motion. The tape is now tensioned and stopped at the BOT marker, and the LOAD indicator is lit. Refer to figures 4-3 and 4-4 for timing diagrams.

For the double-load option, pressing and releasing the LOAD switch a second time causes a positive pulse output from U26-8 which is gated with  $\overline{\text{LON}}$  at gate U28-5. Since LON is high until the tape unit has been loaded, the pulse sets flip-flops U27-5 (LDB) and U41-3 (LON). LDB is an input to the forward ramp generator which causes the capstan to move the tape forward. When the BOT sensor detects a BOT marker, the BOTA signal goes high. BOTA at U43-10 and LDB at U43-9 are gated at U43-8, applying a low input at U44-13. A low input at U44-13 makes  $\overline{\text{RSTB}}$  go low.  $\overline{\text{RSTB}}$  is an input at U31-9 which causes U31-8 to go low, resetting LDB flip-flop U27 and stopping tape motion. The tape is now tensioned and stopped at the BOT marker. The LOAD indicator should be lit.

#### 4-11 Blower Motor Control

Figure 4-5 shows a simplified diagram of the blower motor circuit. When relay K3 on the tape control board is energized during the tape loading sequence, relay K3 contacts 12 and 13 close. This connects the triac output circuit to the gate of the triac CR1 through resistor R1. This turns on triac CR1 and allows ac operating voltage from power supply transformer T1 to be applied through the triac to blower motor M1. When relay K3 is deenergized, triac CR1 turns off and removes the ac operating voltage from the blower motor. The triac assembly is located on top of the blower motor.

#### 4-12 Reel Servo Electronics

Figure 4-6 shows a simplified diagram of the reel servo electronics. The reel servo electronics consist of two identical circuits; the supply reel servo circuits and the tape-up reel servo circuits. Since the operation of both circuits is identical, only the supply reel servo circuit is described.

The input to the reel servo amplifier is a tape position sensor and detector which provides a voltage that is linearly related to the position of the tape in the operating range.

#### 4-13 Vacuum Chamber Tape Position Sensor Circuits

The input to the reel servo amplifier is the tape position sensor. This is a transducer and detector for the tape in the operating range.

The tape position sensor uses an oscillator that drives the variable capacitor transducer, the output of which is detected and amplified by a synchronous detector. Figure 4-7 shows a simplified schematic diagram of the vacuum chamber tape position oscillator and sync detector circuits. Figure 4-8 contains the timing diagram.

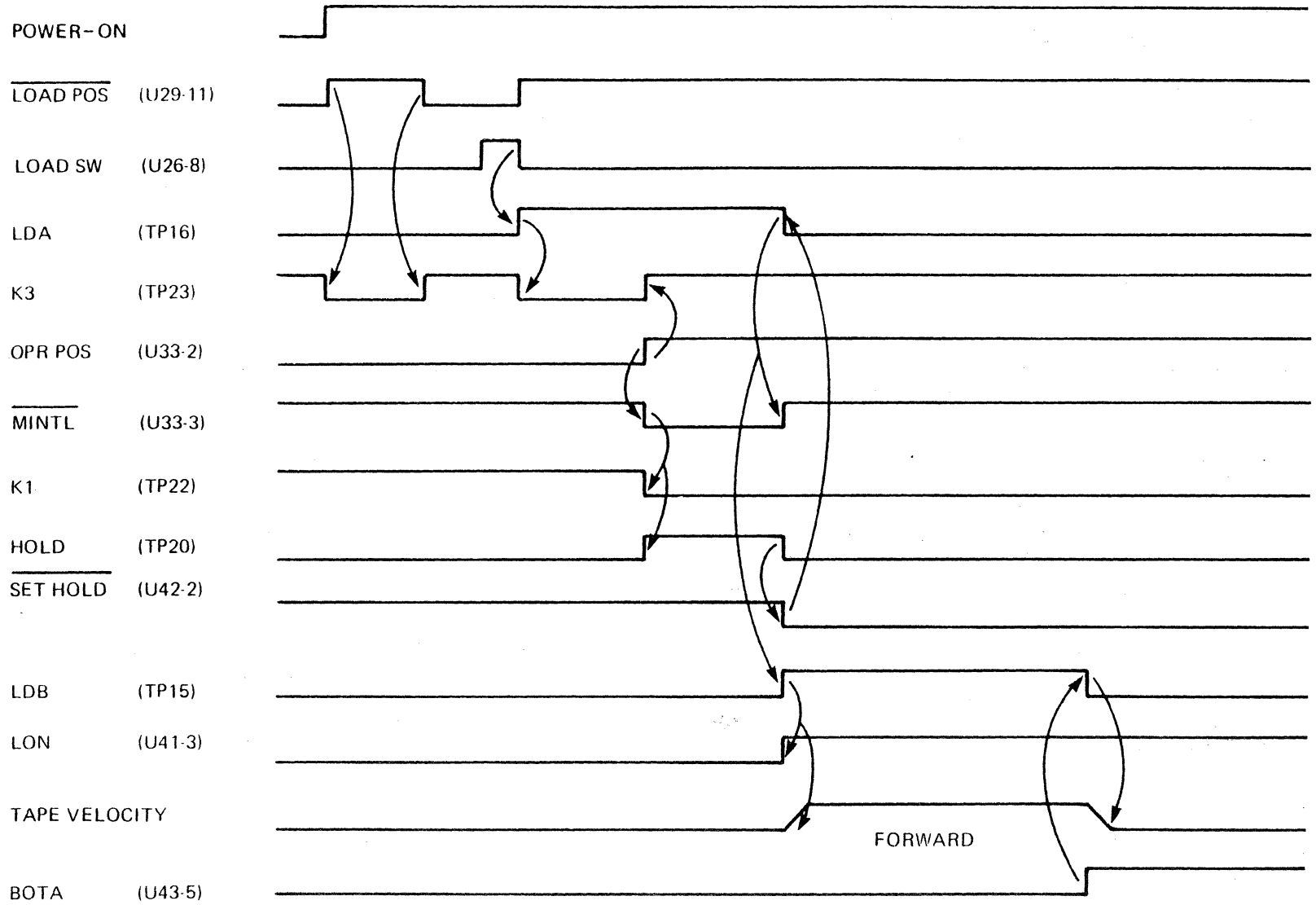


Figure 4-3. Single Load Sequence Timing Diagram

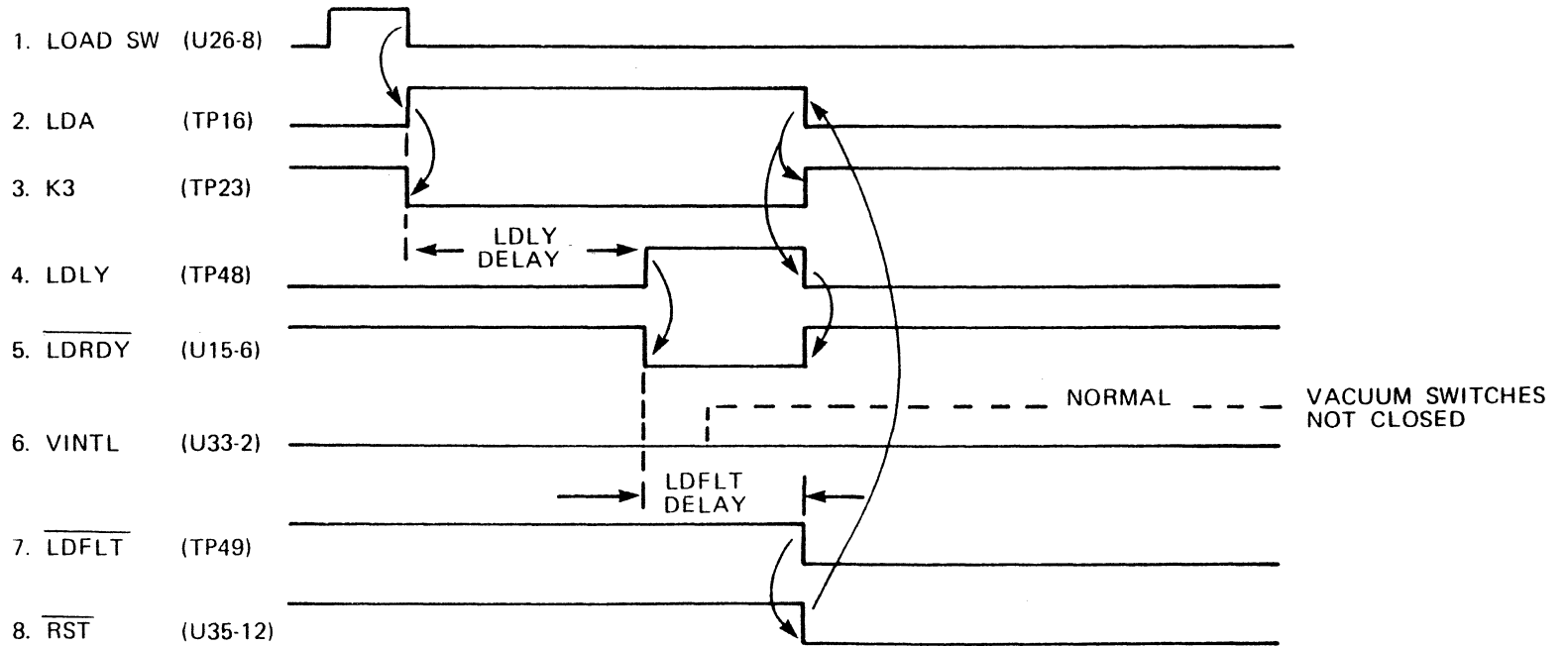


Figure 4-4. Load Fault Sequence Timing Diagram

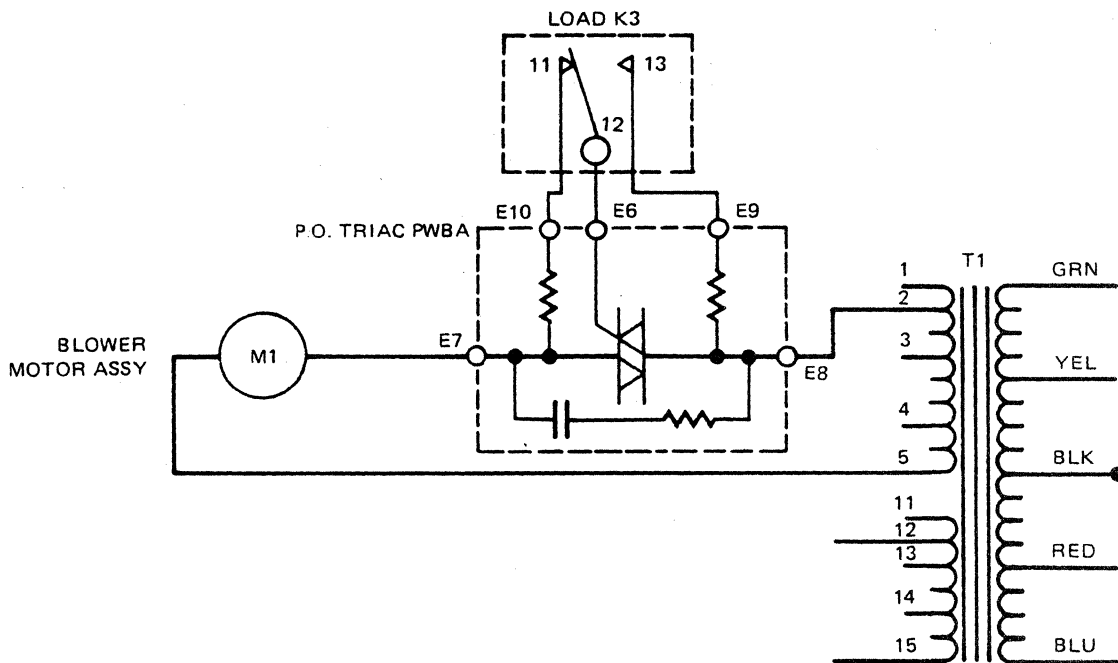


Figure 4-5. Blower Motor Control Simplified Diagram

Figure 4-8 contains the timing diagram. The output of the 8100 oscillator is a triangular wave that is determined by the integration of a square wave with R8107, C8101 and U50. When Q8103 and Q8102 are turned on and the output of U50 is at +5 volts, the collector of Q8103 is at +5 volts and current flows through R8107, charging capacitor C8101. This causes the output of U50 to decrease as capacitor C8101 is charged. Capacitor C8101 charges until the output of U50 reaches -5 volts. At this time, the base of Q8102 is less than the base voltage of Q8101, turning transistors Q8102 off and Q8101 on. Transistor Q8103 is also turned off, since R8105 is connected to -5 volts and the output of U50 increases toward +5 volts. Since the charging rate of C8101 is constant, the output of U50 is a triangular waveform with a period of 75 microseconds.

The triangular waveform is applied to the vacuum chamber transducers. The transducers are variable capacitors with a capacitance that varies according to the position of the tape in the vacuum chambers. The other plate of the capacitor is connected to an amplifier, one for each chamber. Since the circuits are also identical, only the supply sync detector (functional module 8300) is described.

The plate of the variable capacitor transducer is connected to pin 2 of amplifier U55. Amplifier U55 has a gain that is the ratio between R8302 and the transducer capacitive reactance. The amplifier gain increases at 20 dB per decade. This is the characteristic of a differentiator amplifier. As the capacitance of the transducer varies, the



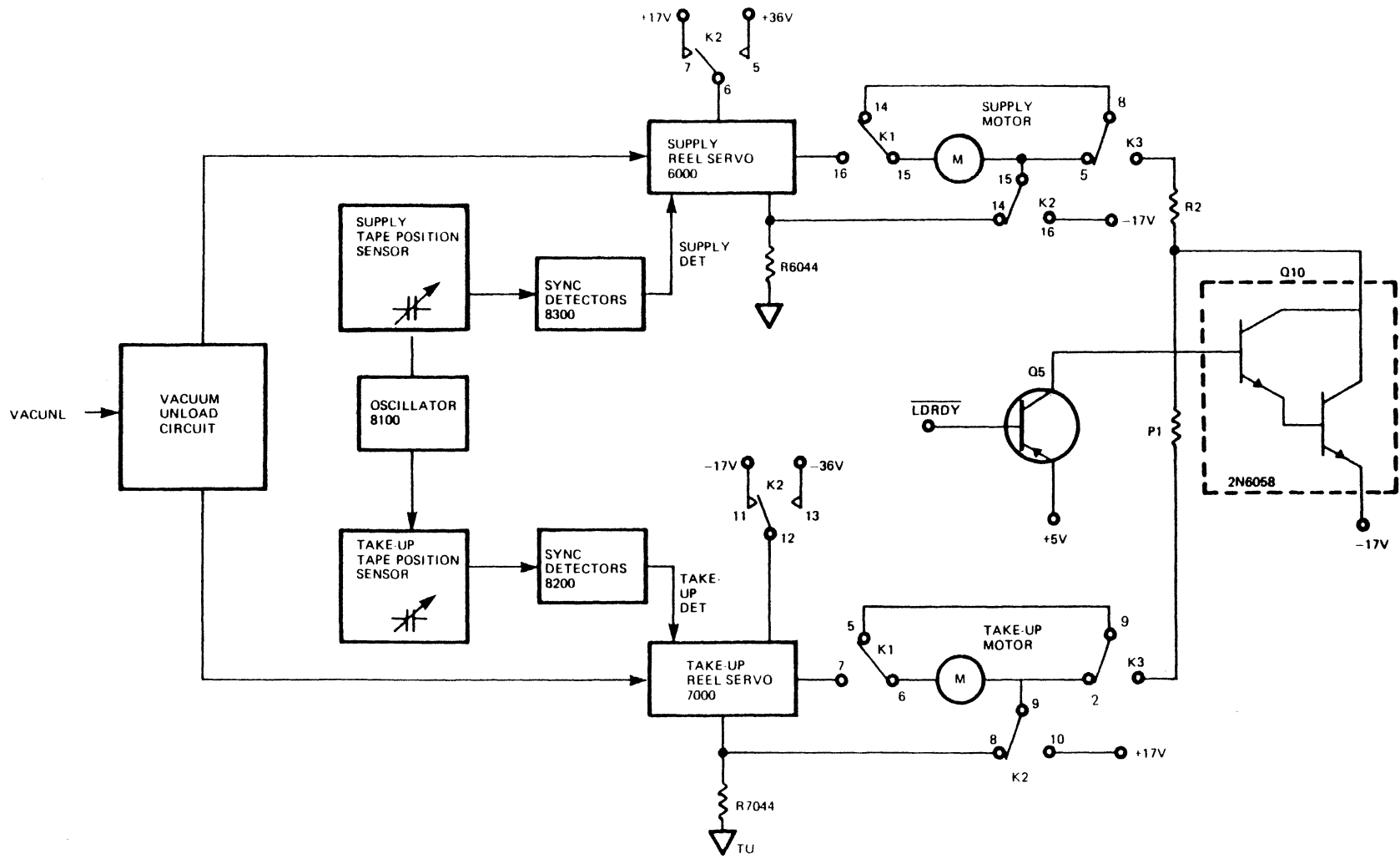


Figure 4-6. Reel Servo Electronics Simplified Diagram

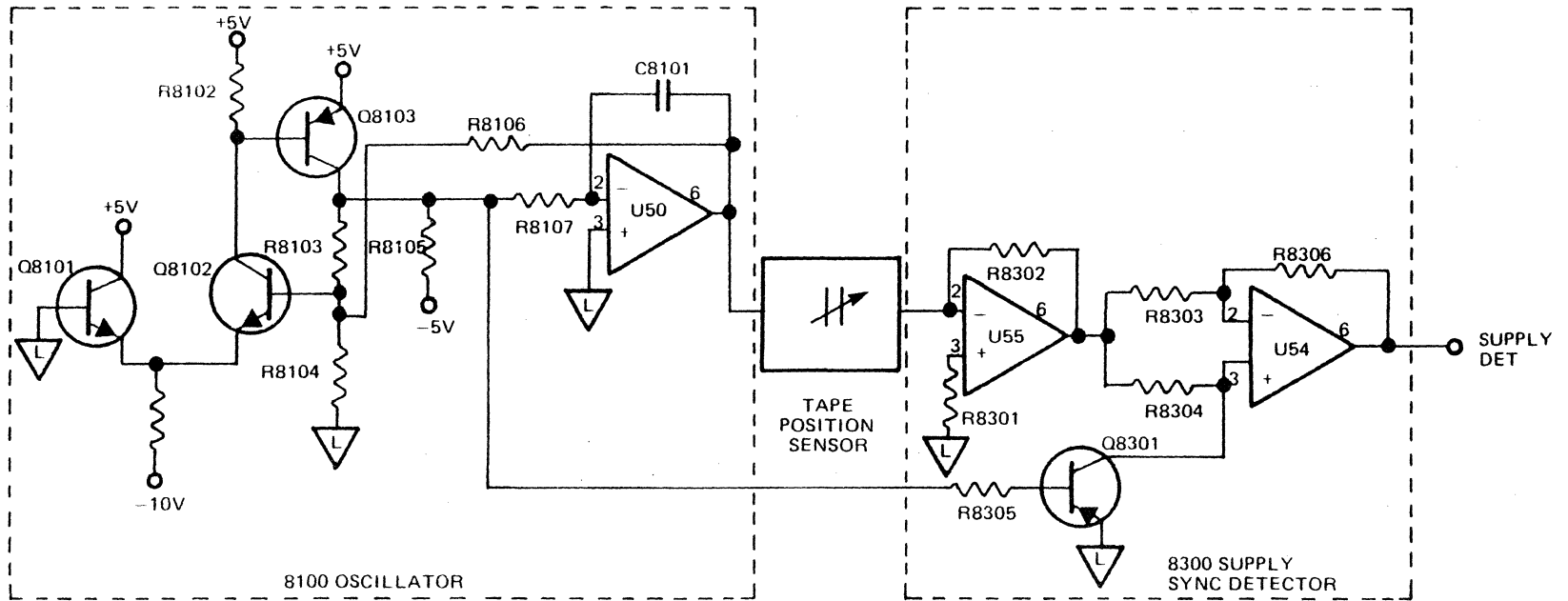
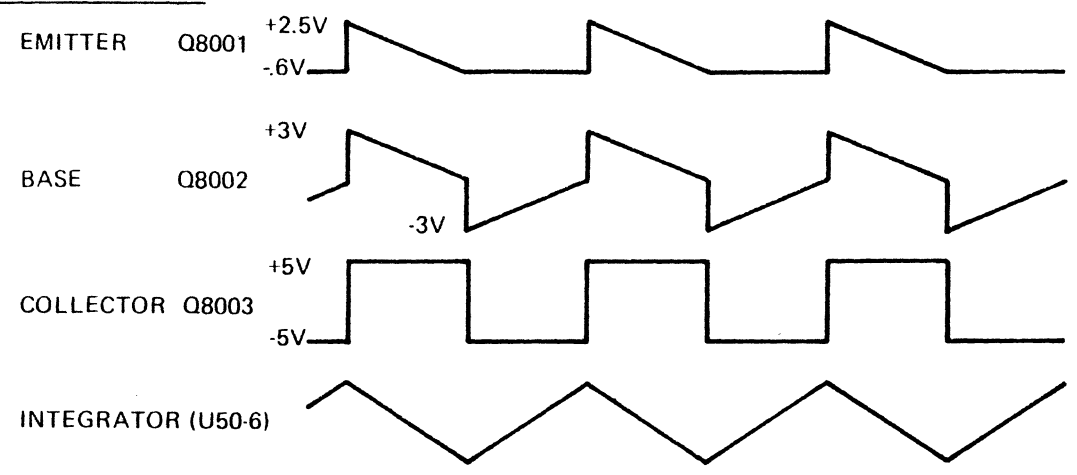
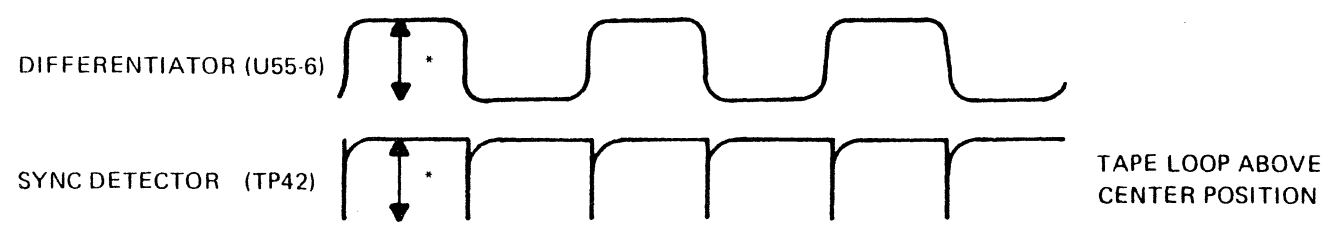


Figure 4-7. Vacuum Chamber Position Sensor Control Simplified Diagram

8100 OSCILLATOR



8300 SUPPLY SYNC DETECTOR



\*AMPLITUDE VARIES WITH TAPE POSITION

Figure 4-8. Tape Position Sensor Circuit Timing Diagram

gain of the amplifier also varies. The output of the amplifier is a square wave since the triangular wave output of the oscillator is differentiated and the amplitude of the square wave varies according to the transducer capacitance.

The output of amplifier U55 is connected to a synchronous full wave rectifier composed of U54 and Q8301. A square wave signal from the oscillator is applied to the base of Q8301 through R8305. The negative half of the square wave saturates Q8301, setting pin 3 of U54 at ground potential. At the same time, the output of U55 is also negative and is applied to the inputs, pins 2 and 3, of U54 through R8303 and R8304. Since pin 3 of U54 is grounded, and R8303 and R8306 are equal, the output of U54 is the inverted output of U55 with unity gain.

The positive portion of the oscillator square wave turns off Q8301. At this time the output of U55 is also positive. Since the input impedance of U54 is high, very little voltage drop occurs across R8304 and the output of U55 is applied without reduction to pin 3 of U54. The open loop gain of U54 is also very large, so pin 2 of U54 has to also be equal to the output of U55. This occurs only when there is very little voltage drop across R8303 and almost no voltage drop across R8306. This occurs only if the output of U54 is equal to the output of U55. Consequently, the output of U55 is rectified, with the unity gain of U54 applying a positive voltage level output to the supply reel servo circuit.

#### 4-14 REEL SERVO CIRCUITS

Figure 4-9 shows a simplified diagram of the supply reel servo circuits. The output of the sync detector is connected to U6047-2 through a filter network of R6003, C6001, C6002 and R6007. This input network filters out the ripple from the U54 rectifier. The feedback around U6047 is the series connection of R6010 and potentiometer R6011. The closed loop gain of U6047 is changed by adjusting potentiometer R6011. Potentiometer R6006 is connected to U6047 through R6008 and is used to adjust the output of U6047 to zero when the tape is positioned in the center of the vacuum chamber.

U6053, Q6002, Q6003 and 2N6051 (Q3) and 2N6058 (Q1) on the heatsink comprise the power amplifier stage of the reel servo electronics. R6021 and R6022 are feedback resistors for the amplifier. The output of U6047 is connected to U6053 by either R6015 or R6019 through FET 6004. Since R6019 has a lower resistance than R6015, the gain of the power amplifier stage is about five times greater when R6019 is the input resistor. R6019 is the input resistor when the output of U6047 is greater than +1.7 volts, or when the tape unit is rewinding. Q4 is turned off when RWDC and REWD are high when the tape unit is not rewinding, and the collector of Q4 is at -10 volts as are both sides of R64 since CR8 is forward-biased. This biases the gate of FET Q6001 at -10 volts, turning off Q6001. When RWDC or REWD go low, Q4 is saturated and its collector goes to +5 volts. The bias voltage at the gate of Q6001 is increased at a rate determined by the time constant of R64 and C42. When the voltage becomes greater than -0.5 volt, CR6005 is back-biased, turning on FET 6001 and connecting the output of U6047 to R6019. When RWDC and REWD are high again, Q4 is again turned off and C42 is quickly discharged through CR8, turning Q6001 off.

The output of U6047 is also connected to resistor networks R6013/R6014 and R6012/R6017. Since the operation of the networks is identical, only the R6012/R6017 network is described. When there is no current flow through R6019, and U6053-2 is at virtual ground potential, the cathode of CR6004 is also at ground potential. When the output of U6047 increases to 1.7 volts, CR6004 is forward-biased. Any further increase

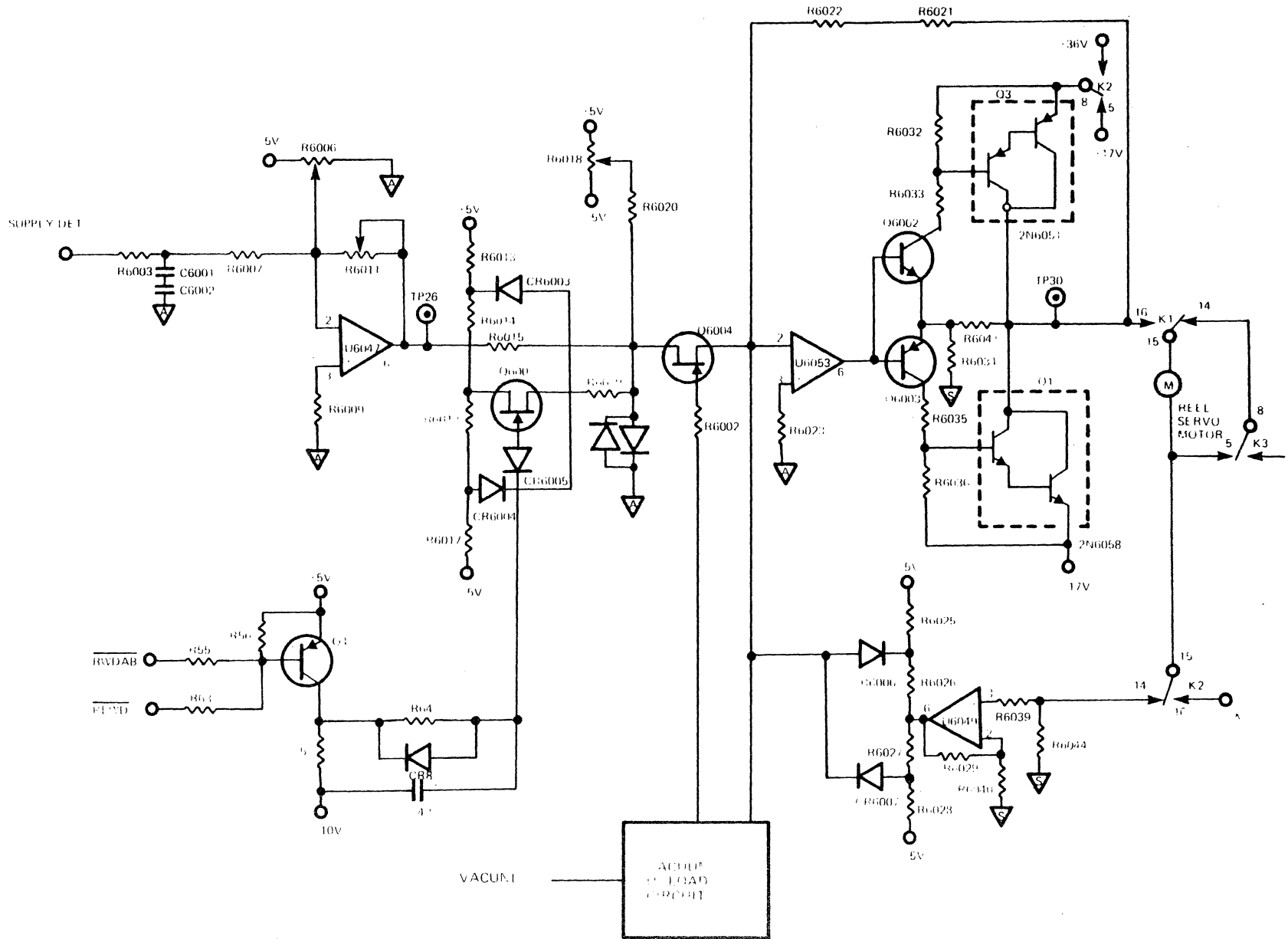


Figure 4-9. Supply Reel Servo Circuits

in the output of U6047 causes the cathode of CR6004 to increase correspondingly. Consequently, R6019 is connected to the output of U6047 whenever the output is greater than 1.7 volts.

Potentiometer R6018 is connected to input of U6053 through R6020 and FET 6004, and is used to adjust the output of the power amplifier stage to create a torque in the reel motors to compensate for tape tension, keeping the tape in the center of the range.

During all operations, except unload, FET Q6004 is held in the on condition by the conduction of transistor Q6. During a tape unload sequence, Q6 is turned off when the VACUNL signal goes high. This turns off Q6004 and disconnects the output of U6047 from U6053.

The output of U6053 is connected to the bases of Q6002 and Q6003. If the output of U6053 increases, Q6002 is turned on, the collector of Q6002 drops, and the base of power transistor 2N6051 also drops. Power transistor 2N6051 is turned on, causing its collector potential, and the output at TP30 to increase. When the output of U6053 goes negative, Q6003 and power transistor 2N6058 are turned on and the output at TP30 is driven negative.

The output of the reel servo power stage is connected to the reel motor through relay K1. The motor return goes through relay K2 and R6044. The voltage drop across R6044 is connected to U6049 pin 3 by R6039. U6049 and associated components form a feedback network that prevents motor current from exceeding 14 amps. Closed loop gain of U6049 is set by R6029 and R6040. The output of U6049 is resistor networks R6026/R6025 and R6027/R6028. Since the two networks function in the same manner, only one is described. When the output voltage of U6049 reaches +5.6 volts, CR6007 becomes forward-biased. The cathode of U6049 decreases the output of the power amplifier.

When the tape unit starts to rewind, relay K2 energizes. The 2N6051 transistor in the supply reel servo is connected to +17 volts when K2 is not energized. When K2 is energized, the transistor is connected to the +32-volt supply. The motor return is normally connected to R6044; however, when K2 is energized, the motor return is connected to -17 volts. Therefore, for the motor to stop, the supply reel servo must have an output of -17 volts, and at full speed, the motor can have 49 volts across it. These changes are required so the servo can develop enough voltage to handle the high speed during rewind.

During the unload operation when FET Q6004 is turned off, the VACUNL signal is applied to pin 3 of U6047 from diode CR13. This ensures that Q6004 remains turned off during unload.

#### 4-15 Capstan Servo Electronics

The forward reverse ramp generator and the rewind generator are inputs to the capstan amplifier. These generators determine the speed, direction and the rise times for the capstan motor and the tape motion. The following paragraphs describe the operation of the two generators and the capstan amplifier. Figure 4-10 contains the capstan servo block diagram.

#### 4-16 Forward/Reverse Ramp Generator

The forward/reverse ramp generator has five inputs: two reverse, and three forward. Figure 4-10 shows a simplified schematic of the forward/reverse ramp generator

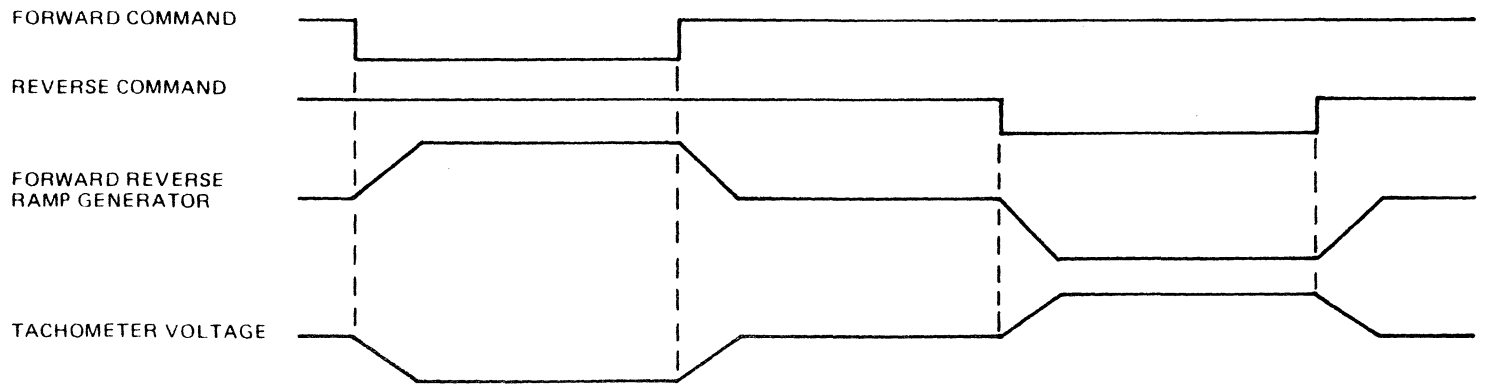
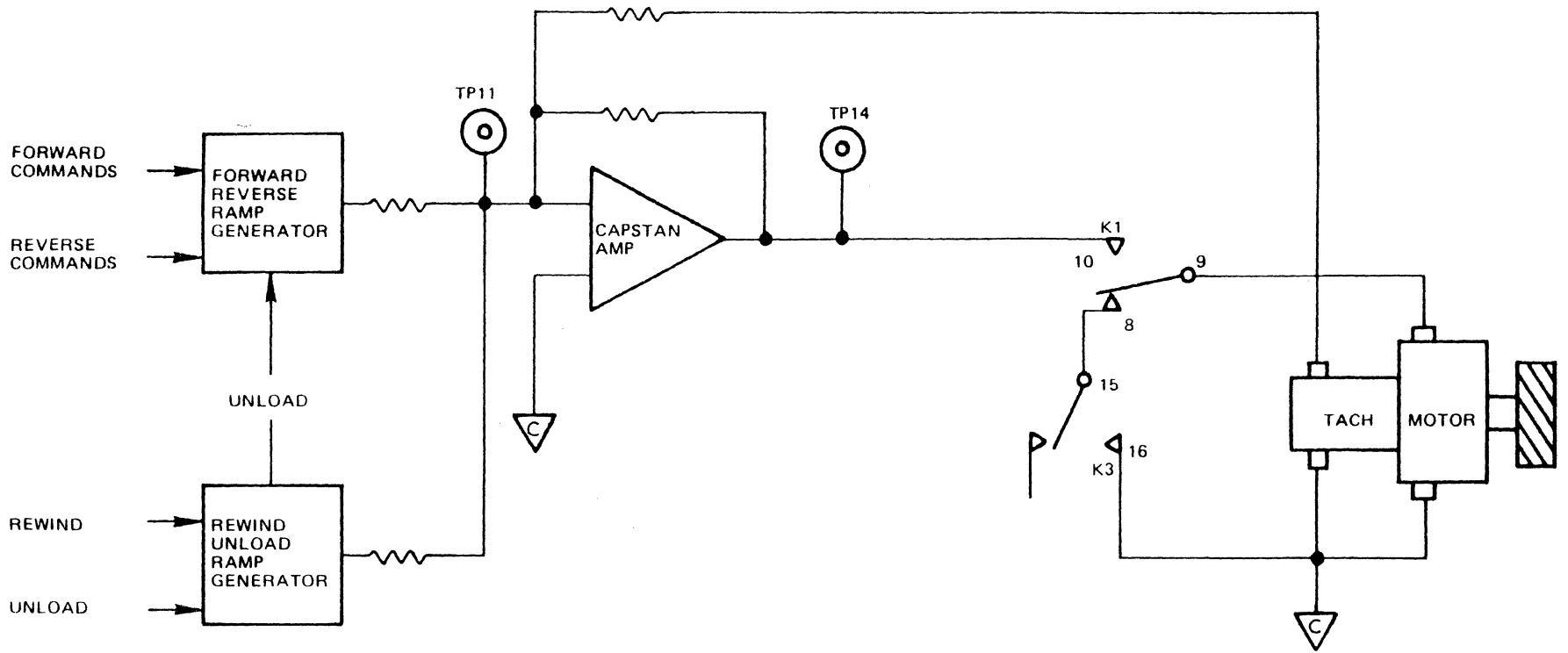


Figure 4-10. Capstan Servo Block Diagram

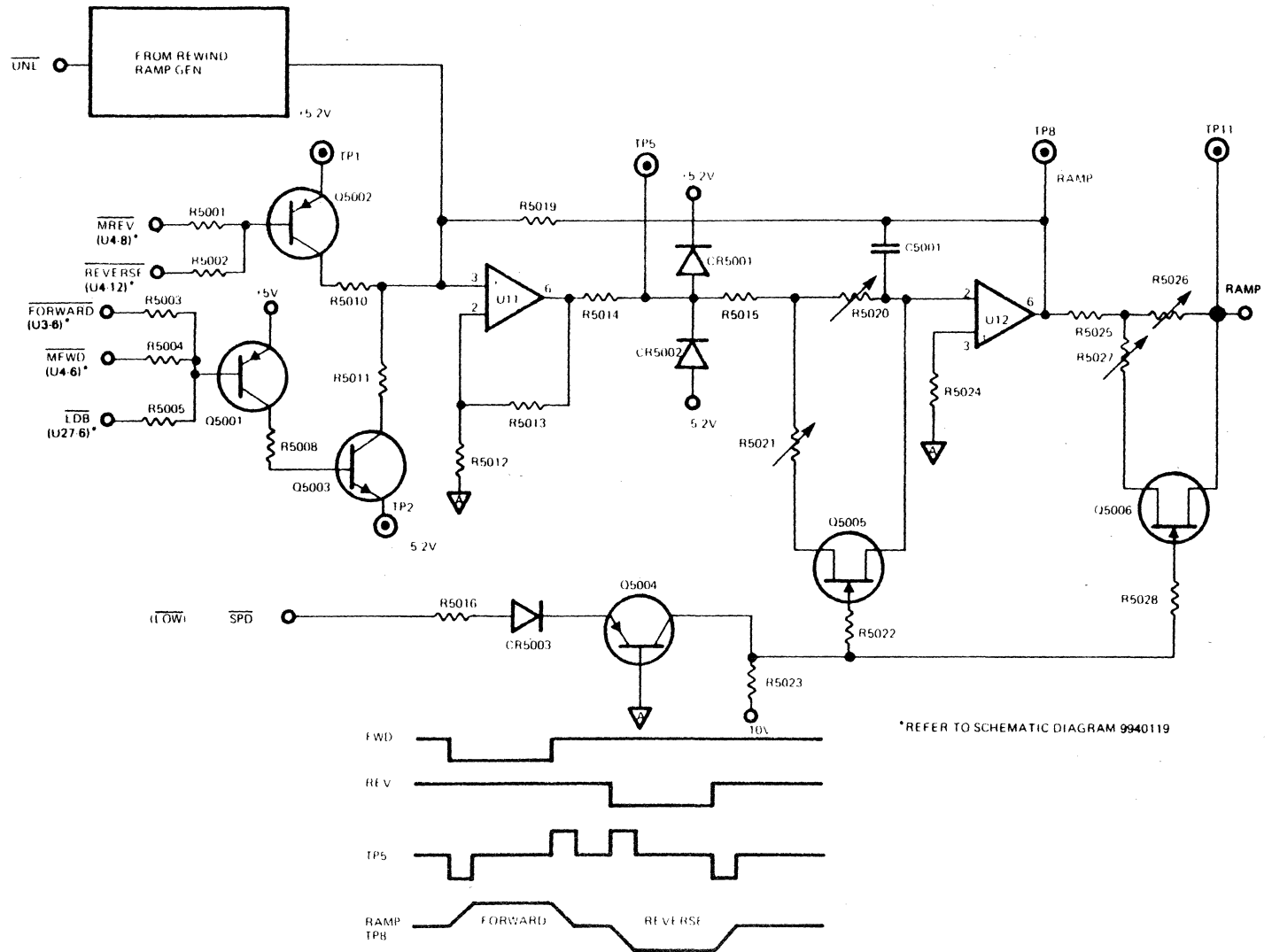


Figure 4-11. Forward/Reverse Ramp Generator Simplified Diagram



circuits These inputs are normally high, and Q5001, Q5002 and Q5003 are turned off. When FORWARD is set low, Q5001, conducts at saturation and its collector voltage goes to +5 volts. This biases Q5003 into saturation and the collector of Q5003 goes to -5 volts. Q5003 is connected to pin 3 of U11 through R5011, causing the output of U11 to switch to -10 volts. The -10 volts at U11-6 is connected through R5014 to the cathode of CR5002. The cathode of CR5002 is pulled toward -10 volts. However, since the anode of CR5002 is at -5 volts, the voltage at the cathode is clamped at -5.6 volts. This -5.6 volts is applied across the series connection of R5015 and potentiometer R5020 to U12-2 and to C5001.

Current flows through R5015 and R5020 and charges C5001 at a constant rate. Since the other plate of C5001 is connected to the output of U12-6, and U12 has a large, open loop gain, the output at U12-6 increases at a rate determined by R5015, R5020 and C5001. Adjusting R5020 consequently changes the rise time at the output of U12. Feedback resistor R5019 is connected between output of U12 and the input to U11, and is equal to the resistance of R5011. Therefore, when the output of U12 reaches +5 volts, it balances the -5 volts generated by Q5003 at the input of U11-3. Because of the high gain at U11, the output of U11 switches to zero volts and U12-6 is stabilized at +5 volts. Any decrease in output of U12 is regulated by an increase in the output voltage of U11 and charges C5001 back to +5 volts.

The output of U12 is connected through the series connection of R5025 and potentiometer R5026 to the capstan amplifier. Potentiometer R5026 sets the forward/reverse capstan speed. When FORWARD goes high, Q5001 and Q5003 are turned off, removing the -5 volts from U11-3. This leaves feedback resistor R5019 with positive voltage at U11-3 and the output of U11 switches to +10 volts. The anode of CR5001 is clamped to +5.6 volts, causing current flow through R5015 and R5020 to discharge C5001, and decrease the output of U12. When U12-6 reaches zero volts, the input voltages of U11 are zero and the output of U11 switches to zero volts. The fall time is determined by the discharge rate of C5001 and is equal to the rise time.

The rise/fall ramps and the output of U12 are accurately controlled by the +5 volt regulators, since the remote voltage sense for these two power supply regulators is supplied by the forward/reverse ramp generator circuits.

When the REVERSE input is set low, Q5002 conducts at saturation, applying +5 volts through R5010 to U11-3. U11-6 switches to +10 volts. Therefore, the operation of the ramp generator is the same as for a forward, except the polarity of the voltages are reversed. The forward/reverse ramp generator also receives an input from the rewind ramp generator during both rewind and unload operations (paragraph 4-9).

The dual-speed option FET's Q5005 and Q5006 are used to parallel R5020 with R5021 and parallel R5026 with R5027. This will switch to the higher of the tape speeds. For low-speed operation, SPD is low, back-biasing CR5003 and turning off Q5004. This causes the collector of Q5004 to be pulled to -10 volts through R5023. R5022 and R5028 are also connected to the collector of Q5004 and apply the -10 volts to the gates of Q5005 and Q5006, turning the FET's off and removing potentiometers R5021 and R5027 from the circuit.

In high-speed operation, SPD is set high, forward-biasing CR5003 and causing Q5004 to conduct. R5002 and R5028 are pulled by Q5004's collector to about 3 volts, turning

on FET's Q5005 and Q5006. FET Q5006 parallels R5021 and R5020, increasing the rise/fall times of the ramp generator. Q5006 parallels R5027 and R5026, decreasing the resistance of the input resistor to the capstan amplifier and increasing the speed.

#### 4-17 Rewind Ramp Generator

The second input to the capstan amplifier comes from the rewind ramp generator. During rewind operations, the rewind ramp generator is used to generate a negative ramp output to the capstan amplifier. This input also contains a switching transistor that causes the forward/reverse ramp generator to generate a negative ramp output during both rewind and unload operations. Figure 4-12 shows a simplified schematic of the rewind ramp generator. Inputs to the ramp generator are the rewind signal RWRD and unload signal UNL. These two signals are normally high. Consequently, during normal operation, Q3002 conducts at saturation and Q3003 and Q3001 are turned off, and the REWD output is low.

During a rewind operation, a low input from RWRD sets the anode of CR3003 low, turning off Q3002 and allowing C3001 and C3002 to charge toward -10 volts through R3006. The potential at U30-10 moves toward -10 volts, causing it to go more negative than U30-11. This causes the output of U30 and REWD to switch high. As C3001 and C3002 continue to charge, the base of Q3003 becomes negative, turning on Q3003. As C3001 and C3002 continue to charge, the potential at the emitter of Q3003 increases at the same rate until Q3003 conducts at saturation, holding the emitter at -5 volts. The input resistors to the capstan amplifier are R3008 and potentiometer R3013 which set the rewind speed.

When UNL or RWRD go low, the base of Q3001 becomes negative, causing Q3001 to conduct at saturation. Q3001 then applies +5 volts through resistor R3010 to U11-3 in the forward/reverse ramp generator. This causes the forward/reverse ramp generator to generate a negative ramp output to the capstan amplifier. When RWRD and UNL both are high, Q3002 turns on, forcing C3001 and C3002 to charge towards +5 volts through R3001. The voltages at the base and emitter of Q3003 move towards +5 volts and when the base reaches ground potential, Q3003 is turned off. U30-10 is then more positive than U30-11 and U30-13 switches to -10 volts. REWD is then clamped low by CR3004.

#### 4-18 Capstan Amplifier

The outputs of the two ramp generators are connected to U20-2. Since pin 2 is the summing junction of the capstan amplifier, the adjustment of the ramp generator output potentiometer sets the capstan amplifier output voltage and, consequently, the tape speed (figure 4-13). Offset potentiometer R4001 is connected to U20-2 through R4002. The output of U20-6 is set to zero by R4001, compensating for component variations. Feedback resistor R4007 sets the gain of U20. U20 drives the bases of Q4001 and Q4002, creating a null region since Q4001 and Q4002 are turned on only when the output of U20-6 has reached  $\pm 0.6$  volt. Since both halves of the power amplifier are identical, only one half is described.

When the output of U20-6 is greater than +0.6 volt, Q4001 is turned on. The base of the 2N6051 power transistor is lowered and the collector increases the voltage at the output (E). Consequently, a positive output at U20-6 causes the output of the capstan servo at pin E to be positive.

The output of the capstan amplifier is connected through relay K1 to the capstan motor. The capstan motor return is connected to ground through R9. Current feedback is accomplished by R4005 which senses the voltage drop across R9. A tachometer is attached to the capstan motor and the output is connected to the capstan amplifier summing junction

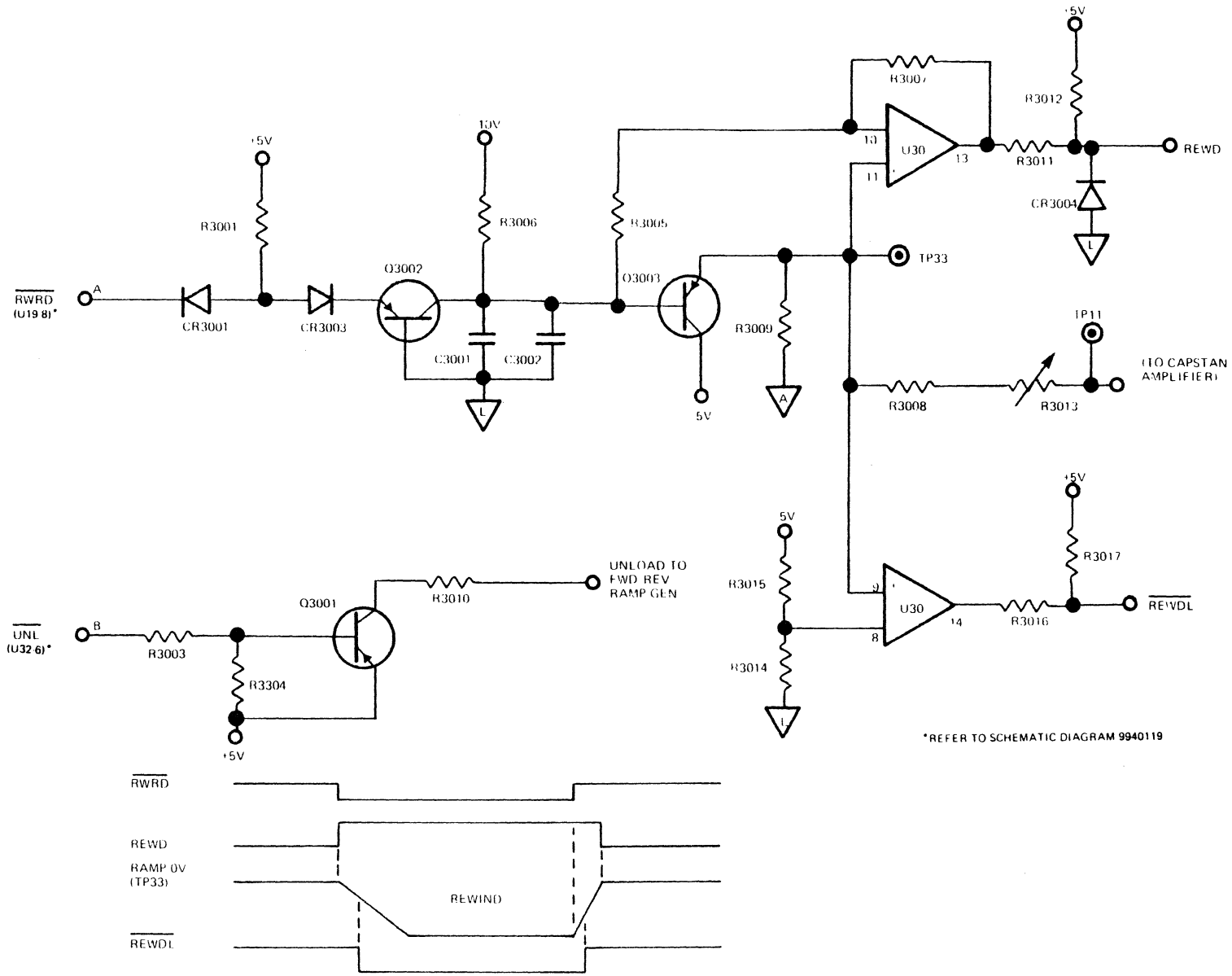


Figure 4-12. Rewind Ramp Generator Circuit Simplified Diagram



through R4003 and R4004. The tachometer allows the capstan servo to accurately regulate the capstan speed.

#### 4-19 On-Line/Off-Line Logic

Figure 4-14 shows a simplified schematic diagram of the on line/off line circuit. After completion of the load sequence, when LON is set, the tape unit is put on line by momentarily engaging the ON LINE switch. As a result, flip-flop U40-8 produces a negative pulse output which toggles the flip-flop at U41-9 through gate U40-6. Flip-flop U41-5 is set because it was reset during the load sequence by the low RSTC signal at U35-10. The ON LINE lamp driver is driven by a low at U41-6 which turns on the ON LINE indicator. When gate U2 is enabled by the SLTB signal, the output of U2-3 is low, asserting the IONL signal. If the ON LINE switch is pressed again, flip-flop U41-5 resets. Flip-flop U41-5 can also be reset by pressing the RESET switch, producing a negative pulse output from U39-3 (RESET). This causes RSTD to go low at U44-6, and RSTC to go low at U44-8 and U35-10. A low input to U35-10 causes U35-8 to go low, resetting U41-5.

The external controller can also set the tape unit off line by asserting the IOFFL signal input through J101-L/J102-L. When IOFFL is asserted, U39-11 goes low, causing U35-8 to go low. The low output of U35-8 is applied to U41-10, resetting flip-flop U41-5.

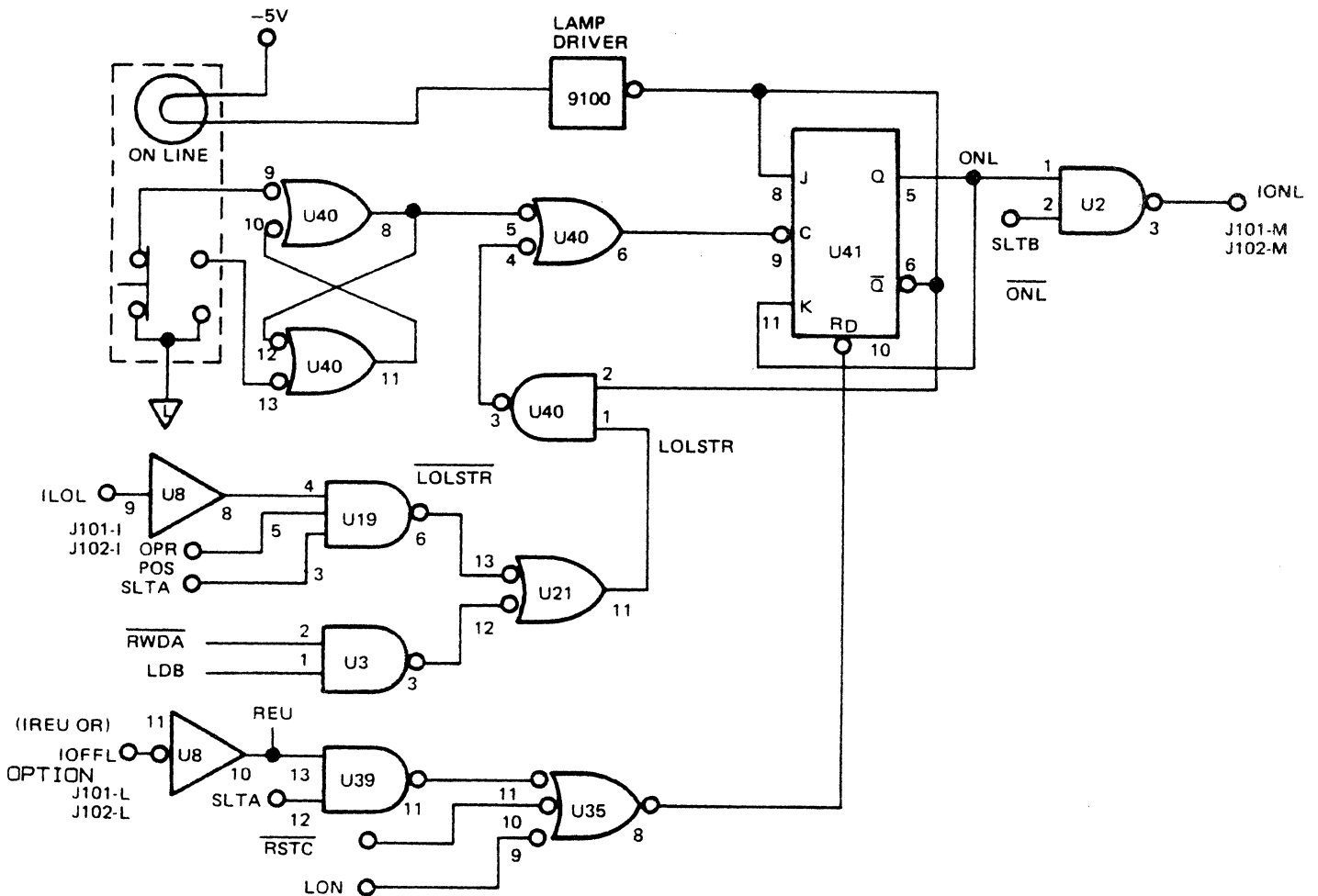


Figure 4-14. On-Line/Off-Line Logic Simplified Diagram

When the tape unit is equipped with the auto load on-line option, the tape unit is automatically placed on line after the tape has been loaded on the tape unit. When the tape has been loaded, the LDB flip-flop U27 is set as previously described in the circuit description for the load logic circuits. The LDB signal is an input to the forward ramp generator and causes the capstan to move the tape toward the BOT marker. The setting of the LDB flip-flop also produces a high input at U3-1. Since a rewind operation is not taking place, the RWDA signal at U3-2 is also high. This causes the LOLSTR signal at U21-11 to go high. The high LOLSTR signal is applied to U40-1. Since flip-flop U41-9 is not set at this time, the ONL signal at U40-2 is also high. This results in a low output at U40-3 which enables flip-flop U41 with a high input at U41-9. The tape is stopped at the BOT marker when LDB is reset (refer to the circuit description for the load logic circuits, paragraph 4-20). LDB low causes the LOLSTR signal to go low, setting flip-flop U41. The low output from U41-6 causes the ON LINE indicator to illuminate. When the STLB signal at U2-2 is high (tape unit address selected or continuous high), the IONL signal to the controller is asserted.

#### 4-20 Address Logic

Figure 4-15 shows a simplified diagram of the address logic. The address logic circuits, after recognizing the tape unit address, enables the tape unit to respond to external commands and to drive the interface lines. If only one tape unit is connected, the external controller must still assert the correct ISELECT input. When the tape unit is addressed, the low input is inverted at U5-13, and a high is applied to U13-5. If P8-6 and 3 are connected, the tape unit must be on line with ONL high at U13-4 before U13 can respond to the input. When U13-6 output SLTA goes low, the SELECT output to the data

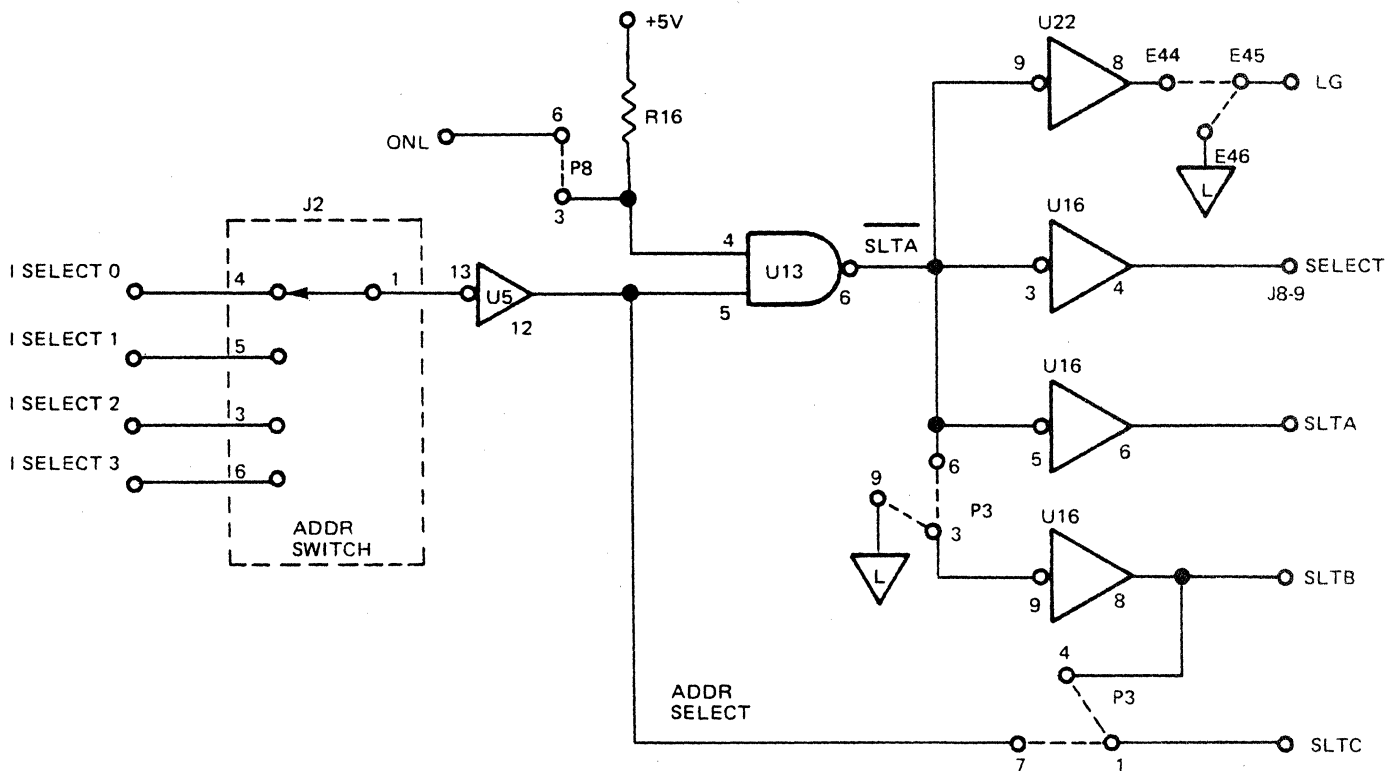


Figure 4-15. Address Logic Simplified Diagram

electronics at U16-4 goes high, as does the SLTA output to the control electronics at U16-6. SLTA also drives the RESET light, indicating the tape unit is selected. The SLTB output at U16-8 is either continuously high, pins P3-3 and 9 connected, or it is gated high in the same manner as the SLTA output. If pins P3-7 and 1 are connected, the SLTC output from U5-12 is high when the unit is addressed. If pins P3-4 and 1 are connected, the SLTC signal duplicates the SLTB signal at U16-8.

#### 4-21 Forward/Reverse Control Logic

Figure 4-16 shows a simplified schematic diagram of the forward/reverse control circuits. When the tape unit is on line, selected, not rewinding or loading, and all interlock conditions are set, it is able to respond to external command inputs. At this time the output of U2-6, IRDY is low and ORS is high. When ISFC is asserted by the external controller, gate U3-6 produces a low output that goes to the forward/reverse ramp generator which produces a positive-going ramp output to the capstan amplifier. This ramp output eventually stabilizes at some dc voltage suitable for the tape speed requirements of the specific tape unit.

Tape movement in the reverse direction, at synchronous speed, is initiated when the external controller asserts the ISRC signal. In this instance, the forward/reverse ramp generator responds by producing a negative-going ramp output, driving the capstan motor in the reverse direction.

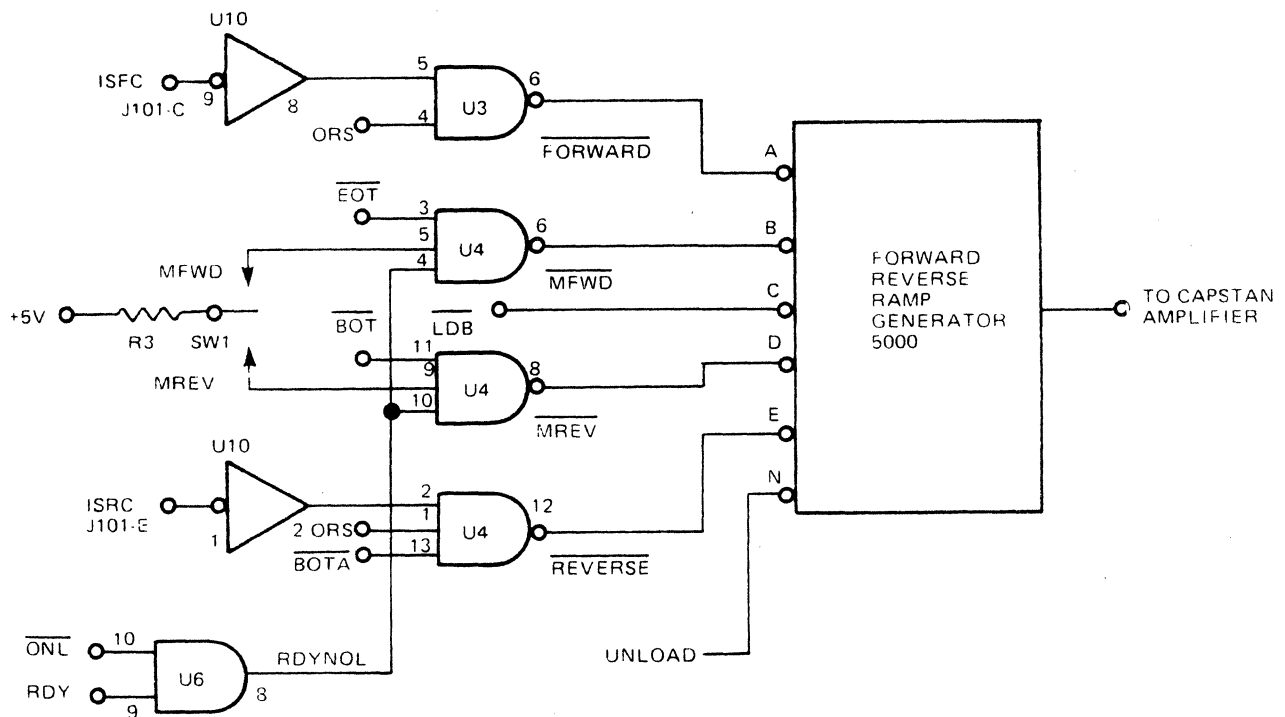


Figure 4-16. Forward/Reverse Control Logic Simplified Diagram

When the tape unit is not on line, and RDY is high, RDYNOL at U6-8 is high, enabling gates U4-6 and 8. This enables manual forward/reverse control using switch SW1. The manual forward command is gated with EOT which prevents the tape from being run off the end of the reel. BOT is gated with the manual reverse to prevent the tape from running off the beginning of the reel.

#### 4-22 Write/Overwrite Control Logic

Figure 4-17 shows a simplified schematic diagram of the write/overwrite control circuit, and figure 4-18 shows the write/overwrite timing diagram. To record data, the ISFC and ISWRT signals must be asserted. When the ISFC signal is asserted, the FORWARD input to U3-9 is low and the output of U3-8 is high, producing a high MOTION signal input to U3-12 and a low MOTION output, via J8-10, to the data electronics. The MOTION signal is delayed by the R5 and C1 time constant at U3-13 and differentiated by C2, R66, R67 generating a pulse at TP6 that is used as the clock input to flip-flops at U9-12, U9-9 and U14-1. With the ISWRT input asserted, the SWRT output of U9-3 is clocked high. With the IOVW not asserted, a high is applied to U9-11 which results in the U9-6 output being clocked high. The two high levels are applied to gate U14-4 and 5, forcing the output of U14-6 low. This low is coupled through U14/U22, producing a low WRITE ENABLE output at J8-6 to the data electronics.

To perform an overwrite operation, the ISFC, ISWRT, and IOVW inputs must all be asserted (figure 4-17). When these signals are asserted, flip-flops U9-3, U9-5, and U14-3 are set. Gate U14-6 is inhibited by the Q output of U9-6. However, all inputs to gate U15 are high and a WRITE ENABLE output to the data electronics is produced. Near the end of a record in which the overwrite sequence is occurring, the LRC input at U14-13 is set low, resetting the U14-3 output low. Consequently, WRITE ENABLE is set high, ending the overwrite operation.

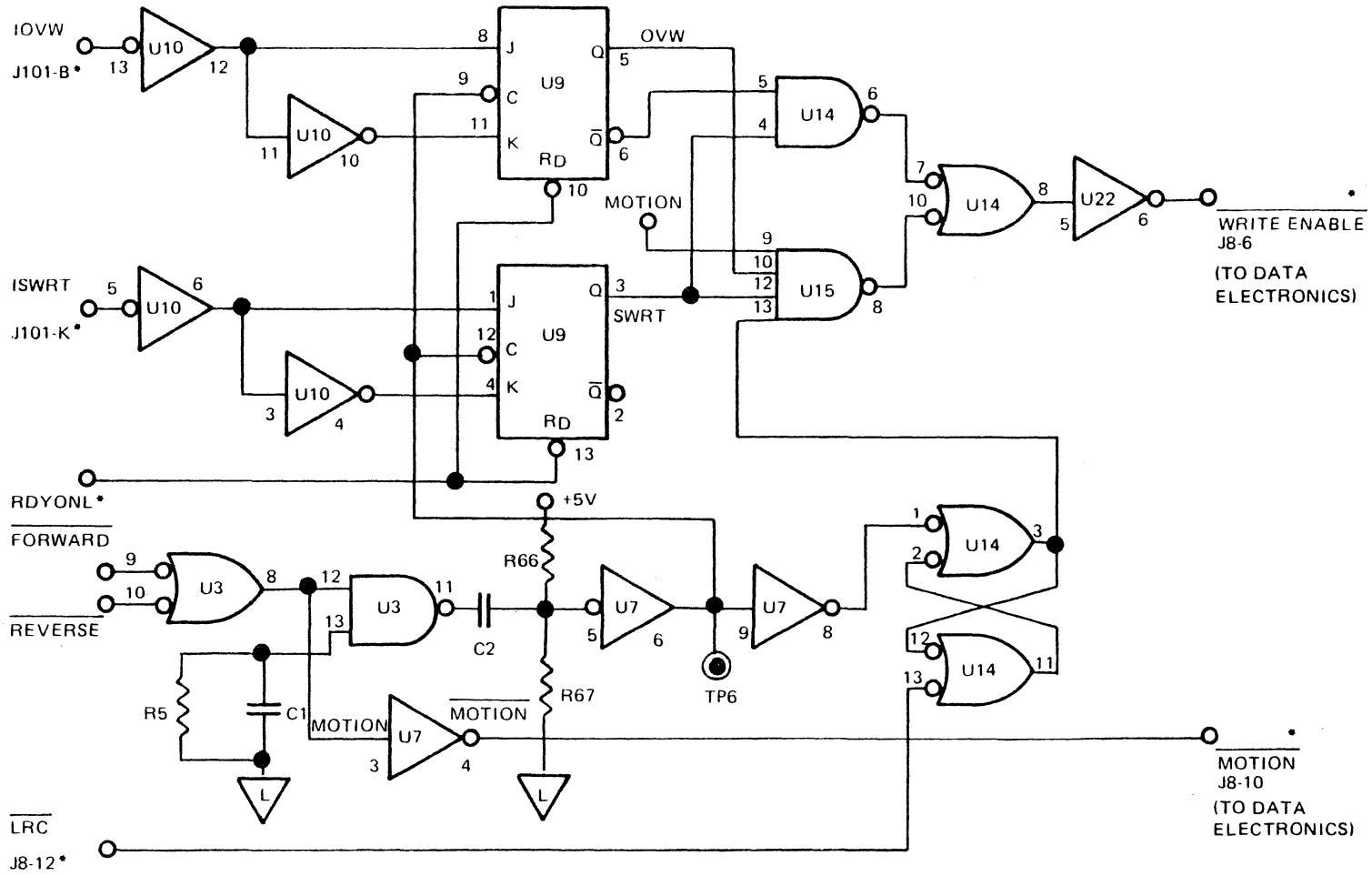
#### 4-23 Rewind/Unload Control Logic

Figure 4-19 shows a simplified diagram of the unload control circuits. A tape rewind operation is initiated when either the external controller asserts the IREW signal or when the REWIND switch/indicator is pressed. If the tape is positioned with the BOT marker at the BOT/EOT sensor and the REWIND switch is momentarily engaged, the tape unit will perform a tape unload sequence. Refer to figure 4-20 for the timing diagram.

To unload, the REWIND switch is pressed and then released, and U26-3 produces a positive pulse output. When the tape BOT marker is at the BOT/EOT sensor and the RWDA and ONL are high, U29-12 produces a negative pulse output, setting the UNL output U32-6 low. U32-3 (RWDA) is not set because the RSTA signal is low when the tape BOT marker is at the BOT/EOT sensor.

When the UNL signal at U32-6 goes low, RSTC and RSTA are kept low and the UNL input of U2-10 also goes low. This deenergizes relay K3, turning off the vacuum motor. At the same time, the UNL input at U35-5 goes low. This keeps interlock relay K1 energized after the interlock switches have opened. The UNL signal at pin B of the rewind ramp generator also goes low and turns on transistor Q3001. The collector of this transistor is connected to the forward/reverse ramp generator. When Q3001 conducts, the forward/reverse ramp generator generates a negative ramp output and the capstan motor is driven in the reverse direction.





\*REFER TO SCHEMATIC DIAGRAM 9940119.

Figure 4-17. Write/Overwrite Control Circuits Simplified Diagram

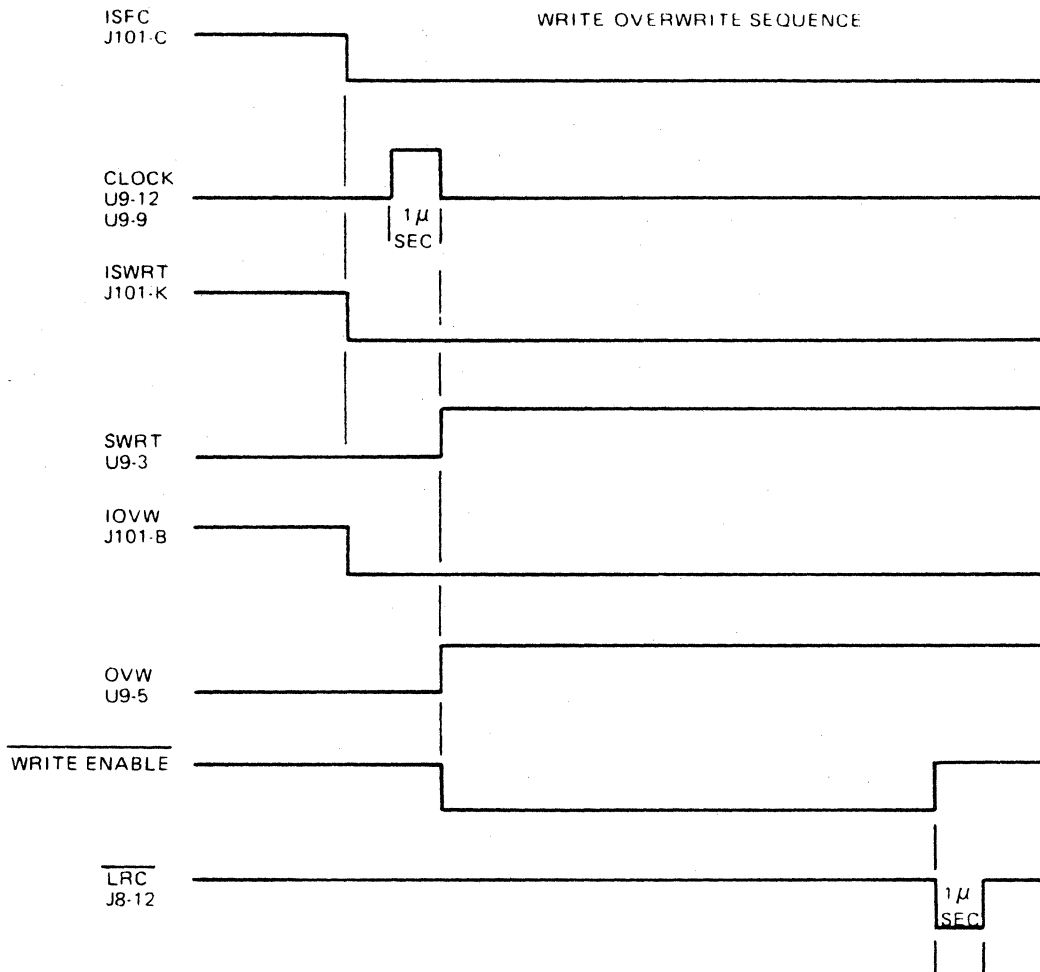


Figure 4-18. Write/Overwrite Timing Diagram

Tape on the take-up reel is pulled off by the capstan, and the interlock switches open. This causes the  $\overline{\text{INTL}}$  signal at U31-12 to go high. With high inputs at pins 12 and 13 of U31, the VACUNL signal at pin 11 goes high. This turns off transistor Q6, thereby turning off FETs Q6004 and Q7004 in the supply reel and take-up reel servos, respectively. The high VACUNL signal applied to the supply reel and take-up reel servos from CR13 ensures that Q6004 and Q7004 remain in the turned-off condition.

The supply reel motors keep turning until the tape has been pulled out of the EOT/BOT assembly. When this occurs, the TPC signal at U2-13 goes low and the output at U2-11 goes high. This allows capacitor C48 to charge through resistor R74. When the voltage at U1-4 reaches the voltage at U1-5, the output of U1 switches to -10 volts and  $\overline{\text{LDFLT}}$  is clamped low at -0.6 volt by CR9. When  $\overline{\text{LDFLT}}$  goes low, it causes the  $\overline{\text{RST}}$  signal at U35-12 to go low. This resets flip-flop U32, causing the UNL signal to go low.

Figures 4-21 and 4-22 contain the simplified schematic and timing diagram for the rewind control circuits. When the tape is not positioned at the BOT marker and the external controller asserts the IRWE signal or the REWIND switch is pressed, the tape rewinds at 250 ips. When the IREW signal is asserted, the output of U33-6 goes low, setting U32-3. The low RWDA signal at U32-2 causes the REWIND indicator to illuminate and also causes the

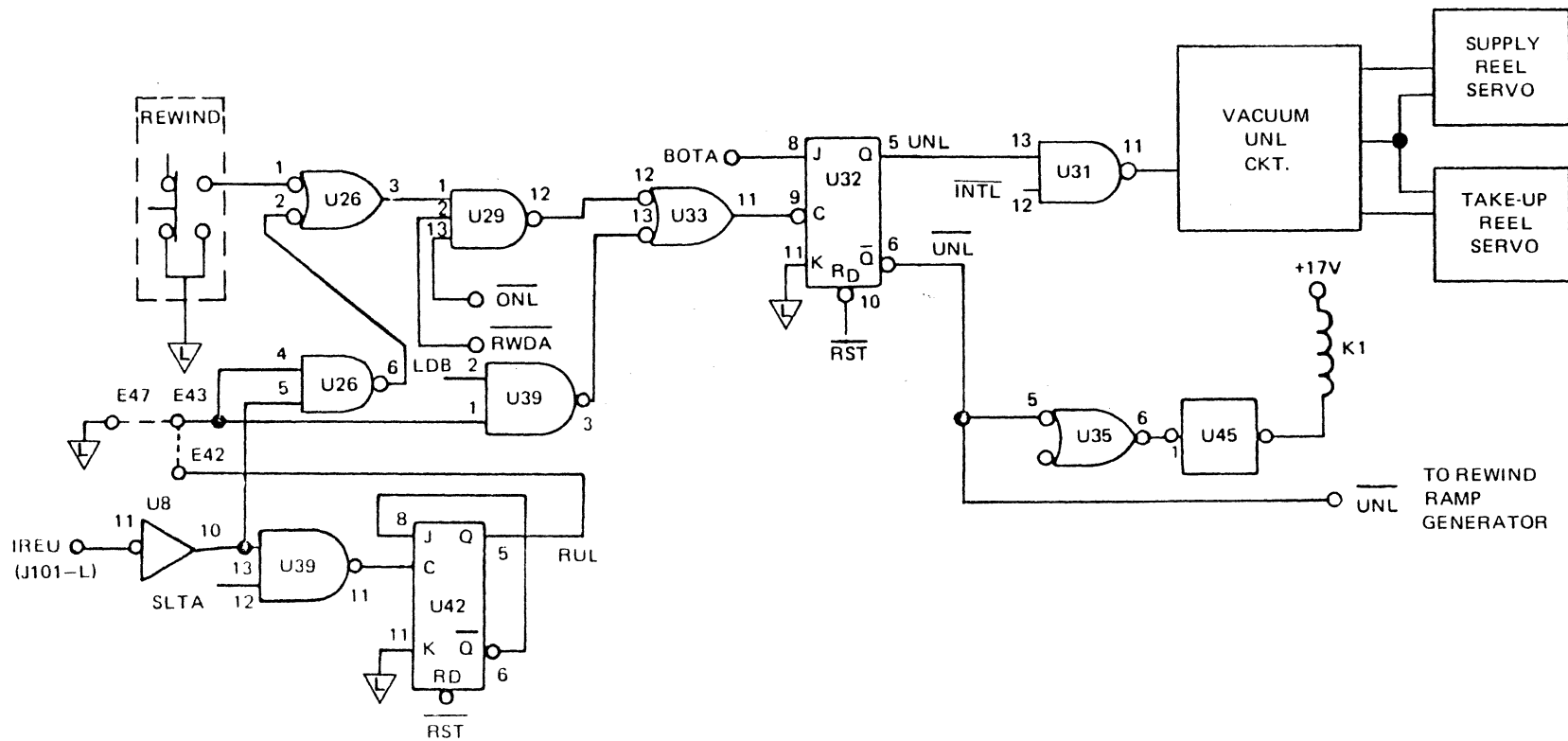


Figure 4-19. Unload Control Circuit Simplified Diagram

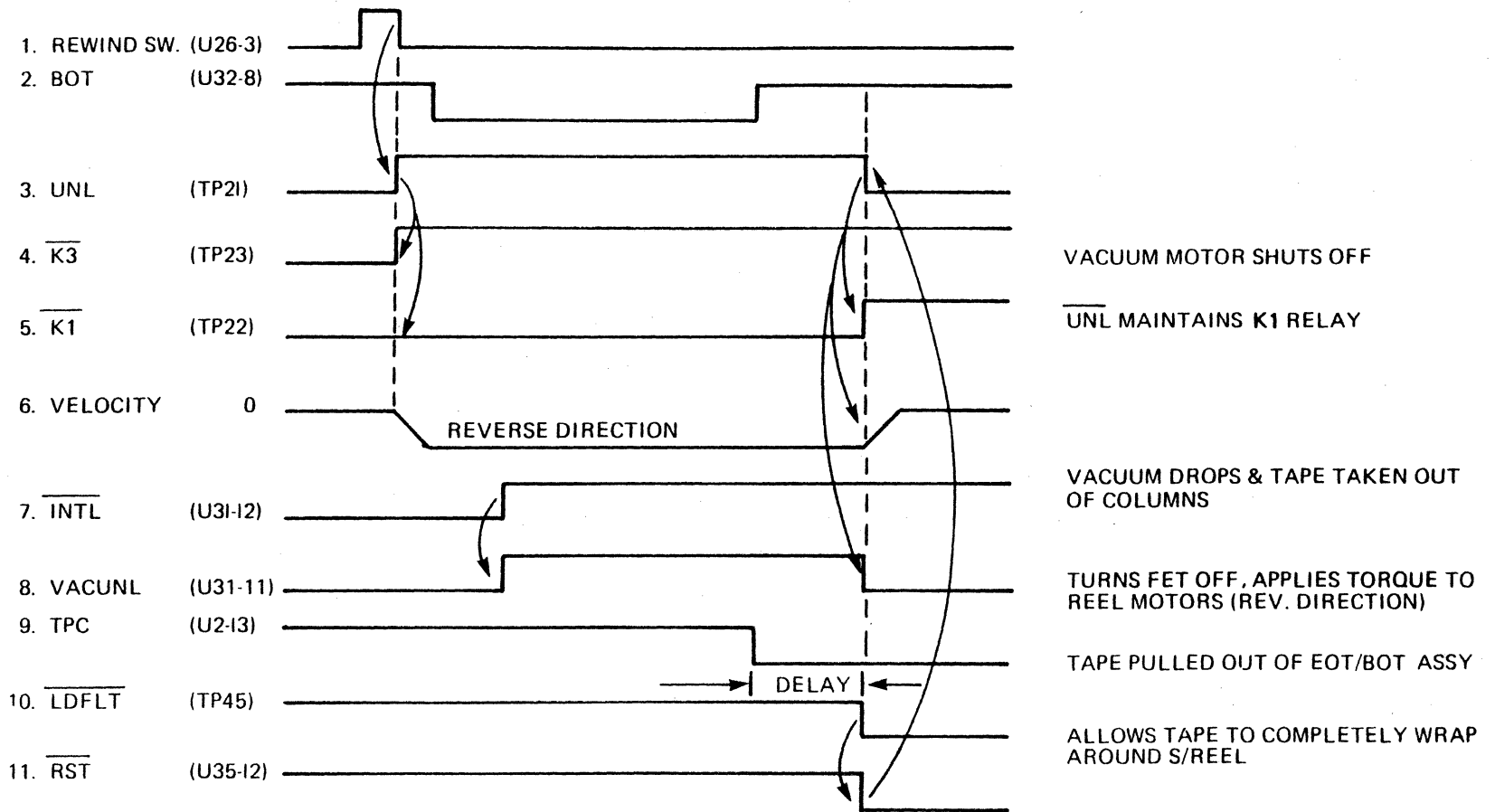


Figure 4-20. Tape Unload Sequence Timing Diagram

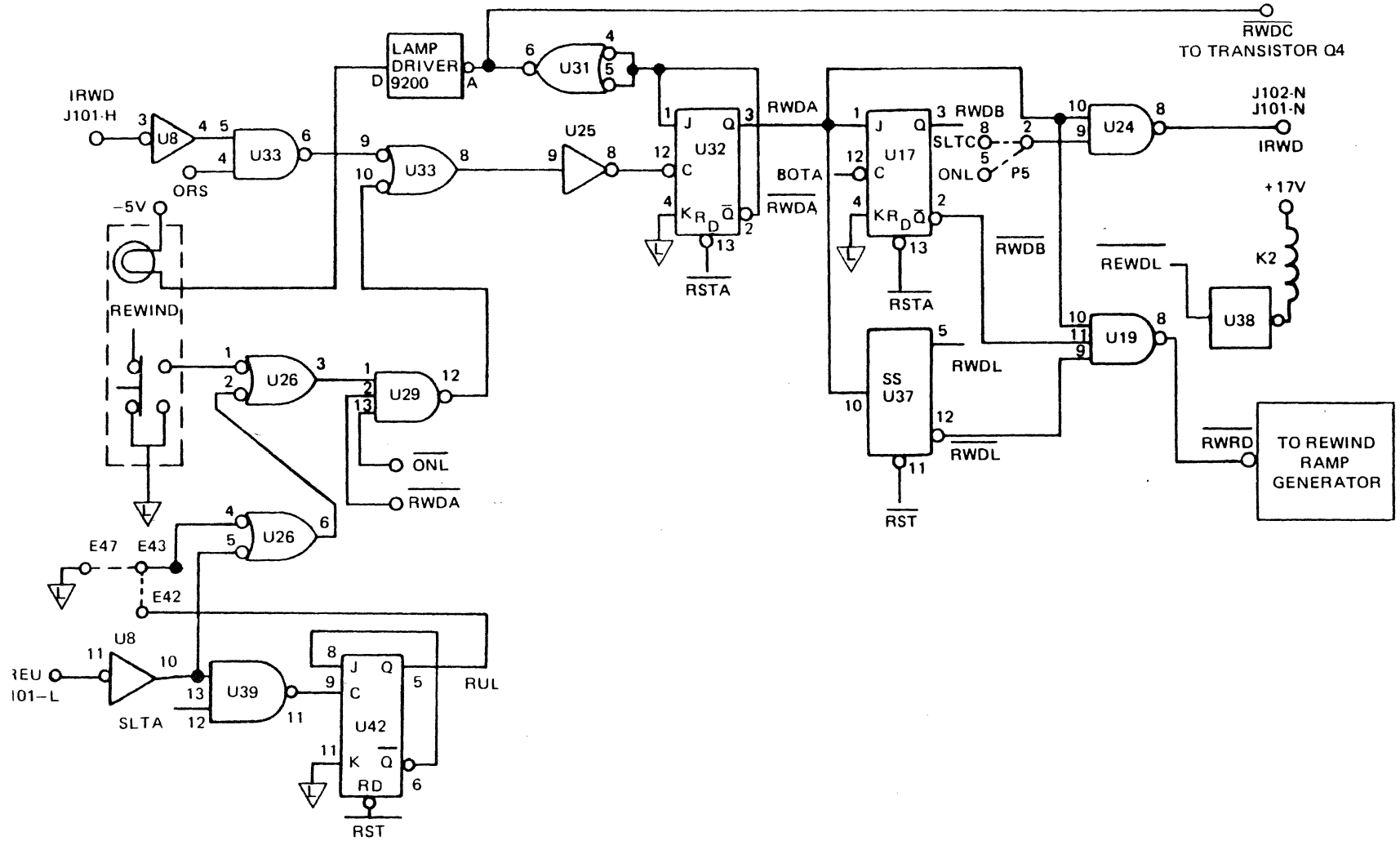


Figure 4-21. Rewind Control Circuits Simplified Diagram

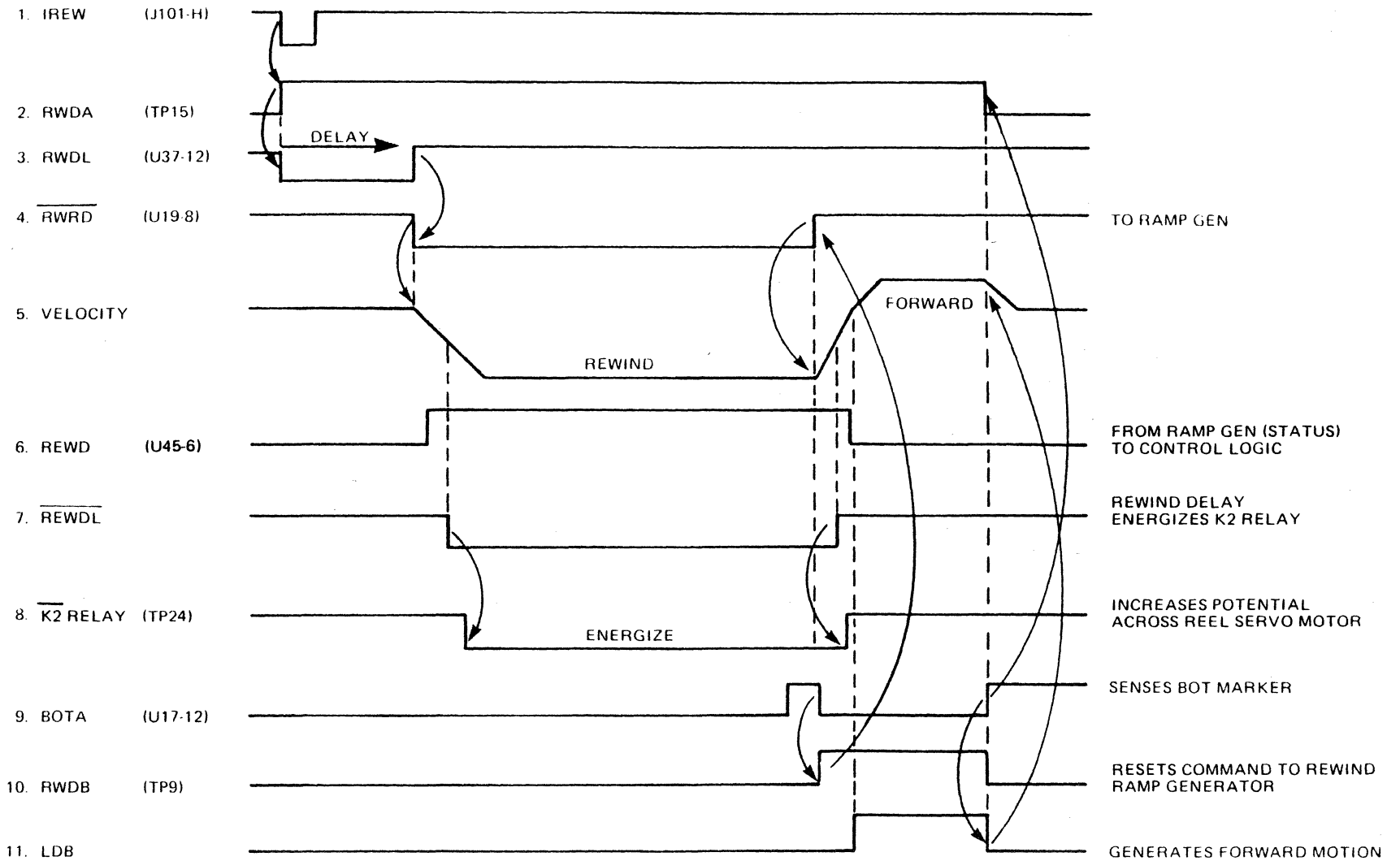


Figure 4-22. Tape Rewind Sequence Timing Diagram

RWDC signal at U31-6 to go low. The low RWDC signal is applied to transistor Q4 through R55. This causes Q4 to saturate and turn on high gain FETs Q6001 and Q7001 in the supply reel and take-up reel servos, respectively. The RWDA output, now high, asserts the IRWD status signal to the external controller at J101-N/J102-N.

The RWDA signal is also applied to gate U19-10 and single-shot U37-10. The high RWDA signal triggers U37. When single-shot U37-12 has timed out, all inputs to gate U19 are set high. The output of U19-8 goes low and energizes relay driver U38. When relay K2 is energized, +32 volts is applied to the reel servos instead of the +17 volts. Relay K2 also changes the motor return voltage. The higher voltage enables the reel servos to be driven at the increased tape speed. Gate U19-8 also applies a rewind command, a low RWRD signal, to the base of transistor Q3001 in the rewind ramp generator. This turns Q3001 on and causes the forward/reverse ramp generator to generate a negative ramp output in conjunction with rewind ramp generator. This negative ramp is applied to the capstan amplifier and causes the capstan amplifier to drive the capstan motor in the reverse direction at the increased speed of 250 ips. The low RWRD signal to the rewind ramp generator also causes the REWD signal from the rewind ramp generator to go high.

When the tape passes the BOT marker, RWDB at U17-3 is set high by the BOTA pulse from U25-6 which sets flip-flop U17. This causes the RWRD signal at U19-8 to go high. When the RWRD signal goes high, transistor Q3001 is turned off, the REWD signal goes low, and the rewind relay K2 is deenergized. Both the forward/reverse ramp generator and the rewind ramp generator ramp down until the capstan has stopped. Since the RWDB signal is high, LDB at U27-5 is set high when the REWD signal goes low at U21-1, 2 and causes flip-flop U27 to set through NOR gate pin U28-8. The low LDB signal at U27-6 is applied to the forward/reverse ramp generator and causes the capstan to be moved forward until the BOT marker is detected. When the BOT marker is detected, RSTB goes low, causing RSTA to go low. This resets LDB, RWDA, and RWDB. The tape is positioned at the BOT marker. If the REWIND switch is momentarily pressed again, the tape unloading sequence previously described will be performed by the tape unit.

#### 4-24 EOT/BOT Control Logic

Figure 4-23 shows a simplified schematic diagram of the EOT and BOT control logic. These circuits are used to provide an indication when the tape has passed or is positioned at the EOT or BOT marker. The outputs of the EOT/BOT circuits are passed through appropriate interface circuits to the external controller.

The output of both the EOT and BOT amplifiers is normally low, and goes high when active. Since both amplifier circuits are identical, only the EOT amplifier is described. The output of the EOT amplifier goes high when the EOT marker is in front of the EOT phototransistor.

Initially, the current through R2104 is set with blank tape in front of the EOT phototransistor so that the voltage at U30-5 is negative. When U30-5 is more negative than U30-4, the output of U30-2 is negative and pin (B) of functional module 2100 is clamped to -0.6 volt by CR2101. The phototransistor receives an increase of light from the EOT reflective marker, creating an increase of current through R2101 and R2103. The increase in current caused by the EOT marker creates an increase in voltage drop across R2104 so that U30-5 goes positive. The output is switched to high, setting EOTA.

EOTA is applied to NAND gates U23-4 and U24-5. When the tape has been removed from in front of the EOT/BOT assembly, the reflector post in front of the assembly

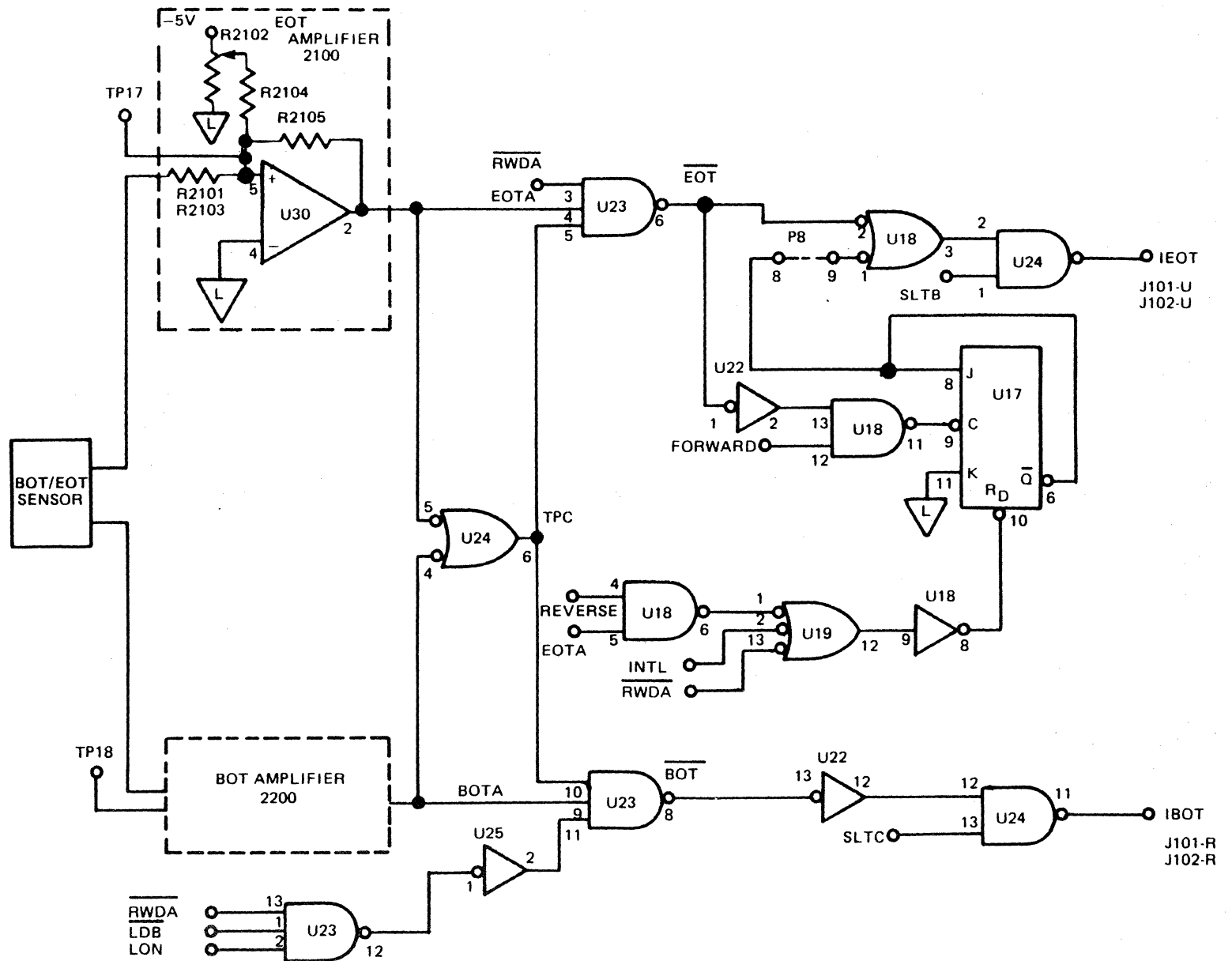


Figure 4-23. EOT/BOT Control Logic Simplified Diagram



reflects the light, setting both BOT and EOT amplifiers high. Two highs at U24-4 and 5 set TPC at U24-6 low, gating EOT high at U23-6. If the tape unit is rewinding, RWDA at U23-3 is also low, preventing EOT from asserting IEOT through U18-3. EOT through U18-11 sets U17-5 when FORWARD is asserted at U18-12. If the jumper between pin P8-9 and 8 is connected, the output of U17-6 is connected to U18-1, asserting IEOT at J101-U/J102-U whenever the EOT marker has been passed in the forward direction. U17-5 is reset when the marker has been passed in the reverse direction, a rewind operation is initiated, or the interlock is broken.

BOTA is gated with TPC, RWDA, LDB and LON from U23-12 at U23-11. IBOT at J101-R/J102-R is not asserted if the tape unit is loading, rewinding or the tape is not on the tape path.

#### 4-25 Density Select Logic

Figure 4-24 shows a simplified diagram of the density select circuits. When the density select option is selected, pin P8-1 and 4, and pins P8-2 and 5 are connected. Therefore, when either input at U13-12 or 13 goes low, the output of U13-11 goes high. As a result, the HI DEN lamp is illuminated and the HI DEN output to the data electronics at J8-3 is set low. In addition, the SLTB signal gates the output of U13-8 through line driver U21-6, setting the IDDI output at J101-F/J102-F low. The IDDI output indicates high density operation to the external controller. In the dual-speed option when high density is asserted HID at U13-11 causes SPD to go low at U13-3 and the tape unit operates at the lower speed.

When the quad density option is used and PE operation is selected, the tape unit operates at the lower of the two tape speeds. The  $\overline{\text{SPD}}$  signal for this mode goes low when the IDDI signal from the controller goes low. In the 7- and 9-track NRZI modes of operation, the tape unit operates at the higher speed. The SPD signal for these modes is held high, regardless of density selection. High or low density can be selected only for 7-track NRZI operation with the quad density option. The 9-track switch option is used with the quad density option, and when in the 7-track position, causes the IDDI signal to go low when high density is selected. This also causes the 9-track signal to the data electronics to go low, indicating 7-track operation. For both the 9-track NRZI and PE modes of operation, only high density is used. Therefore, the IDDI signal to the controller goes low (indicating high density) for all modes of quad density operation, except 7-track NRZI low density operation.

The dual-speed option is not used for single density operation. The single density for 7-track NRZI operation can be high or low.

#### 4-26 9-Track Circuit

Figure 4-25 shows a simplified diagram of the 9-track circuit. The 9-TRACK switch is used with the quad density option and combination 7- and 9-track, single speed, NRZI tape units. When the 9-TRACK switch is used with the quad density option, pins P1-5 and P1-2, E33, and E34, and P1-1 and P1-4 are connected. When the 9-TRACK switch is pressed, U34-3 goes low at pin A of lamp driver 9500 and at inverter U16-1. This causes the 9-TRACK switch lamp to illuminate and the 9-TRACK signal at J8-2 to go high. The high 9-TRACK signal is applied to the data electronics, indicating

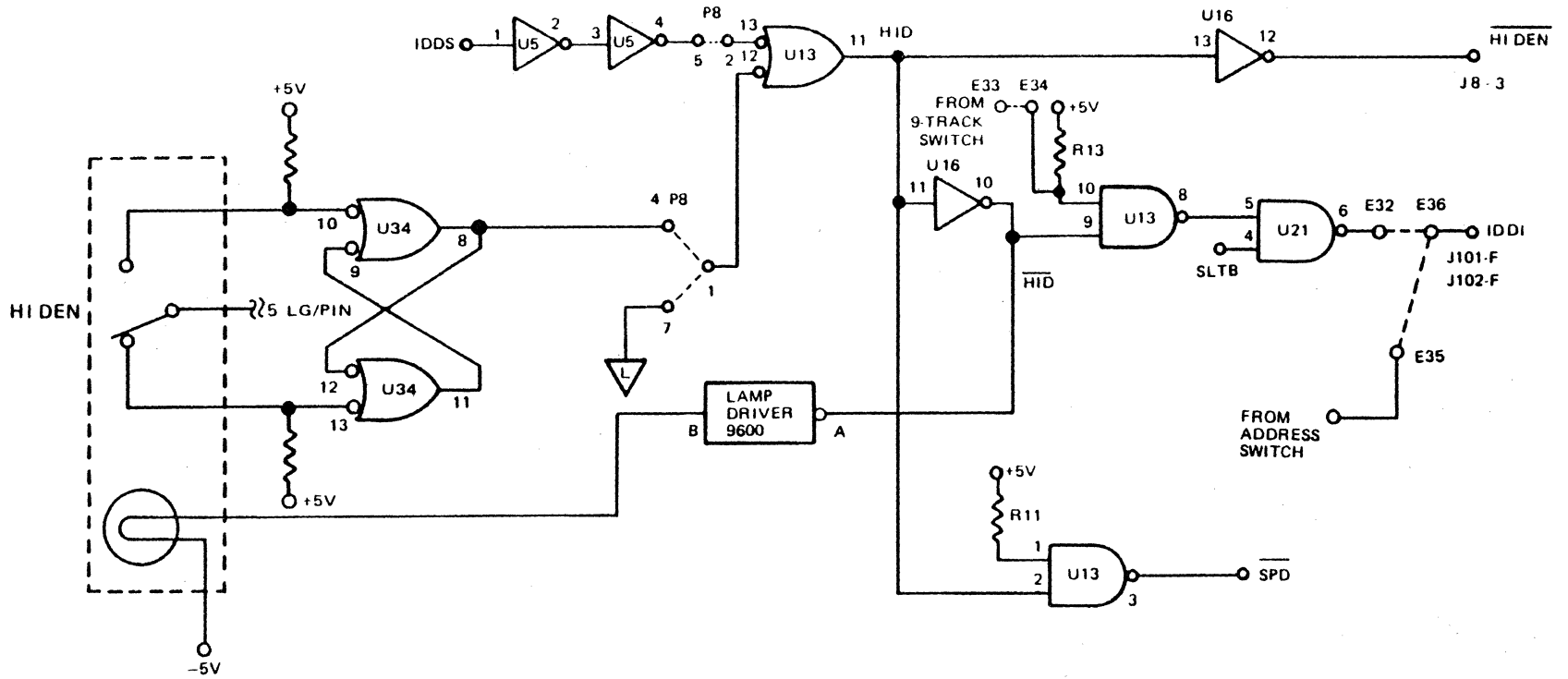


Figure 4-24. Density Select Circuits Simplified Diagram

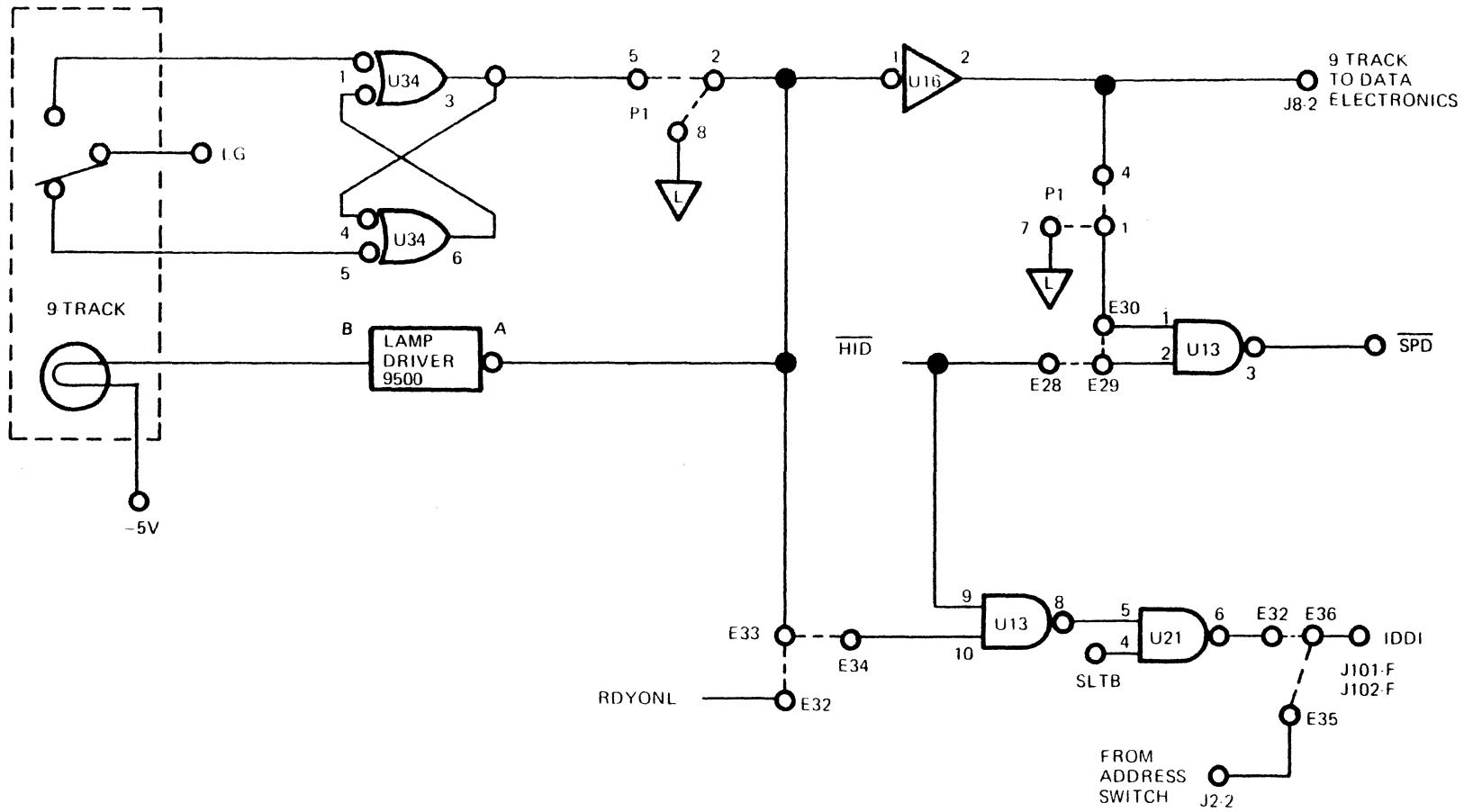


Figure 4-25. 9-Track Circuit Simplified Diagram

9-track operation. With the 9-TRACK switch in the 9-track position, a low is also applied to U13-10 in the density select circuit. This holds the IDDI signal to the controller low in 9-track operation (indicating high density). The SPD signal at U13-3 goes low when the IDDI signal goes low for phase encoded operation. This causes the tape unit to operate at the lower speed.

When 7-track operation is used in the quad density option, the 9-TRACK switch is released to place the switch in the 7-track position. This applies a high input to 9500-A, U16-1 and NAND gate pin U13-10 in the high density circuit. This causes the 9-TRACK switch lamp to extinguish and the 9-TRACK signal at J8-2 to go low, indicating 7-track operation. The high input to U13-10 enables the IDDI signal for high or low density selection. This allows the IDDI signal to the controller to indicate both high and low density only in the 7-track NRZI mode of operation. In the 7-track position of the 9-TRACK switch, a low is applied to U13-1. This holds the SPD signal high during 7-track operation and causes the tape unit to operate at the higher speed.

The 9-track switch option is also used for combination 7- and 9-track, single speed, 800 bpi NRZI tape units. On these units, the input to U13-1 is held low. This causes the SPD signal to be held high. The RYDYONL signal is used on read only tape units. This signal is jumpered through pins E32 and E33 to the 9-TRACK switch. When the front panel disable option is used, LG goes high when the tape unit is on line and selected. When LG is high, flip-flop U34-3 cannot change status.

#### 4-27 File Protect Circuit

The file protect circuit, see figure 4-26, can be connected as either a file protect circuit or a write enable circuit. When connected as a file protect circuit, the FILE PROTECT lamp is illuminated when a file reel without a write ring is mounted on the tape unit. This indicates that writing or erasing on the tape is not possible. When connected as a write enable circuit, the WRITE ENABLE lamp is illuminated when a file reel with a write ring is mounted on the tape unit. This indicates that writing or erasing on the tape can be performed.

When a write ring is installed in the file reel, the high INTLA signal is applied to inverter U5-11 and to the data electronics as the WRITE POWER signal at J8-1. The low output from U5-10 is applied to U5-9 and U21-10. The low input at U21-10 causes the IFPT signal to the controller at J101-P/J102-P to go high. This indicates that the tape is not file protected (a write ring is installed in the file reel). The low input to U5-9 is inverted and turns on relay driver Q1/Q2. This energizes the write lockout solenoid which secures the write lockout assembly. If the circuit is connected as a file protect circuit, the jumper between P1-3 and P1-9 is connected and the jumper between P1-3 and P1-6 is not connected. Since the input to lamp driver 9400 is then high, the FILE PROTECT lamp remains extinguished. This indicates that writing or erasing on the tape can be performed. If a write ring is not installed in the file reel, the input to lamp driver 9400 will be low, causing the FILE PROTECT lamp to illuminate. This indicates that writing or erasing on the tape is not possible.

When the circuit is connected as a write enable circuit, the jumper between P1-3 and P1-6 is connected; the jumper between P1-3 and P1-9 is not connected. Since the input to lamp driver 9400 is then low, the WRITE ENABLE lamp illuminates. This indicates that writing or erasing on the tape can be performed. If a write ring is not

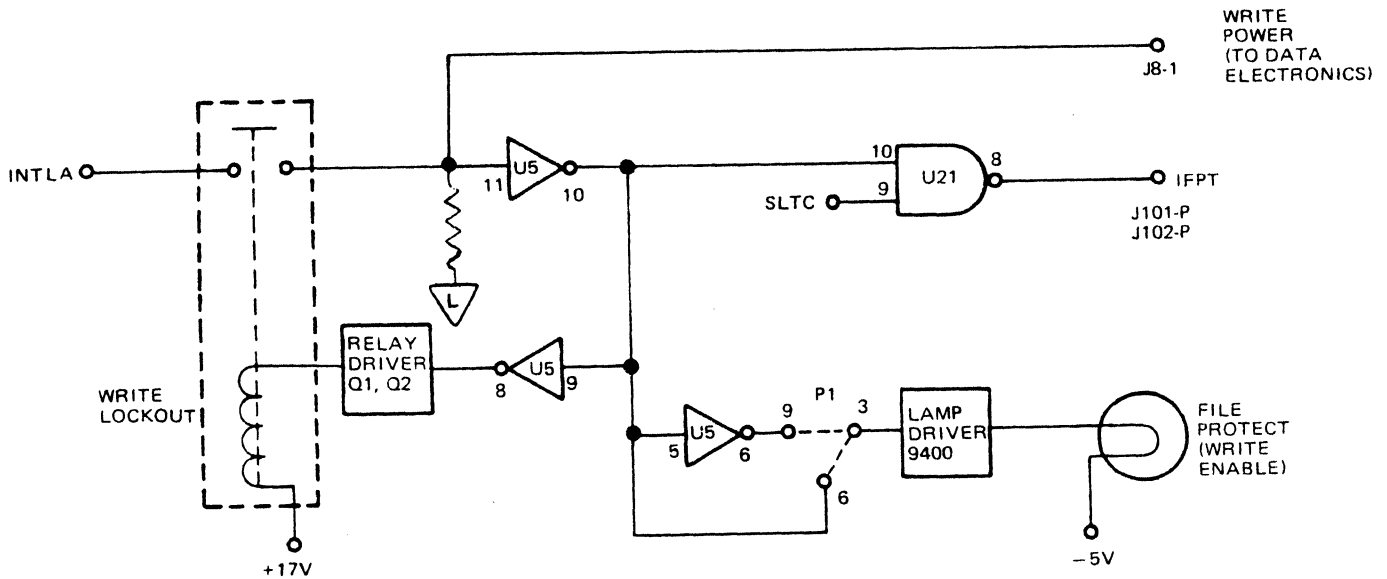


Figure 4-26. File Protect Circuit Simplified Diagram

installed in the file reel, the input to lamp driver 9400 will be high, causing the WRITE ENABLE lamp to remain extinguished. This indicates that writing or erasing on the tape is not possible.

#### 4-28 DATA BOARD ELECTRONICS

The following paragraphs describe the operation of the NRZI and PE data boards. The data boards perform the functions of reading and writing data on magnetic tape. Complete schematic diagrams for the NRZI and PE Data Board circuits are contained in Chapter 6.

#### 4-29 NRZI Data Board Operation

The NRZI data board contains nine circuits, one for each of the data tracks. For a seven-track head, tracks 0 and 1 are not used. The circuits are divided into two parts, the write and the read circuits. Both the write and the read operation are described in the following paragraphs. Since the circuits for the different tracks are identical, only one will be described.

#### 4-30 NRZI Write Circuits

The WRT DATA PARITY input (IWDP) is inverted at U29-4 and is gated with DATA READY (I DATA READY) setting U32-10 low if a logic one is present on the interface. Refer to figures 4-27 and 4-28. The low transition through C101 turns off Q101 setting U29-10 low and keeping U32-10 low through jumper 101 to 102. Capacitor C101 is charged through R103 and potentiometer R102 until Q101 is again conducting at saturation, setting flip-flop U33-3 through jumper 103 to 104. For a single gap head,

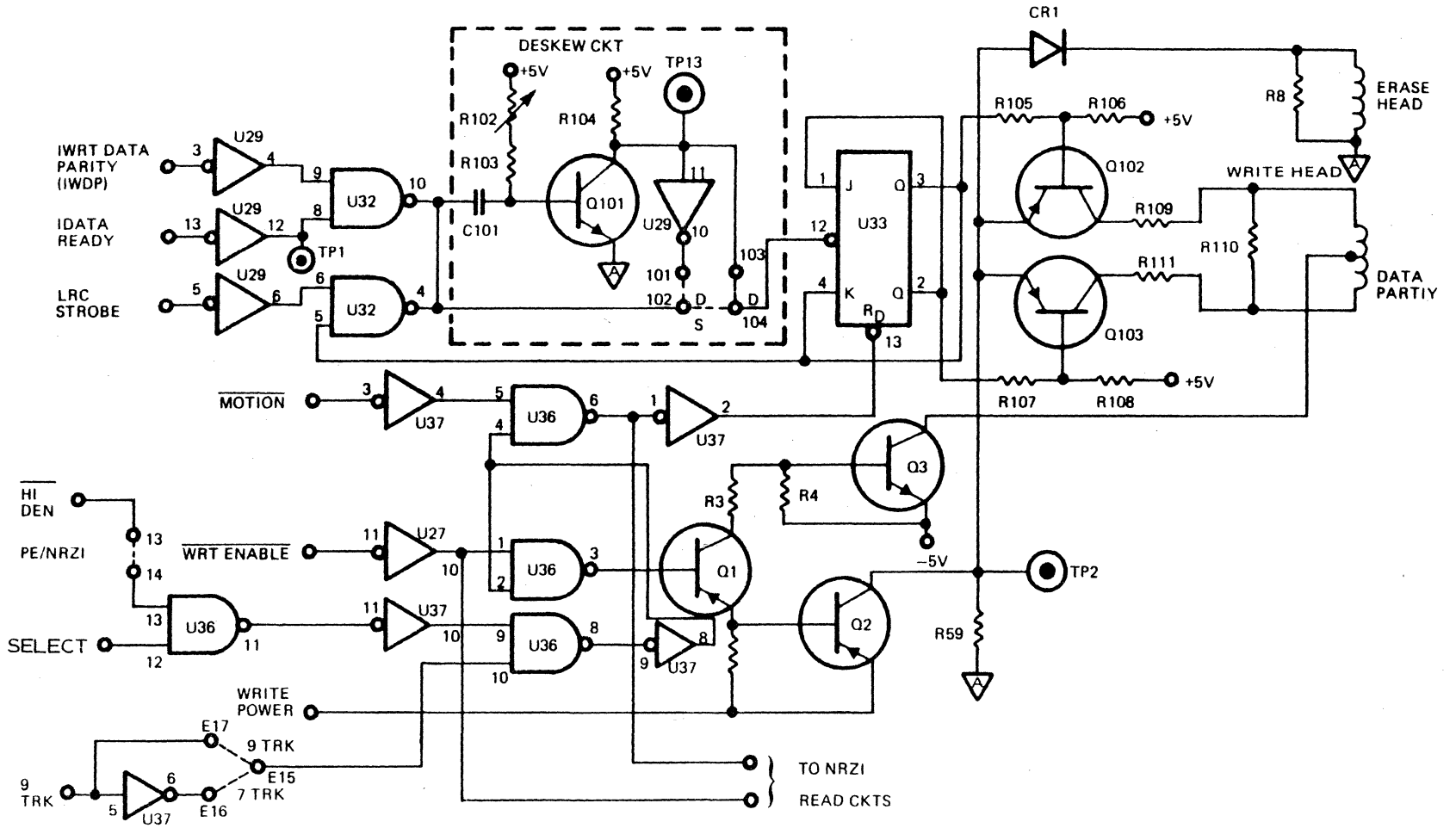


Figure 4-27. NRZI Write Data Board Circuits Simplified Diagram

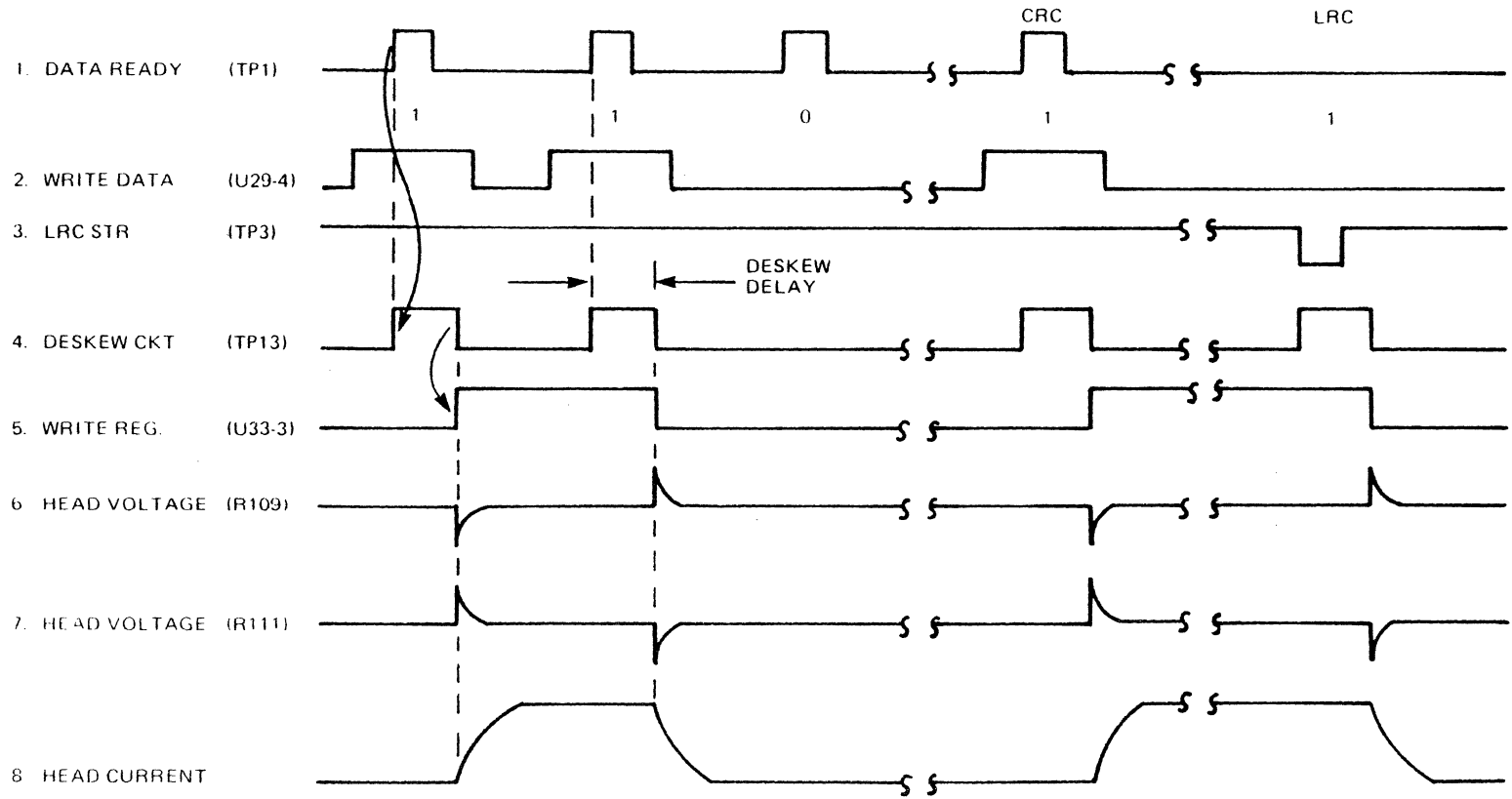


Figure 4-28. NRZI Write Data Timing Diagram

U32-10 is connected directly to U33-12 through jumper 102 to 104. Another DATA READY and logic one will reset U33-3. If U33-3 is set when the LRC strobe occurs, U32-4 will reset U33-3 through Q101.

The outputs at pins 3 and 2 of flip-flop U33 alternately drive Q102 and Q103 so that everytime flip-flop U33 sets or resets a flux change occurs on the tape.

The write current is supplied by the WRITE POWER and WRITE ENABLE signals. If WRT ENABLE is low, Q1 will conduct at saturation, which will cause Q2 and Q3 to conduct at saturation as long as WRITE POWER supplies +5 volts to Q2 emitter. A jumper is installed between 13 and 14 when the density (HI DEN) signal controls the operation of the NRZI data board when it is used with a PE data board. A jumper is installed between E17 and E15 for 9-track operation, or between E16 and E15 for 7-track operation, when the 9-TRACK signal controls the operation of the NRZI data board or when it is used on a quad-density (three data card) tape unit. Transistor Q2 supplies current through CR1 for the erase head and for differential head drivers Q102 and Q103 and transistor Q3 supplies the head current.

#### 4-31 NRZI Read Circuits

Read head signals ranging from 5 to 35 millivolts are amplified by U103. Refer to figures 4-29 and 4-30. The gain of U103 is determined by series connection of R115, R118 and potentiometer R117. For a single gap head, a jumper from J3 to J4 is included as well as diodes CR101, CR102, CR103, and CR104.

The output of U103 at TP101 is connected to diode CR105 and to unity gain inverter U104. The output of U104 is connected to CR106. These output signals are compared to a read threshold voltage at diode CR107. For normal threshold about 25% of maximum voltage, Q5 is saturated and Q4 is turned off setting the voltage at the base of Q6 by voltage divider R13, R15 and R16. The read threshold at the emitter of Q6 is set by the base voltage.

A jumper from 2 to 3 is connected for a dual gap head configuration setting U30-6 high. If, for example, READ THRESHOLD 1 is 0 volts and WRITE ENABLE is high, U28-11 goes low and U26-12 goes high, turning off Q5. U30-11 is set low, turning on Q4. Since R14 has a lower resistance than R13, the read threshold is set high at about 45% of the maximum voltage. If, for example, READ THRESHOLD 2 is asserted, U26-8 goes low setting U30-11 and U26-12 high and turning off Q4 and Q5. Since R15 has a higher resistance than the parallel combination of R13 and R15, the read threshold is set lower, at approximately 12% of the maximum voltage.

For single gap heads, a jumper is connected from 1 to 2 setting U28-11 high. If, for example, READ THRESHOLD 1 is set high, U26-8 goes high and U30-6 goes low, and U26-12 goes high turning off Q5 and saturating Q4. This sets the threshold high. If, for example, READ THRESHOLD 2 is set, U26-12 and U30-11 are set high turning off Q5 and Q4 setting the threshold low.

Therefore, if the output voltage is higher than the threshold, CR107 is reverse biased and the signal is not impeded, applying the positive peaks from the amplifier and inverter to differentiator U105.



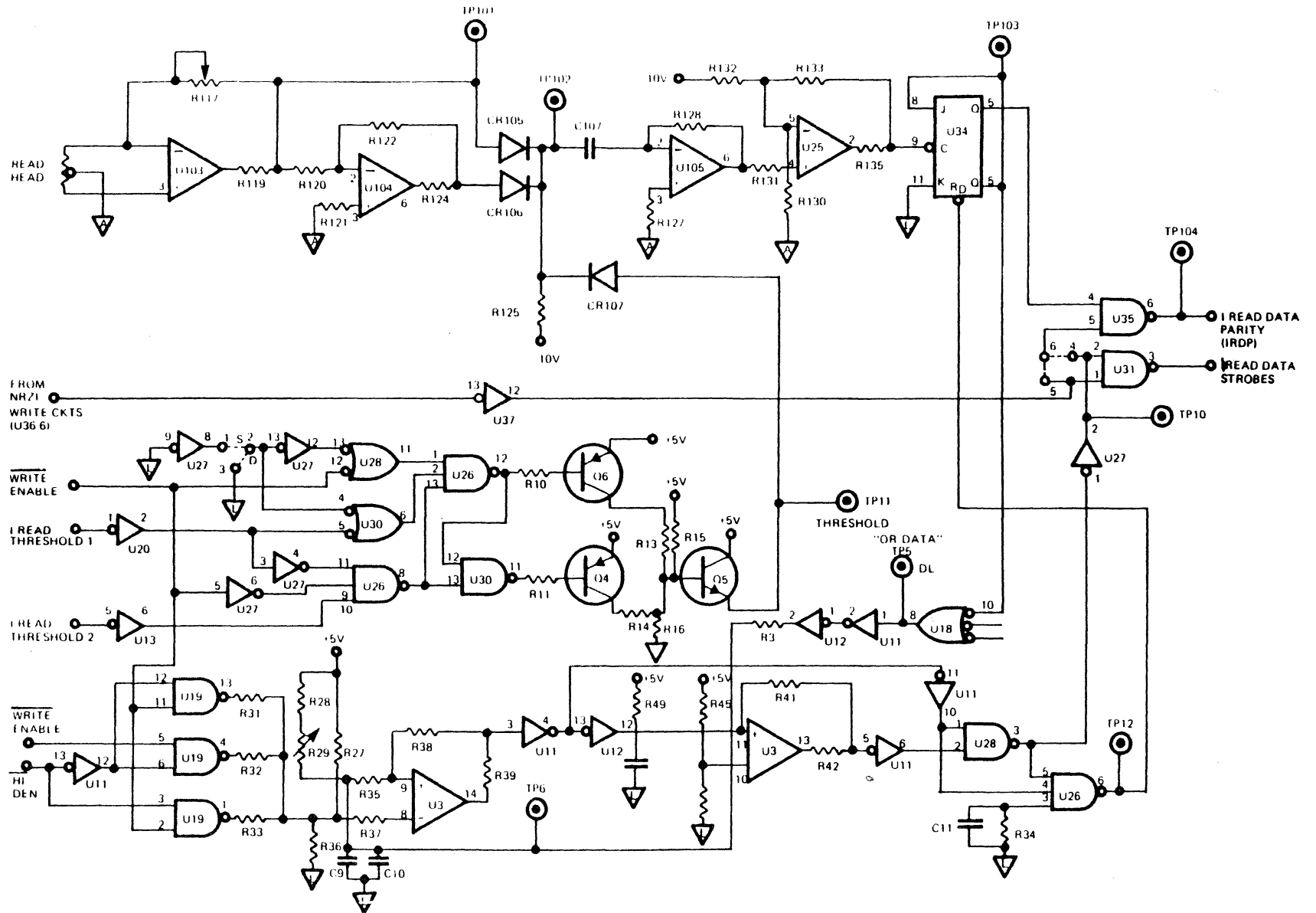


Figure 4-29. NRZI Data Board Read Circuits Simplified Diagram

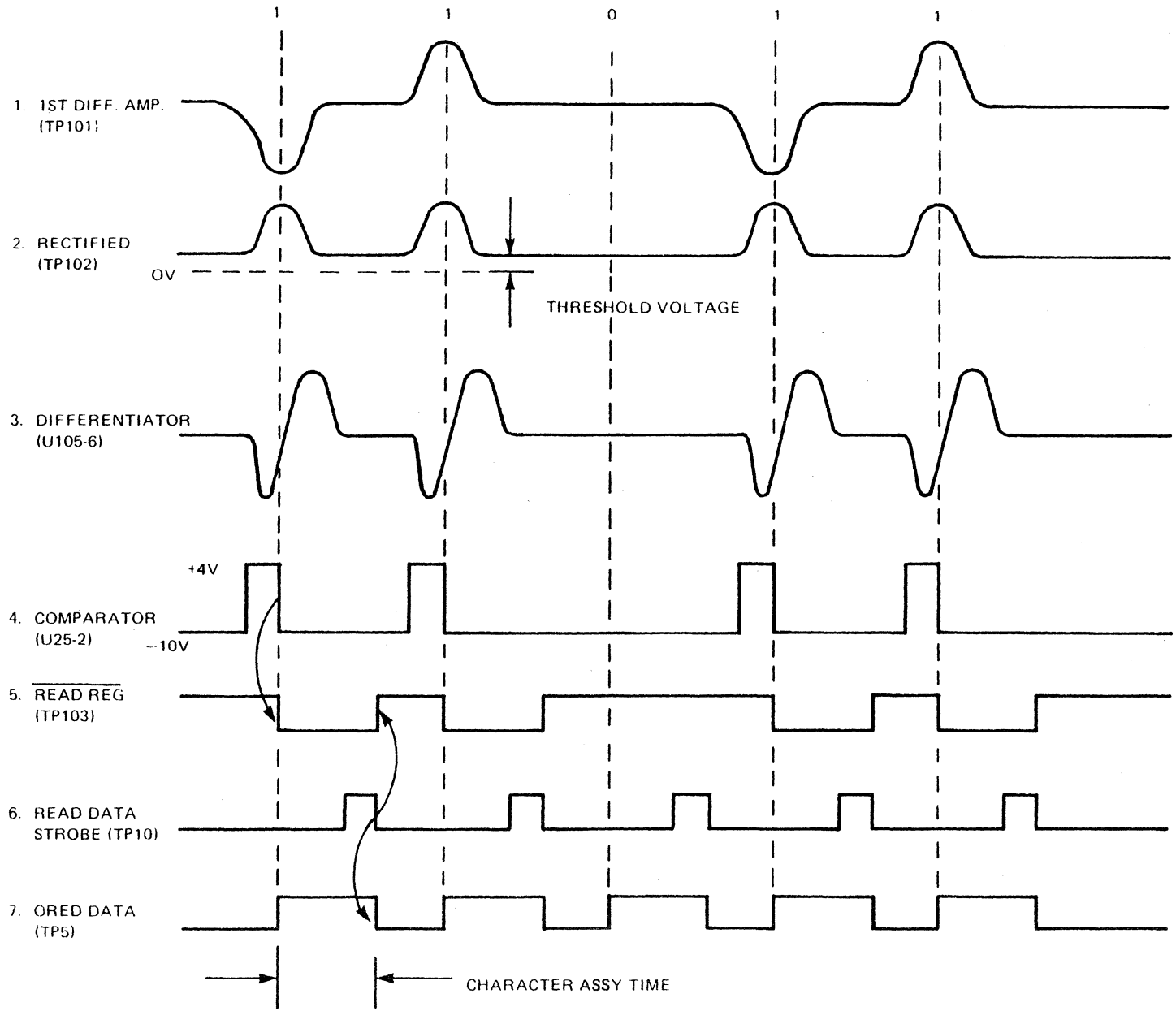


Figure 4-30. NRZI Read Data Timing Diagram

The gain of U105 is determined by the reactance of C107 and R128, so the gain of U105 increases at 20 db per decade until U105 is cut off by R128 and C108. Therefore, the peaks of the signals are changed to zero crossings and the amplitude is less dependent upon the data pattern since the output is related to the rate of change of the input which is constant. When the output of U105 crosses zero and goes negative, comparator U25-2 switches high. As U25-2 goes low, it sets U34-5. Flip-flop U34 is gated with MOTION or READ DATA STROBE at U35-5 to drive the READ DATA PARITY line.

Any low input to U18 sets +DL high. This sets U12-2 high allowing C9 and C10 to charge through R28 and potentiometer R29. When the voltage at TP6 and U3-9 reaches the voltage at U3-8, U3-14 switches high. The voltage at U3-8 is set by the voltage divider formed by R27 and R36 creating a delay that is set equal to 1/2 the data rate. R31, R32 and R33 parallel R36 lowering the voltage at U308 and decreases the delay of the circuit during read-after-write and high density read operations.

U12-12 goes high when U3 switches high allowing C13 to charge through R49. When the voltage at U3-11 reaches the voltage at U3-10, U3-13 switches high, creating a delay of about 1 second. When U3-14 switches high U28-3 goes low until U3-13 goes high. This 1 second pulse is gated at U31-1 with MOTION to create the READ DATA STROBE.

When U28-3 goes high, all the inputs to U26-6 are high which sets U26-6 low resetting flip-flop U34.

Jumpers on the board determine if seven track, single gap, and speed are asserted. NRZI is always asserted. All of the read flip-flops are connected to a resistive ladder at TP9 that is useful in determining skew problems.

#### 4-32 PE Data Board Operation

The PE Data Board contains nine circuits, one circuit for each of the data tracks. The circuits are divided into write and read circuits. Both the write operation and read operation are described in the following paragraphs. Since the circuits for different tracks are identical, only one data track will be described.

#### 4-33 PE Write Circuits

The write current amplitude is set to the NRZI write current level when switching to the write mode.

When  $\overline{\text{WRT ENA}}$  is true, U16-3 will be low, turning on Q10, Q11 and Q12. Refer to figures 4-31 and 4-32. Q12 conducts at saturation, supplying the current for the write heads (-WRT PWR). Q11 supplies the current for the differential head drivers (+WRT PRW SW). Flip-flop U1-3 is set high (HI CURRENT) by U16-3, applying a low to U15-6 causing conduction of U15. With U15 on, R101 and R105 are in parallel and establish an increased-driving power through the differential head drivers. When MOTION is true, U17-12 is set low turning on Q7 and establishing envelope power (ENV PWR) for the read circuits.

The WRT DATA PARITY input is inverted at U6 and clocked into flip-flop U7-5 by DATA RDY. The outputs of flip-flop U7-6 and 7 alternately drive the differential head drivers creating a flux change on the tape.

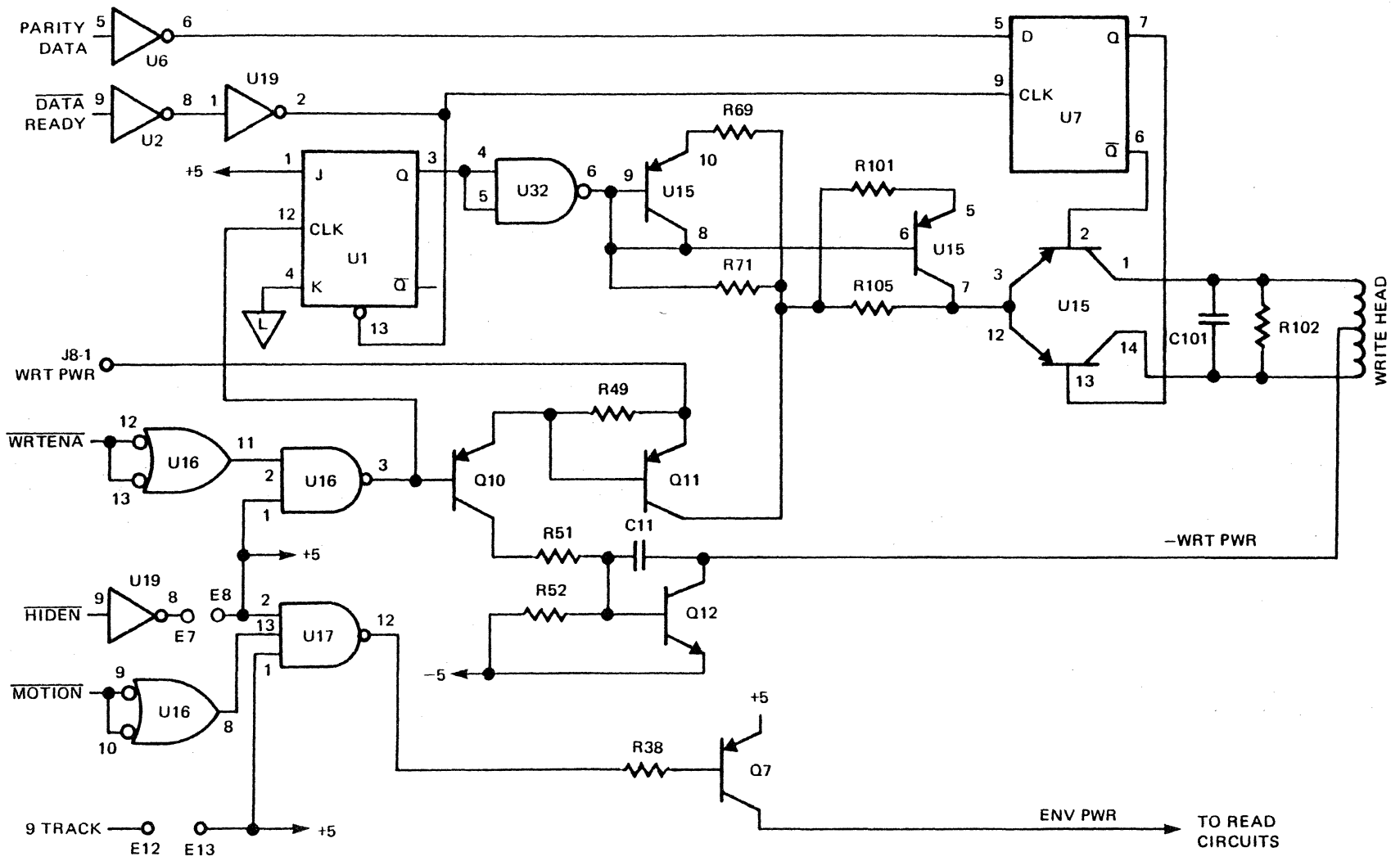
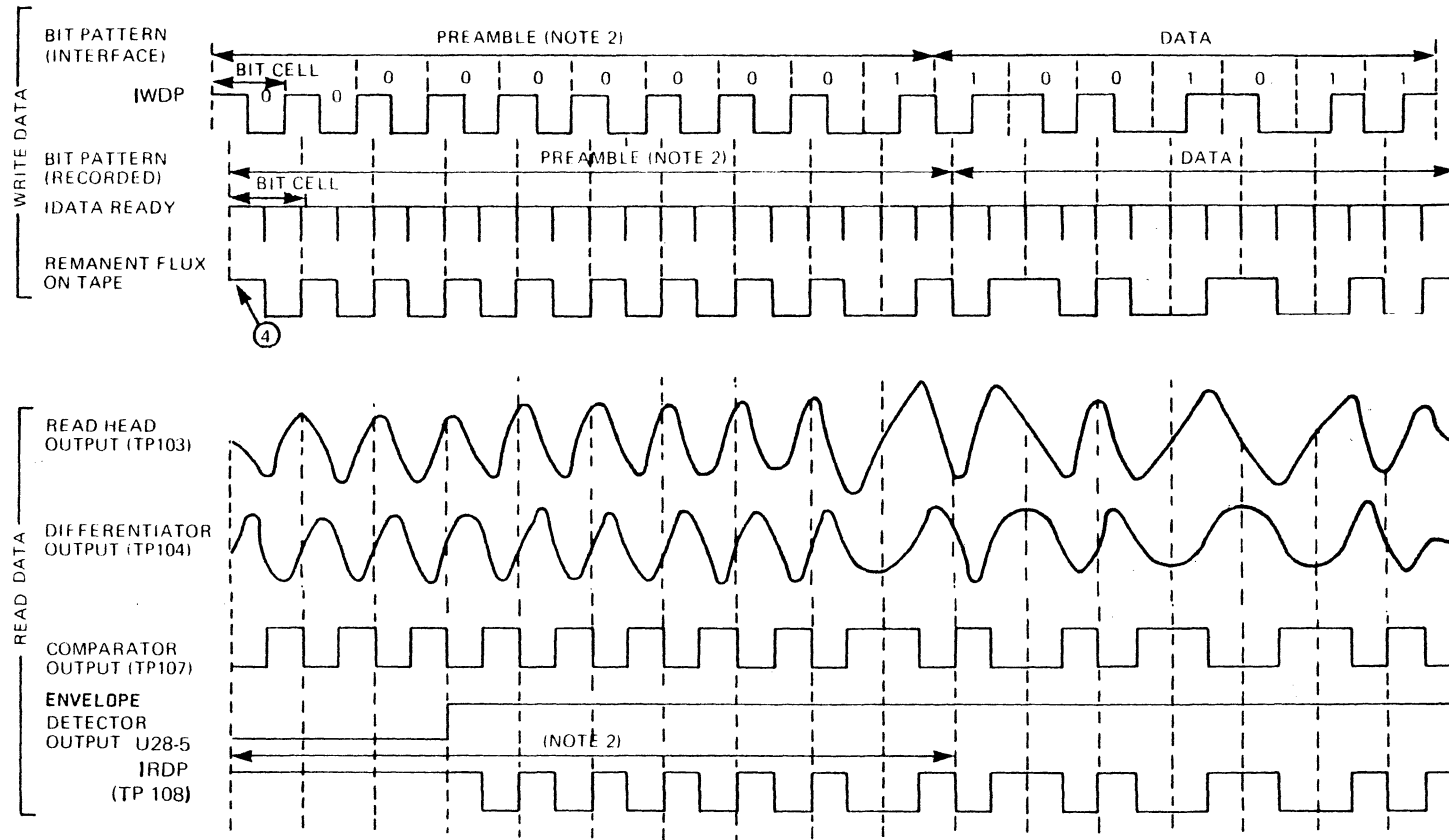


Figure 4-31. PE Write Circuits Simplified Diagram



- NOTES
1. TAPE UNIT MUST BE SELECTED, READY, AND ON LINE
  2. PREAMBLE IS SHOWN SHORTENED TO SIMPLIFY DRAWING. PREAMBLE CONSISTS OF 40 ZEROS FOLLOWED BY ONE 1
  3. POSTAMBLE NOT SHOWN. POSTAMBLE CONSISTS OF ONE 1 FOLLOWED BY 40 ZEROS
  4. FLUX POLARITY OF INTERRECORD GAP

Figure 4-32. PE Data Write/Read Timing Diagram

When the first data ready signal is received, U1-3 is set low causing a high on U15-6. This stops conduction of U15 and removes R101 from the differential head driver circuit thereby reducing the driving power through the differential head drivers. The write current is reduced to the normal PE write current level.

#### 4-34 PE Threshold Dynamic Switching (Write)

At the beginning of a write operation,  $\overline{\text{WRT ENA}}$  true and  $\overline{\text{MOTION}}$  true clocks U23 and sets U23-14 to a low. Refer to figure 4-33. U18-11 is conditioned high causing Q6 to be OFF. U18-3 is held low by WRT ENA and conditions U17-6 high causing Q5 to be OFF. With Q5 and Q6 OFF, the threshold level will be at 8%. The voltage follower U35 transmits the established voltage at the intersection of R31 and R32. U35 is always in a conductive state and the voltage level will be determined by R31 and R32 when Q5 and Q6 are OFF or by R31, R32 and R34 when Q5 is ON and Q6 is OFF or by R31, R32 and R35 when Q5 is OFF and Q6 is ON.

At the first write data ready signal, U23 is cleared, setting U23-14 high causing U18-11 to go low. U18-11 going low turns on Q6, establishing a 26% threshold level.

At the end of the write operation, ENV lines go low and clock U23 setting U23-14 to a low. U23-14 going low conditions U18-11 to a high and turns off Q6 establishing an 8% threshold level.

#### 4-35 PE Threshold Dynamic Switching (Read)

A jumper from E10 and E9 is connected for a dual gap head configuration setting U18-6 high. Refer to figure 4-33. When  $\overline{\text{WRT ENA}}$  is false, U18-3 is set high. For a normal read, RD THRESHOLD 1 and 2 are false, U17-8 is set high causing U17-6 to go low and U18-11 to go high. These conditions cause Q5 to be ON and Q6 to OFF, thereby establishing a 22% threshold level.

When RD THRESHOLD 1 is asserted, U17-8 goes low setting U17-6 and U18-11 high and turning OFF Q5 and Q6. This establishes an 8% threshold level.

#### 4-36 Write/Erase Operation

When  $\overline{\text{WRT ENA}}$  goes low at U20-2, U20-3 goes high causing U21-13 to go low. U21-13 going low discharges C8 through R43 establishing a delayed conditioning at U22-10. This is done to avoid a false error created by the initial surge through the Erase Head. (Reference figures 4-34 and 4-35).  $\overline{\text{WRT ENA}}$  being true turns on Q13, Q14 and Q16 supplying voltage to the Erase Head. Erase V is applied to U21-7 and U21-8 causing a low on U22-4 and a high on U22-1. These conditions establish a low at U22-11 and a high at U22-9. U22-8 is conditioned high and does not set the Erase flip-flop.

If the Erase Head is open, Erase V at U21-8 will rise above Reference V1 causing U21-14 to go low. A low at U21-14 causes U22-12 to go high and conditions U22-8 to go low. U22-8 going low sets the Erase Error flip-flop which terminates tape motion and drops the ready interface signal.

If the Erase Head is shorted, Erase V at U21-7 will drop below Reference V2 causing U21-1 to go low. A low at U21-1 causes U22-12 to go high and conditions U22-8 to a low. U22-8 going low sets the Erase Error flip-flop.

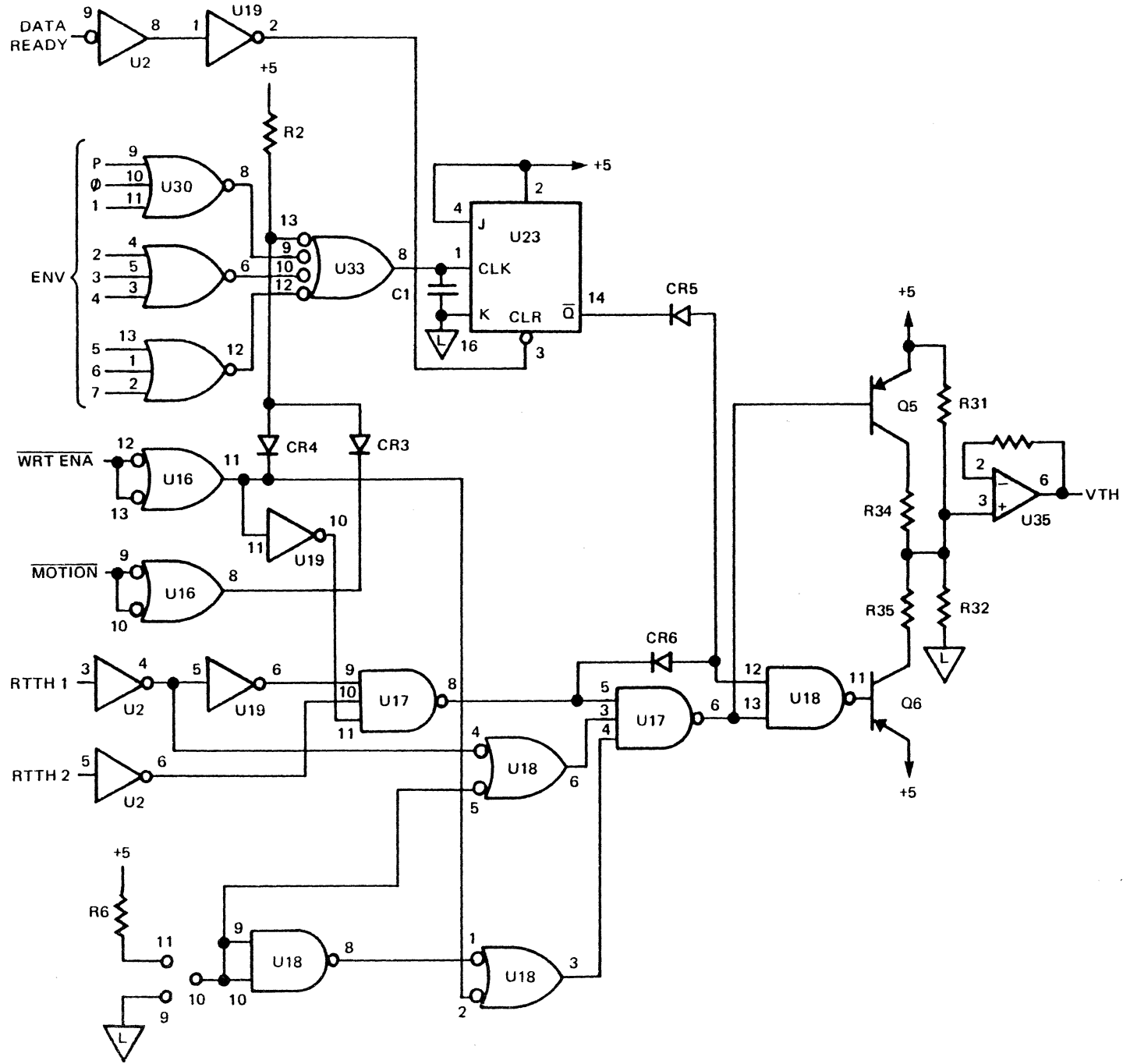


Figure 4-33. PE Threshold Dynamic Switching Circuits Simplified Diagram

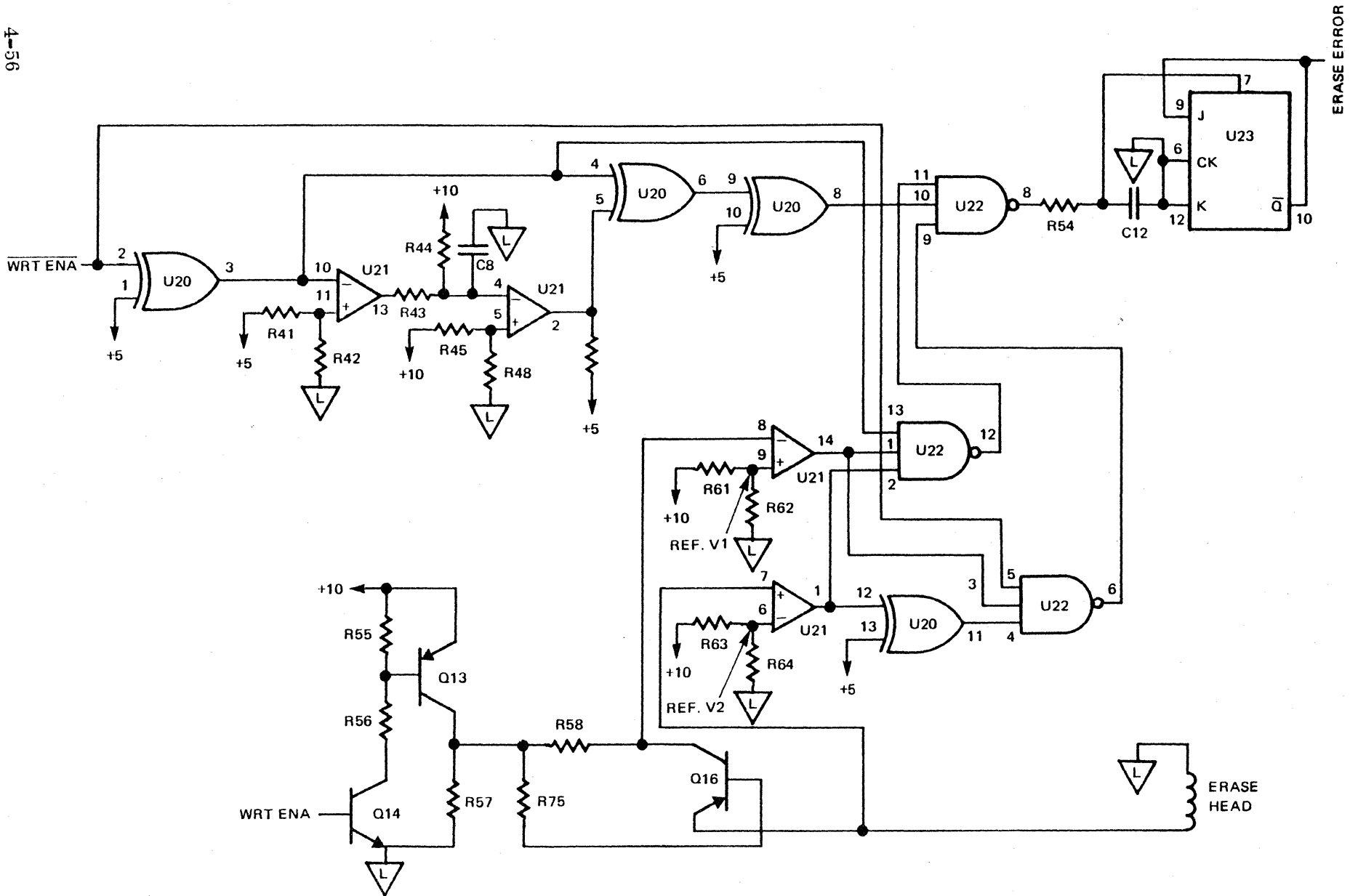


Figure 4-34. Erase Current Failure Circuits Simplified Diagram



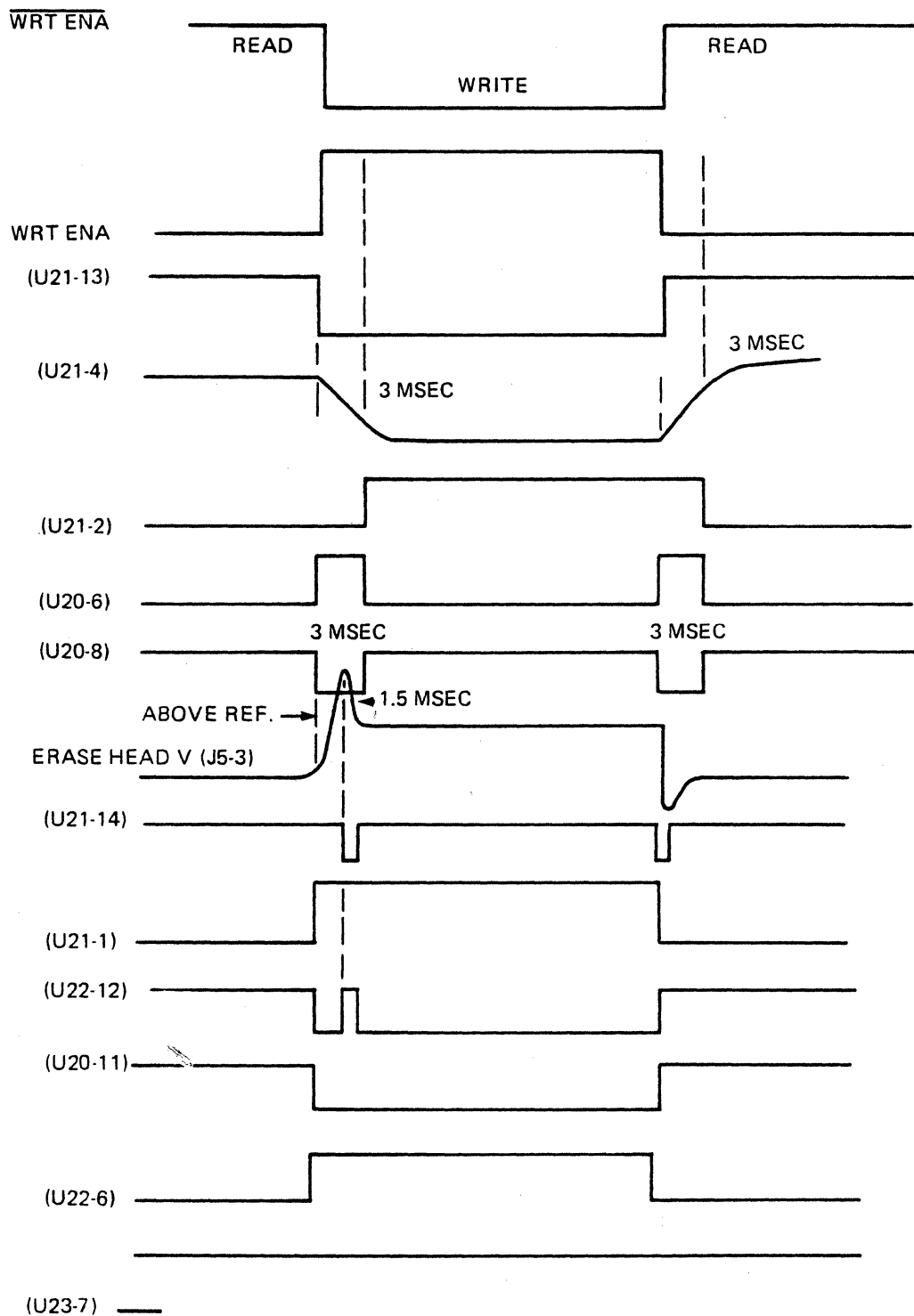


Figure 4-35. Erase Current Failure Timing Diagram

#### 4-37 Read/Rewind Operation

During a read operation no current should be flowing through the Erase Head. Erase V will be low causing U21-14 to be high and U21-1 to be low. WRT ENA will be low causing a high at U22-10 and 11. WRT ENA will be high causing a low at U22-9 conditioning U22-8 to a high.

If Erase Head Current is detected, Erase V will rise above Reference V2 causing U21-1 to go high. U21-1 going high causes U22-6 to go high and U22-8 to go low which sets the Erase Error flip-flop and terminates tape motion, drops the ready interface signal and drops the rewinding interface signal.

#### 4-38 PE Read Circuits

The read head signals are amplified by the differential amplifier U101. Refer to figure 4-36 and 4-37.

U101 is connected to differentiator U102. The gain of U102 is determined by the reactance of C104 and R114, so the gain of U102 increases at 30 db per decade until cut off by R114 and C105. Therefore, the peaks of the signals are changed to zero crossings and the amplitude is less dependent upon data pattern since the output signal is related to the rate of change of the input, which is constant. The output of U102 is applied to the zero crossing detector at U103-8 and to the envelope detector at U103-4. The zero crossing detector detects whenever the differentiators negative going output crosses zero, creating a positive output signal at U103-14. The signal is applied to the line driver at U32-1 and gated with the output of the envelope detector.

The envelope detector includes three circuits of U103 and flip-flop U28. U103 compares the output of the differentiator with the read threshold reduced by 1/2 by R125 and R127. The thresholds are 26%, 22% and 8%. If the signal is more negative than the threshold, U103-2 switches high allowing C108 to charge through R130. The R130/C108 time constant is such that U103-1 is switched high allowing C109 to charge through R135. When U103-11 rises to a sufficient level U103-13 is switched high and applied to flip-flop U28-2. U28-2 is clocked by U103-14 setting U28-5 high conditioning U32 to allow read data to appear at U32-3.

When there are no negative pulses applied to U103-4, C108 will charge to a level causing U103-1 to go low. U103-1 going low causes U103-13 to go low applying a low to U28-2 which is clocked into the flip-flop setting U28-5 to a low. U28-5 going low disables read data at U32-3.

#### 4-39 PE Delayed +5 Volts

The +5 volts to line drivers U29, U31 and U32 is delayed to eliminate false data at the outputs of the line drivers. Refer to figure 4-38.

When +5 comes up Q4 is turned ON causing Q3 to be turned OFF. With Q3 going OFF, C5 is allowed to charge through R15 to a sufficient level to turn ON Q2. Q2 turning ON causes Q1 to turn ON and applies +5 DEL to U29, U31 and U32. The R15/C5 time constant establishes the desired time delay for +5 DEL.

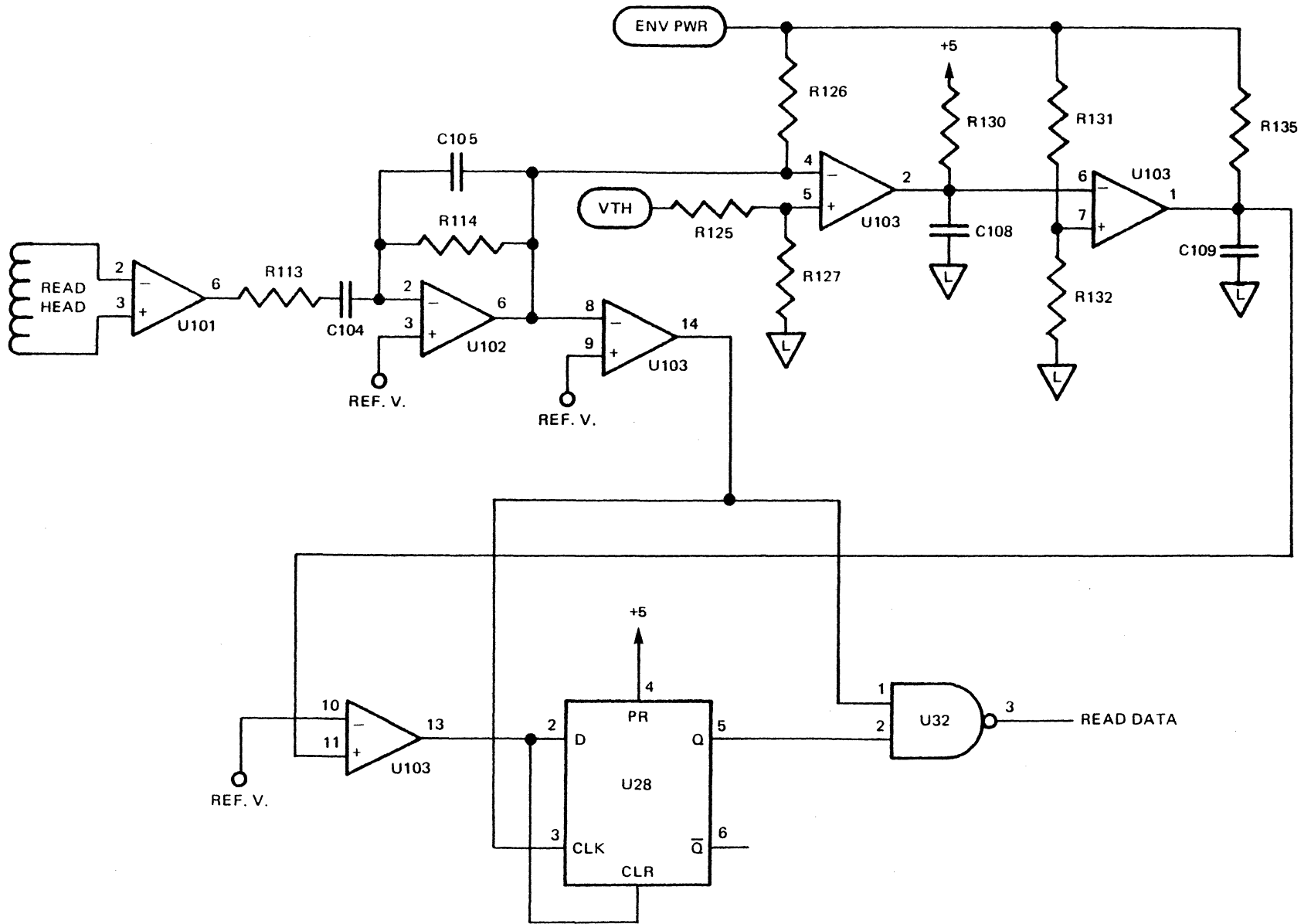


Figure 4-36. PE Read Circuits Simplified Diagram

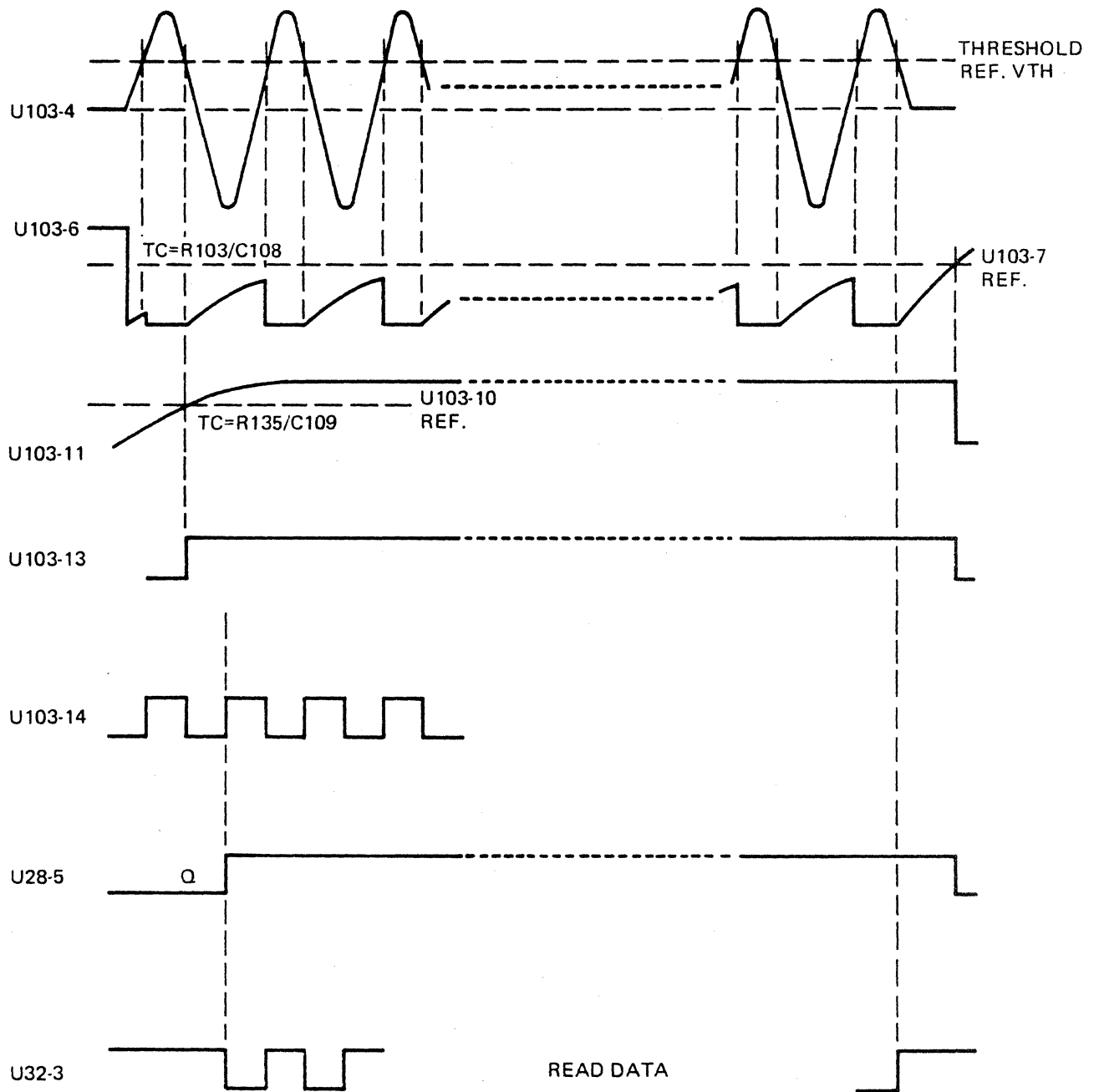


Figure 4-37. PE Read Timing Diagram

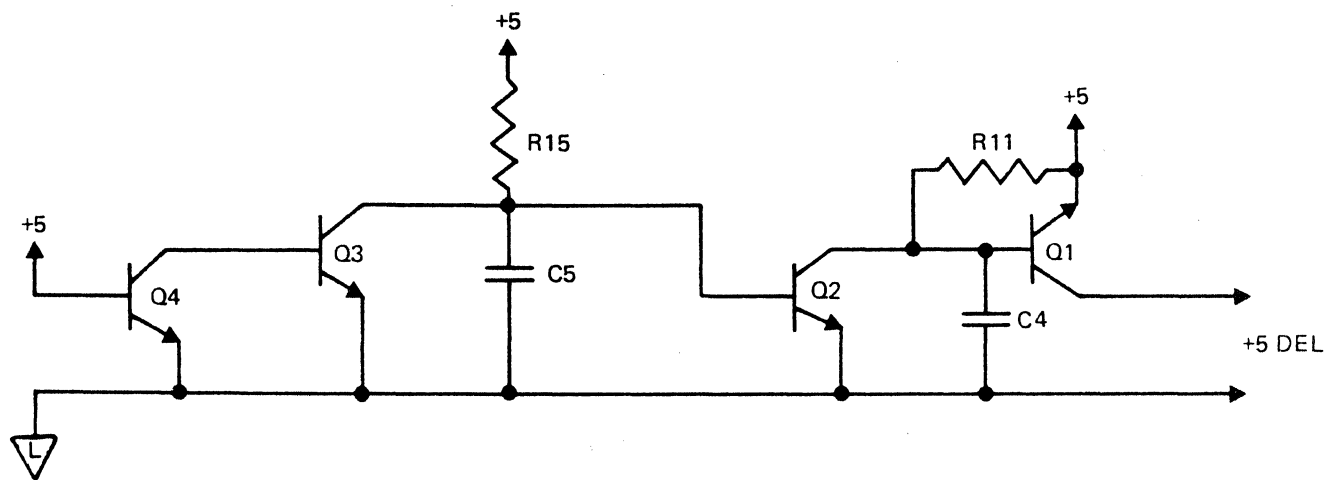


Figure 4-38. PE +5 Volt Delayed Circuit Simplified Diagram

#### 4-40 PRIMARY POWER CIRCUITS

The primary power circuits consist of a power supply module mounted on the tape unit baseplate and the power supply regulator circuits located on the tape control board. The power supply module contains a power transformer, rectifiers, capacitors, fuses, and two power resistors. A heatsink, for mounting the power supply and servo power transistors, is attached to the power supply module. The power supply regulator circuits consist of the four regulator circuits and a power reset circuit. The following paragraphs describe the operation of the power supply module and the power supply regulator circuits.

#### 4-41 Power Supply Module

The power supply module supplies unregulated  $\pm 36$  volts to the reel servos, the capstan servos and the power supply regulator circuits. Refer to figure 4-39. Primary power is supplied through optional line filter FL1 and front panel ON/OFF switch S1 to stepdown transformer T1. The unregulated  $\pm 17$  volt outputs are supplied by full-wave rectifier CR1, and the  $\pm 36$  volt outputs are supplied by half wave rectifiers CR2 and CR3. Capacitors C1, C2, C3 and C4 are used for filtering the unregulated output.

Interconnection between the power supply module and the power supply regulator circuits on the tape control board is provided by a harness that is plugged into tape control board connector J26. Through this connector the unregulated  $\pm 17$  and  $\pm 36$  volt outputs are distributed to the other circuits on the tape control board.

#### 4-42 Power Supply Regulator Circuits

The power supply regulator circuits on the tape control board consist of four separate regulator circuits which supply +10 volt, +5 volt, -10 volt and -5 volt outputs. Refer to functional module 1000 on the tape control board schematic diagram in Chapter 6. In addition, the power supply regulator circuits also provide a reset (PSET) signal to the tape unit control circuits. The PSET signal initializes various logic circuits when power is first turned on, or disables the servo motors and disconnects the write power from the data boards when the  $\pm 17$  or  $\pm 10$  volt power supplies malfunction.

#### 4-43 +10 Volt Regulator

The +10 volt regulator consists of series regulator transistor Q4, mounted on the heatsink, and a voltage sensing network associated with Q1004. See figure 4-40. Unregulated +17 volts is applied to the collector of series regulator transistor Q4 through R1026 and +10 volts is output from the emitter through R1016. The base voltage of Q4 is regulated by the voltage divider network consisting of R1012, R1013 and transistor Q1004. The base of sensing transistor Q1004 is referenced to the +10 volt output across diodes CR1012 through CR1016. CR1015 is a reverse biased 6.2 volt Zener diode. If the regulator output of functional module 1000 rises above +10 volts, Q1004 conducts more causing the base voltage of Q4 to drop. This causes the output to decrease. Conversely, if the output falls below -10 volts, Q1004 conducts less causing the base potential of Q4 to increase. In this manner, an accurate +10 volt output is maintained. In addition to providing +10 volts regulated output, CR1015 supplies a reference voltage to the  $\pm 5$  volt regulator circuits.

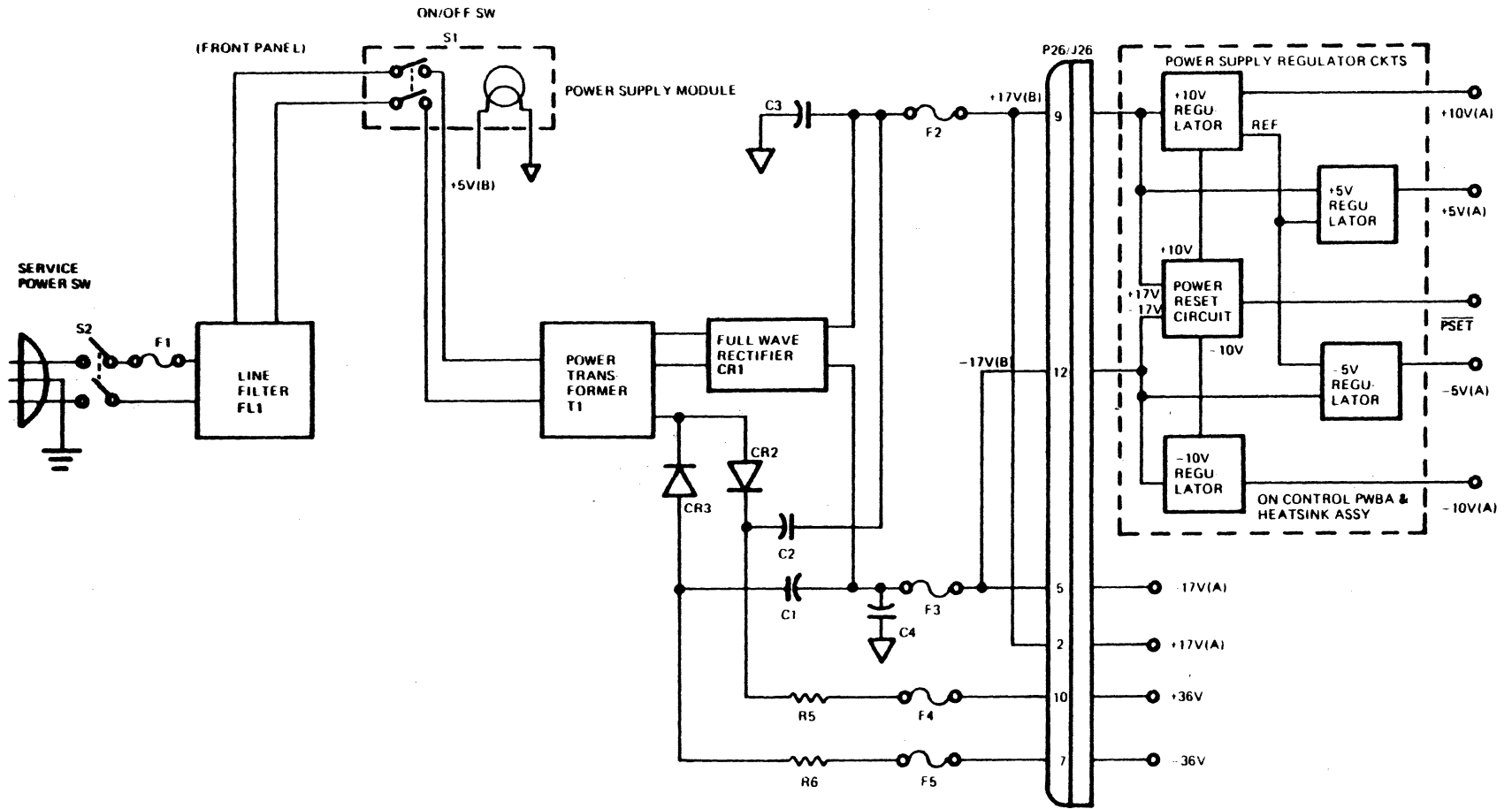


Figure 4-39. Simplified Diagram of Primary Power Circuits

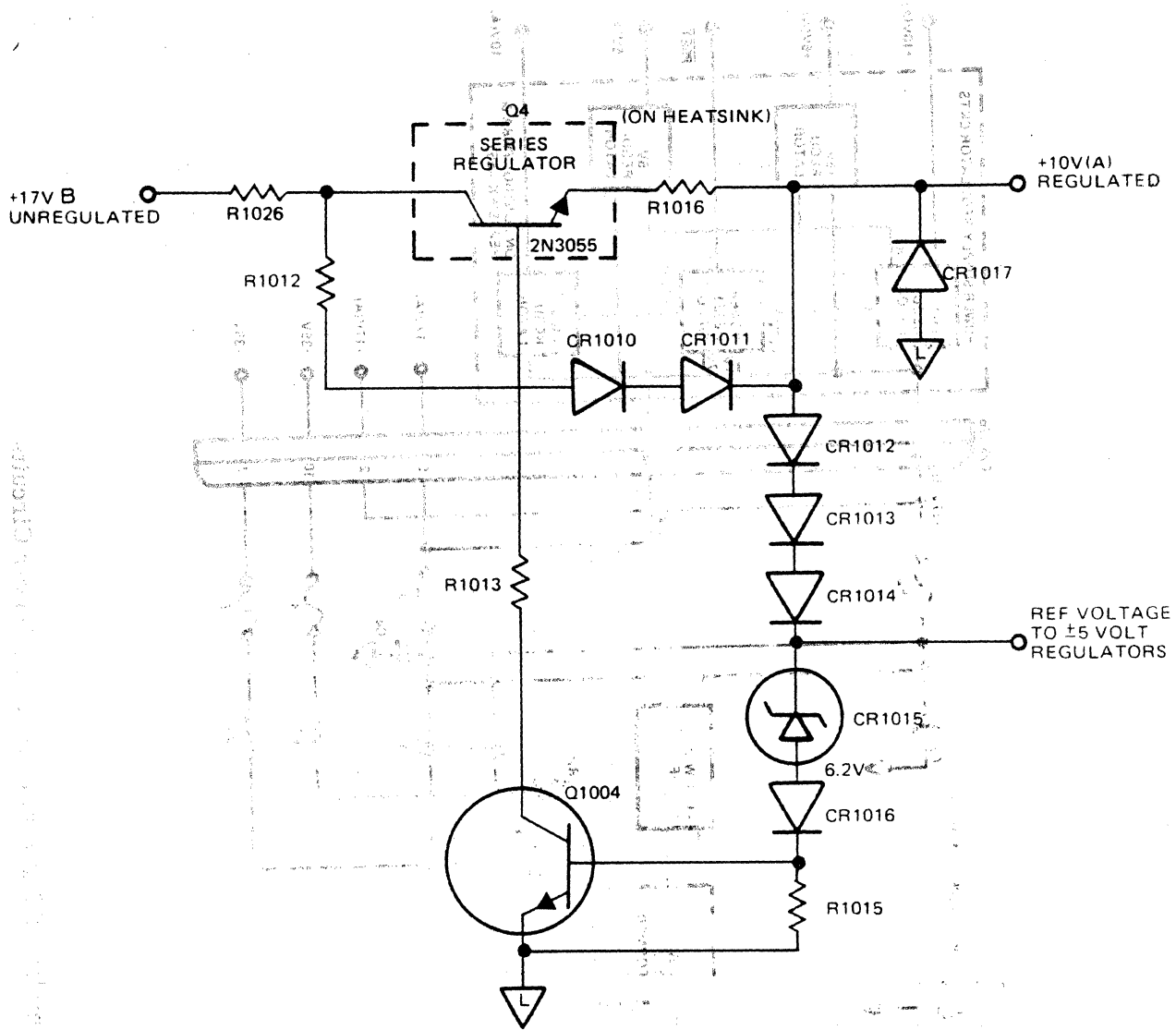


Figure 4-40. +10 Volt Regulator Circuit Simplified Diagram

Diodes CR1010 and CR1011 provide over-current protection. If the base to emitter voltage of Q4 and the voltage drop across R1016 ever become more than two diode drops below the base voltage, the two diodes will become forward biased and conduct. This causes the Q4 base voltage to drop. Diode CR1017 prevents power turn-on transients from causing output to go below -0.6 volts.

4-44 -10 Volt Regulator

The -10 volt regulator consists of series regulator transistor Q8 and reference diodes CR1007, CR1004 and CR1005. See figure 4-36. Diode CR1007 is a 10 volt Zener diode. The three diodes set the base voltage of the Q8 to regulate the voltage at the emitter of the series regulator. Diode CR1008 provides over-current protection by always maintaining the -10 volt regulated output more negative than -9.4 volts. If the



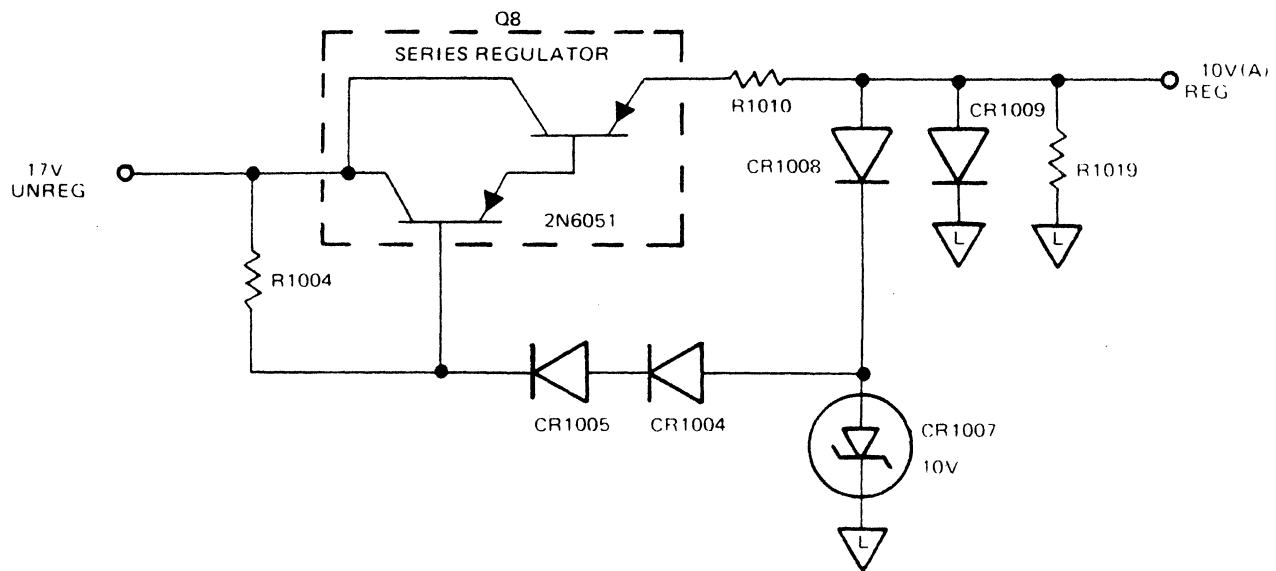


Figure 4-41. -10 Volt Regulator Circuit Simplified Diagram

output voltage rises above  $-9.4$  because of an increase in current flow through R1010, CR1008 will conduct, lowering the base voltage of Q8 and the output. Diode CR1009 prevents power turn-on voltages from exceeding  $+0.6$  volts.

#### 4-45 +5 Volt Regulator

The  $+5$  volt regulator circuit is referenced to Zener diode CR1015 in the  $+10$  volt regulator and uses remote sensing for regulating its output. See figure 4-42. The circuit consists of series regulator transistor Q9 and operational amplifier U46, with associated components.

To maintain  $+5$  volts at the remote location (at TP1 of the forward-reverse ramp generator) operational amplifier U46 is used to control the base voltage of Q9. One input of amplifier U46 is referenced to Zener diode CR1015 at R1018 and the other input comes from the remote sensing circuit. Potentiometer R1018 is adjusted so that the output of U46 provides the correct base voltage to Q9, needed to maintain the voltage at the remote location at  $+5$  volts. Diodes CR1018, CR1019, and CR1020 provide over-current protection by serving as a current path if the regulated output falls more than 3-diode drops below the output of U46 (base of Q9) because of an increase in voltage drop across R1027. This causes the  $+5$  volts output voltage to be decreased. Diode CR1021 is for protection against transients during power turn-on and keeps the regulated output from going below  $-0.6$  volts.

The  $+5$  volt regulator also incorporates an SCR crowbar protection circuit, consisting of Zener diode CR1022 and SCR Q1005. If the regulated voltage output rises above  $6.2$  volts, CR1022 breaks down and conducts, turning on Q1005. This, in turn, provides a shorted path to ground for the unregulated input of  $+17$  volt, causing fuse F2 on the power supply module to burn out.

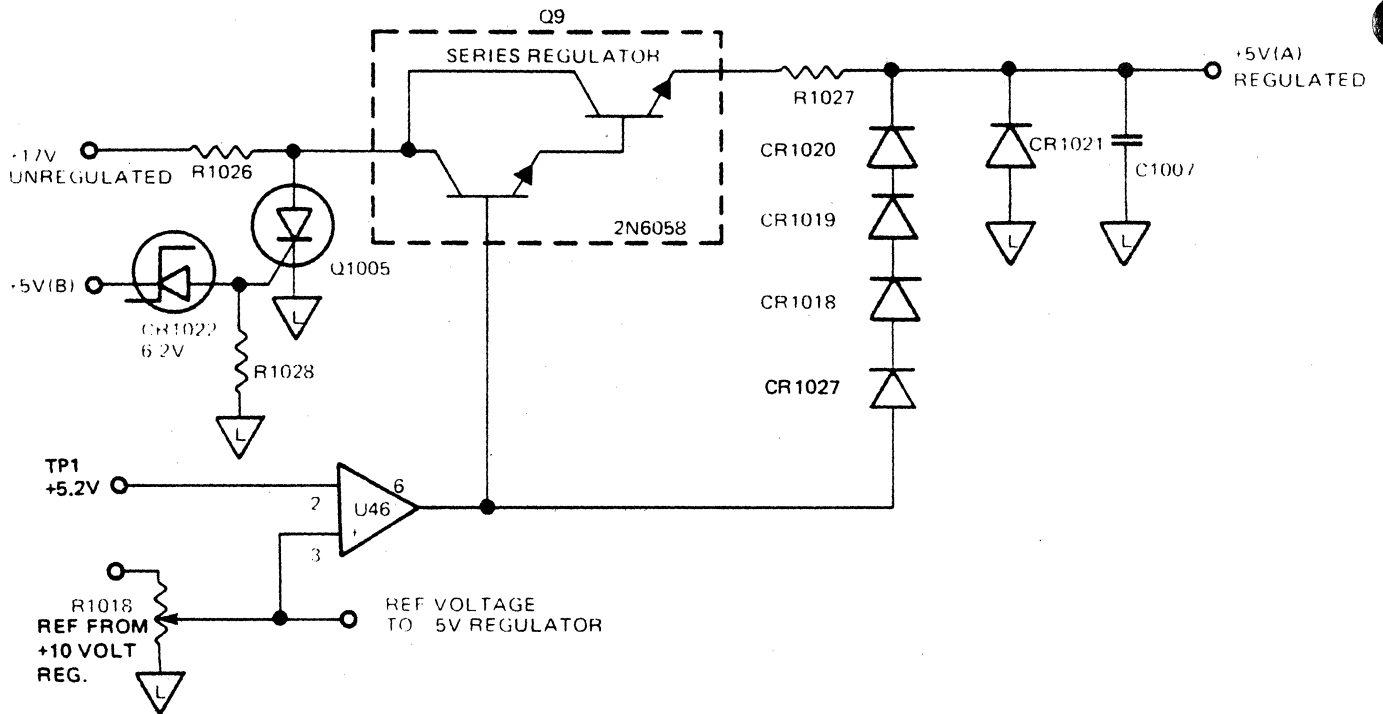


Figure 4-42. +5 Volt Regulator Circuit Simplified Diagram

4-46 -5 Volt Regulator

The -5 volt regulator functions very similar to the +5 volt regulator. See figure 4-43. It is referenced to Zener diode CR1015 (see figure 4-40) and uses an operational amplifier (U48) and remotely sensed -5.2 volts to control the base voltage of series regulator Q11.

The positive input of operational amplifier U48 is referenced to ground, and the negative input is taken from voltage divider R1020 and R1024. One end of the voltage divider is referenced to the 6.2 volt Zener diode CR1015 through R1020 and potentiometer R1018 while the other input is connected to the -5 volt remote sensing test point TP2, on the forward-reverse ramp generator. Potentiometer R1024 is adjusted so that the output of amplifier U48 maintains the base voltage of Q11 such that the voltage at the remote location is -5 volts.

Diodes CR1023, CR1024 and CR1025 provide overcurrent protection and diode CR1026 serves as protection against turn-on transients. These diodes function essentially the same as those described for the +5 volt circuit in the preceding paragraph.

4-47 Power Reset Circuit

Figure 4-44 shows a simplified diagram of the power reset circuit. The circuit consists of Q1001, Q1002, Q1003 and associated components. The emitter of Q1003 is connected to +17 volts through R1026 (see schematic diagram 9940119, sht. 1 of 3) and

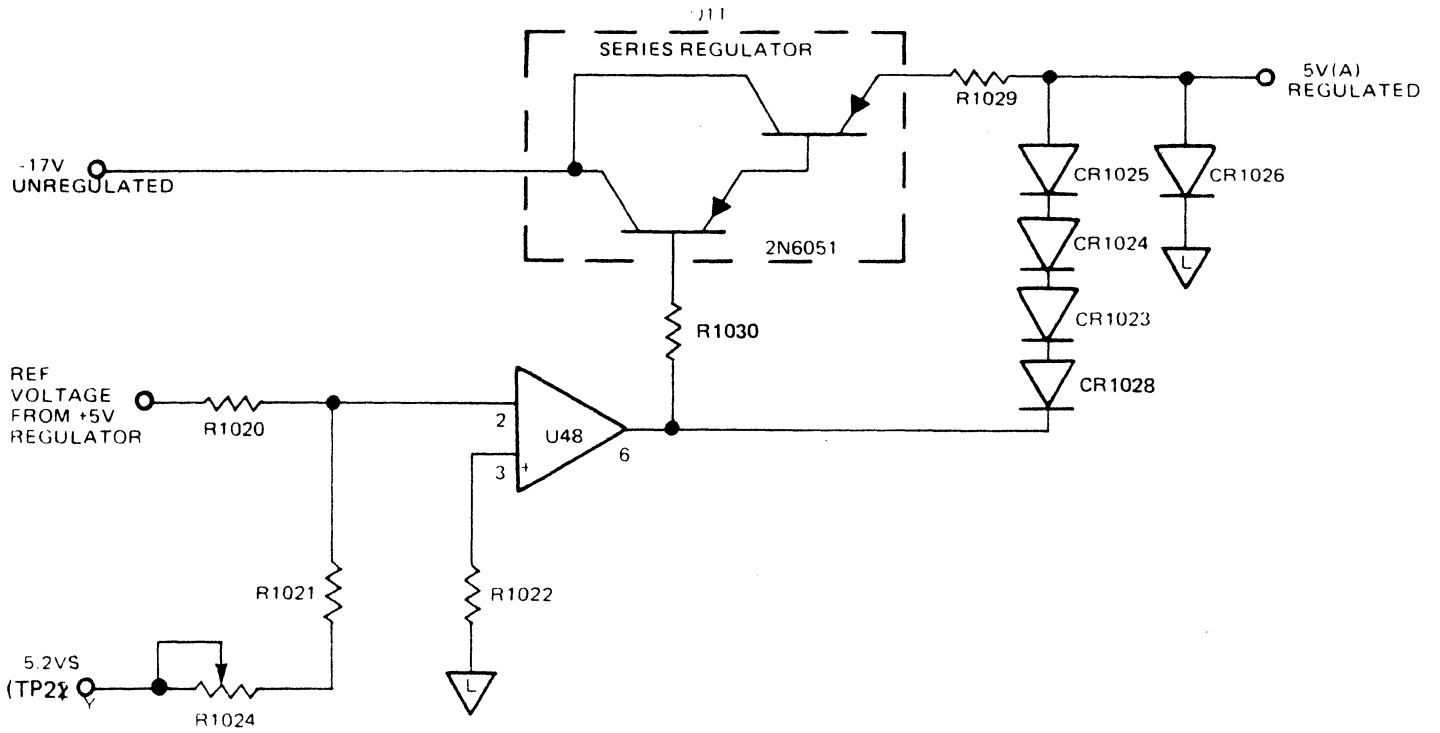


Figure 4-43. -5 Volt Regulator Circuit Simplified Diagram

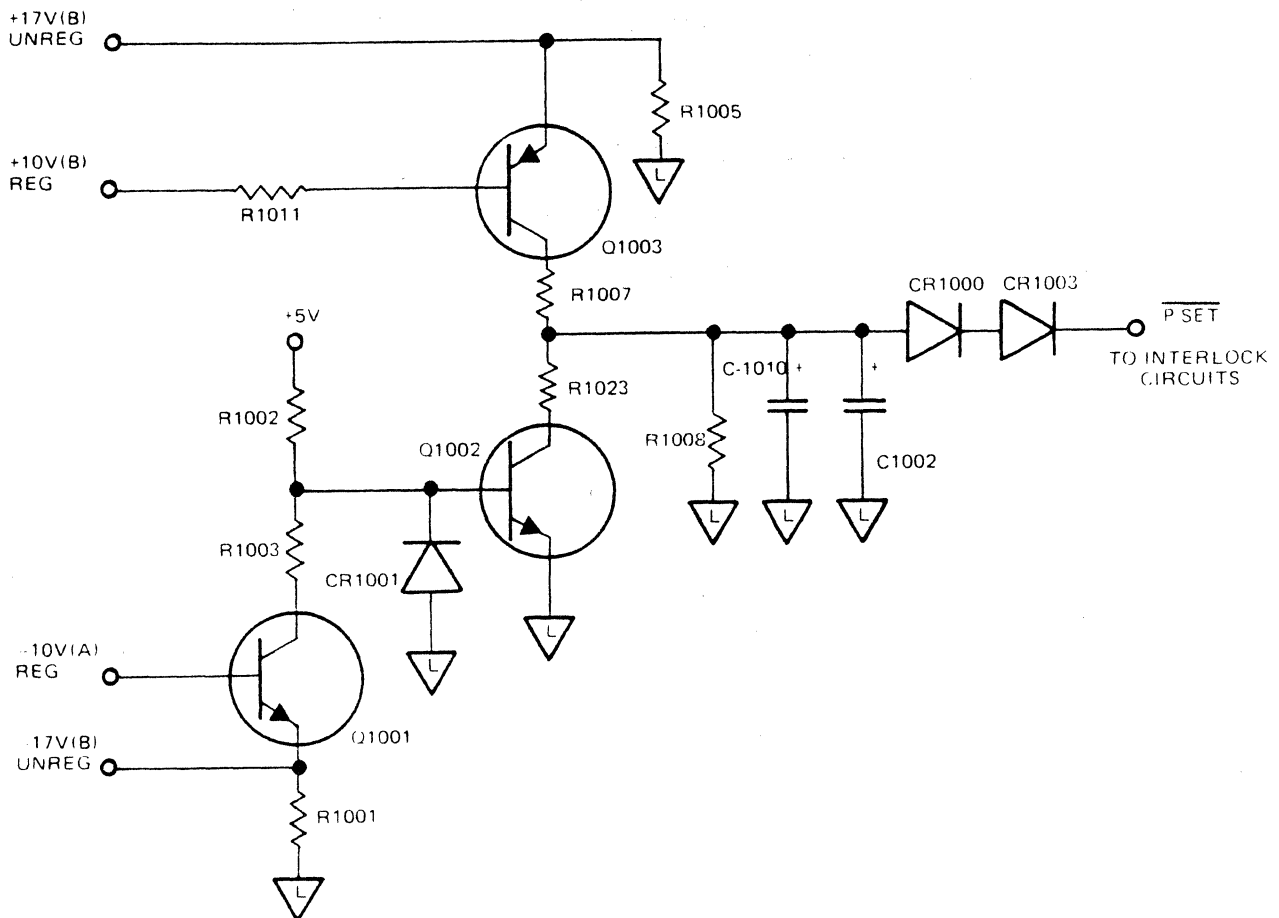


Figure 4-44. Power Reset Circuit Simplified Diagram

the base is connected to +10 volts through R1011. Under these conditions Q1003 conducts at saturation, causing the collector to be near +17 volts and the voltage on the PSET output at approximately +3 volts (logic high). However, if the +17 volts falls or the +10 volts rises, and the  $V_{be}$  of Q1003 becomes less than 0.6 volts, transistor Q1003 turns off and PSET becomes less than 0.6 volts, transistor Q1003 turns off and PSET becomes a logic low.

The PSET signal can also fall to a low logic level under the control of Q1001 and Q1002. When the -17 volts at (B) and the -10 volts at (A) are at their correct levels Q1001 conducts at saturation, conducting current through CR1001 and R1003. This keeps the base of Q1002 at -0.5 volts and Q1002 shut off. If, however, the -17 volt line rises to near -10 volts, or the -10 volts falls to near -17 volts and the  $V_{be}$  of Q1001 falls below 0.6 volts, Q1001 stops conducting and the base voltage of Q1002 rises. As Q1002 begins to conduct, PSET will fall to a low logic level.

When power is first turned on, PSET is always at a logic low. As the power supply voltages reach their nominal levels, PSET remains low for a time period determined by C1002, R1007 and R1008. This temporary logic low signal is used to initialize logic circuits on the tape control board.

#### 4-48 TAPE TRACK LAYOUT AND DATA FORMATS

#### 4-49 TAPE TRACK LAYOUT

The magnetic tape unit reads and writes standard 9-track or 7-track tapes depending on the exact equipment configuration. Figure 4-45 shows the orientation and layout dimensions of tape tracks for both formats. Note that 9-track tape is used both for PE or NRZI recording, whereas 7-track tape is used only for NRZI.

#### 4-50 Beginning and End of Tape Formats

In order to assure reliability and tape compatibility in the storage of data, an erased area is recorded in the vicinity of the beginning-of-tape (BOT) marker that is affixed near the reference edge at the start of every tape and an unrecorded area is left in the vicinity of the end-of-tape (EOT) marker affixed at the trailing end of a tape reel. These unrecorded areas are specified in figure 4-46.

The manner of recording the first data after a BOT marker depends on whether the data is NRZI or PE format. On NRZI recorded tapes, the first data record begins after a delay of approximately 6 inches. On PE recorded tapes, there is first a PE identifying burst, consisting of alternate "1's" and "0's" on channel P, all others being erased. Then, there is a space, after which the first data record starts. Minimum spacing between data records is 0.6 inch.

#### 4-51 NRZI Data Recording Format

When using NRZI coding, a logical 1 bit appears on the interface lines as a low voltage level and a logical 0 as a high voltage level. However, on the tape a logical 1 bit is recorded as a flux change and a logical 0 bit as no change. The direction of the change is immaterial. Refer to figure 4-47.

### TRACK SPACING FOR SEVEN- AND NINE-TRACK TAPE

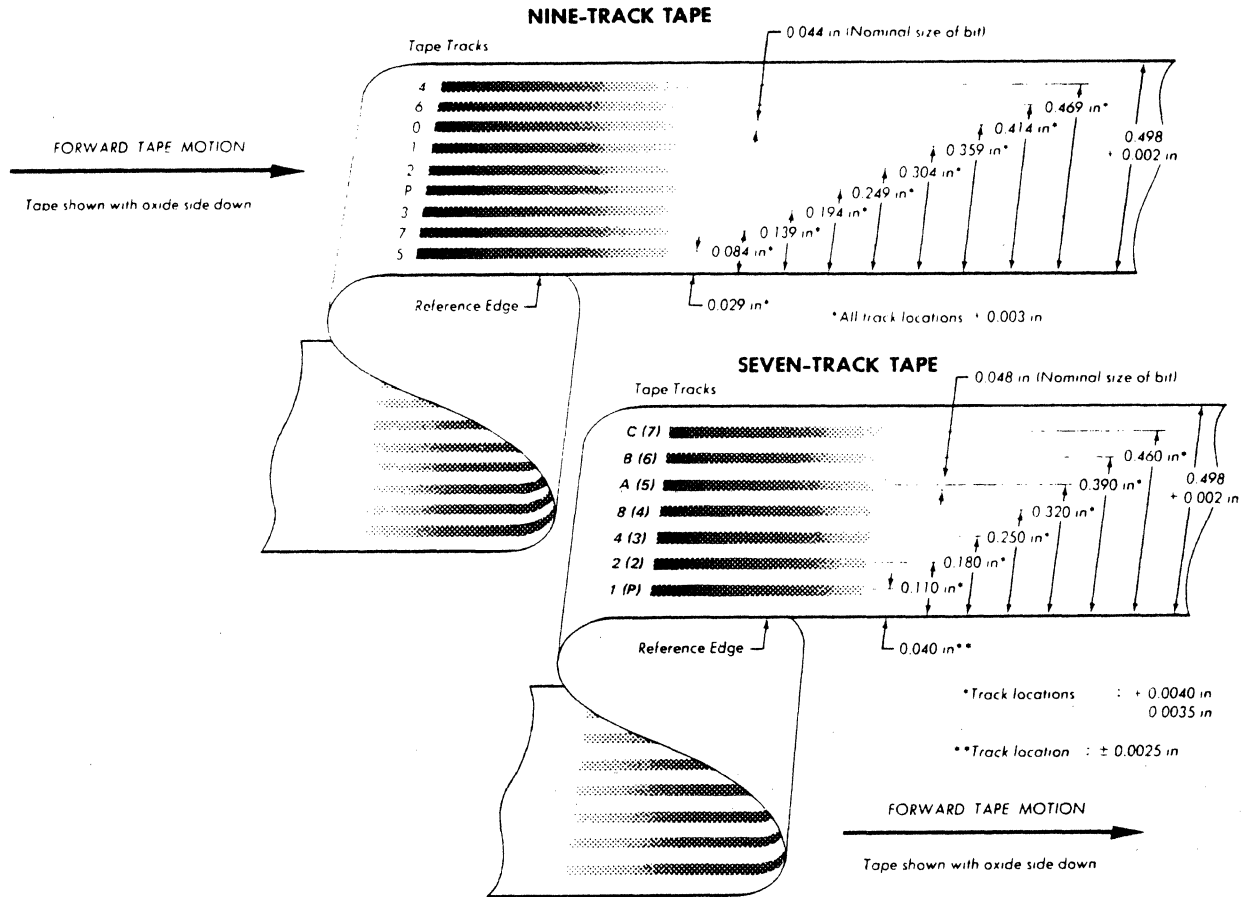


Figure 4-45. Tape Track Layouts

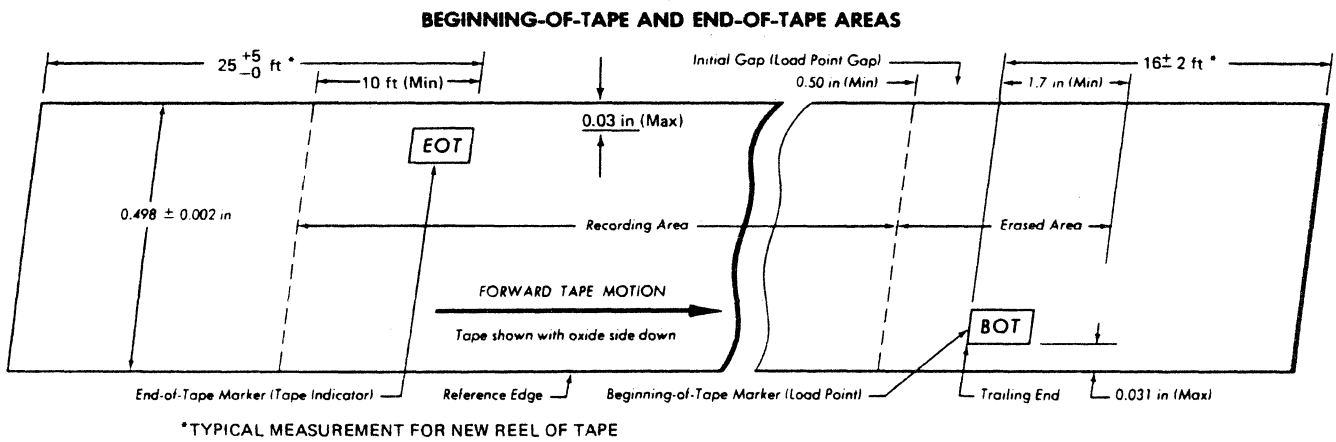


Figure 4-46. BOT and EOT Erase Formats

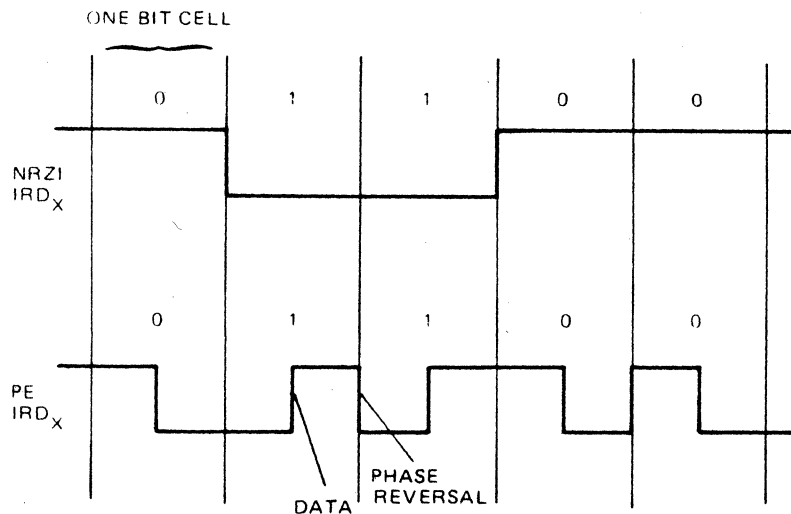


Figure 4-47. NRZI and PE Data Formats

The data is formatted and recorded on the tape in blocks referred to as records. The exact configuration of a record depends on whether the tape is in 7- or 9-track format. On 9-track tape, each record consists of the data, a cyclic redundancy check (CRC) character, and a longitudinal redundancy (LRC) character. The CRC character must occur four character times after the final data character, and the LRC character must occur four character times after the CRC. A minimum spacing of 0.5 inch is required between records. The end of a record is shown in figure 4-48.

On 7-track tape, each record consists of data, followed by an LRC character only, as shown in figure 4-48. Minimum spacing between data records is 0.6 inch.

#### 4-52 PE DATA RECORDING FORMAT

On the interface a low-to-high transition in the middle of the bit cell time is defined as a logical 1 and a high-to-low transition as a logical 0. Refer to figure 4-49. A phase reversal occurs between successive zero bits to establish proper transition relationships for the data. Consequently, two data strobes (data ready) are used by each PE data bit. On the tape a logical 1 bit is recorded as a flux change in one direction and a logical 0 as a flux change in the opposite direction. On the output lines the data is self-clocked and does not require an output clock (read strobe).

The data is formatted on the tape in records, with each record consisting of a preamble, the data, and a postamble. See figure 4-48. The preamble consists of 40 characters of logical 0's and one character of logical 1. The postamble is a mirror image of the preamble, and consists of one character of logical 1 and 40 characters of logical 0's. A minimum spacing of 0.5 inch is required between records. PE data is always recorded on 9-track tape.

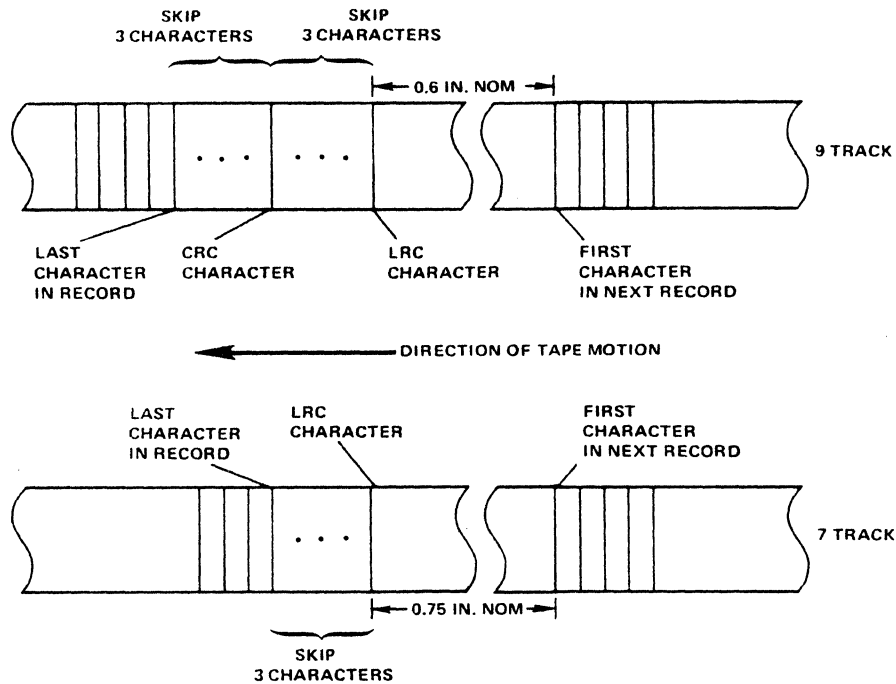


Figure 4-48. End-of-Record Mark Formats for 7- and 9-Track NRZI Tapes

4-53 RECORD AND FILE MARKS

Standard end-of-record and end-of-file mark formats for NRZI recordings are shown in figures 4-47 and 4-50 respectively. The corresponding preamble and postamble for PE recording is described in paragraph 4-51. The end-of-file mark for PE recording is shown in figure 4-51.

4-54 PROGRAM SEQUENCE

The data formats described in paragraphs 4-50 through 4-53 have various gaps preceding or following the records, end-of-file marks, etc. These gaps serve the purposes of protecting previously recorded data during a write operation and assuring the accuracy of data read from the tape during any possible combined sequence of reading, writing, and editing. The gaps also allow ample time for the tape motion to start and stop.

The implementation of these gaps is the function of the formatter. In the formatter these gaps translate into time delays between two signal pulses, prior to starting an operation (pre-delays) and delays after completing an operation (post-delays). Because the length of the gaps, as measured on tape, is to be maintained constant regardless of tape speed, the pre-delays and post-delays vary in time depending on the tape

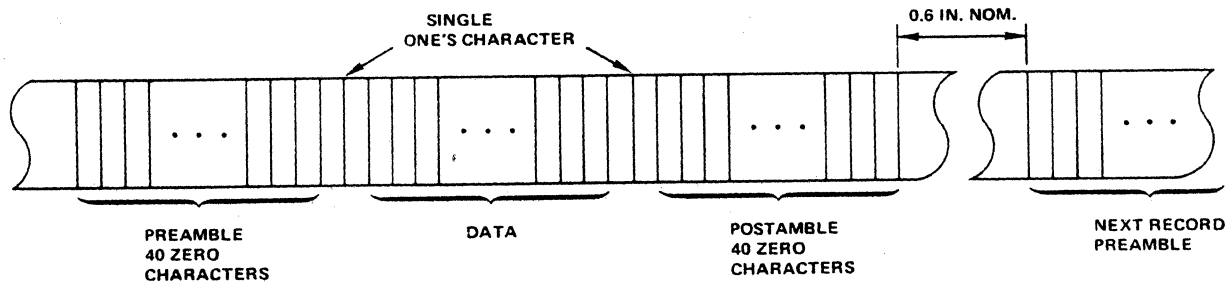


Figure 4-49. PE Record Data Format

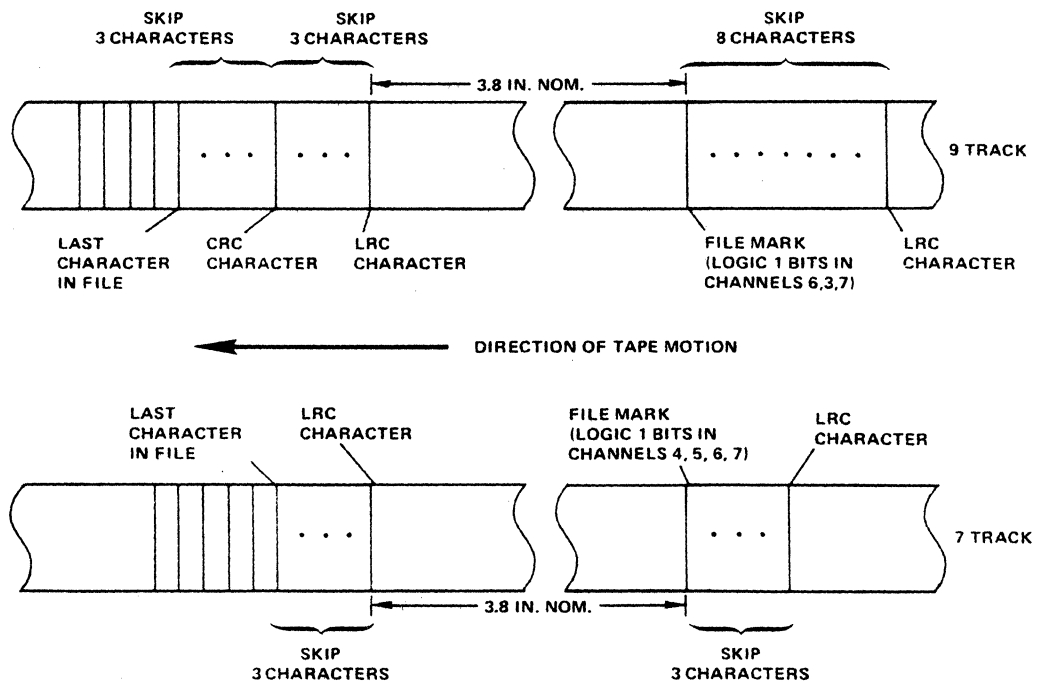


Figure 4-50. End-of-File Mark Formats for 7- and 9-Track NRZI Tapes



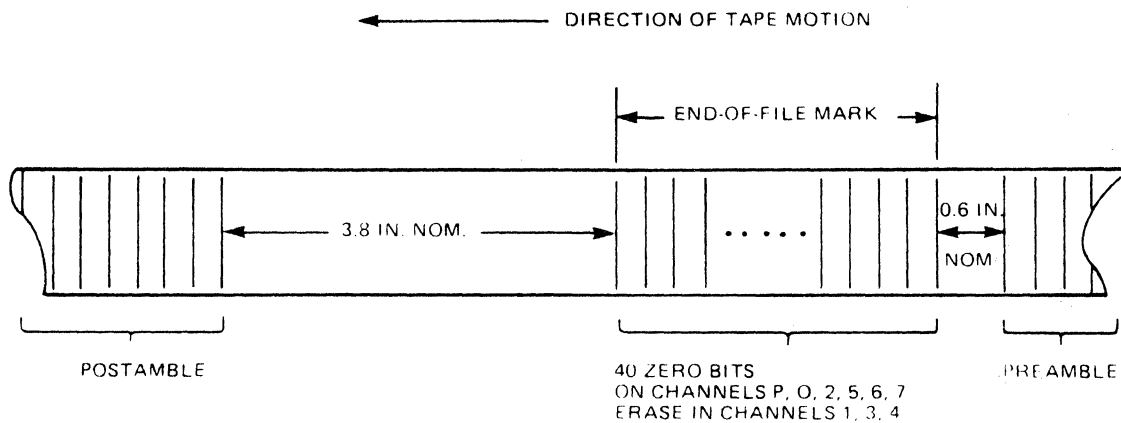


Figure 4-51. End-of-File Mark for PE Tapes

speed. Table 4-2 contains a listing of the essential pre-delays and post-delays for various NRZI and PE tapes. The information in table 4-2 is expressed in terms of distances on tape as well as time.

#### 4-55 START UNIT, WRITE RECORD

Figure 4-52 shows control inputs and output timing for the sequence of starting the tape unit, writing and then rewinding the tape to the load point. The sequence is as follows:

- a. Assert ISELECT address line (0, 1, 2, or 3).
- b. Check the presence of IRDY, IONL, and IBOT signals from the tape unit.
- c. Assert ISFC and ISWRT. ISWRT can be cleared after 10 sec.
- d. The tape unit will accelerate to synchronous speed. After a pre-delay programmed by the formatter, data present at the formatter inputs will be gated to the WRITE DATA lines and clocked into the tape unit synchronous with the DATA READY clock.
- e. After the last character in the record is written, the formatter will gate the proper CRC, LRC, as they are shown in figures 4-48, 4-50 and 4-51.
- f. The formatter will wait for the post-delay and then disable the ISFC signal. The tape unit will stop after the stop distance of 0.190 inch.
- g. Assert IREW for at least 1 sec.
- h. Verify that IRWD is asserted until the tape has rewound and is repositioned at BOT (IBOT asserted).

TABLE 4-2. PRE-DELAYS AND POST-DELAYS

OPERATION	PRE-DELAYS	
	TYPICAL DELAY (in msec)	TOTAL DELAY (in ns)
Write from BOT	91.00	6.640
Write - Dual Gap Head		
7-channel	7.30	0.365
9-channel	5.65	0.240
Write - Single Gap Head		
7-channel	7.30	0.515
9-channel	7.65	0.390
Write File Mark	50.00	3.565
Read from BOT	18.90	1.607
Read Forward	4.00	0.120
Read Reverse	4.00	0.120
Read Reverse/Edit	4.00	0.120
	POST-DELAYS	
Write	1.00	0.265
Write File Mark	1.00	0.265
Read Forward	0.00	0.190
Read Reverse/Edit		
7-channel	4.30	0.515
9-channel	2.65	0.390
Read Reverse		
7-channel	2.65	0.390
9-channel	1.00	0.265
<p>NOTES: 1. NRZI tapes can be either 7 or 9 tracks; PE tapes are always 9 tracks.            2. Write head to read head distance on dual gap heads = 0.150 inch.            3. Write head to erase head distance = 0.340 inch on all heads.</p>		

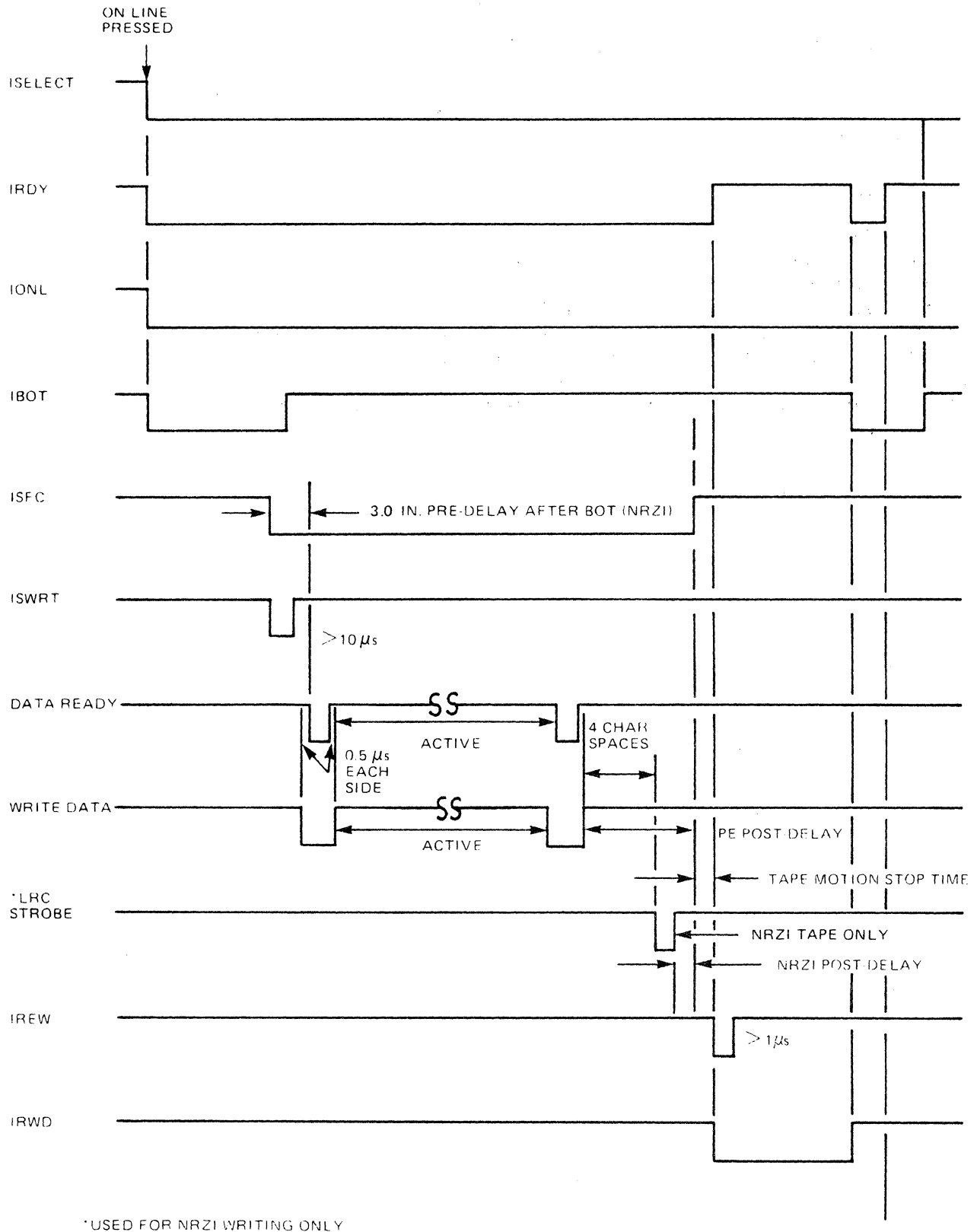


Figure 4-52. Timing Diagram for a Typical Start-Write-Stop Sequence

4-56      START UNIT, READ RECORD

The process for reading data is the same as that for writing data, except ISWRT is not asserted. Data is sampled on the READ DATA lines at the trailing edge of the READ DATA strobe.

4-57      EDIT/OVERWRITE SEQUENCE

An individual record within a file can be edited by writing over the same number of characters of existing data. The sequence is as follows: First, the record is read in the forward direction and tape is stopped at the end of the record; next, the record to be edited is read in reverse edit mode (ISRC) and a post-delay, as shown in table 4-2, is inserted by the formatter as the beginning of the record is reached. This post-delay assures that the head is stopped in the proper place in the interrecord gap to start the edit overwrite operation. Then ISWRT, ISFC and IOVW are asserted to perform editing of the next record in the forward direction. The timing is the same as for a normal write operation.

## Chapter 5

# MAINTENANCE

### 5-1 INTRODUCTION

This chapter contains information required to maintain the 2750 Series Magnetic Tape Unit. The chapter contains preventive maintenance information, checkout and alignment procedures, component replacement instructions, and troubleshooting procedures. Before using the information in this chapter, the maintenance technician should have a thorough knowledge of the material contained in Chapter 4. The simplified schematic, logic, and timing diagrams in Chapter 4 and the drawings provided in Chapter 6 will also prove helpful during checkout and alignment, or in troubleshooting the tape unit.

### 5-2 PREVENTIVE MAINTENANCE

Preventive maintenance for the magnetic tape unit consists of periodic cleaning, checking for wear of tape handling components, and replacement of worn parts as necessary. To ensure reliable operation of the tape unit at optimum design potential and high mean time between failures, a scheduled preventive maintenance program is recommended. This program is divided into operator preventive maintenance and service engineer preventive maintenance. Preventive maintenance requirements for the operator and the service engineer are discussed in paragraphs 5-3 and 5-6. Table 5-1 lists preventive maintenance procedures which should only be performed by a qualified service engineer or maintenance technician.

### 5-3 OPERATOR PREVENTIVE MAINTENANCE

Operator preventive maintenance requirements consist of observing the general operating precautions listed in paragraph 5-4 and performing periodic cleaning as discussed in paragraph 5-5.

### 5-4 General Operating Precautions

Observe the following precautions to ensure proper operation of the tape unit:

- a. Keep dust cover closed when not loading or unloading tape. This prevents contaminants from impairing operation and causing data dropouts.
- b. Ensure that tape is correctly positioned on the guides before tensioning or the tape may be damaged. Take up tape slack before loading.
- c. To prolong tape life, avoid touching the tape except at the leader portion.

- d. Do not touch tape, moving components, or electronic components while the tape is in motion or the tape unit is on line.
- e. To ensure data reliability, do not bring magnetized objects in contact with, or in the vicinity of, the tape unit.

#### 5-5 Cleaning the Tape Unit

At the end of each 8-hour shift, clean the following areas of the tape unit: head and associated guides, roller guides, tape cleaner, vacuum column, and capstan. The following paragraphs present instructions for cleaning tape unit.

#### CAUTION

Do not use rough or abrasive cloths to clean the head and head guides. Use only 90% isopropyl alcohol. Other solvents, such as carbon tetrachloride, may result in damage to the head lamination adhesive.

#### CAUTION

Do not apply excessive solvent to the tape guides. Excessive solvent may seep into the precision guide bearings, causing contamination and a breakdown of the bearing lubricant.

To clean the head, head guides, and tape cleaner use a lint-free cloth or cotton swab moistened with 90% isopropyl alcohol. Wipe the head and tape cleaner carefully to remove all accumulated oxide and dirt.

To clean the capstan, use only a cotton swab moistened with isopropyl alcohol to remove accumulated oxide and dirt.

To clean vacuum column glass, use a lint-free cloth and any commercial glass cleaner that leaves no residue. Remove any matter that covers the vacuum holes.

#### 5-6 SERVICE ENGINEER PREVENTIVE MAINTENANCE

Table 5-1 tabulates the periodic maintenance to be performed by the service engineer or maintenance technician.

#### 5-7 CHECKOUT AND ALIGNMENT

The checkout and alignment procedures can be used to verify that the equipment is operating within specifications, or to check a particular suspected circuit. Test equipment required to perform the maintenance procedures is listed in table 5-2. Test equipment with equivalent characteristics may be substituted for the listed equipment. If abnormal indications are obtained during performance of the following procedures, refer to the troubleshooting procedures in paragraph 5-52. For component location on the circuit boards refer to the assembly drawings provided in Chapter 6.

TABLE 5-1. SERVICE ENGINEER PREVENTIVE MAINTENANCE

MAINTENANCE PROCEDURE	HOURS BETWEEN MAINTENANCE *	MAINTENANCE TIME (HOURS)
Check read skew, write deskew, tape tracking, head wear, tape speed, ramps, EOT/BOT, and data electronics gain and character assembly time. Check 36V fuse (F4, F5) and replace if blown.	2,000	0.75
Replace reel motor brushes	5,000	0.10
Replace capstan motor	10,000	1.0
Replace reel motors and reel drive belts	15,000	1.0
Replace control switches, lamps, and photo sensor assembly	15,000	1.0
*Duty cycle dependent; hours should be counted only when tape is under tension.		

TABLE 5-2. TOOLS AND TEST EQUIPMENT

COMMON NAME	MANUFACTURING MODEL OR TYPE NUMBER
Alignment tool	9810017
Micrometer	Any
IBM master skew tape	432640
Dual channel oscilloscope	Tektronix 453
Belt tension tool, pneumatic assembly	T0023-01A
Miscellaneous shims	(Refer to Recommended Spare Parts List, Chapter 6)
TX-1200 Tape Transport Exerciser	Wilson Labs (00295)
Tachometer, speed indicator, 1000 rpm, 500 ft	JACQUET 230L
Digital Multimeter	Weston 4440
Master output tape	Pericomp (or equivalent)

Acceptable limits are defined in each adjustment procedure, taking into consideration the assumed accuracy of the test equipment specified in table 5-2. When the measured value of any parameter is within the specified acceptable limits, no adjustments should be made. If the measured value falls outside the specified acceptable limits, adjustments should be made in accordance with the relevant procedure.

## NOTE

Some adjustments may require corresponding adjustments in other parameters. Ensure that corresponding adjustments are made as specified in the individual procedures. The +5 and -5 regulator voltages must be checked prior to attempting any electrical adjustments. Any change to the +5 or -5 regulator voltage will require additional adjustments, in the following sequence, to the EOT/BOT amplifier, capstan speed, ramps, and reel servo.

When any adjustment is made, the value set should be as near as possible to the exact value specified in the procedure. Refer to the drawings in Chapter 6 for component location on the tape control board.

5-9 Adjustment of Regulated Supplies

The  $\pm 10$  volt and  $\pm 5$  volt regulated supplies are located on the tape control board, but only the  $\pm 5$  volt supplies are adjustable. Adjustments made on one regulator affect the other, so both regulators must be adjusted until the outputs of both are correct. Limits for the  $\pm 10$  volt and  $\pm 5$  volt supply are listed below. Any adjustment of the voltage regulators generally necessitates readjustment of the capstan speed, ramps, reel servos and EOT/BOT. Apply primary power to the tape unit and proceed with the alignment listed in the following paragraphs. Power supply parameters are listed below.

Power Supply (Vdc)	Nominal Value (Vdc)	Acceptable Range (Vdc)	Adjust to:	Test Points
+10	+10	-11.50 to +9.50	No adjustment	TP25
-10	-10	-11.50 to -9.50	No adjustment	TP32
+5	+5.2	+5.35 to +5.05	$+5.2 \pm .05$	TP1
-5	-5.2	-5.35 to -5.05	$-5.2 \pm .05$	TP2

5-10 +5 Vdc Supply Regulator Adjustment

- Connect the leads of the digital multimeter between TP1 (+) and TP3 (analog ground).
- The digital multimeter display should indicate  $+5.2 \pm 0.15$  Vdc. If the indication is out of tolerance, adjust potentiometer R1018 for an indication of  $+5.2 \pm .05$  Vdc.



5-11 - 5 Vdc Supply Regulator Adjustment

- a. Connect the leads of the digital multimeter between TP2 (+) and TP3 (analog ground).
- b. The digital multimeter display should indicate  $- 5.2 \pm 0.15$  Vdc. If the indication is out of tolerance, adjust potentiometer R1024 for an indication of  $- 5.2 \pm .05$  Vdc.

NOTE

Potentiometer R1024 is readjusted for the final speed adjustment.

5-12 ADJUSTMENT OF EOT/BOT AMPLIFIERS

The EOT/BOT amplifier circuit is located on the tape control board. Perform the following steps to prepare the tape unit and then continue to the amplifier adjustments.

NOTE

The 5-volt regulators must be checked and adjusted, if necessary, prior to checking the EOT/BOT amplifier system.

- a. Apply power to the tape unit.
- b. Load a reel of tape and advance it to the BOT marker.

5-13 BOT Amplifier Adjustment

- a. Remove the head covers. Check and, if necessary, adjust positions to ensure that the EOT/BOT tape sensor and the reflective post are parallel to the tape path. Refer to figure 5-1.
- b. Position the tape on the BOT marker.
- c. Connect multimeter between TP18 and logic ground. Replace the head covers.
- d. Position the tape on the BOT marker and adjust potentiometer R2202 so that the BOT marker voltage is  $+ 1.5$  Vdc minimum. Position tape off BOT marker and check to see that the voltage swings to a minimum of  $- 1.5$  Vdc.

5-14 EOT Amplifier Adjustment

- a. Remove the head covers. Check, and if necessary, adjust positions to ensure that the EOT/BOT tape sensor and the reflective post are parallel to the tape path. Refer to figure 5-1.
- b. Position the tape on the EOT marker.

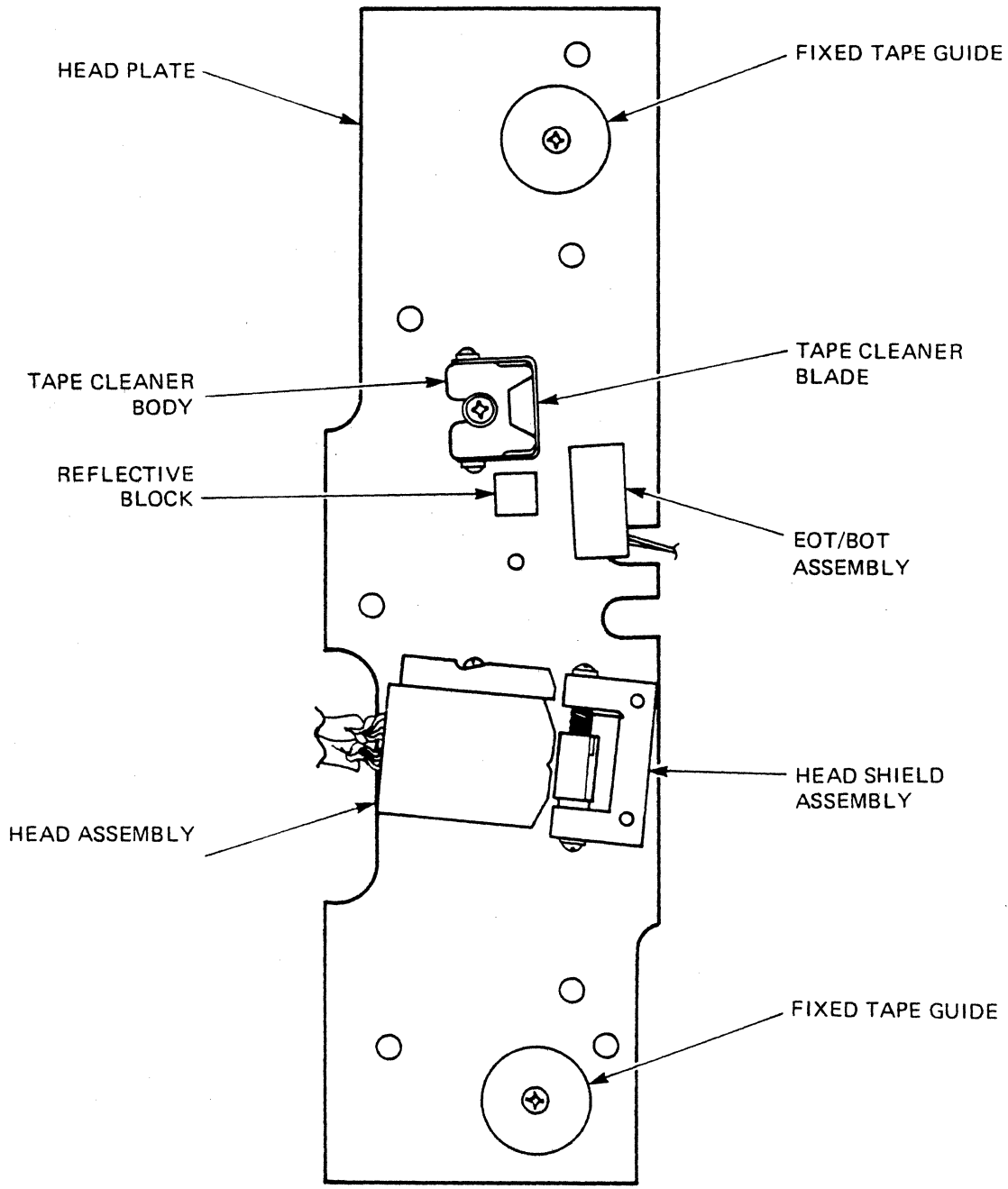


Figure 5-1. Head Plate Assembly

- c. Connect a multimeter between TP17 and ground. Replace the head covers.
- d. Position the tape on the EOT marker and adjust potentiometer R2102 so that the EOT marker voltage is +1.5 Vdc minimum. Position tape off EOT marker and check to see that the voltage swings to a minimum of - 1.5 Vdc.
- e. Remove the tape threaded between the EOT/BOT assembly and the reflective post. Verify that the voltages at TP17 and TP18 are at least + 1.5 Vdc.

#### 5-15 ADJUSTMENT OF CAPSTAN SPEED

The synchronous forward and reverse speeds are adjustable. The following procedures include the capstan amplifier offset adjustment, a coarse speed adjustment and then a fine speed adjustment. Adjustments are given for both single and dual speed units.

Perform the following steps to prepare the tape unit for use and then continue to the capstan speed adjustments.

#### NOTE

The  $\pm 5$  Volt regulators must be checked and adjusted, if necessary, prior to readjusting the capstan speed.

- a. Apply power to the tape unit.
- b. Load a reel of tape and advance it to the BOT marker.

#### 5-16 Offset Adjustment

- a. Connect the leads of the digital multimeter between TP10 (+) and TP3 (analog ground).
- b. Adjust offset potentiometer R4001 until the voltage displayed on the digital multimeter is between - 0.05 and + 0.05 Vdc (zero voltage).

#### 5-17 Capstan Speed Coarse Adjustment (Single Speed)

- a. Thread tape on the tape unit so that it does not wrap around the capstan and set the forward/reverse switch to reverse.
- b. Connect the leads of the digital multimeter between TP12 (+) and TP3 (analog ground).
- c. Adjust potentiometer R5026 until the digital multimeter display indicates the voltage appropriate for the speed requirements of the specific machine. The voltage readings for the different speeds are shown in the following list.

Speed (ips)	Voltage (Vdc)	Tolerance
37.5	0.465	+ 0.010
45	0.587	+ 0.010
75	0.987	+ 0.010

5-18 Capstan Speed Fine Adjustment (Single Speed)

The capstan mounted strobe disc is used to perform fine tape speed adjustments of the synchronous speed. Tape speed adjustments made using the strobe disc are accomplished by illuminating the capstan hub with a fluorescent light source and adjusting potentiometer R5026 until the disc image, created by the pulsating light source, becomes stationary. The accuracy of the adjustment is determined by the length of time in which the disc image completes one revolution. If the image takes longer to make one revolution than the time specified in the list, the unit is still within specifications.

$$\text{time for one revolution} = 628 / (\text{tape speed}) \text{ (accuracy percent)}$$

Tape speed (ips)	1% Tolerance (rotation time) (seconds)
37.5	17
45	14
75	8.4

The strobe disc should be used as follows:

Part No. 9210378-02 (37.5/75 ips) - the outer ring is used when the light source is 50 Hz, and the inner ring when the light source is 60 Hz;

Part No. 9210378-03 (45 ips) - the outer ring is used when the light source is 60 Hz, and the inner ring is used when the light source is 50 Hz.

Perform the adjustments as follows:

- a. Rethread tape around capstan.

Perform the adjustments as follows:

- a. Rethread tape around capstan.
- b. Adjust potentiometer R5026 until image becomes stationary within 1% in reverse direction.
- c. Set the forward/reverse switch to forward and adjust - 5 volt potentiometer R1024 until disc image becomes stationary (within 1%).

5-19 Adjustment of Capstan Rewind Speed (Single or Dual Speed)

Before adjusting the capstan rewind speed, verify that the capstan synchronous speed is correct (paragraph 5-15). Perform the following steps for the tape unit rewind adjustment.

NOTE

The 5-volt regulators must be checked and adjusted, if necessary, prior to checking the capstan rewind speed.

- a. Apply power to the tape unit.
- b. Load a reel of tape and advance it to BOT marker.
- c. Connect the leads of the digital multimeter between TP12 (+) and TP3 (analog ground).
- d. Set forward/reverse switch to forward. Record the voltage indicated on the digital multimeter display.
- e. The correct rewind voltage is calculated by using the following formula:

$$\frac{\text{measured voltage}}{\text{tape speed}} \times 250 \text{ ips} = \text{rewind voltage.}$$

- f. After calculating the rewind voltage, initiate a rewind operation. Adjust potentiometer R3013 until that voltage is displayed on the digital multimeter.

NOTE

For an alternate method using a hand-held tachometer, insert sensing lead of tachometer into capstan. Press start button and observe indicator. Adjust potentiometer R3013 for an indication of 2400 rpm.

5-20 Capstan Speed Coarse Adjustment (Dual Speed)

- a. Thread tape on the tape unit so that it does not wrap around the capstan and use the forward/reverse switch to generate forward motion.
- b. Connect the lead of the digital multimeter between TP12 (+) and TP3 (analog ground).
- c. Set the tape unit to the lower speed and perform the procedures in 5-16 through 5-19.
- d. Set the tape unit to the higher speed and perform the following procedures:

- e. Adjust potentiometer R5027 until the digital multimeter display indicates the voltage appropriate for the speed requirements of the specific machine. The voltage readings for the different speeds are listed in paragraph 5-17.

#### 5-21 Capstan Speed Fine Adjustment (Dual Speed)

The capstan mounted strobe disc is used to perform fine tape speed adjustments of the synchronous speed. Refer to paragraph 5-18 for part number of the applicable set of rings. Tape speed adjustments made using the strobe disc are accomplished by illuminating the capstan hub from a fluorescent light source and adjusting potentiometer R5027 until the disc image, created by the pulsating light source, becomes stationary. The accuracy of the adjustment is determined by the length of time in which the disc image completes one revolution. Tolerances are shown in paragraph 5-18. If the image takes longer to make one revolution than the time specified in the list, the unit is still within specifications.

Perform the adjustments as follows:

- a. Rethread tape around capstan.
- b. Set the tape unit for the lower speed first. Adjust potentiometer R5026 until image becomes stationary within 1% in reverse direction.
- c. Set the forward/reverse switch to forward, and adjust - 5 volt potentiometer R1024 until disc image becomes stationary (within 1%) for higher speed on dual-speed units.
- d. Set tape unit to high speed. Adjust potentiometer R5027 until disc image becomes stationary (within 1%) in forward direction.

#### 5-22 RAMP TIMING ADJUSTMENT (Single Speed)

The four tape acceleration and deceleration ramps (forward and reverse, and start and stop) are controlled by a single potentiometer located on the tape control board. Load a reel of tape and proceed with the following adjustments.

#### NOTE

The  $\pm 5$ -volt regulators must be checked and adjusted, if necessary, prior to checking the ramp timing.

- a. Connect the oscilloscope input to TP8 and sync the oscilloscope at TP5. Ground oscilloscope at TP3.
- b. Initiate a forward-stop tape sequence using either the tape transport exerciser or the forward/reverse switch. Observe the oscilloscope display (see figure 5-2).

- c. Adjust potentiometer R5020 until the ramp width at the 95% point corresponds to the appropriate time for the tape unit speed.

Tape Unit Speed (ips)	Ramp Time (ms)
37.5	10.0
45	8.33
75	5.0

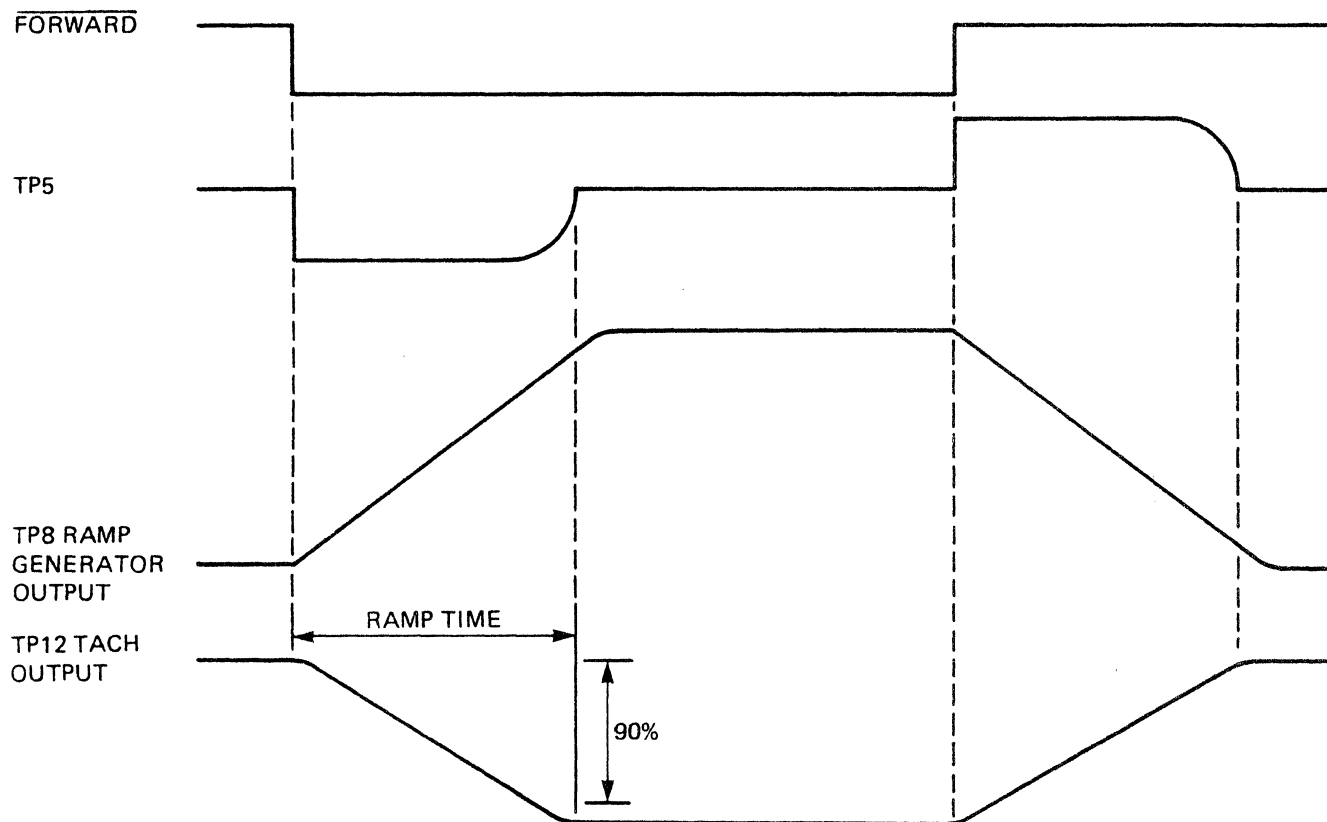


Figure 5-2. Forward Ramp Waveform

## 5-23 RAMP TIMING ADJUSTMENT (Dual Speed)

The four tape acceleration and deceleration ramps (forward and reverse, and start and stop) are controlled by a single potentiometer adjustment located on the tape control board. Set the tape unit to the lower speed and follow the adjustment given in paragraph 5-22. After ramp timing has been completed, set the tape unit to the higher speed. Load a reel of tape on the tape unit and proceed with the following adjustments.

### NOTE

The  $\pm 5$ -volt regulators must be checked and adjusted, if necessary, prior to checking the ramp timing.

- a. Connect the oscilloscope input to TP8 and sync the oscilloscope at TP5. Ground oscilloscope at TP3.
- b. Initiate a forward-stop tape sequence using either the tape transport exerciser or the forward/reverse switch. Observe the oscilloscope display (see figure 5-2).
- c. Adjust potentiometer R5021 until the ramp width at the 95% point corresponds to the appropriate time for the tape unit speed. See the list in paragraph 5-22.

## 5-24 REEL SERVO ELECTRICAL ADJUSTMENTS

The reel servo electrical adjustments consist of the supply reel servo electrical adjustment and the take-up reel electrical adjustment. For dual speed units, set the tape unit to operate at the higher of the two speeds. This adjustment must be made at the higher speed. Perform the following steps to prepare the tape unit for the adjustments.

### NOTE

The  $\pm 5$ -volt regulators must be checked and adjusted, if necessary, prior to checking the ramp timing.

- a. Apply power to the tape unit.
- b. Remove the head covers. Load a loop of tape in the vacuum chamber as shown in figure 5-3.
- c. Momentarily engage the LOAD control.

## 5-25 Supply Reel Servo Electrical Adjustment

- a. Adjust potentiometer R6011 to middle of range.
- b. Connect the leads of the digital multimeter between TP26 (+) and TP3 (-) (ground).



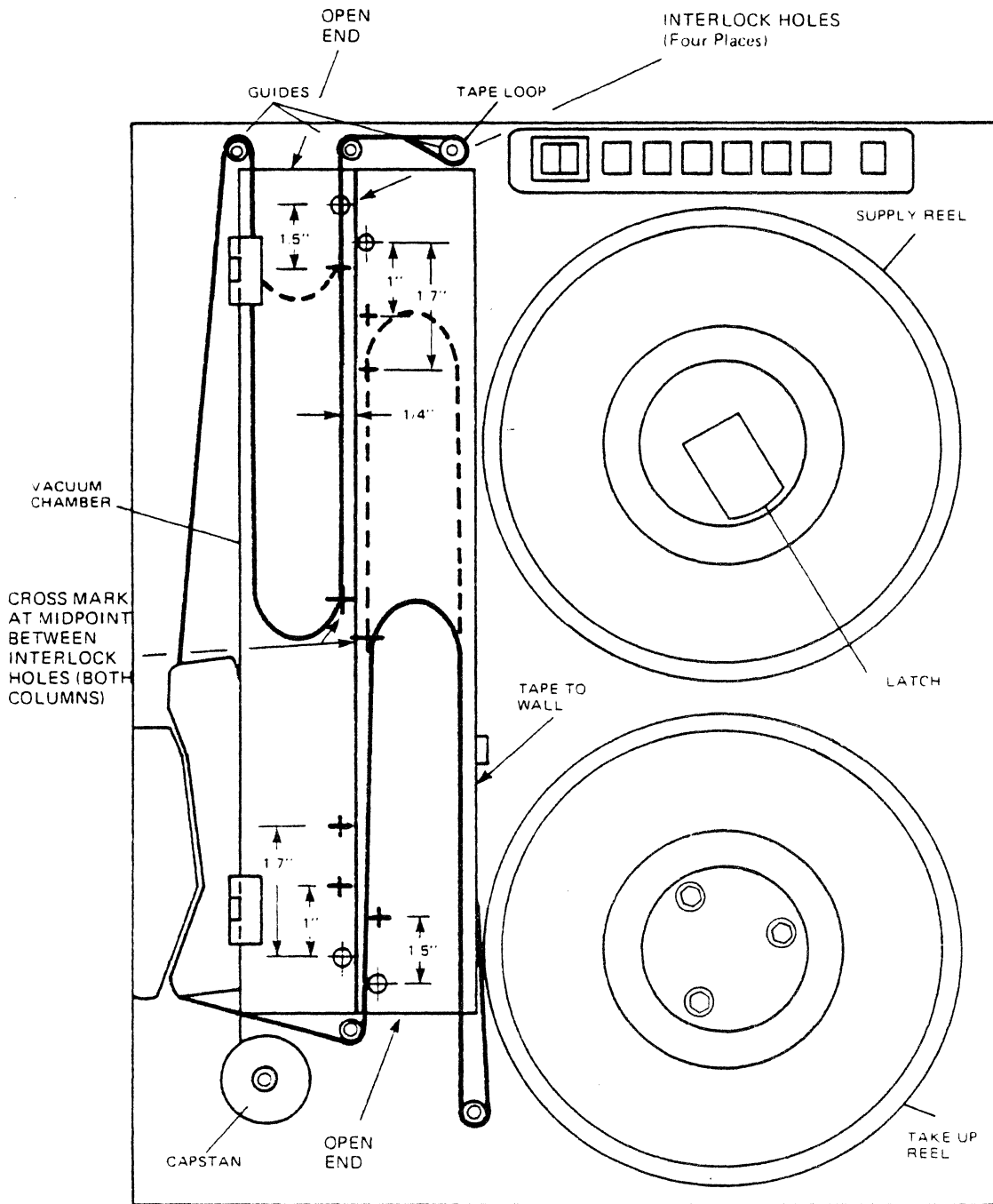


Figure 5-3. Tape Loop for Vacuum Column Servo Adjustment

- c. Position tape loop so that tape intersects a point 1/4 inch from vacuum column wall and half the distance between interlock holes (figure 5-3). Adjust potentiometer R6006 for indication of zero volts ( $\pm 10\text{mV}$ ) on digital multimeter.

- d. Locate tape loop so that tape intersects point 1/4 inch from vacuum column wall and 1.5 inches from supply column open end interlock hole. Adjust R6011 until 1.8 volts ( $\pm 30\text{mV}$ ) is indicated.
- e. Locate tape loop in center of column as in step c. Readjust R6006 for indication of zero volts ( $\pm 10\text{mV}$ ) on digital multimeter.
- f. Connect multimeter leads to TP31 and TP3 (-). Adjust R6018 until +1.5 volts ( $\pm 0.1\text{ volt}$ ) is indicated on digital multimeter.
- g. Remove loop of tape and load a full reel of tape with a nearly empty reel on supply hub.
- h. Using the forward/reverse switch, alternately run tape in forward and reverse directions. Adjust potentiometer R6011 for proper tape travel. Tape should intersect point 1/4 inch from vacuum column wall and 1.5 inches (+0.1, -0.2) from open end interlock hole.

Loop position at closed end of chamber should operate between 1 inch and 1.7 inches from interlock hole. If the operating points do not fall within the above regions, complete steps i and j, then repeat step h.

#### NOTE

For 37.5 ips tape units, move outer marks .5 inch toward center.

For 25 ips tape units, move outer marks 1 inch toward center.

- i. Load a full reel on supply hub.
- j. Using the forward/reverse switch, alternately run tape in forward and reverse directions. Adjust potentiometer R6018 so that tape travel is symmetrical between the two interlock holes ( $\pm 0.5\text{ inch}$ ).

5-26

#### Take-Up Reel Servo Electrical Adjustment

- a. Adjust potentiometer R7011 to middle of range.
- b. Connect the leads of the digital multimeter between TP29 (+) and TP3 (-) (ground).
- c. Position the tape loop so that tape intersects a point 1/4 inch from vacuum wall and half the distance between interlock holes (figure 5-3) Adjust potentiometer R7006 for an indication of zero volts ( $\pm 10\text{mV}$ ) on the digital multimeter.
- d. Locate tape loop so that tape intersects a point 1/4 inch from vacuum wall and 1.5 inches from take-up column open end interlock hole. Adjust R7011 until 1.8 volts ( $\pm 30\text{mV}$ ) is indicated.
- e. Locate tape loop in center of column as in step c. Readjust R7006 for indication of zero volts ( $\pm 10\text{mV}$ ) on digital multimeter.

- f. Connect multimeter leads to TP31 and TP3 (-). Adjust (R7018) until +1.5 volts ( $\pm 0.1$ ) is indicated on digital multimeter.
- g. Remove loop tape-up of tape and load a full reel of tape with a nearly empty reel on hub.
- h. Using the forward/reverse switch, alternately run tape in forward and reverse directions. Adjust potentiometer R7011 for proper tape travel. Tape should intersect point 1/4 inch from vacuum column wall and 1.5 inches ( $\pm 0.1$ ,  $-0.2$ ) from open end interlock hole.

Loop position at closed end of chamber should operate between 1 inch and 1.7 inches from interlock hole. If the operating points do not fall within the above regions, complete steps i and j, then repeat step h.

#### NOTE

For 37.5 ips tape units, move outer marks .5 inch toward center.

For 25 ips tape units, move outer marks 1 inch toward center.

- i. Load a full reel on take-up hub.
- j. Using the forward/reverse switch, alternately run tape in forward and reverse directions. Adjust potentiometer R7018 so that tape travel is symmetrical between the two interlock holes ( $\pm 0.5$  inch).

#### 5-27 NRZI DATA BOARD ELECTRICAL ADJUSTMENTS

The following paragraphs describe the adjustments required for proper operation of the NRZI data board. Refer to Chapter 6 for component location drawings. Acceptable limits are defined in each of the following adjustment procedures for both the dual and single gap head assemblies. The following list indicates which adjustment procedures are applicable to dual and single gap head assemblies and the order in which the adjustment procedures should be performed.

- a. Read amplifier gain adjustment procedure: dual and single gap heads.
- b. Read head skew measurement and adjustment procedure: dual and single gap heads.

- c. Write head skew: dual gap heads only.
- d. Head shield adjustment: dual gap heads only.
- e. Read strobe: dual and single gap heads.

5-28 Read Amplifier Gain Adjustment

The gain of each of the read amplifiers is independently adjustable. Perform the following steps to prepare the tape unit for the adjustment procedure.

- a. Clean the head assembly and tape path as described in paragraph 5-5.
- b. Apply power to the tape unit.
- c. Load a master output tape on the tape unit and advance it to the BOT marker.
- d. Use the TX-1200 Tape Transport Exerciser (or its equivalent) to write 800 bpi all ones on all channels. Refer to the tape transport exerciser manual (Part No. 9580062) for equipment interconnect and set up instructions.
- e. Connect oscilloscope to TP101.
- f. Read during write and adjust potentiometer R117 until the analog signal displayed on the oscilloscope is 10 volts peak-to-peak (figure 5-4).
- g. For single gap heads, adjust R117 for 10 volts peak-to-peak.
- h. Repeat steps f through g for all channels using TPX01 and potentiometers RX17 (X is 2 through 9).

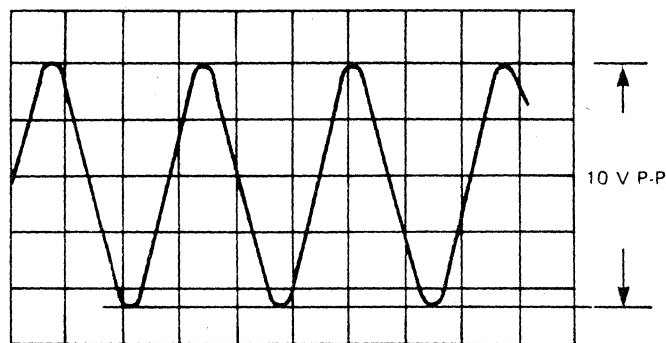


Figure 5-4. Amplifier Waveforms, NRZI All Ones (TP101)

Read Head Skew Measurement and Adjustment

The read head skew measurement and adjustment procedures should only be required when the tape head has been replaced. The adjustment of read skew is accomplished mechanically by shimming one of the fixed head guides. The shims are 0.0005 inches thick and correct for 37.5 microinches of skew. No more than four shims are allowed under a guide. Both guides should not be shimmed on the same head plate assembly. Remove the guide and place the shim on the screw that mounts the guide; and reassemble the guide on the head plate assembly. Load the IBM master skew tape on the tape unit and perform the following adjustments.

## 5-30 Skew Measurement and Adjustment (Nine-Track)

- a. Using a dual trace oscilloscope, connect channel A to TP603 and channel B to TP703 for nine-track units.
- b. Using the forward/reverse switch, run the tape forward. Observe the time displacement between the two signals displayed on the oscilloscope (figure 5-5). Calculate the amount of displacement (refer to table 5-3).
- c. If the displacement is less than 100 microinches, no shimming is required. If the displacement is greater than 100 microinches and TP703 is the leading signal, the guide on the capstan side of the head assembly should be shimmed. The number of shims required can be calculated as follows:

$$\text{Number of shims} = \frac{(\text{tape speed})}{37.5 \times 10^{-6}} \times (\text{time displacement})$$

- d. After the guide has been shimmed, verify that the distance displacement is less than 100 microinches.
- e. Use staircase skew method (paragraph 5-38) to measure read skew for all tracks simultaneously. Verify less than 100 microinches of static skew or less than 75 microinches of dynamic skew.

## 5-31 Skew Measurement and Adjustment (Seven-Track)

- a. Using a dual trace oscilloscope, connect channel A to TP903 and channel B to TP103.
- b. Using the forward/reverse switch, run the tape forward. Observe the time displacement between the two signals displayed on the oscilloscope (figure 5-5). Calculate the amount of displacement (refer to table 5-3).
- c. If the displacement is less than 100 microinches, no shimming is required. If the displacement is greater than 100 microinches and TP103 is the leading signal, the guide on the capstan side of the

head assembly should be shimmed. The number of shims required can be calculated as follows:

$$\text{Number of shims} = \frac{(\text{tape speed}) \times (\text{time displacement})}{37.5 \times 10^{-6}}$$

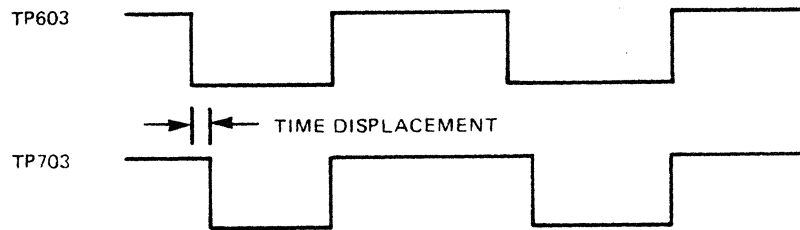


Figure 5-5. Output Waveforms (TP103, TP203, TP603, TP703)

- d. After the guide has been shimmed, verify that the distance displacement is less than 100 microinches.
- e. Use staircase skew method (paragraph 5-35) to measure read skew for all tracks simultaneously. Verify less than 100 microinches of static skew or less than 75 microinches of dynamic skew.

#### 5-32 Write Head Deskew Adjustment

##### NOTE

Deskew adjustment is applicable to dual gap heads only.

To ensure proper write head deskewing, the read head gap scatter must first be plotted using the IBM master skew tape. This plot is then duplicated while writing on a tape by adjusting the write deskew delay potentiometers. Load the IBM master skew tape on the tape unit and perform the following adjustments.

#### 5-33 Read Head Gap Scatter Plot

- a. Using a dual trace oscilloscope, connect channel A to TP5 (ORed data) and sync to positive-going signal.
- b. Set the forward/reverse switch to forward and monitor TP103 through TP903 with channel B of the oscilloscope. Record the time displacement between channels A and B (figure 5-6).

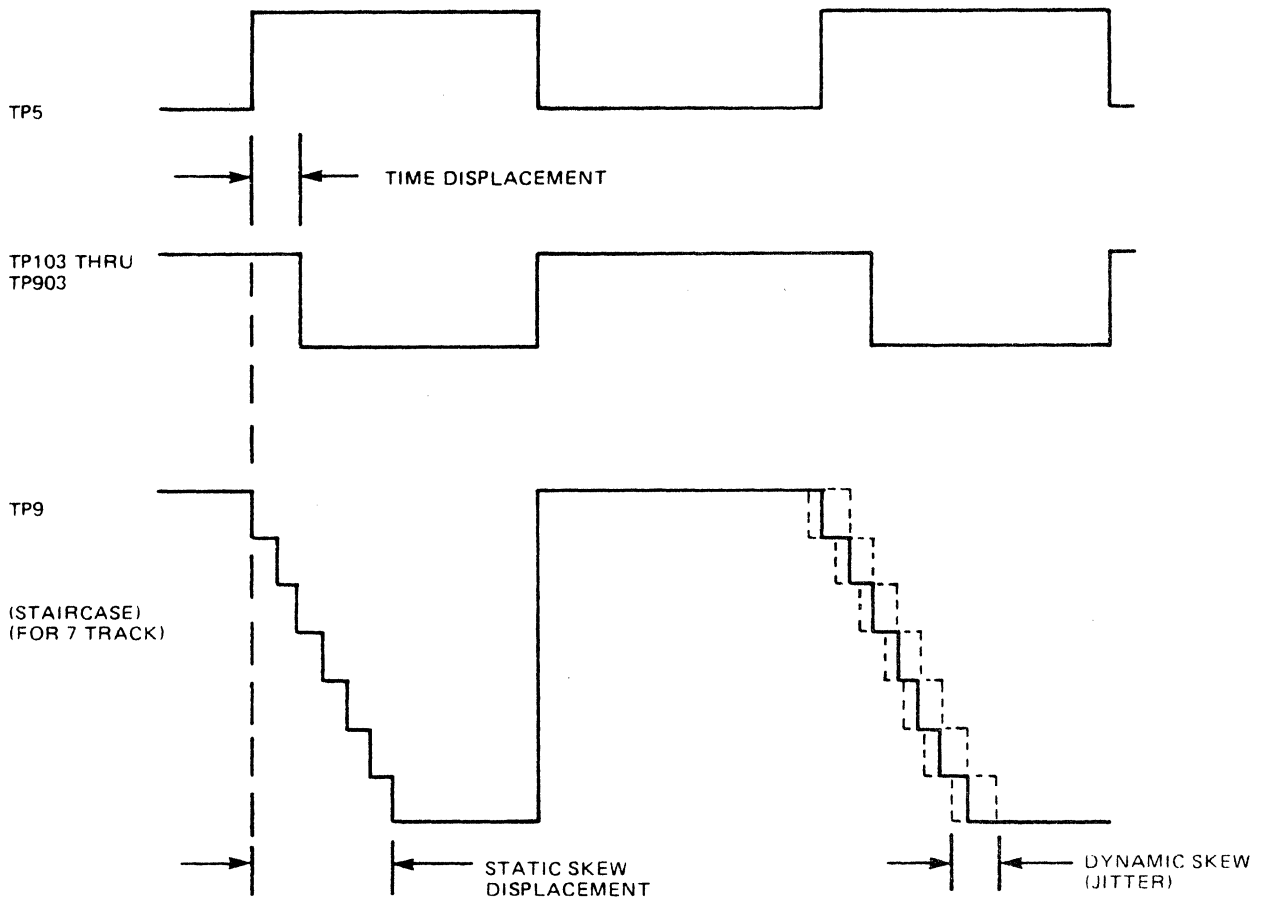


Figure 5-6. Time Displacement between Channels A and B and 7-Track Staircase Skew Waveforms

5-34 Write Deskew Adjustment

- a. Unload the IBM master skew tape from the tape unit and load a reel of tape on the unit.
- b. Advance the tape to the BOT marker.
- c. Use the TX-1200 Tape Transport Exerciser to write all ones in all channels. Refer to the tape transport exerciser manual (Part No. 9580062) for equipment interconnection and set up instructions.

NOTE

Steps d and e are required only for new data PWBA replacements.

- d. Connect oscilloscope to TP13.
- e. Adjust potentiometer R102 so that the negative pulse displayed on the oscilloscope is 4.25 microseconds at 75 ips; 7.05 microseconds at 45 ips; 8.5 microseconds at 37.5 ips, or 12.75 microseconds at 25 ips. Set potentiometer R202 through R902 to minimum value (clockwise).
- f. Connect channel A of oscilloscope to the test point with the smallest delay time measured in 5-33b (first track in). Connect channel B of oscilloscope to TP103 through TP903 and, while monitoring the signals at these test points, adjust the write deskew potentiometers (R102 through R902) so that the read head gap scatter plot duplicates the time delays recorded in paragraph 5-31.
- g. Use the staircase skew method (paragraph 5-35 to measure read skew after a write operation. Verify that read after write total skew (static and dynamic) is less than 150 microinches for forward and reverse.

TABLE 5-3. TIME DISPLACEMENT FOR 150 MICROINCHES

Speed (ips)	R/W Skew Displacement (microinches)
37.5	4
45	3.3
75	2.

5-35 Staircase Skew Measurement

A quick check of all read skew or write deskew can be made by observing the waveform at TP9 (figure 5-6). The length of time from the first step to the last is the total skew displacement. The total read skew (static and dynamic) using an IBM master skew tape, should be no more than 175 microinches. If the skew cannot be brought within limits by shimming the fixed guides, adjust the tape path in accordance with paragraph 5-48.

To perform the read skew measurement proceed as follows:

- a. Sync oscilloscope on the positive going leading edge of the ORed data pulse at TP5.
- b. Connect oscilloscope to TP9 (staircase).
- c. Run the IBM master skew tape in the forward and reverse directions. Verify that the skew is no more than 175 microinches.
- d. The equivalent times for a displacement of 175 microinches is a function of tape speed as follows:

$$\text{Time (microseconds)} = \frac{175 \text{ microinches}}{\text{tape speed (inches/sec)}}$$



The read after write skew should be no more than 150 microinches when writing all ones. If it is more than 150 microinches, the following procedure is an alternate method of write deskew measurement.

#### 5-36 Write Deskew Measurement

This procedure may be used as an alternate to the procedure contained in paragraph 5-35.

- a. Program the TX-1200 Tape Transport Exerciser to write all ones.
- b. Sync on the positive leading edge at TP5 and monitor TP9 on the oscilloscope.
- c. Adjust potentiometers R102 through R902 for the minimum displacement.
- d. Program the exerciser to alternately write all ones and read reverse.

Readjust potentiometers R102 through R902 for minimum skew displacement in both directions.

#### 5-37 Head Shield Adjustment

Head shield adjustment is necessary to minimize crosstalk between the read and write heads. Perform the following adjustment procedure.

- a. Apply power to tape unit.
- b. Load a reel of tape on the unit.
- c. Remove tape from the capstan so that the only signal present at the output of the read amplifier is crosstalk from the write head.
- d. Use the TX-1200 Tape Transport Exerciser to write all ones on all channels. Refer to the tape transport exerciser manual (Part No. 9580062) for equipment interconnect and set-up instructions.
- e. Connect oscilloscope Channel A to TP601 and Channel B to TP701 (nine-channel) or Channel A to TP901 and Channel B to TP101 (seven-channel).
- f. The amplitude of the signal displayed on the oscilloscope should be less than 0.5 volts.
- g. If the signal amplitude is greater than the allowed limit, remove the head cover. Loosen the two screws securing the head shield (figure 5-1) and adjust the head shield until the voltage is within limits. Be careful that the head shield does not touch the tape and that it remains parallel to the head.

Read Character Assembly Time Adjustment

Load a standard level output tape on the tape unit, then use the TX-1200 Tape Transport Exerciser to write 800 bpi, all ones on all channels. Refer to the tape transport exerciser manual (Amcomp PN9580062) for equipment interconnect and set up instructions. After recording all ones on all channels, rewind the tape to the BOT marker and proceed to the following adjustment procedures.

- a. Connect oscilloscope channel A to TP5.
- b. Run the tape forward in the read mode.
- c. Adjust potentiometer R29 so that the positive pulse observed on the oscilloscope is equal to 50% of a bit time (refer to table 5-4 and figure 5-7).
- d. Perform a write operation and verify that the positive pulse shortens to 34% or 40% of the bit time.

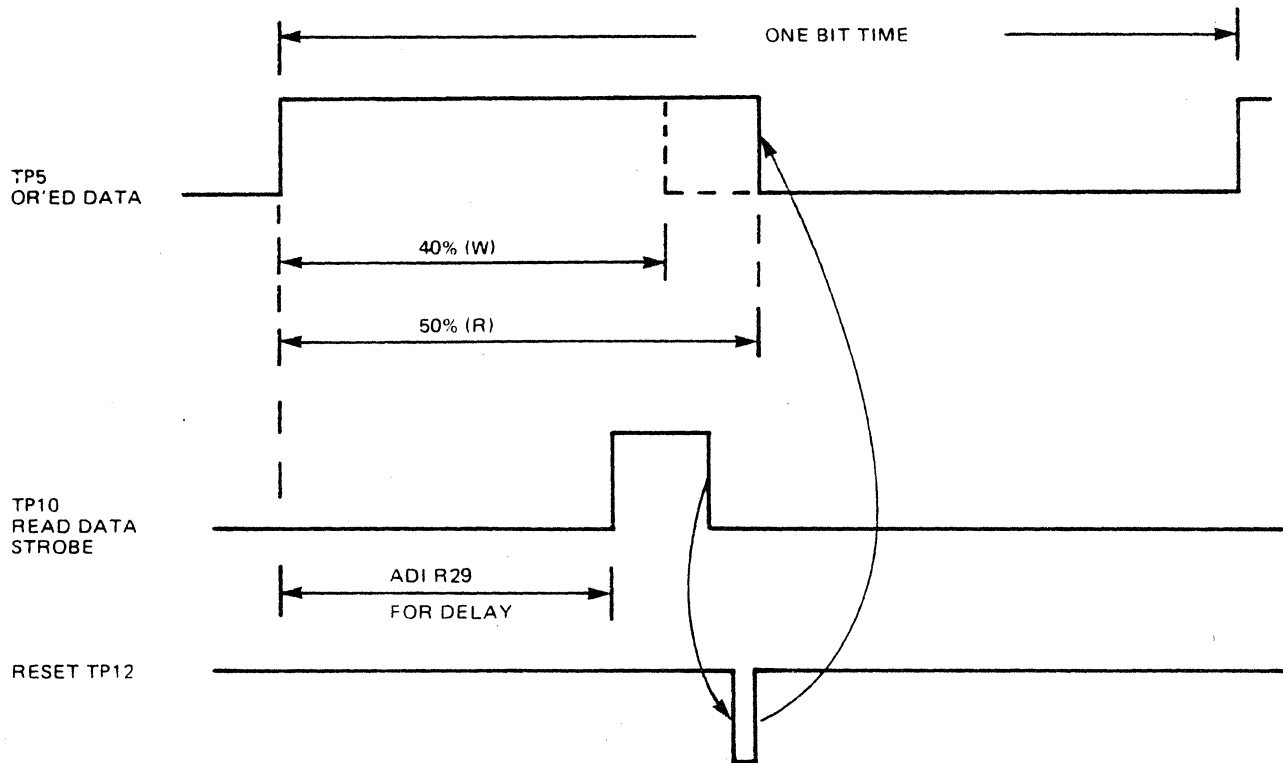


Figure 5-7. Read Character Time Adjustment Waveform

TABLE 5-4. 50% BIT TIME FOR VARIOUS TAPE SPEEDS AND DENSITIES  
50% BIT TIME (MICROSECONDS)

SPEED (IPS)	800 BPI	556 BPI	200 BPI
37.5	17	24	68
45	14	20	56
75	8.5	12	34

5-39 Threshold Measurement

The correct threshold voltages are necessary to correctly read data from tape. Perform the following steps to measure the threshold voltages.

- a. Apply power to the tape unit.
- b. Load a reel of tape on the tape unit and advance it to BOT marker.
- c. Verify that Read Threshold 1 at J301-E and Read Threshold 2 at J301-F are inactive (high).
- d. Set the tape unit off line. Connect oscilloscope to test point TP11. The voltage should be approximately 1.3 volts.
- e. Set the tape unit on line. Set Read Threshold 2 low. The voltage should be approximately 0.7 volts.
- f. For dual-gap version data boards, use the TX-1200 to write data. For single-gap version, activate Read Threshold 1. The voltage should be approximately 2.0 volts.

5-40 PHASE ENCODED DATA BOARD ELECTRICAL ADJUSTMENTS

The adjustments procedures contained in this section should be performed whenever a tape head is replaced. The following list indicates the order in which the adjustment procedures should be performed.

- a. Read amplifier gain adjustment.
- b. Read head skew measurement and adjustment.
- c. Head shield adjustment.

Refer to the PE data board drawing in Chapter 6 for component location.

Read Amplifier Gain Adjustment

The gain of each of the read amplifiers located on the PE data board is independently adjustable. Perform the following steps to adjust the PE data board read amplifiers.

- a. Clean the head assembly and tape path as described in paragraph 5-5.
- b. Apply power to the tape unit.
- c. Load a master output tape on the tape unit and advance it to the BOT marker.
- d. Use the TX-1200 Tape Transport Exerciser to write all ones on all channels. Refer to the tape transport exerciser manual (Part No. 9580062) for equipment interconnect and set up instructions.
- e. Connect oscilloscope to TP104.
- f. Read during write and adjust potentiometer R112 until the analog signal displayed on the oscilloscope is 6 volts peak-to-peak. (Refer to figure 5-8).
- g. Repeat step f for all channels using TPX04 and potentiometers RX12 (X is 2 through 9).
- h. For single gap heads only, after recording all ones on all channels rewind the tape to the BOT marker and perform steps f and g in the read mode.

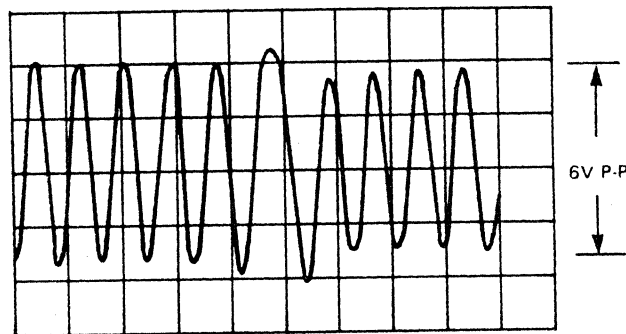


Figure 5-8. Amplifier Waveform (TP104)

Read Head Skew Measurement and Adjustment

The read head skew measurement and adjustment procedures should only be required when the read head has been replaced. The adjustment of read skew is accomplished mechanically by shimming one of the head guides. The shims are 0.0005 inches thick and correct for 37.5 microns of skew. No more than four shims are allowed under any one guide. Only one of the guides should be shimmed on the same headplate

assembly. Remove the guide and place the shim on the screw that mounts the guide and reassemble the guide on the headplate assembly. Perform the following measurement and adjustment steps:

- a. Apply power to the tape unit.
- b. Load the IBM master skew tape on the tape unit and advance it to BOT marker.
- c. Using a dual trace oscilloscope, connect channel A to TP607 and channel B to TP707.
- d. Set the forward/reverse switch to forward. Observe the time displacement between the two signals displayed on the oscilloscope (see figure 5-6). Calculate the amount of displacement (refer to table 5-3).

If the displacement is less than 100 microinches, no shimming is required. If the displacement is greater than 100 microinches and TP707 is the leading signal, the guide on the capstan side of the head assembly should be shimmed. Otherwise shim the other guide. The number of shims required can be calculated as follows:

$$\text{Number of shims} = \frac{(\text{tape speed}) \times (\text{time displacement})}{37.5 \times 10^{-6}}$$

- e. After the guide has been shimmed, verify that the displacement is less than 100 microinches.

#### 5-43 Head Shield Adjustment

The head shield adjustment is used to minimize crosstalk between the read and write heads.

- a. Apply power to the tape unit.
- b. Load a reel of tape on the unit.
- c. Remove tape from the capstan so that the only signal present at the output of the read amplifier is crosstalk from the write head.
- d. Use the TX-1200 Tape Transport Exerciser to write all ones on all channels. Refer to the tape transport exerciser manual (Part No. 9580062) for equipment interconnect and set up instructions.
- e. Connect oscilloscope channel A to TP604 and channel B to TP704.
- f. The amplitude of the signal displayed on the oscilloscope should be less than 0.5 volts.
- g. If the signal amplitude is greater than the allowed limit, remove the head cover. Loosen the two screws securing the head shield (see figure 5-1) and adjust the head shield until the voltage is within limits. Be careful that the head shield does not touch the tape and that it remains parallel to the head.

A quick check of all read/write adjustments can be made by observing the waveform at TP5 (see figure 5-9). The length of time from the first step to the last is the total amount of skew displacement. If the skew is greater than 175 microinches and cannot be brought within limits by shimming the fixed guides, the tape path adjustment (paragraph 5-48) should be performed. Perform the measurement as follows:

- a. Connect oscilloscope to TP5.
- b. Load a skew tape on the tape unit and perform the PE Read Skew Measurement Procedure given in steps c and c.
- c. Using the maintenance switch, run the tape forward. Measure the skew and verify the static skew is less than 100 microinches, and the skew jitter is less than 75 microinches.
- d. Run the tape in reverse and measure the amount of skew. The static skew must be less than 100 microinches and the skew jitter is less than 75 microinches.
- e. Replace the skew tape with a standard tape and perform the PE Read/Write Skew Measurement Procedure given in steps f and g.
- f. Set up the TX-1200 Tape Transport Exerciser to write all ones on all channels
- g. With the exerciser writing all ones on all channels on the tape, measure the total skew time. Verify the total skew is less than 150 microinches.

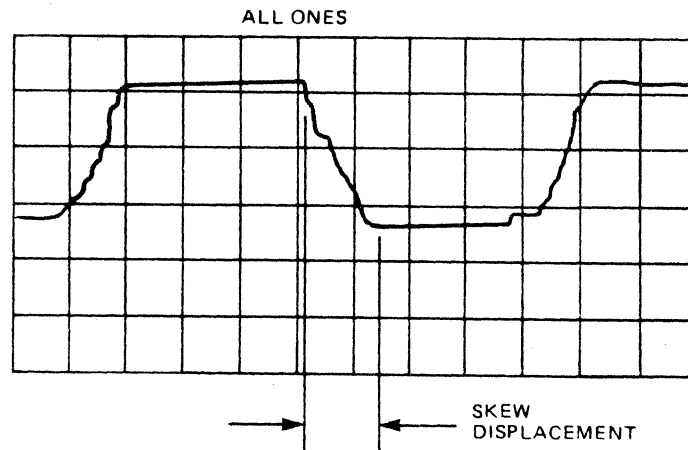


Figure 5-9. PE Staircase Waveform (TP5)

Threshold Measurement

The correct threshold voltages are necessary to correctly read data from tape. To measure the threshold voltages, perform the following steps:

- a. Apply power to the tape unit.
- b. Load a reel of tape on the tape unit. Press and release the LOAD control twice (once on units equipped to automatically position the tape at the BOT marker) to tension the tape and to advance the tape to the BOT marker.
- c. Verify that Read Threshold 1 and Read Threshold 2 are inactive.
- d. Set the tape unit off line. Connect oscilloscope to test point TP4. The voltage should be approximately 0.6 volts.
- e. Set the tape unit on line. Active Read Threshold 2. The voltage should be approximately 0.3 volts.
- f. For dual-gap data boards, use the TX-1200 to write data. For single-gap version, activate Read Threshold 1. The voltage should be approximately 1.3 volts.

5-46 MECHANICAL CHECKOUT AND ALIGNMENT

The following paragraphs present checkout and alignment procedures for the mechanical components of the magnetic tape unit.

5-47 Tape Path Alignment Measurement

Load a tape on the tape unit and perform the following steps.

- a. Using the forward/reverse switch run the tape forward and reverse.
- b. Check at all of the guides for tape curling or warping at the edges while tape is moving. If it is, adjust the tape path (paragraph 5-48).

NOTE

The tape used for this check must be in new condition.

- c. Check that the tape stays in the center of the capstan as the tape is run forward and reverse. If it does not, adjust the tape path.
- d. Remove the tape guide caps from the fixed tape guides on the headplate assembly.
- e. Press the spring-loaded tape guide washers to the headplate. Secure in this position.
- f. Using the forward/reverse switch, run the tape forward and reverse.
- g. Verify that the tape movement across the fixed tape guides is less than 0.010 inches. If the tape is outside these limits, adjust the tape path.
- h. Replace tape guide caps on the guides. Release the spring-loaded washer.
- i. Perform the staircase skew measurement (paragraph 5-35).

5-48 Tape Path Adjustment

Alignment of the tape path components is accomplished by using Alignment Tool 9810017. The tape path components consist of the headplate, the tape guide rollers (supply and take-up), the supply and take-up hub, and the capstan.

CAUTION

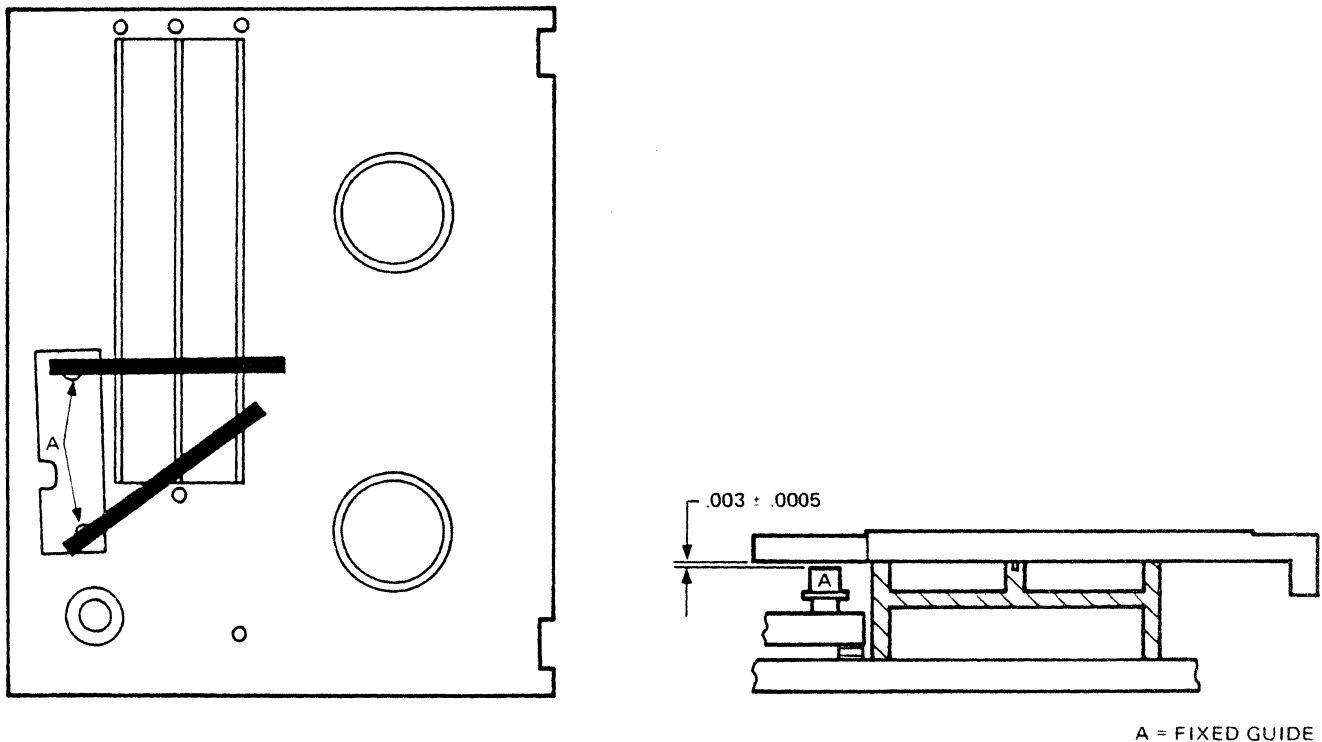
The alignment tool is precision made and must be handled with care to avoid damage.



NOTE

This procedure is required only when fixed tape guide is replaced. Otherwise, do not adjust the head plate.

- a. Remove power from the tape unit.
- b. Remove the two head covers, the reels and the tape unit overlay. Be careful of components on the head plate assembly. The overlay is secured with hook and loop fabric.
- c. Remove the ceramic caps from the two guides.
- d. Remove the vacuum chamber door by unfastening the hinges from the chamber. Leave the hinges on the door.
- e. Check each guide as shown in figure 5-10 which indicates the two positions of the alignment tool. The flat edge of the tool is used. Place the flat edge across the vacuum chamber so that the tool is over the guide and then measure the gap with a feeler gauge. The gap should be  $.003 \pm .0005$  inches.



A = FIXED GUIDE

Figure 5-10. Head Plate Alignment Tool Positioning

- f. If either guide position is out of tolerance, adjust head plate by changing shims of screw nearest to guide requiring adjustment, as follows.

#### CAUTION

Adjustment requires removing the head plate. The three plate-mounting screws each have spacers and, possibly, shims. The gold-colored spacers might be different sizes, silver colored spacers are matched in size. Follow the procedure carefully to avoid spilling spacers and shims. If spacers are removed, keep track of their original positions for re-assembly. Also keep track and retain shims of screws not requiring adjustment.

- g. Unplug head cable connectors and EOT/BOT cable connector.
- h. Slowly loosen the three mounting screws but only until they are disengaged from the deck plate. Then, hold the screw, spacers and shims in place. Tilt the plate so that the spacers do not fall and carefully remove the plate.
- i. Add or remove shims to whichever screw is nearest to the guide requiring adjustment. Shim both, if necessary. To avoid causing tilt of head plate, add shims to center mounting screw by an amount equal to the average change of the other two.
- j. Reinstall plate and re-check guide heights. Repeat procedure until proper height is achieved.
- k. When adjustment is correct, reinstall guide caps and vacuum chamber door and reconnect head cable connectors and EOT/BOT connector.

#### 5-50 Tape Guide Roller Adjustments

#### NOTE

This procedure is required only when tape guide roller is replaced or reversed. Adjustment is not required after bearing replacement unless roller was reversed. Except under these conditions, don't adjust tape guide rollers.

In figure 5-11, the top view of the door shows the five positions of the alignment tool for adjusting each roller, identified by number. The close-up view shows the two positions of the tool for aligning rollers 2 (left) and 1, looking into the end of the vacuum columns. The alignment tool illustrations show the different tool cuts used for the roller offset measurements.

- a. Remove power from the tape unit.
- b. Remove entry guide. (Required only when rollers 3 or 5 are to be changed.)

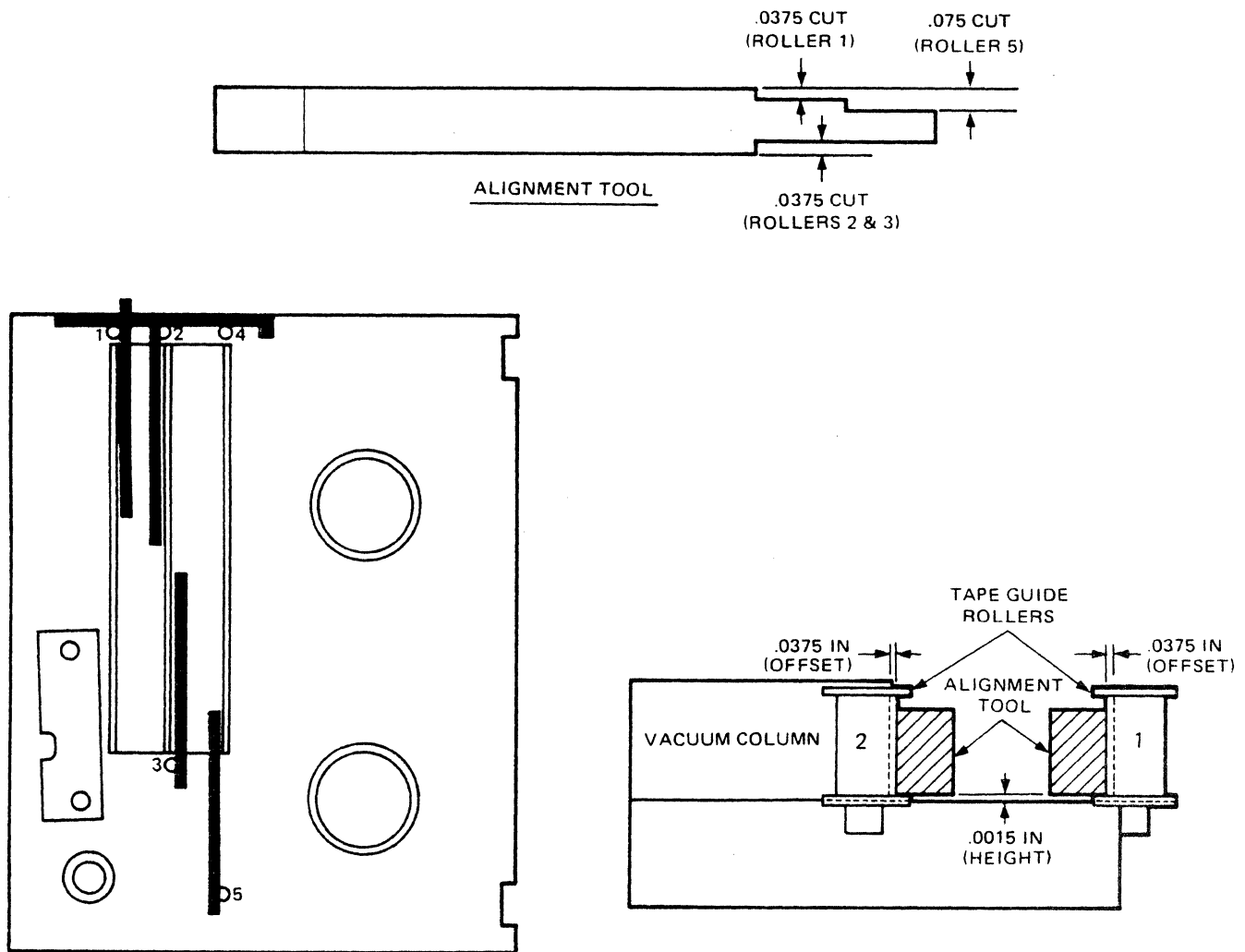


Figure 5-11. Tape Roller Height and Offset Adjustment

- c. Remove reels, head covers, and the tape unit overlay. Be careful of components on the head plate assembly. The overlay is secured with hook and loop fabric.
- d. Remove vacuum cover by unfastening hinges from the chamber. Leave the hinges on the door.
- e. Position alignment tool for roller 1. Make sure proper cut is selected for checking offset, as shown in figure 5-11. If offset is incorrect, adjust as follows:

## CAUTION

There might be shims between roller blocks and deck. Try to keep shims in place when block is loosened or, if they slip out, reinstall in original position.

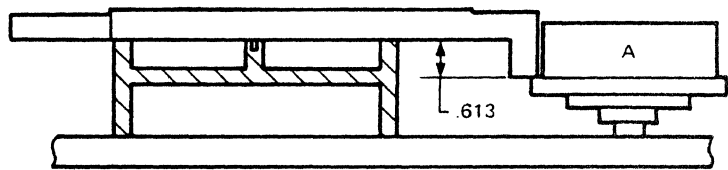
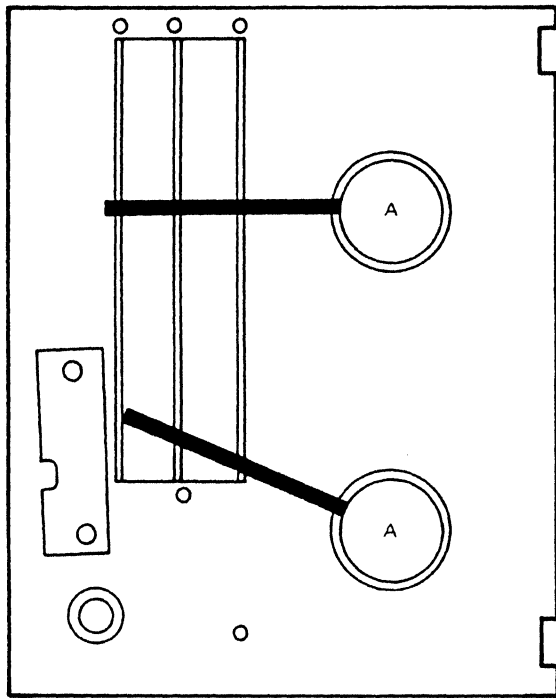
- f. Adjust offset by carefully loosening block mounting screw and positioning roller against alignment tool. Retighten block mounting screw.
- g. With tool in same position, check roller height. As shown in close view, figure 5-11, bottom flange of roller should meet undercut of tool, which corresponds to .0015-inch height from chamber surface. To adjust height, loosen set screw in the side of the block.
- h. Check rollers 2, 3, and 5 for offset and height, using alignment tool as indicated. Note that .0725 offset is used for roller 5. If any offset adjustment is required, observe some caution regarding shims.
- i. Rollers 1 and 2 must be in proper adjustment before roller 4 is checked. Check roller 4 by positioning straight edge of the alignment tool against rollers 1 and 2, as shown. Do not press against the springs of rollers 1 and 2. Adjust roller 4, if necessary, by moving rear flange against alignment tool.
- j. Reinstall vacuum cover and reels and, using the forward/reverse switch, run a scratch tape on forward and reverse to check tape alignment. If tape bites into edges of a roller, push on the roller shaft to determine azimuth correction then add shims as required.
- k. Remove power from tape unit. Remove tape and reels and reinstall overlay, reels and entry guide.

### 5-51 Reel Hub Height Adjustment

#### NOTE

This procedure is required only when a tape hub is replaced. Otherwise do not adjust the reel hub height.

- a. Remove power from tape unit.
- b. Remove reels, head covers and the tape unit overlay. Be careful of components on the headplate assembly. The overlay is secured with hook and loop fabric.
- c. Remove the vacuum chamber door by unfastening the hinges from the chamber. Leave the hinges on the door.
- d. Check each hub as shown in figure 5-12, which indicates the two positions of the alignment tools. The L-shaped edge of the alignment tool and the edges of the reel hub should just touch as the hub is rotated.



A = REEL HUB

Figure 5-12. Reel Hub Height Alignment Tool Positioning

- e. If necessary loosen hub set screws and adjust hub height.

NOTE

Hub is secured by a cover set screw under which there is a set screw tightened against a key which fits into a slot in the shaft. Use Loctite 242 on cover screw when retightening.

- f. Reinstall overlay and vacuum chamber door.

5-52 Capstan Height Adjustment

NOTE

The following procedure is required only when a capstan or capstan motor is replaced. Otherwise, do not adjust the capstan height.

- a. Remove power from the tape unit.
- b. Remove reels, head covers and the tape entry guide.
- c. Remove vacuum chamber door. Remove the door by unfastening the hinges from the chamber. Leave the hinges on the door.

- d. Position the alignment tool on the chamber and capstan as shown in figure 5-13. The capstan should be flush against the .025-inch step of the alignment tool. Measure to the metal edge of capstan itself and not to the plastic speed disk.
- e. If necessary, adjust capstan height by removing allen-head set screw on vacuum supply manifold and loosening shaft set screw located underneath. Retighten set screw and reinstall cap screw with Loctite 242. (Cover screw has nothing to torque against.)

NOTE

The following steps check capstan perpendicular alignment by permitting the tape to run without being guided by the ceramic flanges at the fixed-roller guides.

- f. Remove overlay, which is held on with hook and loop fabric. Remove fixed guide caps and push lower ceramic rings of guides out of tape contact position. This can be done by tilting the rings and jamming them into a fixed-position clear of the tape path or holding them back with masking tape.
- g. Install reels, with scratch tape, and run tape forward and reverse while watching capstan. There should be no lateral motion of the tape. If there appears to be lateral motion, adjust capstan position as follows.

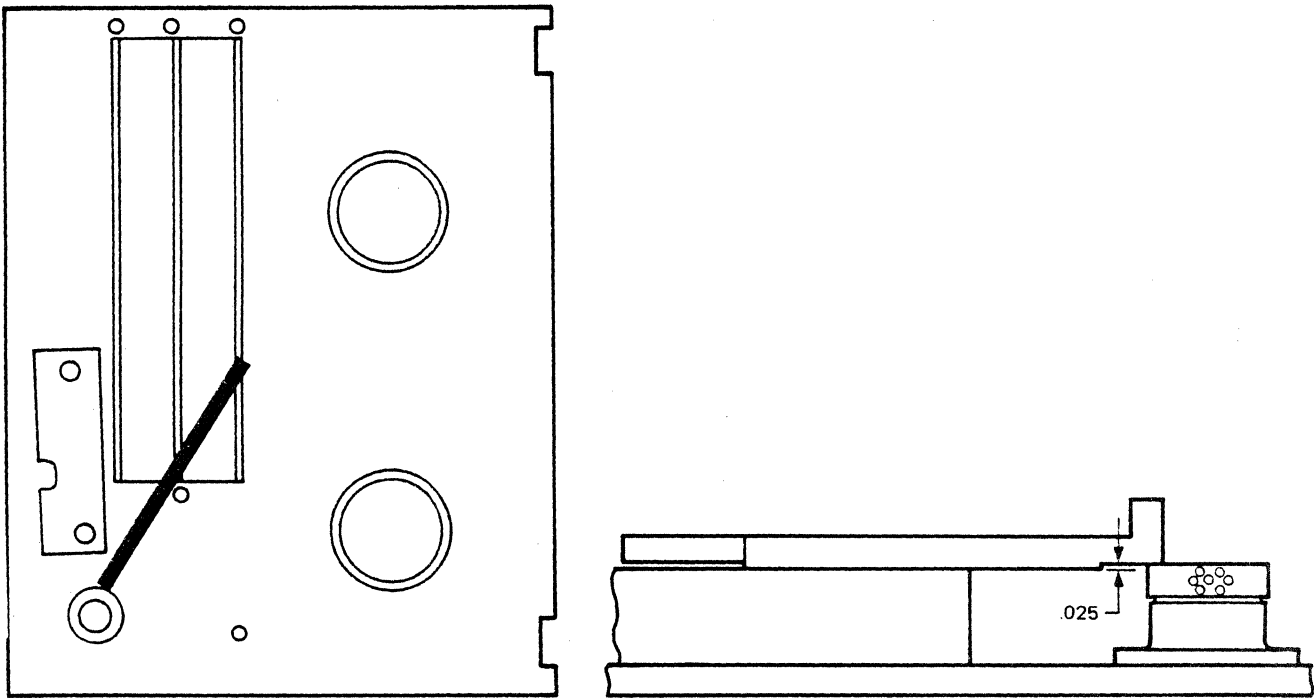


Figure 5-13. Capstan Height Alignment Tool Positioning

- h. Loosen the three capstan assembly mounting screws, located on the deck, outside of the capstan assembly mounting hole.
- i. Adjust set screws, located next to mounting screws. As each set screw is turned clockwise it causes the capstan to tilt toward that set screw. Capstan position is also altered slightly by the retightening of the mounting screws. Repeat procedure as required. One method of finding correct position is to loosen mounting screws, grasp the capstan motor assembly, and manually move it into position that provides proper tape alignment. Then adjust set screws to achieve that position.
- j. When tape is correctly aligned, with mounting screws tightened, torque each mounting screw to 12 inch pounds.
- k. Return fixed guide rings and caps to normal position, remove reels, reinstall overlay, vacuum chamber door and entry guide and reinstall reels.

5-53 Vacuum Motor Belt Tension Adjustment

- a. Remove power from the tape unit.
- b. Remove the four screws holding the vacuum motor shroud to the vacuum motor assembly and remove the shroud.
- c. Loosen the four nuts which secure the vacuum motor to the motor plate assembly.
- d. Attach drive belt tension tool T0023-01A to the drive belt and position the motor assembly so that the tension tool indicates 13 to 15 pounds.
- e. Secure the motor to the plate assembly by tightening the four nuts.
- f. Let the tension tool hang freely from the belt and observe that the reading is 13 to 15 pounds.
- g. Using the four screws removed in step b, replace the vacuum motor shroud.

5-54 Write Lockout Assembly Adjustment

Remove power from tape unit and adjust the write lockout assembly as follows:

- a. Install a reel without a write protect ring on the supply reel hub. Check that the write lockout plunger is centered in the write protect ring groove and not rubbing against the bottom of the groove as reel is rotated.
- b. If the plunger is not centered in the groove, loosen the two write lockout mounting screws and reposition the assembly. Tighten the mounting screws.
- c. If the plunger rubs on the bottom of the groove, loosen the solenoid mounting screws and position the solenoid until the plunger is just clear of the bottom of the groove. Tighten the mounting screws.

- d. Install a reel with a write protect ring on the supply reel hub and check to see that the write lockout microswitch closes.
- e. If the microswitch does not close, loosen the solenoid mounting screws and reposition the solenoid to where the microswitch closes. Tighten the mounting screws.
- f. Apply power to the tape unit. The plunger should be pulled away from the reel and not rub against the reel, when the LOAD control is pressed and released and the tape is tensioned. Verify that the plunger does not rub on the overlay clearance hole. Reposition the overlay if necessary.

#### 5-55 TROUBLESHOOTING

The magnetic tape unit is designed such that major subassemblies may be quickly replaced with a spare assembly in case of failure, to shorten the time the drive is not operational. When a failure is isolated to such an assembly, the preferred corrective action is to replace the defective unit and re-adjust the settings which may have changed.

Troubleshooting the tape unit requires a thorough knowledge of the contents of Chapter 4. Before performing any detailed troubleshooting, the preliminary checks contained in the following paragraph should be performed. If the problem is not identified and corrected by performing the preliminary checks, refer to paragraphs on system level troubleshooting and to the troubleshooting charts. Note that the troubleshooting procedures do not include individual components such as switches, capacitors, resistors, etc. Check such components using conventional voltage and resistance tests with the aid of the schematic and assembly diagrams in Chapter 6.

#### 5-56 PRELIMINARY CHECKS

The following preliminary checks are performed to ascertain that the equipment is connected properly and that the proper operating voltages are present:

- a. Verify that all cables and connectors are in good condition and that connections are made correctly.
- b. Verify that the five fuses on the rear panel are not burned out, and that they are of the specified rating (figure 2-8).
- c. Inspect for evidence of broken wires and overheated components.

#### 5-57 SYSTEM LEVEL TROUBLESHOOTING

An initial check should always be made of the power supply circuits. Specifically, the  $\pm$  regulator supplies should be checked to ensure correct output voltage. Check external equipment to eliminate the possibility of this equipment causing the malfunction. If the malfunction is a control function, or if all channels of data are affected, ensure that all inputs to the tape unit (control and data) are correct.

If a fault is associated with all channels, check the control circuits that provide control signals to the data processing operation. Check for the presence of the control signals at the data board and verify correct logic levels and timing. If a specific signal is missing, conventional signal tracing techniques may be used to lead to the defective circuit. This method should be used to locate problems associated with either read or write data functions. If the problem is associated with only one channel, compare a signal level of a good channel of those of a defective one (all data channels are identical).



If a control problem exists, determine which control function is defective and troubleshoot the appropriate control circuit. Check the suspected circuit for defective logic levels. Also, verify that the timing relationships of the signals developed in the suspected circuits are correct when compared to signals developed independent of the suspected circuit.

#### 5-58 TROUBLESHOOTING CHARTS

The system troubleshooting charts in table 5-5 are provided to aid the maintenance technician in isolating malfunctions in the tape unit. The troubleshooting charts provide typical symptoms of malfunctions along with probable causes, possible remedies and references to procedures within the manual to aid the maintenance technician in isolating a faulty circuit. These tables should be used in conjunction with the assembly and schematic diagrams in Chapter 6.

TABLE 5-5. TROUBLESHOOTING CHART

SYMPTION	PROBABLE CAUSE	REMEDY	REFERENCE PARAGRAPH
Does not start to load.	EOT and BOT not working properly or reflective post dirty or out of adjustment.	Check operation and adjust EOT/BOT amplifier	4-24, 5-12
	LOAD or RESET switch defective.	Check operation of switches.	4-9
	Logic problem, LDA flip-flop is not set.	Repair tape control board.	4-8, 5-8
Load operation does not move tape into vacuum column.	K3 relay or driver defective.	Check to see if K3 contacts close. Replace.	4-9
	Load reel motor driver defective.	Check to see that 17 volts is at J7-3 when Q4 turns on and reel motors turn.	4-9
	Interlock switches defective.	Check operation of switches. Adjust or replace.	4-9, 5-25, 5-26
Load operation moves tape into vacuum column but tension is not made.	Interlock switches do not close.	Check operation of switches. Adjust or replace.	4-9, 5-25, 5-26
	K1 relay or driver defective.	Check to see if K1 contacts close. Replace.	4-9
When capstan moves tape, the interlock switches open.	Osc and sync detector malfunction.	Loop a length of tape in the chambers (figure 5-3). Press the load switch to turn on the vacuum motor. Check the operation of the osc and sync detectors. Replace.	4-9, 5-24
	Capstan speed or ramp not correct.	Remove tape from around capstan. Check capstan speed and ramp at TP12.	4-14, 4-15, 5-15, 5-22, 5-23

TABLE 5-5. TROUBLESHOOTING CHART (Continued)

SYMPTON	PROBABLE CAUSE	REMEDY	REFERENCE PARAGRAPH
When capstan moves tape, the interlock switches open. (Continued)	Reel servo is out of adjustment	Adjust reel servo.	4-12, 4-14, 5-24
Tape moves past BOT marker during LOAD or REWIND.	Dull BOT tab.	Replace BOT tab.	
	BOT amplifier malfunction.	Check operation and adjust the BOT amplifier.	4-24, 5-12
	Logic problem, LDB flip-flop is not reset or RWDB is not set.	Repair tape control board.	4-9
Tape unit does not respond to forward/reverse commands but responds to manual switch.	Tape unit not on line or selected.	Check that the correct select line is asserted. Check on-line switch and flip-flop. Repair if necessary.	4-19, 4-21
	Select, SFC or SRC cable or receiver defective.	Check outputs of receivers for correct levels. Repair.	4-19, 4-20, 4-21
Tape unit does not respond to manual forward/reverse switch.	Defective BOT and EOT sensor or amplifier.	Check operation and adjust amplifier.	4-24, 5-12
	Tape unit is not ready.	Check inputs to gate U36-8 to determine which one is not high.	4-20, 4-21
	Tape unit is on line.	Check and replace on line flip-flop.	4-19
	K1 relay contacts 10/9 do not make.	Check if TP14 and J1-1 are at the same voltage. Replace.	4-9
	Component failure in forward/reverse ramp generator or capstan amplifier.	Check the operation of the components in the ramp generator and amplifier.	4-16, 4-18

TABLE 5-5. TROUBLESHOOTING CHART (Continued)

SYMPTON	PROBABLE CAUSE	REMEDY	REFERENCE PARAGRAPH
Tape unit does not respond to manual forward/reverse switch. (Continued)	Manual switch defective.	Check MFWD and MREV signals.	4-18
Interlock switches are opened during rewind.	K2 relay or driver not working properly.	Check that the contacts of K2 close. Replace.	4-9, 4-23
	The high gain is not switched on in the reel servos.	During a rewind operation, check that each pair of voltages (TP26 and cathode of CR6004, and TP29 and cathode of CR7004) are at same voltage. Replace defective component if necessary.	4-15
	Reel servos are not adjusted or working properly.	Check and adjust the reel servos.	4-12, 5-24
	Rewind speed or ramps are not correct.	Adjust the rewind speed and check the ramp times.	4-16, 5-17
	Logic problem asserting a forward command during rewind operation.	Check that TP 33 is zero during rewind. Repair.	4-16, 4-21
	Fuse F2 or F3 blown.	Check fuse F2 or F3 replace if necessary.	2-13
Responds to forward command but does not write. Reads a good tape correctly.	No write power to data board or write current is not enabled.	Check that write lockout micro-switch is closed and TP3 for PE or TP2 for NRZI data boards is at +5 volts and collector of Q3 is at -5 volts. Repair.	4-22, 4-29, 4-32

TABLE 5-5. TROUBLESHOOTING CHART (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY	REFERENCE PARAGRAPH
Responds to forward command but does not write. Reads a good tape correctly. (Continued)	Interface cable or receiver malfunction.	Check write data, data ready, LRC strobe and SWRT receiver outputs for proper levels. Repair.	4-29, 4-32
	Write head connector not properly plugged into J1.	Check that head connector is securely into J1.	
Data is incorrectly written bur a good tape can be read.	The tape is bad.	Replace the tape.	
	Intermittent connection with write power.	Check that the write lockout solenoid is energized and microswitch is solidly closed. Adjust or replace.	4-22, 4-41, 4-44, 5-54
	Incorrect data format.	Check pre-delays, post delays and data format.	4-48, Table 4-2
	Write deskew needs adjustment.	Adjust the write deskew.	4-29, 5-32
	Component in write electronics defective.	Check operation of write channels and repair if necessary.	4-29, 4-32
A correctly written tape can not be read while being written.	Flux gate improperly adjusted.	Adjust head shield.	5-43
A good tape cannot be correctly read.	Tape path needs cleaning.	Clean the head, guides, and tape cleaner.	5-5
	Read electronics need adjustment.	Adjust the read amplifiers and read strobe.	4-30, 4-33, 5-28, 5-38, 5-43

TABLE 5-5. TROUBLESHOOTING CHART (Continued)

SYMPTION	PROBABLE CAUSE	REMEDY	REFERENCE PARAGRAPH
A good tape cannot be correctly read. (Continued)	Read head connector not properly plugged into J2.	Check that head connector is securely into J2.	
	Interface cable or receiver malfunction.	Check the outputs of the read data cable drivers for proper levels.	
	PE data board component failure in envelope detector circuit.	Check the envelope detector delays. Replace.	4-33
	Component failure in threshold circuit.	Check threshold voltage (PE: TP 4, NRZI: TP11) Repair.	4-31, 4-34, 4-35, 4-38, 5-49
	No select, motion or high density signals on data board.	Check that the signals are present on the data board. Repair.	4-20, 4-21, 4-25
	Component failure in the read channels.	Check operation of read channels and repair if necessary.	4-31, 4-34, 4-35
	For single gap head, faulty write head driver.	Check if any head driver is causing current to flow in the head. Repair.	4-29, 4-32

The following paragraphs provide procedures for replacing various components within the tape unit. These procedures should be read and understood before attempting component removal and replacement. When performing these procedures, the maintenance technician should refer to the mechanical assembly illustrations and drawings in Chapter 6.

## 5-60 TAPE GUIDE ROLLER REPLACEMENT

Replace tape guide roller as follows:

- a. Remove the C-clamp securing the tape guide flange to the tape guide shaft.
- b. Remove the tape guide flange and bearing assembly.
- c. Install the new tape guide flange and bearing assembly.
- d. Secure the new tape guide flange to the tape guide shaft with the C-clamp removed in step a.
- e. Check the tape guide height by mounting the alignment tool as shown in figure 5-11. Position the alignment tool against the tape guide roller.
- f. If the alignment tool is not centered between the flanges of the guide roller, perform the tape guide roller adjustment procedure (paragraph 5-50).

## 5-61 REEL SERVO MOTOR REPLACEMENT

Replace reel servo motor as follows:

- a. Disconnect the servo motor plug from the main harness (figure 1-2).
- b. Loosen the setscrew that secures the reel hub to the motor shaft.
- c. Remove the four screws attaching the motor to the baseplate and remove the motor. Use these screws to attach the new motor to the baseplate.
- d. Mount the reel hub on the shaft of the new motor.
- e. Perform the reel hub height adjustment procedure (paragraph 5-51).
- f. Plug the reel servo motor into the harness.

## CAPSTAN MOTOR REPLACEMENT

Replace capstan motor as follows:

- a. Remove the head covers.
- b. Gently remove the tape unit overlay, ensuring that components mounted on the head plate assembly are not damaged.
- c. Loosen the setscrews securing the capstan to the capstan motor shaft and remove the capstan.
- d. Disconnect the power leads from the capstan motor (figure 1-2).
- e. Remove the screws attaching the capstan motor to the tape unit baseplate. Note location of shims so that the new motor can be shimmed the same way. Re-install screws and shims in same manner when installing the new capstan motor to the tape unit baseplate.
- f. Secure the capstan to the capstan motor shaft. Perform capstan height adjustment procedure (paragraph 5-52).
- g. Install tape unit overlay.
- h. Install the head covers.
- i. Connect power leads to the capstan motor.

## VACUUM MOTOR BELT REPLACEMENT

Replace vacuum motor belt as follows:

- a. Loosen the four screws that secure the vacuum motor to the vacuum motor plate assembly.
- b. Remove the old vacuum motor belt.

## NOTE

The vacuum blower pulley has two positions for mounting the vacuum motor belt: The smaller diameter is for operation from sea level to 2,000 feet, and the larger diameter for operation from 2,000 to 4,000 feet. A high altitude pulley (separate) is used from 4,000 to 8,000 feet.



- c. Install the new vacuum motor belt.
- d. Perform the vacuum motor belt tension adjustment procedure paragraph 5-53.

5-64 HEAD REPLACEMENT

Replace head as follows:

NOTE

The head may require replacement for one of two reasons: internal fault in the head of cable, or wear. The first reason can be established by reading a master tape; the second can be verified by measuring the depth of the wear on the head crown.

- a. Remove the head covers.
- b. Disconnect the tape head connectors.
- c. Remove the two screws which attach the head to the head plate assembly.
- d. Ease the head cable through the hole in the deck.
- e. Route the new head cable through the deck hole.
- f. Using the two screws removed in step c, attach the new head to the head plate assembly.
- g. Connect the tape head connector.
- h. Perform the NRZI or PE data electronics adjustment procedure, paragraph 5-27 or 5-40, respectively.
- i. Replace the head covers.

5-65 VACUUM CHAMBER REPLACEMENT

(Recommended only as factory procedure, because of difficulty in resetting tape path.)

Replace vacuum chamber as follows:

- a. Remove power from the tape unit.

- b. Remove the head covers and fixed reel.
- c. Gently remove the tape unit overlay, ensuring that components mounted on the head plate assembly are not damaged.
- d. Remove the screws attaching chamber entry block and remove the block.
- e. Remove the six screws attaching the vacuum chamber assembly to the tape unit baseplate.
- f. Carefully lift the vacuum chamber assembly from the tape unit baseplate and disconnect the vacuum hoses and signal plug.
- g. Connect the vacuum hoses and signal plug to the new vacuum chamber assembly.
- h. Using the four screws removed in step e, attach the new vacuum chamber assembly to the tape unit baseplate. Using the screws removed in step d, attach the vacuum entry block.
- i. Perform the tape path alignment measurement procedure (paragraph 5-47).
- j. Perform the vacuum chamber adjustment procedure (paragraph 5-24).
- k. Replace the tape unit overlay.
- l. Replace the head covers, and fixed reel.

5-66

#### TRANSDUCER REPLACEMENT

- a. Remove the vacuum chamber assembly (paragraph 5-65, steps a through f).
- b. Remove the ten screws attaching the transducer to the vacuum chamber assembly.
- c. Gently lift the transducer from the vacuum chamber assembly.
- d. Disconnect signal leads from the transducer, noting the terminal connection of the wires.
- e. Disconnect the vacuum hoses from the transducer. Remove the transducer.
- f. Solder the signal leads and connect the hoses to the new transducer.

#### CAUTION

When connecting signal leads to the transducer, precautions must be taken to prevent heat or mechanical damage to the plastic insulation washers on the solder posts.

- g. Using the screws removed in step b, attach the new transducer to the vacuum chamber assembly. Do not tighten screws.

5-46

9592

- h. Connect a 24-inch H<sub>2</sub>O vacuum source to transducers through a V/2 tube, and then tighten screws at terminal end of transducer that is being replaced. Tighten remaining screws in order, working toward opposite end of transducer.
- i. Disconnect vacuum source from transducers.
- j. Replace the vacuum assembly (paragraph 5-65, steps g thru 1).

5-67 VACUUM CHAMBER WINDOW REPLACEMENT PROCEDURE

- a. Remove four screws that attach vacuum chamber window hinges to column.
- b. Remove vacuum chamber window.
- c. Hold new window down firmly in place against vacuum chamber while installing and tightening hinge screws.

CAUTION

To prevent vacuum leaks, ensure that window is held flush against vacuum chamber while tightening hinge screws.

5-68 TAKE-UP REEL REPLACEMENT

Remove and replace take-up reel as follows:

- a. Remove three screws attaching plate to hub.
- b. Remove plate.
- c. Remove old reel flange and replace with new.
- d. Replace plate, align holes, insert screws and tighten.

5-69 GUIDE ROLLER BEARING REPLACEMENT

NOTE

When bearings are replaced, the roller must be reinstalled in its original position. Otherwise, alignment might change. If roller is reversed or replaced, realign per paragraph 5-50.

- a. Move outside end of roller so that it can be reinstalled in the same position.
- b. Remove retaining ring and flat washer located between retaining ring and outside bearing.
- c. Remove roller, with bearings, from shaft. Do not lose flat washer located between bearing and spring.
- d. Remove and replace bearings fitted into each end of roller.
- e. Reassemble, making sure that roller is installed in original position.

OPERATIONAL AMPLIFIER COLOR CODE

On the NRZI data board, the first stage operational amplifier (SN 72709) must always be selected to match the time delay as indicated on table 5-6. If, for example, this amplifier needs to be replaced, its replacement must bear the STC color marking, the appropriate part number of which is also listed in table 5-6. If the operational amplifier is burned in and tested, a red or blue dot will appear next to pin 1; this should not be confused with STC color marking.

TABLE 5-6. SN72709 OPERATIONAL AMPLIFIER COLOR CODE

AMCOMP PN	STC PN	COLOR MARKING	DELAY AS TESTED IN PWBA	
			MINIMUM	MAXIMUM
9260143-02	4008488-02	Pink	0	100 ns
9260143-03	4008488-03	Green	200 ns	500 ns
9260143-04	4008488-04	Ruby Red	600 ns	900 ns
9260143-05	4008488-05	Blue	1 sec	1.3 sec
9260143-06	4008488-06	White	1.4 sec	1.7 sec
9260143-07	4008488-07	Black	1.8 sec	2.1 sec

## Chapter 6

### DRAWINGS AND PARTS LISTS

#### 6-1 INTRODUCTION

This chapter contains parts location illustrations, replaceable parts lists, the assembly drawings, schematics, and wiring diagrams applicable to the 2750 Series Magnetic Tape Unit for Honeywell.

#### 6-2 REPLACEABLE PARTS LISTS

The replaceable parts lists are keyed by figure reference to the parts location illustrations and contain brief descriptive nomenclature and part number for each replaceable part. A replaceable parts list of miscellaneous parts is also included, but not illustrated.

#### 6-3 DRAWINGS

The following list includes the diagrams needed to maintain the 2750 Series Magnetic Tape Unit.

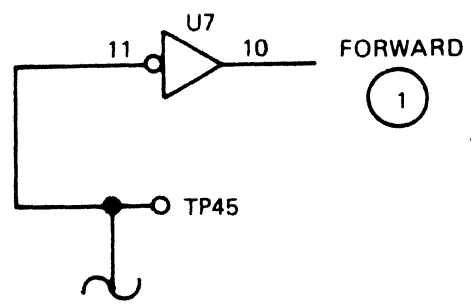
DRAWING TITLE	AMCOMP DRAWING NO.	STC DRAWING NO.
Control PWBA Assembly	9040119	4008555
Control PWBA Schematic	9940119	4008552-01
Jumper Plug Option	9060070	4008243
NRZI PWBA Assembly	9040116	4008557
NRZI PWBA Schematic	9940116	4085453-01
NRZI PWBA Schematic	9940095	4008583-01
P.E. Data PWBA Assembly	9040146	4008556
P.E. Data PWBA Schematic	9940146	4008548-01

DRAWING TITLE	AMCOMP DRAWING NO.	STC DRAWING NO.
Power Supply Assembly	9020217	4008212
Power Supply Schematic	9910043	4008584-01
Power Supply Wiring Diagram	9930046	4008367-01
Vacuum Chamber Wiring Diagram	9930016	4008316-01
Pneumatic Assembly Wiring Diagram	9930047	4008427-01
Dual Triac PWA Assembly	9040132	4010142
Dual Triac Schematic	9940132	4008591-01
Heatsink Assembly	9020159	4008210
Heatsink Wiring Diagram	9930045	4008337-01
System Interconnect Diagram	9930056	4008494-01
System Interconnect Diagram	9930057	4008258-01

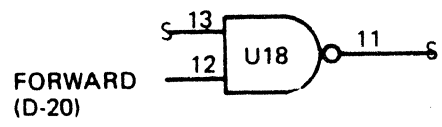
Generally, all logic symbols appearing in the logic diagrams in these drawings are drawn in accordance with MIL-STD-806C. All logic elements are identified by a reference designator, such as U2, indicating the integrated circuit package where the element is located. The pin number of the integrated circuit package follows its reference designator, i. e., U2-8 (refer to figure 6-1).

The method used to indicate signal flow and logic component interconnection on the schematics and logic diagrams is shown below. A circled number at the output of a logic component indicates that the output is the signal source at other inputs. For example, the circled "1" shown below at the output of inverter U7-10 indicates that FORWARD is the signal source at one other input. An alphanumeric number in parenthesis at the input to a logic element indicates the vertical-horizontal coordinates (example: D-20) of the input signal source component on the drawing. For example, the notation (D-20) FORWARD shown at the input to NAND gate U18-12 indicates that the signal source for FORWARD is located at drawing coordinates D-20 (vertical-horizontal).

SOURCE OF SIGNAL  
TO ONE OTHER INPUT



COORDINATES OF  
SIGNAL SOURCE



SYMBOL	TABLE	SYMBOL	TABLE																																																																						
<p>INVERTER</p> <p>A — X</p> <p>X A</p>	<table border="1"> <tr><td>A</td><td>X</td></tr> <tr><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td></tr> </table>	A	X	0	1	1	0	<p>NOR</p> <p>A — X</p> <p>B —</p> <p>X A+B</p>	<table border="1"> <tr><td>A</td><td>B</td><td>X</td></tr> <tr><td>0</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td></tr> </table>	A	B	X	0	0	1	0	1	0	1	0	0	1	1	0																																																	
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Note: Boolean equations are positive logic convention.

Figure 6-1. Signal Flow and Logic Symbols

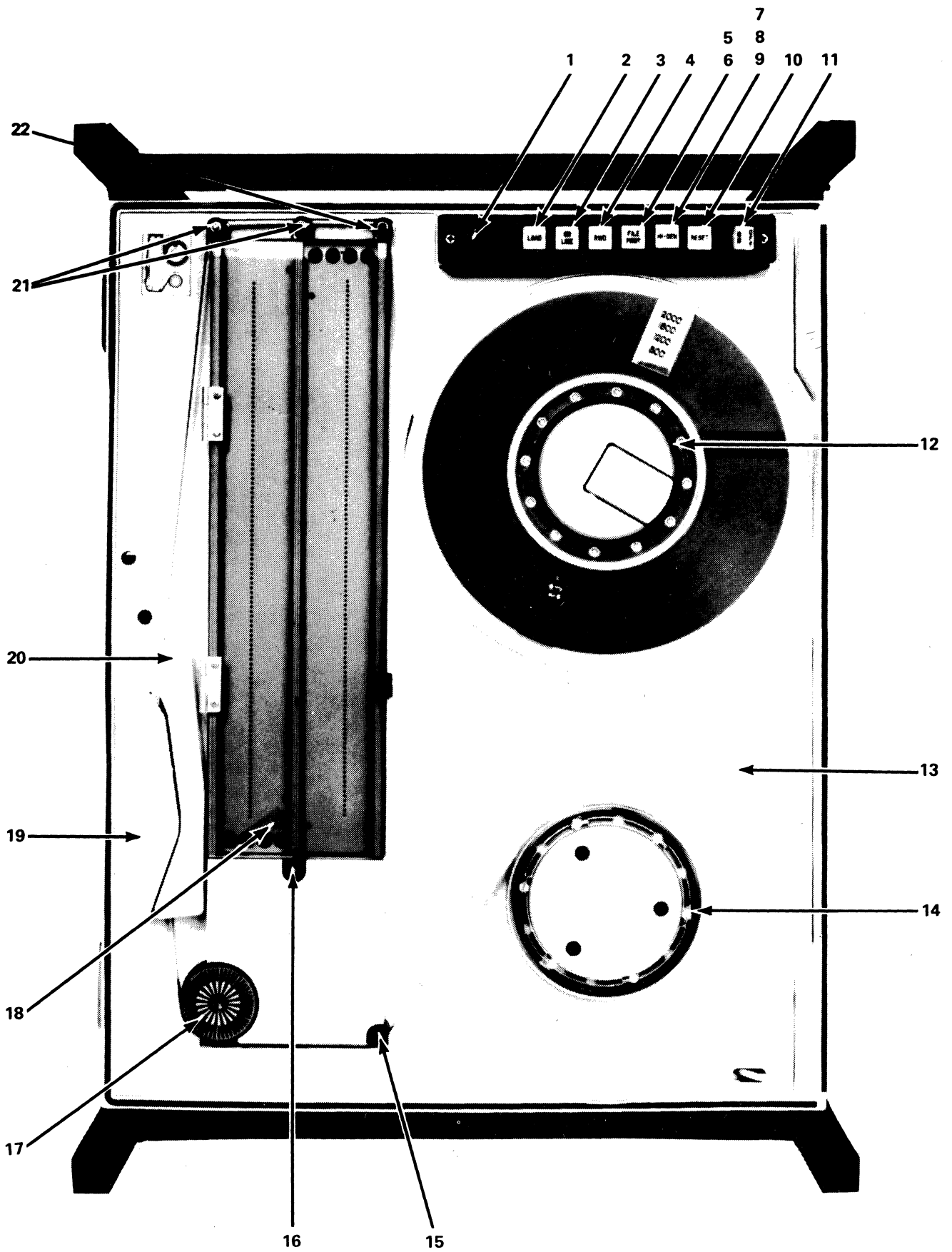


Figure 6-2. 2750 Series Parts Location, Front View



TABLE 6-1. REPLACEABLE PARTS LIST (FRONT)

FIGURE REF	DESCRIPTION	AMCOMP PN	STC PN
6-2			
1	Address Switch (Option) Momentary Switches	08200004-01	10076156
2	Load	08300016-04	10076145
3	On Line	08300016-02	10076143
4	Rewind	08300016-03	10076144
5	File Protect Indicator	11520001-01	10076149
6	Write Enable Indicator (Option) Alternate Action Switch	11520001-02	
7	HI DEN	08300018-01	10076147
8	1600 BPI (Option)	08300018-02	10076148
9	9 Track (Option)	08300018-03	
10	Reset	08300016-05	10076146
11	Power Switch Bulb	9260049-01 11130001-01	4008458-01 10079023
12	Reel Retainer Assembly	9020035-01	4008200-01
	Cover	9210356-01	4008339-01
	Hub	9210357-01	4008343-01
	Handle	9210358-01	4008340-01
	Spring	9210706-01	4008345-01
	Rubber Ring	9260074-01	4008341-01
	Plunger	9260074-01	4008341-01
	Push Rod	9260075-01	4008342-01
	Actuator	9260076-01	4008347-01
	Pad	9260101-01	4008348-01
	Spring	9260076-01	4008347-01
	Groove Pin	9260101-01	4008348-01
	Plastic Ball	5000003-01	10092066
13	Reel (Take-up)	9260154-01	4008242-01
14	Reel Retainer Assembly (fixed)	9020218-01	4008201-01
	Cover	9210804-01	4008349-01
	Hub	9210805-01	4008350-01
15, 22	Tape Roller Assembly	9020123-01	4008203-01
	Shaft, tape guide	9210427-01	4008322-02
	Guide, Roller	9210683-01	4008327-01
	Spring	9210592-01	4008323-01
	Bearing	20111002-01	10110009
	Spacer, Shaft	35191201-10	10200034
	Ring, Retaining	54010002-01	10090025
16, 21	Tape Roller Assembly	9020039-02	4008202-02
	Guide, roller	9260127-01	4008324-01
	(other parts same as item 15)		
17	Strobe Disc		
	37.5/75 ips	9210378-02	4008226-02
	45 ips	9210378-03	4008226-02
18	Vacuum Chamber Assembly	9020059-03	4008204-03
	Window Subassembly	9060205-01	4008309-01
	Tape Position Sensor Assembly	9020233-01	4008301-01
	Vacuum Block Assembly	9060055-02	4008320-02
	Gasket, Vacuum Block	9260119-01	4008313-01
	Harness Assembly	9260081-01	4008317-01
	Latch		

TABLE 6-1. REPLACEABLE PARTS LIST (FRONT) (Continued)

FIGURE REF	DESCRIPTION	AMCOMP PN	STC PN
6-2 19	Head Cover Assembly (Short)	9060223-01B	4008286-01
	Head Cover (Short)	9260175-01	4008287-01
	Banana Plugs (2)	47000101-01	10073411
	Nuts (2)	45400601-01	10028003
20	Head Cover Assembly (Long)	9060224-01B	4008288-01
	Head Cover (Long)	9260176-01	4008289-01
	Banana Plugs (2)	47000101-01	10073411
	Nuts (2)	45400601-01	10028003

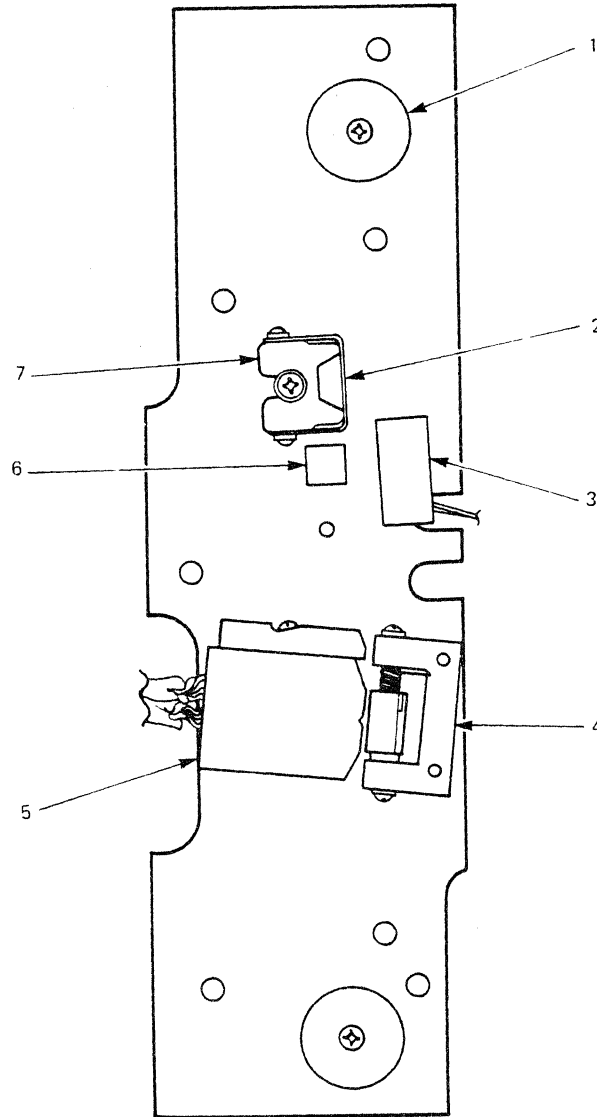


Figure 6-3. Head Plate Assembly Parts Location

TABLE 6-2. REPLACEABLE PARTS LIST  
HEAD PLATE ASSEMBLY (9020158)

FIGURE REF	DESCRIPTION	AMCOMP PN	STC PN	
6-3	1	Fixed Tape Guide	9210783-01	4008262-01
	2	Blade, Tape Cleaner	9210279-01	4008260-01
	3	EOT/BOT Assembly	9060063-01	4008269-01
	4	Head Shield Assembly	9020032-01	4008270-01
	5	Head Assembly:		
		7-Track, Dual Gap	9510010-01	NA
		7-Track, Single Gap	9510025-01	NA
		9-Track, Dual Gap	9510066-01	4008334-01
		9-Track, Single Gap	9510027-01	NA
		7-Track/9-Track, Read Only	9510037-01	NA
		7-Track/9-Track, Read Only	9510043-01	NA
		9-Track, Single Gap, Read Only Without Erase	9510046-01	NA
	6	Reflective Block	9210325-01	4008505-02
7	Body, Tape Cleaner	9210277-01	4008267-01	

NOTE: Indicate machine model number and tape speed when ordering.

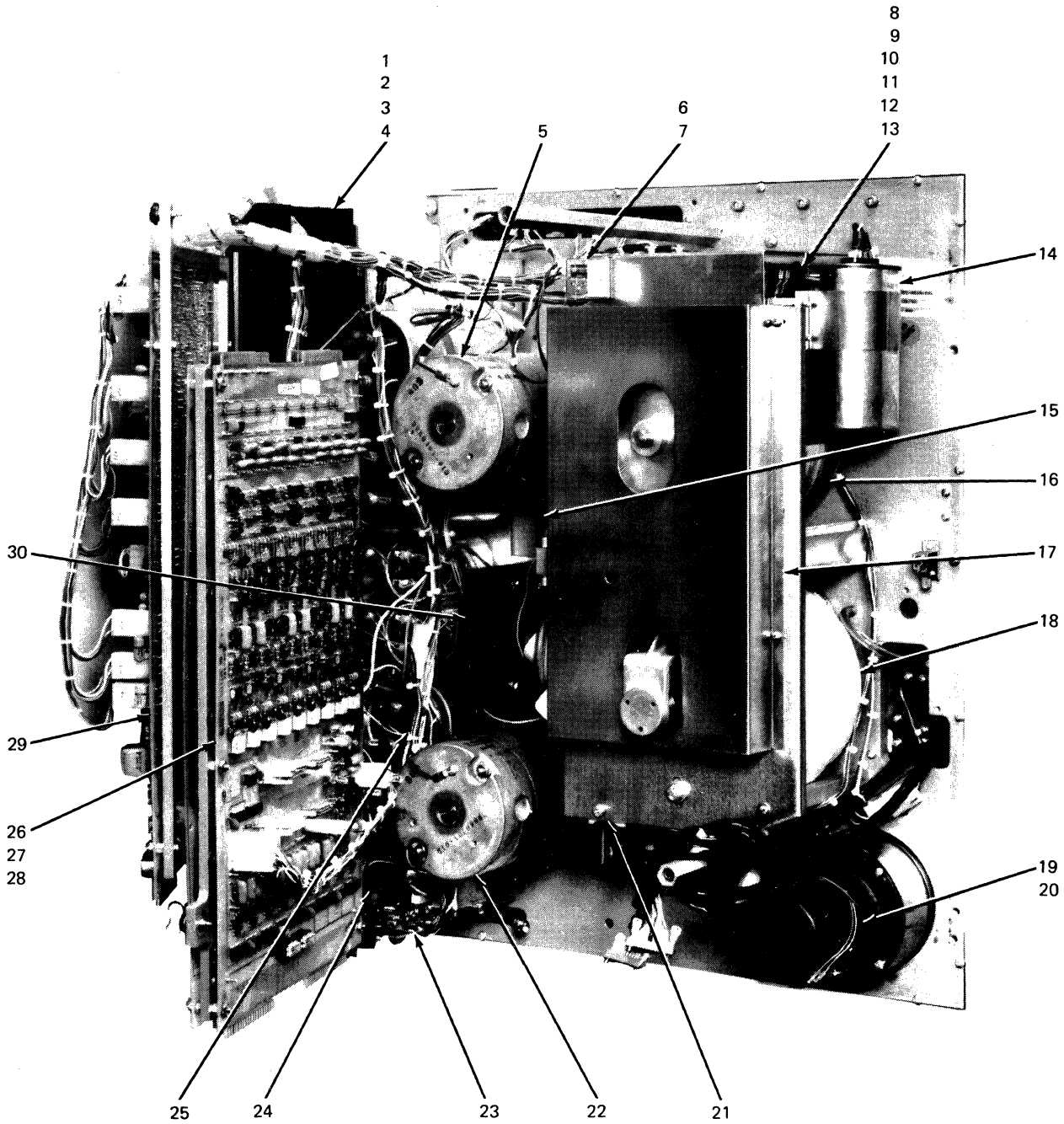


Figure 6-4. 2750 Series Parts Location, Rear View

TABLE 6-3. REPLACEABLE PARTS LIST (REAR)

FIGURE REF	DESCRIPTION	AMCOMP PN	STC PN
6-4			
1	Heat Sink Assembly	9020159-01	4008210-01
2	Power Transistor, 2N3055	05703055-01	10054092
3	Power Transistor, 2N6058	05706058-01	10054144
4	Power Transistor, 2N6051	05706051-01	10054143
5	Reel Motor Assembly, Supply	9060101-02	4008220-01
	Reel Motor (Supply or Take Up)	9510032-01	4008338
6	Relay (K3) 4 Pole 10A, 12Vdc	41445042-01	10078096
7	Retainer, Relay	50000088-01	10078093
8	Triac Plate Assembly	9020207-01	4008399-01
9	Dual Triac Cable Assembly	9080073-03	4008405
10	Dual Triac PWBA	9040132-03	4010142-03
11	Triac SC260 (Q1)	05500260-01	10068040
12	Triac MAC 10-4	05500104-01	NA
13	Triac SC250 (Q2)	05500250-01	10068038
14	Capacitor, 20 $\mu$ F, 370V	01574206-01	10049013
15	Write Lockout Assembly	9020152-02	4008208-02
16	Blower Assembly	9020206-01	4008378-01
17	Pneumatic Assembly*	9020209-01	4008207-01
18	Blower Motor Cable Assembly	9060200-01	4008228-01
19	Capstan Motor Assembly	9020095-01	4008206-01
20	Capstan	9210709-01	4008232-01
21	Vacuum Switch Assembly (S1, S2, S3).	9020208-02	4008423-01
22	Reel Motor Assembly (Take Up)	9060101-01	4008220-01
	Reel Motor (Take Up or Supply)	9510032-01	4008338
23	Filter FL1	05000001-01	10058079
24	Fuses:		
	Fuse, 10 Amp, 3AG (F2, F3)	09240001-01	10080040
	Fuse, 5 Amp, 3AG (F4, F5)	09230001-01	10080006
	Fuse, 10 Amp, FNM (F1) 90-125 Vac	09240003-01	10080019
	Fuse, 5 Amp FNM (F1) 190-250 Vac	09230004-01	10080041
25	Power Supply Assembly	9020217-01	4008212-01
26	PE Data PWBA	9040146-37**	4010102-04
27	NRZI Data (Single Card)	9040095-17**	4010052-04
28	NRZI Data (Dual Card)	9040096-17**	4010132-04
29	Control PWBA	9040119-XX**	4010002-01
30	Power Transformer TI	9510042-01	4008359-01
<p>*For belt with proper length, see table 2-5.  **Indicate machine model number and speed when ordering.</p>			

TABLE 6-4. MISCELLANEOUS REPLACEABLE PARTS LIST

DESCRIPTION	UTILIZATION			AMCOMP PN	STC PN
	CONTROL BOARD	NRZI BOARD	PE BOARD		
<b>COMPONENTS</b>					
<u>TRANSISTORS</u>					
2N3053	X			05703053-01	10054021
2N3904	X	X	X	05103904-01	10054217
2N3906	X	X	X	05203906-01	10054039
2N5321		X	X	05705321-01	10054220
2N5323		X	X	05705323-01	10054221
2N5639	X			05305639-01	10054218
<u>DIODES</u>					
IN914B	X	X	X	02100914-03	10053148
IN3592	X			02100101-01	10053146
IN4003	X		X	02104003-01	10053117
IN4735	X		X	02204735-01	10053098
IN4740	X			02204740-01	10053033
<u>INTEGRATED CIRCUITS TTL</u>					
SN 7400	X	X	X	03207400-01	10055001
SN 7401		X		03207401-01	10055002
SN 7404	X	X		03207404-01	10055004
SN 7405		X		03207405-01	10055005
SN 7408	X			03207408-01	10055008
SN 7410	X	X	X	03207410-01	10055010
SN 74H11	X			03207411-01	10055011
SN 7420	X			03207420-01	10055015
SN 7430	X			03207430-01	10055017
SN 7438	X	X	X	03207438-01	10055019
SN 74107	X	X	X	03204107-01	10055034
SN 74123	X			03204123-01	10055037
SN 75451	X			03155451-01	10067016
<u>Linear</u>					
LM339	X	X		03000339-01	10067063
SN 72709	X	X		03052709-01	10066051
SN 72709*		X		9260143**	4008488**
SN 72741	X			03052741-01	10066016
<u>DTL</u>					
SN 15836				03100836-01	10062006
SN 151805				03101805-01	10062080

\*See table 5-6 for color code of operational amplifier SN 72709.

\*\*Drawing number only

TABLE 6-4. MISCELLANEOUS REPLACEABLE PARTS LIST (Continued)

DESCRIPTION	AMCOMP PN	STC PN
<u>POWER SUPPLY</u>		
Power Supply Assembly	9020217-01	4008212-01
Transformer Cable Assembly	9060179-01	4008358-01
Diodes, CR2 and CR3:	02400831-01	10053147
Resistor Assemblies, R1 and R2	9060182-01	4008355-01
Resistor Assemblies, R3 and R4	9060182-02	4008355-02
Switch S1	08600004-01	10076150
Diode Rectifier, CR1	02509622-01	10071027
<u>WRITE LOCKOUT ASSEMBLY</u>		
Solenoid, L1	9510029-01	4008442-01
Miniature Switch, S1	08500003-02	10076153
Resistor, WW, 20 Ohms, 5W, R1	04670200-01	10043312
<u>CONTROL SWITCHES/LAMPS/ RELAYS/ETC.</u>		
Power Switch Bulb (SW8FE)	08500004-99	
Lamp	11130001-01	
Lamp (Control Panel)	11520001-01	10076149
Relay (K1 & K2)	41445042-01	10078096
Relay Retainer (K1 & K2)	50000088-01	10078093
SCR40654	05500654-01	10068039
Connector (26 pins)	07120007-01	10041642
Toggle Switch	08100003-01	10076155
<u>SHIM MATERIAL</u>		
Shim .001 inch thickness	9210250-01	4008263-01
.0005 inch thickness	9210250-02	4008263-02
.003 inch thickness	9210248-01	4008445-01
.005 inch thickness	9210249-01	4008446-01
.010 inch thickness	9210246-01	4008444-01







REV	DATE	BY	APPROVED
A	RELEASE/5201-353		
B	REVISED PER E051015A		
C	REVISED PER E0510140		

-77				E10 to E12				270PF	10 PF	470PF	1500PF	2200PF		.01				100PF		1800	1620	5110	5110	150	1800	150	4700	1000	10K	21.5K	5620	2870	3600	3600	-77
-75				E10 to E11				470PF	22PF	470PF	2200PF	3300PF		.022				220PF		1000	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	5620	2870	3600	3600	-75
-74	E7 TO E8	E2 TO E3	E103-E903 TO E104-E904	E102-E902 TO E101-E901				470PF	22PF	680PF	3300PF	3300PF	3300PF	.022				220PF		680	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	5620	2870	4700	4700	-74
-73								470PF	22PF	680PF	4700PF	4700PF	4700PF	.033				220PF		330	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	5620	2870	4700	4700	-73
-72								470PF	22PF	680PF	6800PF	.01	3300PF	.047				220PF		330	3160	2610	2610	150	1800	150	4700	1000	10K	21.5K	5620	2870	4700	4700	-72
-71								470PF	22PF	680PF	.01	.01	.033	.047				220PF		220	3160	2610	2610	150	1800	150	4700	1000	10K	21.5K	5620	2870	4700	4700	-71

-57				E10 to E12				270PF	10 PF	470PF	1500PF	2200PF		.01				100PF		1800	1620	5110	5110	150	1800	150	4700	1000	10K	21.5K	3480	1780	3600	3600	-57
-55				E10 to E11				470PF	22PF	470PF	2200PF	3300PF		.022				220PF		1000	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	3480	1780	3600	3600	-55
-54	E7 TO E8	E2 TO E3	E103-E903 TO E104-E904	E102-E902 TO E101-E901				470PF	22PF	680PF	3300PF	3300PF	3300PF	.022				220PF		680	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	3480	1780	4700	4700	-54
-53								470PF	22PF	680PF	4700PF	4700PF	4700PF	.033				220PF		330	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	3480	1780	4700	4700	-53
-52								470PF	22PF	680PF	6800PF	.01	3300PF	.047				220PF		330	3160	2610	2610	150	1800	150	4700	1000	10K	21.5K	3480	1780	4700	4700	-52
-51								470PF	22PF	680PF	.01	.01	.033	.047				220PF		220	3160	2610	2610	150	1800	150	4700	1000	10K	21.5K	3480	1780	4700	4700	-51

-37				E10 to E12				270PF	10 PF	470PF	1500PF	2200PF	470PF	3300PF				100PF		1800	1620	5110	5110	150	1800	150	4700	1000	10K	21.5K	21.5K	8250	3600	3600	-37
-35				E10 to E11				470PF	22PF	470PF	2200PF	3300PF	1000PF	6800PF				220PF		1000	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	21.5K	8250	3600	3600	-35
-34	E7 TO E8	E2 TO E3	E103-E903 TO E104-E904	E102-E902 TO E101-E901				470PF	22PF	680PF	3300PF	3300PF	2200PF	6800PF				220PF		680	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	21.5K	8250	4700	4700	-34
-33								470PF	22PF	680PF	4700PF	4700PF	6800PF	6800PF				220PF		330	3160	5110	5110	150	1800	150	4700	1000	10K	21.5K	21.5K	8250	4700	4700	-33
-32								470PF	22PF	680PF	6800PF	.01	6800PF	.01				220PF		330	3160	2610	2610	150	1800	150	4700	1000	10K	21.5K	21.5K	8250	4700	4700	-32
-31								470PF	22PF	680PF	.01	.01	4700PF	.022				220PF		220	3160	2610	2610	150	1800	150	4700	1000	10K	21.5K	21.5K	8250	4700	4700	-31

-17				E10 to E12				270PF	10 PF	470PF	1500PF	2200PF	470PF	3300PF				100PF		680	1620	5110	5110	120	1800	120	4700	1000	10K	21.5K	8250	3600	3600	-17
-15				E10 to E11				470PF	22PF	470PF	2200PF	3300PF	2200PF	4700PF				220PF		330	3160	5110	5110	120	1800	120	4700	1000	10K	21.5K	8250	3600	3600	-15
-14	E7 TO E8	E2 TO E3	E103-E903 TO E104-E904	E102-E902 TO E101-E901				470PF	22PF	680PF	3300PF	3300PF	3300PF	4700PF				220PF		330	3160	5110	5110	120	1800	120	4700	1000	10K	21.5K	8250	4700	4700	-14
-13								470PF	22PF	680PF	4700PF	4700PF	3300PF	.01				220PF		330	3160	5110	5110	120	1800	120	4700	1000	10K	21.5K	8250	4700	4700	-13
-12								470PF	22PF	680PF	6800PF	.01	6800PF	.01				220PF		330	3160	2610	2610	120	1800	120	4700	1000	10K	21.5K	8250	4700	4700	-12
-11								470PF	22PF	680PF	.01	.01	4700PF	.022				220PF		330	3160	2610	2610	120	1800	120	4700	1000	10K	21.5K	8250	4700	4700	-11

DASH NOS.	JUMPERS	J3, J4	J2	Q101-Q901	C101-C901	C109-C909	C108-C908	C107-C907	C101-C901	C10	C9	C5	C4	C11-C911	R7	R16	R49	R113	R112	R111	R110	R109	R104	R103	R102-R902	R33	R32	R31	R28-R928	R127-R927	DASH NO.
		CONNECTORS		TRANSISTOR	DIODES				CAPACITORS														POT								

NOTE: FOR SCHEMATIC SEE 9940116, SHT 1.

2700		<b>AMCOMP</b>
N/A: 9040095		
SCHEMATIC DIAGRAM - NRZ1 DATA PWBA, HONEYWELL		
C	9940095	C

8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

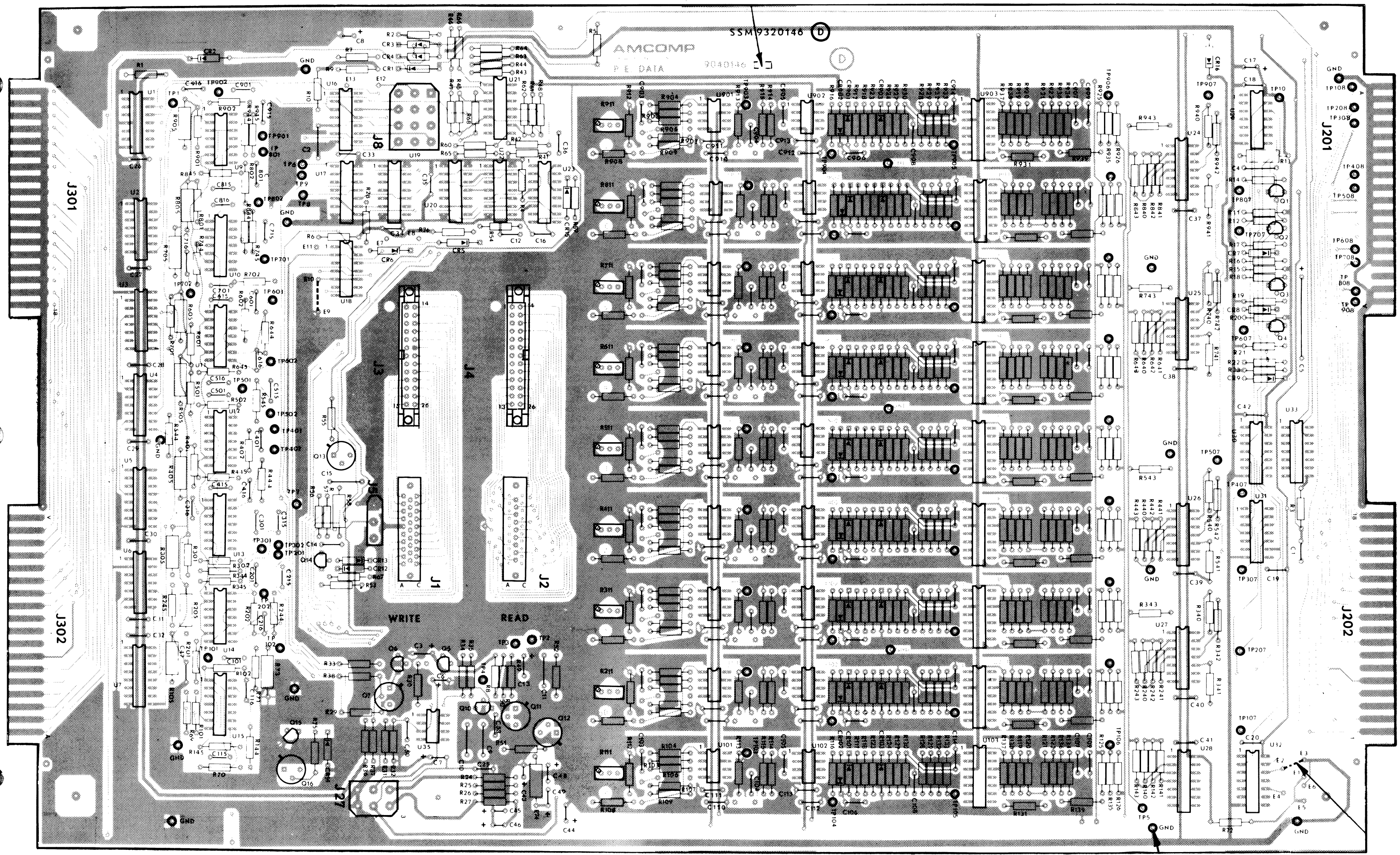
REVISIONS			
ZONE	LTR.	DESCRIPTION	DATE APPROVED
A		RELEASE PER 2700-019	2/6/77 <i>[Signature]</i>
B		REVISED PER EO 52119	5/12/77 <i>[Signature]</i>
C		REVISED PER EO 52337	12/14/78 <i>[Signature]</i>

DASH NO	J8A7-J8B7	J8A7-J8B7	E7 TO E9	E13 TO E14	E101-E904 TO E102-E902	E103-E903 TO E104-E904	E2 TO E3	07210009-01	07720003-01	07110002-01	07110003-01	07110004-01	2N3904	2200 PF	470 PF	2200 PF	1500 PF	470 PF	10 PF	270 PF	100 PF	21.5K	1620	10K	1000	4700	120	120	5110	5110	330	3600	3600	-17
-17	J8A7-J8B7												2N3904	2200 PF	470 PF	2200 PF	1500 PF	470 PF	10 PF	270 PF	100 PF	21.5K	1620	10K	1000	4700	120	120	5110	5110	330	3600	3600	-17
-15	J8A7-J8B7	END TO E11											2N3904	4700 PF	3300 PF	2200 PF	470 PF	22 PF	470 PF	220 PF	21.5K	3160	10K	1000	4700	120	120	5110	5110	330	3600	3600	-15	
-14													2N3904	4700 PF	1000 PF	3300 PF	3300 PF	680 PF	22 PF	470 PF	220 PF	21.5K	3160	10K	1000	4700	120	120	5110	5110	330	4700	4700	-14
-13													2N3904	6800 PF	2200 PF	4700 PF	4700 PF	680 PF	22 PF	470 PF	220 PF	21.5K	3160	10K	1000	4700	120	120	5110	5110	330	4700	4700	-13
-12													2N3904	.01	1000 PF	.01	6800 PF	680 PF	22 PF	470 PF	220 PF	21.5K	3160	10K	1000	4700	120	120	2610	2610	330	4700	4700	-12
-11													2N3904	.01	6800 PF	.01	.01	680 PF	22 PF	470 PF	220 PF	21.5K	3160	10K	1000	4700	120	120	2610	2610	330	4700	4700	-11
								J2	J3, J4	J5	J8B	J27B	Q101-Q901	C9	C10	C101-C901	C107-C907	C108-C908	C109-C909	C110-C910	C111-C911	R33 1/4W 1%	R49 1/4W 1%	R102 R902 POT 1/4W 20%	R103 R903 1/4W 5%	R104 R904 1/4W 5%	R109 R909 1W 5%	R111 R911 1W 5%	R112 R912 1/4W 1%	R113 R913 1/4W 1%	R116 R916 1/4W 5%	R127 R927 1/4W 5%	R128 R928 1/4W 5%	DASH NO.
								CONNECTORS					TRAN-SISTORS	CAPACITORS						RESISTORS														

NOTES:  
1. FOR SCHEMATIC DIAGRAM SEE 9940116 SHT 1.

QTY. REQ.	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL
LIST OF MATERIAL				

<p><b>NOTICE</b></p> <p>THIS DWG SHALL NOT BE DUPLICATED OR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH PROVIDED OR DISCLOSED IN WHOLE OR IN PART WITHOUT WRITTEN CONSENT OF AMCOMP, INC. HOWEVER, IF THIS DWG IS SPECIFIED TO BE GIVEN TO ANY BRANCH OF GOVERNMENT THIS DWG MAY BE USED AS IS PERMITTED BY THE DATA CLAUSE PER CONTRACT OR SUB-CONTRACT.</p>	<p>UNLESS OTHERWISE SPECIFIED</p> <p>DIMENSIONS ARE IN INCHES</p> <p>DECIMALS .002</p> <p>ANGLES .2X .2X .2X</p>		<p>SIGNATURE</p> <p><i>[Signature]</i></p>	<p>DATE</p> <p>3-15-77</p>	<p><b>AMCOMP</b></p> <p>SUNNYVALE, CALIFORNIA</p> <p>TITLE</p> <p>COMP. VERS. TABLE-NRZI DATA PWA</p> <p>SIZE <b>D</b> DRAWING NO. 9940096</p> <p>SCALE PROJ. NO. SHEET / OF /</p>
	<p>MATERIAL</p> <p>NRZI/PE HNYWL 9040096</p>		<p>CHK.</p> <p><i>[Signature]</i></p>	<p>DATE</p> <p>2/15/77</p>	
	<p>FINISH</p> <p>USED ON NEXT ASSY.</p>		<p>APP.</p> <p><i>[Signature]</i></p>	<p>DATE</p> <p>3-16-77</p>	
	<p>APPLICATION</p>		<p>REV</p> <p>C</p>		

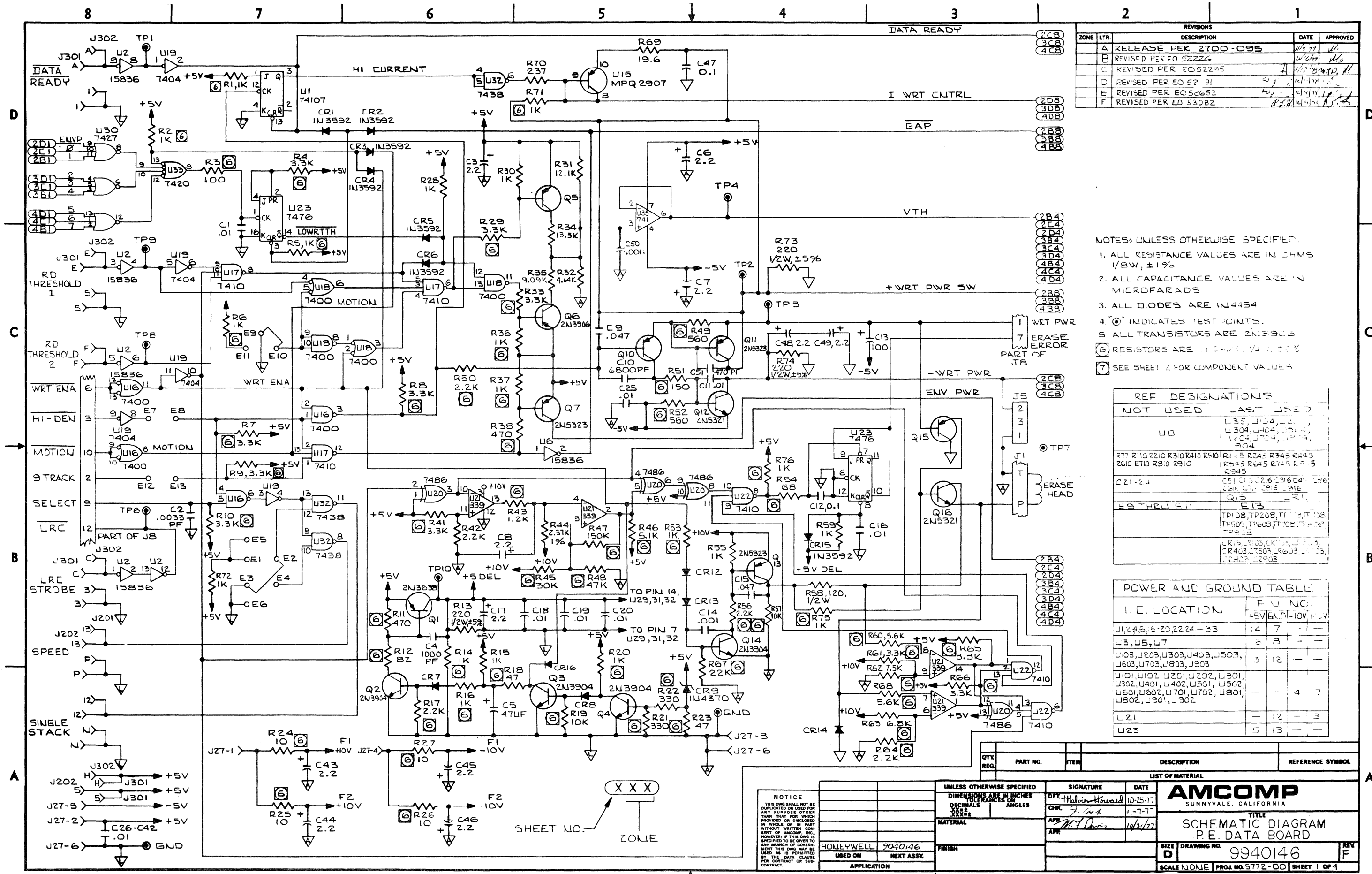


REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED
	A	RELEASE PER 2700-095	11/5/77	[Signature]
	B	SEE EO 52295	1/19/78	[Signature]
	C	SEE EO 52391A	2/21/78	[Signature]
	D	SEE EO 52573	4/12/78	[Signature]
	DI	SEE EO 52751	6/14/78	[Signature]
	E	SEE EO 52711	12/19/78	[Signature]
	F	SEE EO 52970	12/19/78	[Signature]

**AMCOMP**  
SUNNYVALE, CALIFORNIA

TITLE  
**P.E. DATA PWA**

SIZE <b>D</b>	DRAWING NO. <b>9040146</b>	REV. <b>F</b>
SCALE FULL PROJ. NO. 572-00 SHEET 1 OF 1		



REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED
A		RELEASE PER 2700-095	11/2/77	
B		REVISED PER EO 52226	11/2/77	
C		REVISED PER EO 52295	11/2/77	
D		REVISED PER EO 52791	11/2/77	
E		REVISED PER EO 52652	11/2/77	
F		REVISED PER ED 53082	11/2/77	

- NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCE VALUES ARE IN OHMS 1/8W, ±1%
  2. ALL CAPACITANCE VALUES ARE IN MICROFARADS
  3. ALL DIODES ARE 1N4454
  4. \* INDICATES TEST POINTS.
  5. ALL TRANSISTORS ARE 2N3903
  6. RESISTORS ARE 1% TOLERANCE
  7. SEE SHEET 2 FOR COMPONENT VALUES

REF DESIGNATIONS	
NOT USED	LAST USED
U8	U35, U34, U33, U304, U404, U304, U304, U304, U304
R77, R110, R210, R310, R410, R510, R610, R710, R810, R910	R145, R245, R345, R445, R545, R645, R745, R845, R945
C21-24	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24
EA THRU EI1	E13
	TP108, TP208, TP308, TP408, TP508, TP608, TP708, TP808, TP908, TP108
	CR403, CR503, CR603, CR703, CR803, CR903

POWER AND GROUND TABLE	
I. C. LOCATION	F U NO.
U1, U4, U6, U20, U22, U24 - 33	4 7 - -
U3, U5, U7	6 8 - -
U103, U203, U303, U403, U503, U603, U703, U803, U903	3 12 - -
U101, U102, U201, U202, U301, U302, U401, U402, U501, U502, U601, U602, U701, U702, U801, U802, U901, U902	- - 4 7
U21	- 12 - 3
U23	5 13 - -

QTY. REQ.	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL

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UNLESS OTHERWISE SPECIFIED	SIGNATURE	DATE
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ANGLES	Holleywell	10-25-77
MATERIAL	CHK. J. Smith	11-7-77
APPROVED	APP. M. J. Davis	11/2/77
APPROVED		

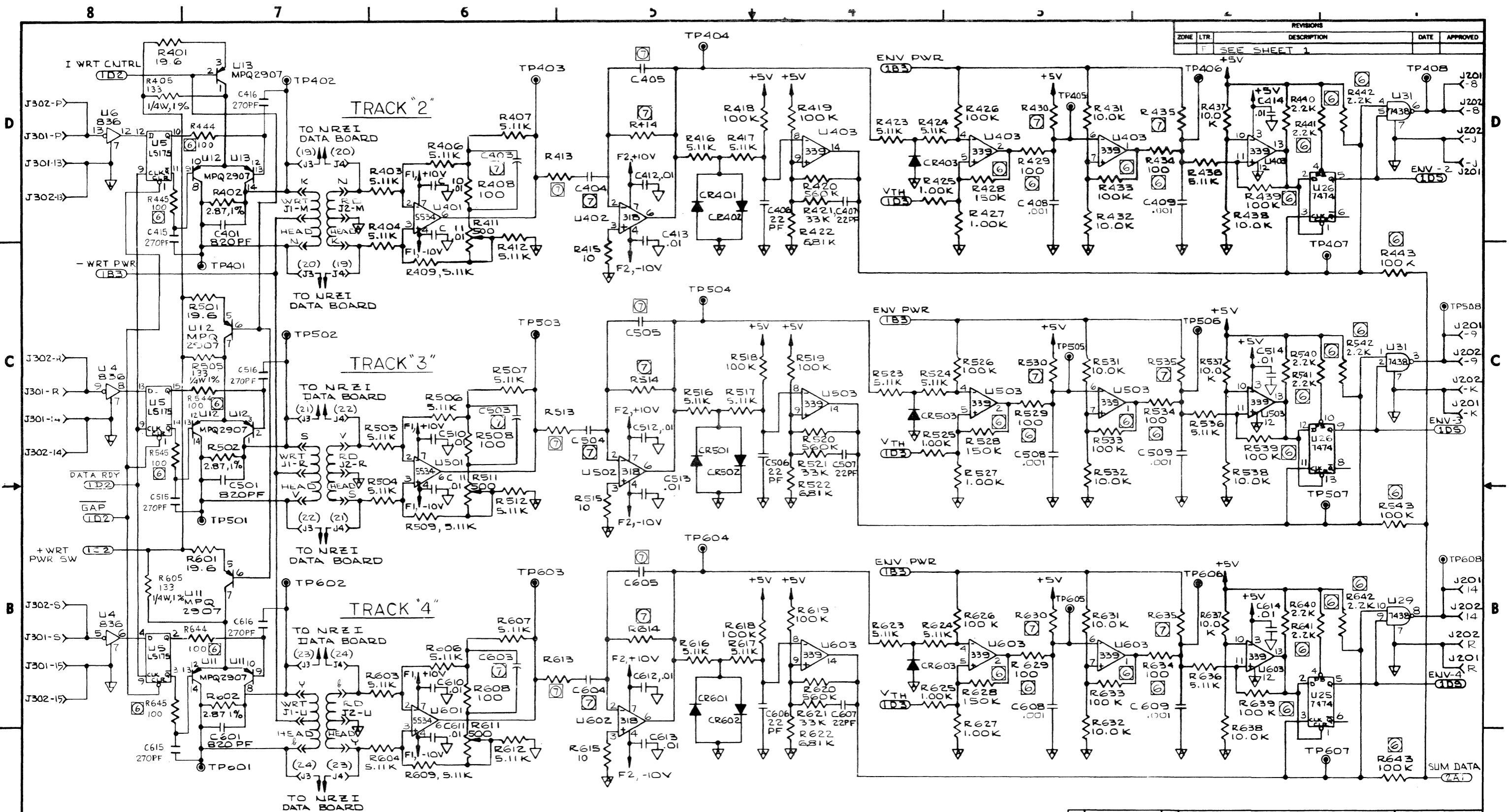
**AMCOMP**  
SUNNYVALE, CALIFORNIA

TITLE  
**SCHEMATIC DIAGRAM  
P.E. DATA BOARD**

SIZE **D** DRAWING NO. **9940146** REV **F**

SCALE 1/8"=1" PROJ. NO. 5772-00 SHEET 1 OF 4

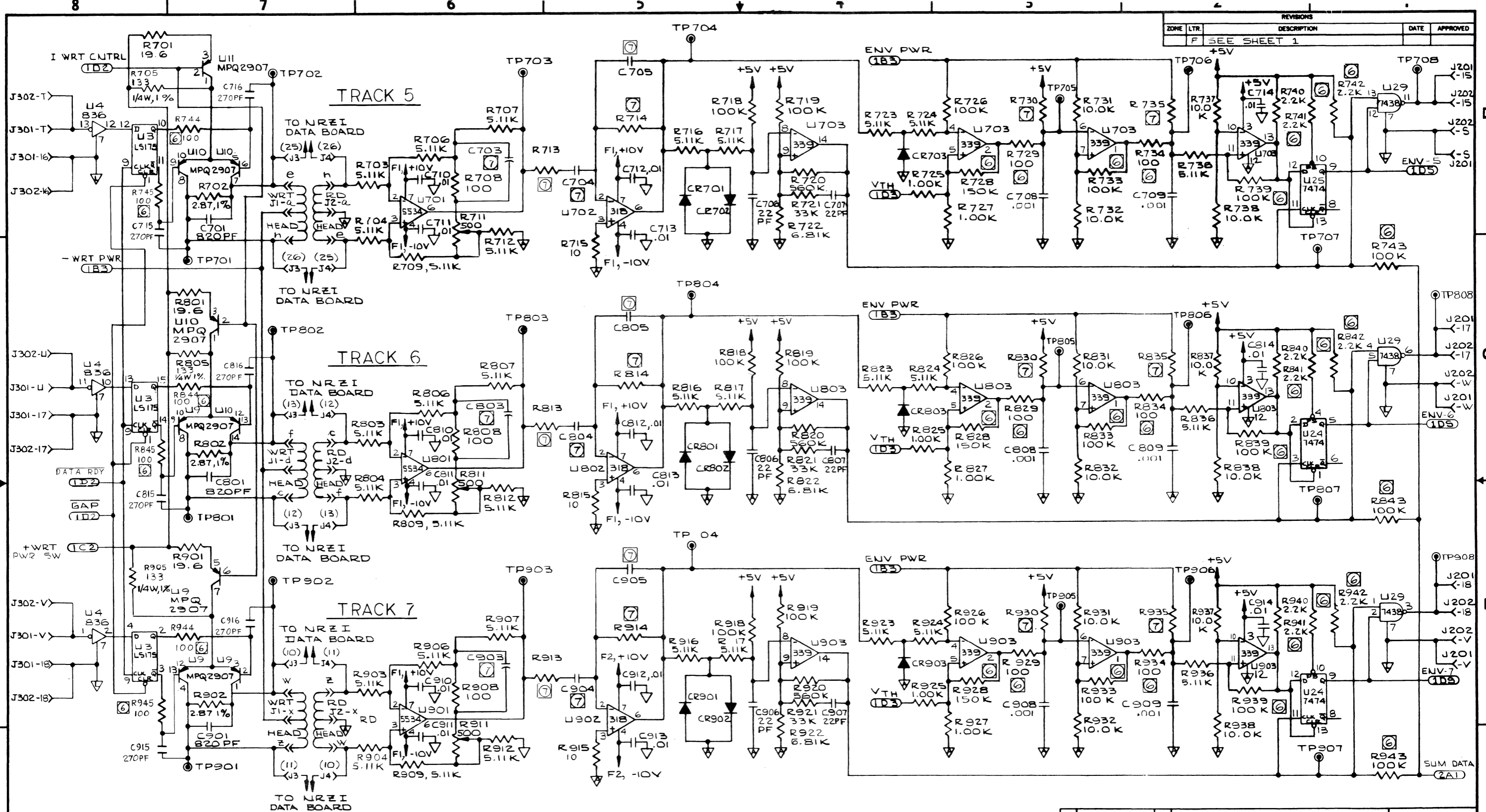




ZONE	LTR.	DESCRIPTION	DATE	APPROVED
F	SEE SHEET 1			

QTY REQ	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL
LIST OF MATERIAL				

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	DIMENSIONS ARE IN INCHES	DPT. <i>Michael J. Newell</i>	8-30-77	
	DECIMALS	CHK		
	ANGLES	APR		
MATERIAL	APR			
FINISH	APR			
HONEYWELL	E/I			
USED ON	NEXT ASSY.			
APPLICATION				



ZONE	LTR.	DESCRIPTION	DATE	APPROVED
F	SEE SHEET 1			

QTY. REQ.	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL
LIST OF MATERIAL				

NOTICE  
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WITHOUT WRITTEN  
CONSENT OF AMCOMP, INC.  
HOWEVER, IF THIS DRAWING IS  
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ANY BRANCH OF GOVERNMENT  
THIS DRAWING MAY BE  
USED AS IS PERMITTED  
BY THE DATA CLAUSE  
PER CONTRACT OR SUB-  
CONTRACT.

UNLESS OTHERWISE SPECIFIED	SIGNATURE	DATE
DIMENSIONS ARE IN INCHES DECIMALS XXX's	DPT-Halpin	8-30-71
MATERIAL	AKR	
HONEYWELL	E/I	
USED ON	NEXT ASSY.	
APPLICATION		

**AMCOMP**  
SUNNYVALE, CALIFORNIA

TITLE  
**SCHEMATIC DIAGRAM**  
P.E. DATA BOARD

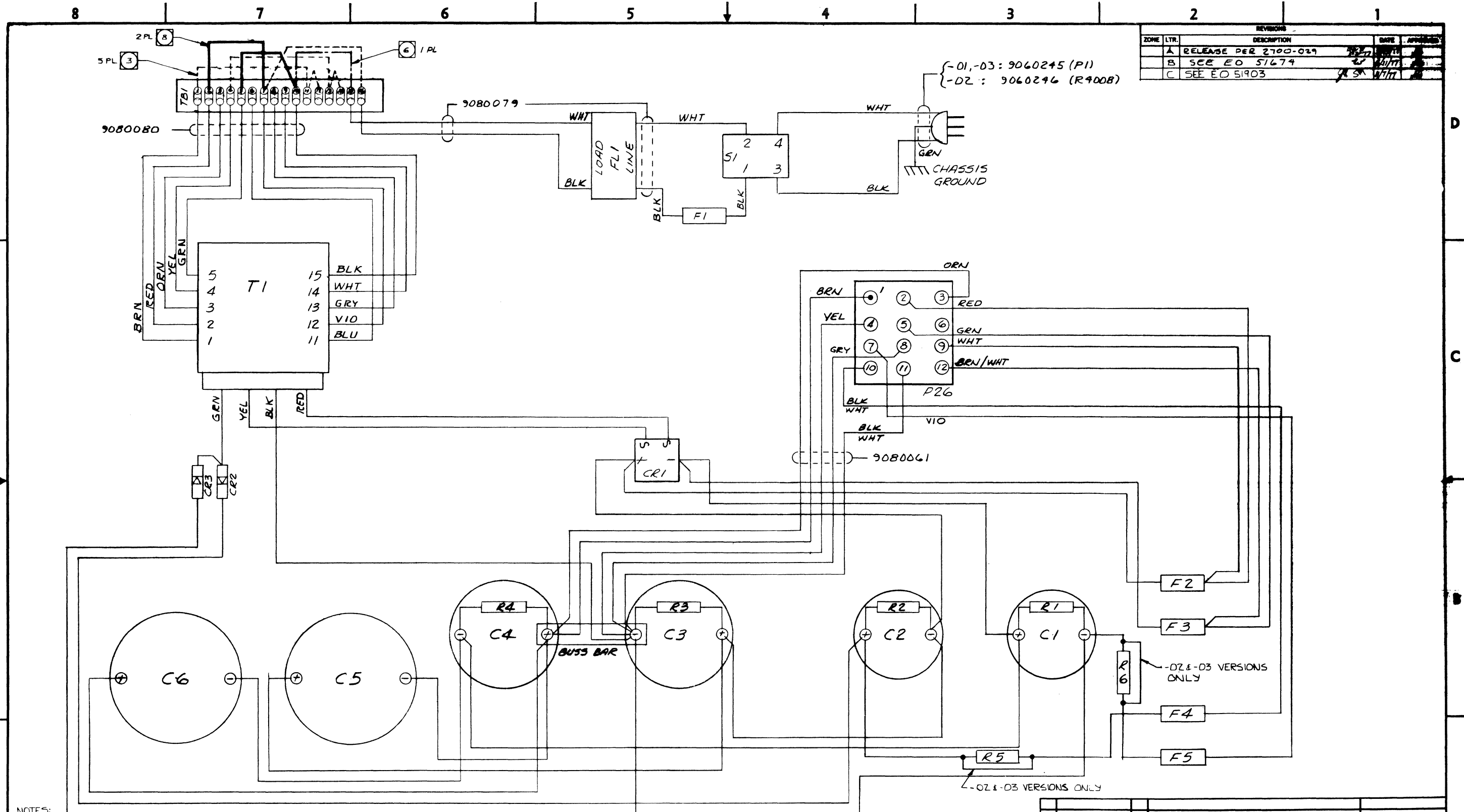
SIZE **D** DRAWING NO. **9940146** REV **F**

SCALE **NO. 1** PROJ. NO. **5772-00** SHEET **4** OF **4**









REVISIONS		DATE	APPROVED
ZONE	LTR.		
A	RELEASE PER 2700-029	5-11-77	[Signature]
B	SEE EO 51674	5-19-77	[Signature]
C	SEE EO 51903	5-17-77	[Signature]

{-01,-03: 9060245 (P1)  
-02: 9060246 (R400B)}

- NOTES:
- FOR ASSY. DRAWING SEE 9020217.
  - ALL WIRES NOT COLOR CODED SHALL BE WHITE.
  - INDICATED JUMPERS ARE USED ON -02 VERSION ONLY.
  - WIRING SHOWN IS FOR 115V.
  - PREFIX REFERENCE DESIGNATIONS WITH A6.
  - INDICATED JUMPER FOR -01 & -02 VERSIONS ONLY.
  - INDICATED JUMPERS FOR 02 & 03 VERSIONS ONLY.
  - INDICATED JUMPERS FOR -01, -02 & -03 VERSIONS ONLY.

QTY. REQ.	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL
			LIST OF MATERIAL	
			UNLESS OTHERWISE SPECIFIED	
			DIMENSIONS ARE IN INCHES	
			TOLERANCES ON DECIMALS ANGLES	
			FRACTIONS	
			MATERIAL	
			FINISH	
			USED ON NEXT ASSY.	
			APPLICATION	

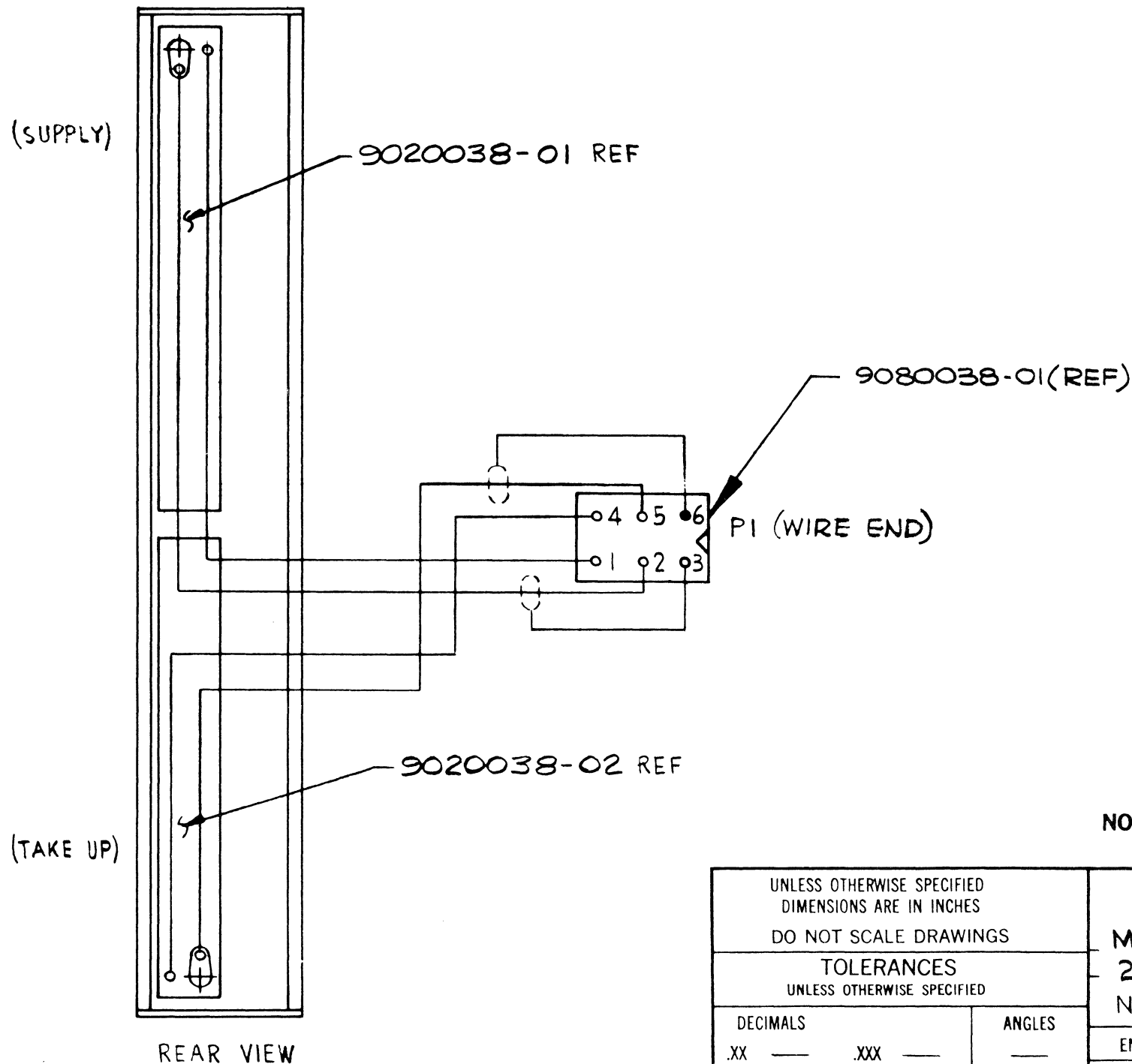
  

NOTICE	UNLESS OTHERWISE SPECIFIED	SIGNATURE	DATE
THIS DWG SHALL NOT BE DUPLICATED OR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH PROVIDED OR DISCLOSED IN WHOLE OR IN PART WITHOUT WRITTEN CONSENT OF AMCOMP, INC. HOWEVER IF THIS DWG IS SPECIFIED TO BE GIVEN TO ANY BRANCH OF GOVERNMENT THIS DWG MAY BE USED AS IS PERMITTED BY THE DATA CLAUSE FOR CONTRACT OR SUBCONTRACT.	DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ANGLES	[Signature]	5-11-77
		CHK [Signature]	5-19-77
		APR [Signature]	5-19-77

AMCOMP	
SUNNYVALE, CALIFORNIA	
TITLE	
WIRING DIAGRAM	
POWER SUPPLY	
SIZE	DRAWING NO.
D	9930046
SCALE	PROJ. NO. 1621-01 SHEET 1 OF 1

REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED
	A	PRODUCTION RELEASE	11/30/73	<i>[Signature]</i>
	B	SEE EO 50072	7/21/76	<i>[Signature]</i>
	BI	SEE EO 51400	4/21/78	<i>[Signature]</i>

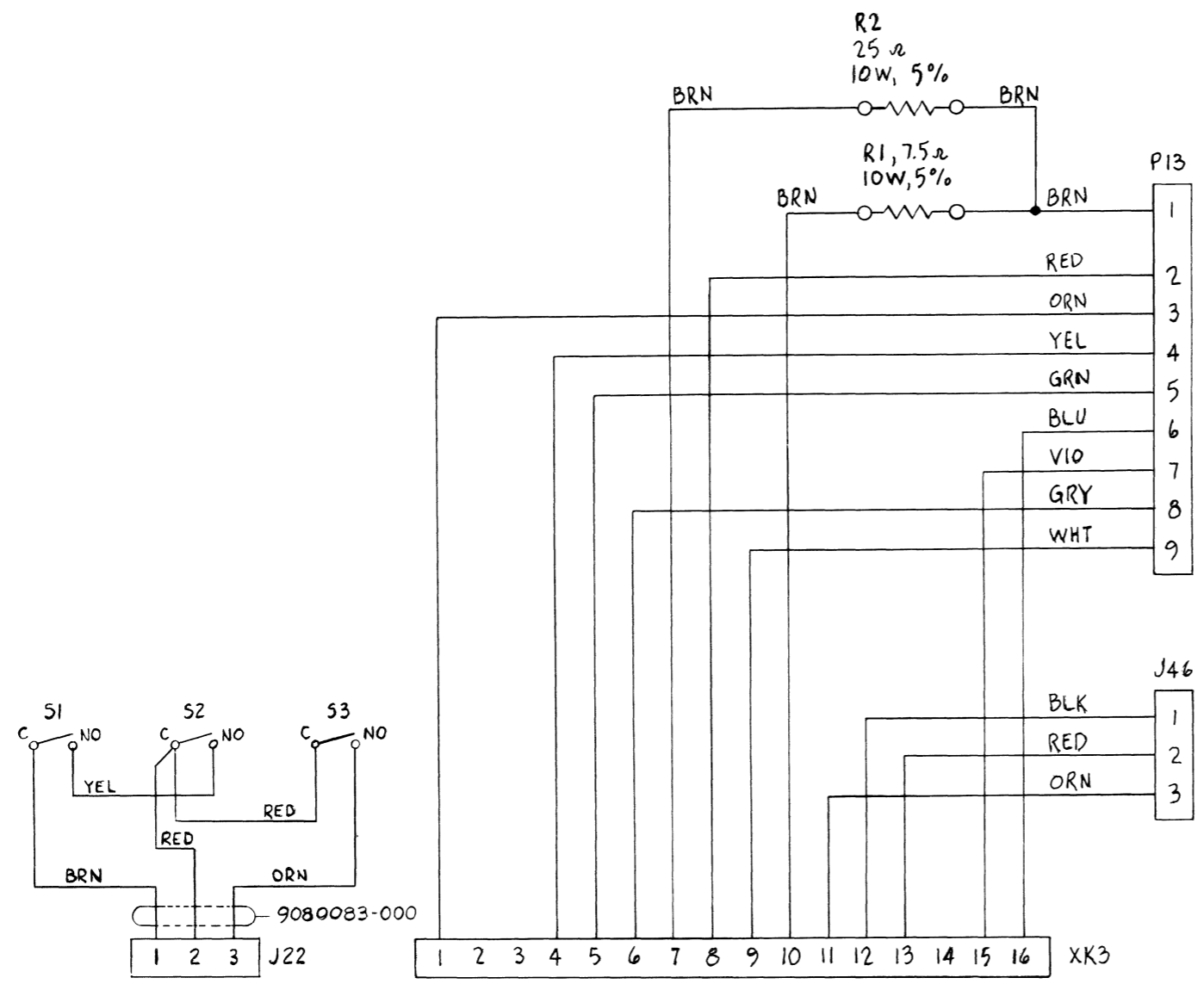


NOTES:  
 1. PHYSICAL APPEARANCE PER 2740;  
 ELECTRICAL CONNECTIONS APPLY  
 TO 2740, 2750, 2760.

NOTES:

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DO NOT SCALE DRAWINGS		MODEL: 2740, 2750, 2760 N/A: 9020050		<b>AMCOMP</b> SUNNYVALE, CALIFORNIA  VACUUM CHAMBER - WIRING DIAGRAM	
TOLERANCES UNLESS OTHERWISE SPECIFIED		ENGINEER <i>R. J. Courne</i> 11-30-73			
DECIMALS .XX — .XXX —	ANGLES —	CHECKED <i>A. J. Turner</i> 11-28-73	DRAWING NO. 9930016		
MATERIAL:		DRAFTSMAN <i>T. J. ...</i> 10-1-73	SIZE <b>B</b>	REV. <b>BI</b>	
			SCALE NONE	SHEET 1 OF 1	

REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED
	A	RELEASE / 2700-070	7/29/77	[Signature]
	E	REVISED PER 201 595	3/23/77	[Signature]



NOTES  
 1. PREFIX REFERENCE DESIGNATIONS WITH A13

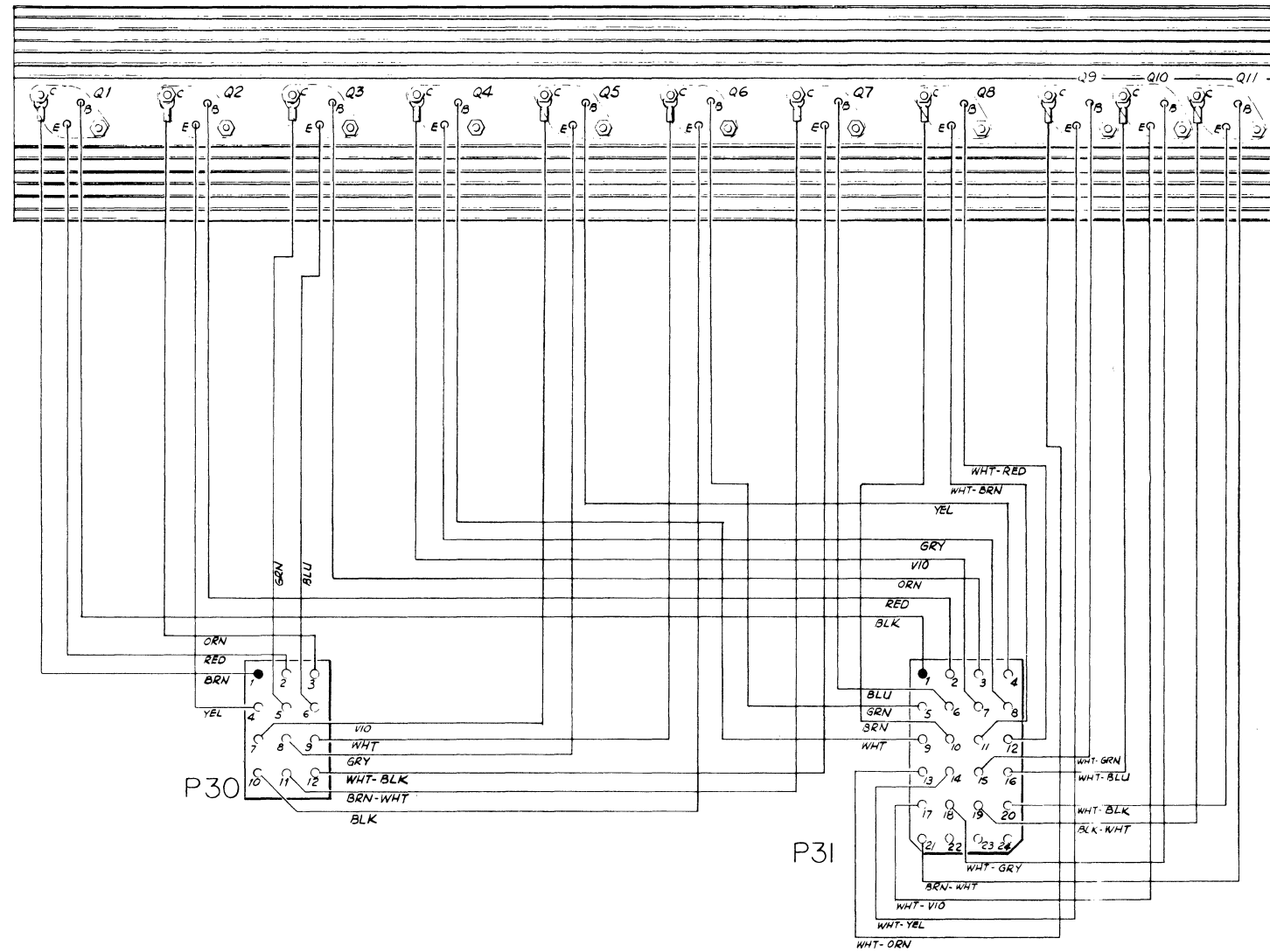
QTY REQ.	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL
LIST OF MATERIAL				

<p><b>NOTICE</b></p> <p>THIS DWG SHALL NOT BE DUPLICATED OR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH PROVIDED OR DISCLOSED IN WHOLE OR IN PART WITHOUT WRITTEN CONSENT OF AMCOMP, INC. HOWEVER, IF THIS DWG IS SPECIFIED TO BE GIVEN TO ANY BRANCH OF GOVERNMENT THIS DWG MAY BE USED AS IS PERMITTED BY THE DATA CLAUSE PER CONTRACT OR SUB-CONTRACT.</p>	UNLESS OTHERWISE SPECIFIED	SIGNATURE	DATE	<p><b>AMCOMP</b></p> <p>SUNNYVALE, CALIFORNIA</p> <p>TITLE</p> <p>WIRING DIAGRAM - PNEUMATIC ASSY</p>
	DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX = ± .XXX = ±	DFT. [Signature]	7-7-77	
	MATERIAL	CHK. [Signature]	7-21-77	
	FINISH	APR. [Signature]	7/29/77	
USED ON	NEXT ASSY.	SCALE	PROJ. NO.	REV. B
APPLICATION		SHEET 1 OF 1		



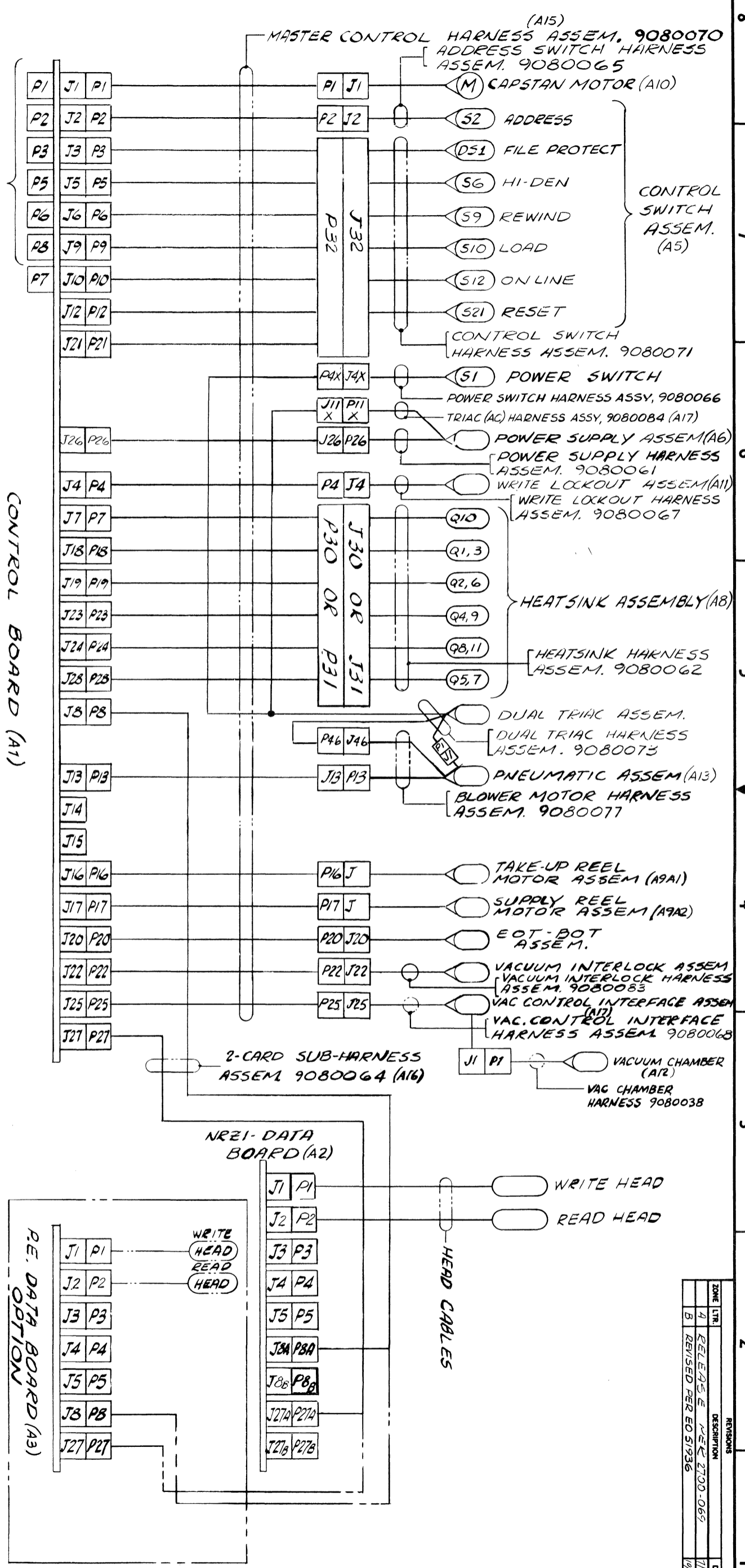
8 7 6 5 4 3 2 1

REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED
		RELEASE PER 2700-001	1/1/77	JLR



QTY. REQ.	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL
LIST OF MATERIAL				

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	<p>MATERIAL</p> <p>FINISH</p>	<p>USED ON</p> <p>NEXT ASSY.</p>	<p>SIZE</p> <p>D</p> <p>DRAWING NO.</p> <p>9930045</p>	<p>REV</p> <p>A</p>
	<p>APPLICATION</p>	<p>SCALE NONE</p> <p>PROJ. NO. 1621-01</p> <p>SHEET / OF /</p>		



**LEGEND**

(M) MOTORS

CONNECTORS

ASSEMBLIES

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2740 STD	ENG. DES.
USED ON	NEXT ASSY
APPLICATION	

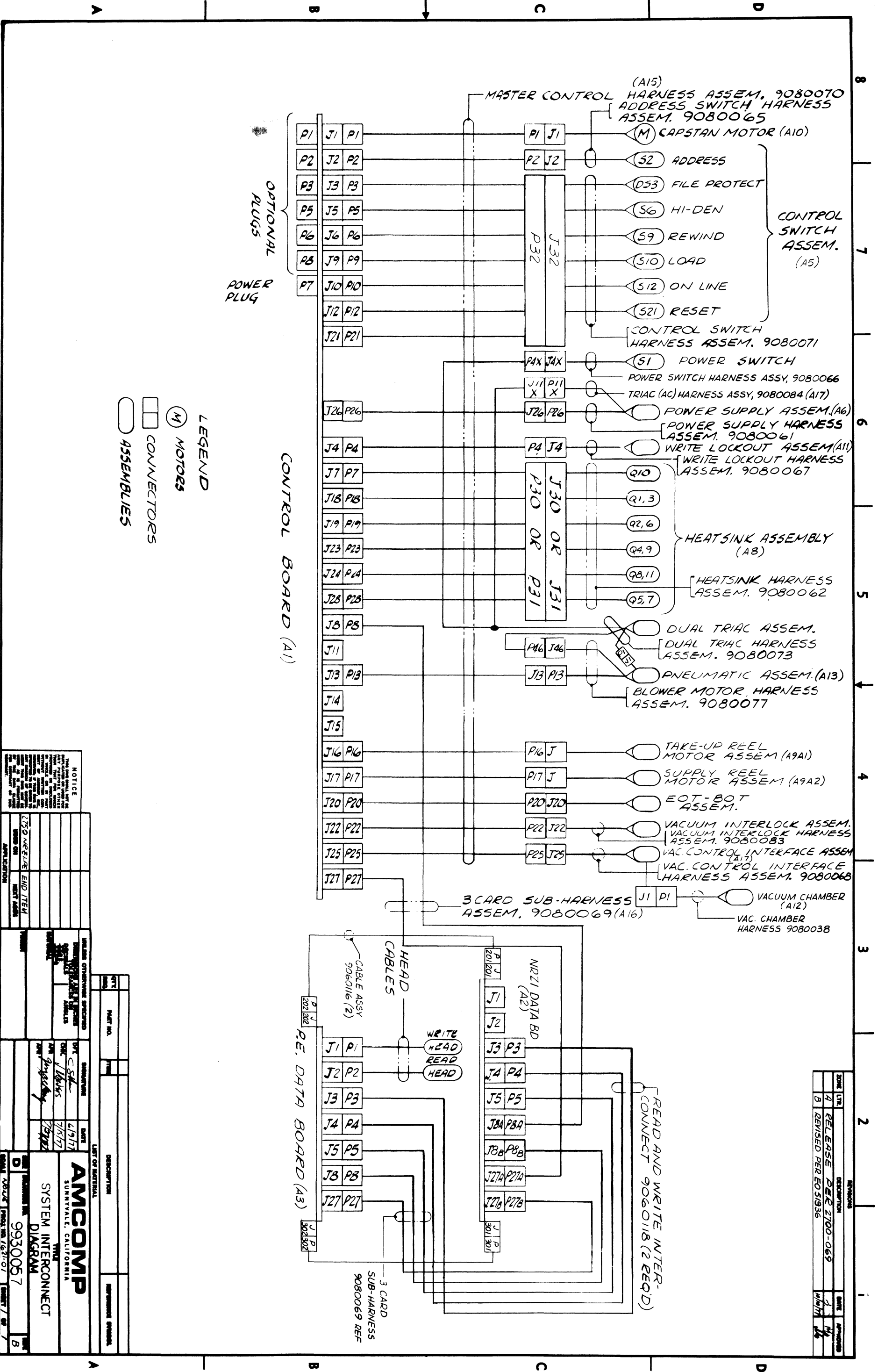
QTY	PART NO.	ITEM	DESCRIPTION	REFERENCE SYMBOL

UNLESS OTHERWISE SPECIFIED	DATE
DIRECTOR	6/9/77
DESIGNER	7/10/77
CHECKER	7/28/77
APPROVED	7/28/77
DATE	

<b>AMCOMP</b>	SUNNYVALE, CALIFORNIA
TITLE	SYSTEM INTERCONNECT DIAGRAM
SIZE	D
DRAWING NO.	9930056
SCALE	AS SHOWN
PROJ. NO.	427-071
SHEET	1 OF 7

ZONE	LTR.	DESCRIPTION	DATE	APPROVED
4	RELEASE	4-27-00-069	7/28/77	140
B	REVISED PER EO 51936		10/1/77	140





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DATE	DESCRIPTION	BY	CHKD
6/9/77	SYSTEM INTERCONNECT DIAGRAM	J. M. ...	J. M. ...
7/8/77			
7/9/77			

**AMCOMP**  
SUNNYVALE, CALIFORNIA

SYSTEM INTERCONNECT DIAGRAM  
9930057

ZONE	DATE	DESCRIPTION
A	7/1/77	RELEASE PER 2700-069
B	7/1/77	REVISED PER EO 51936