

DIGI-DATA CORPORATION
8580 Dorsey Run Rd., Jessup, Md. 20794

**SYNCHRONOUS DIGITAL
TAPE TRANSPORT**

1600 AND 1700 SERIES

**OPERATING AND
SERVICE MANUAL**

ADDENDUM

The following changes have been made in this manual:

DWG. NO.
CD-0003

C1 is changed to C150. Its value is changed from 33,000 10VDC to 25,000 15VDC.

C2 is changed to C148. C3 is changed to C149.

Add Note 8: K1 relay socket mates with K1 R10-E1-X4-V185 and jumper W1 is not installed.

SC-0146

F3 is changed from 3AG 3 AMP to 3AG 3 AMP SLO-BLO.

LD-0011

Connector P1, pin T is connected to +12V for V185 series relays only.

W1: Install for V700 series relays only.

K2: P & B R10-E1-X2-V700(24V) is changed to P & B R10-E1-X4-700(24V).

K1 is changed from P & B R10-E1-X4-V700(24V) to P & B R10-E-V700 (24V) OR P & B R10-E1-X4-V185(12V).

CA-0044

Beneath "Model 1700 45 ips" RB is changed from 7.50K to 470K. CC is changed from 4.7 to 6.8.

Delete RK for all speeds in both models.

SC-0146

Change transistor Q7 from type 2N5296 to type TIP3055.

LD-0002)
LD-0006)

BOT SENSOR changed to $\overline{\text{BOT}}$; EOT SENSOR changed to $\overline{\text{EOT}}$.

LED BOT SENSOR ADDENDUM replaces paragraphs 6.5.2, 6.15, and Figure 6.4.

SC-0154)
CD-0032)

Capacitor C1021 is changed from 470pf to 220pf.

Transistor Q38 is now labeled GET 914.

INSPECTION AND WARRANTY

INSPECTION OF RECORDERS

The recorder should be inspected immediately after receipt. Press down on the printed circuit cards to insure that they are firmly in place in their sockets.

After visual inspection, the recorder should be operated and tested. All Digi-Data recorders are thoroughly tested at the factory and should be in perfect operating condition when received by the customer.

If the unit has been damaged in any way during shipment, a claim should be filed with the carrier and a copy of the claim forwarded to Digi-Data Corporation. We then will advise you of the best way to arrange repair of the damaged equipment.

WARRANTY

Digi-Data Corporation warrants each recorder to be free from defects in material and workmanship. In support of this warranty, Digi-Data guarantees to service or adjust, at the plant in Jessup, Maryland, for one year from the date of delivery of the recorder to the original purchaser, any defective parts, provided transportation charges have been prepaid by the customer and our inspection discloses to our satisfaction that the equipment is defective in material or workmanship. If misuse or abnormal conditions of operation are determined to be the cause of improper operation of the recorder, however, repairs will be billed at cost; in the latter situation, an estimate will be submitted to the customer prior to initiating repair of the equipment.

If any fault should develop in the recorder, please notify Digi-Data Corporation, giving us full details of the irregularity and including the model and serial number of the recorder. We will provide you with service instructions or shipping details immediately upon receipt of your notification.

SHIPPING

All shipments of Digi-Data equipment should be made via major air lines or air freight carriers and within original containers if possible. Otherwise, recorders should be surrounded by not less than two inches of rubberized hair or similar shock-absorbing material and enclosed in heavy cardboard boxes. The initial cardboard box then must be packed in a wooden box or second heavy-weight cardboard box. Digi-Data Corporation assumes no responsibility for damage to recorders which have been improperly packed.

Contents	Page
Section 1	DESCRIPTION AND SPECIFICATIONS
1.1	Introduction 1-1
1.2	Description of Equipment 1-1
1.3	Specifications 1-3
Section 2	OPERATION
2.1	Controls and Indicators 2-1
2.1.1	Description of Controls 2-1
2.1.2	Description of Indicators 2-1
2.2	Operating Procedures 2-4
2.2.1	Turning Transport On 2-4
2.2.2	Loading Tape 2-4
2.2.3	On Line Operation 2-4
2.2.4	Rewinding 2-5
2.2.5	Unloading the Tape 2-5
2.2.6	Reloading from End of Tape 2-5
2.2.7	Power Failure Recovery 2-5
2.3	Daily Cleaning
Section 3	INSTALLATION
3.1	Unpacking 3-1
3.2	Repacking for Shipment 3-1
3.3	Mechanical Installation 3-1
3.4	Electrical Installation 3-3
Section 4	INTERFACING AND CONTROL
4.1	General 4-1
4.2	Tape Format 4-1
4.3	Interface Circuit 4-4
4.4	Interface Signals 4-6
4.5	Transport Control 4-6
4.5.1	Motion Timing 4-6
4.5.2	Write Operations 4-8
4.5.3	Read Operation 4-12
4.5.4	CRCC Generation 4-14
4.5.5	Non-Stop Operation 4-15
Section 5	THEORY OF OPERATION
5.1	Mechanical Operation 5-1
5.2	Transport Block Diagram 5-1
5.3	Power Supply 5-2
5.4	Capstan Servo System 5-4
5.5	Reel Servo System 5-7

LIST OF ILLUSTRATIONS

Figure		Page
2-1A	Model 1600 Tape Transport	2-2
2-1B	Model 1700 Tape Transport	2-3
3-1	Multiple Transport Cabling	3-4
4-1A	7 Track Format	4-2
4-1B	9 Track Format	4-3
4-2	Transport/Controller Interface Circuit	4-5
4-3	Write Operation Timing Diagram	4-10
4-4	Read Operation Timing Diagram	4-13
4-5	CRCC Generator	4-20
5-1	Transport Block Diagram	5-3
5-2	Capstan Servo Block Diagram	5-5
5-3	Capstan Servo Waveforms	5-6
5-4	Write and Read Circuitry Simplified Schematic	5-11
5-5	Write and Read Circuitry Waveforms	5-13
5-6	Deskewing Operation Waveforms	5-14
5-7	Load Sequence Timing Diagram	5-17
5-8	Rewind Sequence Timing Diagram	5-19
6-1A	Tension Arm Operating Positions Model 1600	6-9
6-1B	Tension Arm Operating Positions Model 1700	6-10
6-2A	Tape Tension Measurement Model 1600	6-21
6-2B	Tape Tension Measurement Model 1700	6-22
6-3	Head Wiring Diagram	6-24
6-4	BOT/EOT Sensor Wiring Diagram	6-26
6-5	Skew Measurement Waveform	6-27
6-6	Arm Position Sensor Wiring Diagram	6-30

LIST OF TABLES

		Page
3-1	Unformatted Transport Interface Connector	3-5
4-1	OEM NRZI Interface Signals	4-16
4-2	Motion Control Delays (9 Track)	4-21
4-3	Motion Control Delays (7 Track)	4-22
4-4	Typical IBG Length Calculations	4-23
4-5	Overwrite Positioning Calculations	4-24
6-1	Transport Adjustments	6-15

SECTION 1

DESCRIPTION AND SPECIFICATIONS

1.1 Introduction

This manual provides installation, operating and maintenance information for Digi-Data's series 1600 and 1700 magnetic tape transports.

These machines record and read digital information on one-half inch wide magnetic tape in a manner compatible with IBM machines and ANSI standards. The tape transport is designed for use in data handling systems which generate input tapes for computers or translate computer output tapes into other media.

The tape transport includes complete power supplies and all components and circuitry required to move the tape and record and read data. The interface between the transport and the associated system consists of DTL/TTL compatible logic signals and is designed to allow several transports to share a single interface.

Formatted transports include two circuit cards within the machine which perform all required timing and error control functions. A separate manual is provided for these cards.

Unformatted transports require external circuitry which controls the timing of all operations and generates and checks error control codes. The external formatter may be shared by up to four transports. The formatting functions may be included in the system associated with the transport or may be provided by a Digi-Data magnetic tape formatter or special interface system.

1.2 Description of Equipment

The transport contains three motors, one for each tape reel and one driving the capstan. Each motor is controlled by an independent servo system. The tape is wrapped 180 degrees around the capstan to provide a large area of contact. Friction between the tape and capstan moves the tape without the use of pinch rollers or idler wheels. All tape motions are generated by the capstan, with the independent reel motors supplying or taking up tape as the capstan requires. The reels are isolated from the capstan by spring loaded arms which

create a constant tape tension and also provide tape to the capstan while the reel motors are accelerating. The constant tension provided by the arms produces a constant pressure between head and tape without the use of a pressure pad. Each arm is monitored photoelectrically by the associated reel servo, which accelerates or brakes the reel motor as required to keep the tension arm within its operating area. This system permits the tape to be rapidly started or stopped by the capstan while allowing considerably more time for the reels to be accelerated.

The motor control system in the transport provides a high speed rewind under servo control with the tape being wound under constant tension. The rewind operation returns the tape to the BOT marker, ready for further operation or for unloading. Unloading is accomplished at low speed to minimize wear on the leader portion of the tape.

Protective circuitry in the transport will disconnect the motors from the servo amplifiers if improper tape threading or a faulty servo causes the tension arms to leave the normal operating positions.

If a power failure occurs the transport utilizes stored energy to stop the tape and relax the tension arms without unthreading the machine.

1.3 Specifications

REEL DIAMETER	1600 8.5 in.	1700 10.5 in.
TAPE CAPACITY	1200 ft.	2400 ft.
TAPE SPEED (STANDARD)	25 ips	45 ips
REWIND SPEED	100 ips	150 ips
START/STOP TIME	15+ 1 msec	8.3 + .55 msec
START/STOP DISTANCE (ALL SPEEDS)	0.19+0.02 in.	0.19+0.02 in.
PANEL WIDTH	19.00 in.	19.00 in.
PANEL HEIGHT	12.25 in.	24.50 in.
DEPTH (BEHIND PANEL)	11.25 in.	10.00 in.
DEPTH (TOTAL)	13.25 in.	12.00 in.
WEIGHT	45 lbs.	75 lbs.
TAPE SPECIFICATIONS	0.5 in. wide, 1.5 mil thick, Computer Grade	
SPEED VARIATION (LONG TERM)	+ 1%	
SPEED VARIATION (INSTANTANEOUS)	+ 3%	
TAPE TENSION	7 + 1 oz.	
NUMBER OF TRACKS	7 or 9, IBM compatible spacing	
TAPE PATH	Head and guide spacing IBM compatible	
RECORDING MODE	NRZI or Phase Encoding (IBM compatible)	
DATA DENSITY	7 Track NRZI: 9 Track NRZI: 9 Track PE:	200, 556, or 800 cpi 800 cpi 1600 cpi
INTERCHANNEL DISPLACEMENT ERROR	150 micro inches max.	
ERASE HEAD	Full width DC, IBM compatible	
ELECTRONICS	Solid State, All silicon	
ELECTRICAL INTERFACE	DTL/TTL Compatible	
POWER	115/220 VAC, 48-400 Hz. 200 Watts AC Line filtered	
OPERATING ENVIRONMENT	35° to 110° F Humidity to 95% Non-condensing Altitude to 20,000 ft.	

SECTION II

OPERATION

2.1 Controls and Indicators

Figure 2-1 shows the location of all operator controls and indicators.

2.1.1 Description of Controls

POWER	A pushbutton switch that applies power to the transport.
LOAD	A pushbutton switch that initiates the tape loading sequence. Pressing the switch will cause the reels to apply tension to the tape. The tape will then advance to the beginning of tape (BOT) mark and halt.
REWIND	A pushbutton switch that initiates the rewind operation. Pressing the switch will place the tape transport OFF LINE, and rewind the tape to BOT. Pressing the switch when tape is at BOT will cause tape to unload from the take-up reel at low speed.
ON/OFF LINE	A pushbutton switch that places the transport in the ON LINE mode (enabling remote control) if tape is loaded. The transport may be placed OFF LINE at any time by pressing the switch again.

2.1.2 Description of Indicators

POWER	This indicator is illuminated when power is applied to the transport.
ON LINE	This indicator is illuminated when the transport is in ON LINE status and under remote control.
RING IN	This indicator is illuminated when a write ring is on the supply reel, permitting writing or erasing of tape. If the indicator is not illuminated, no writing or erasing of tape is possible.

2-2

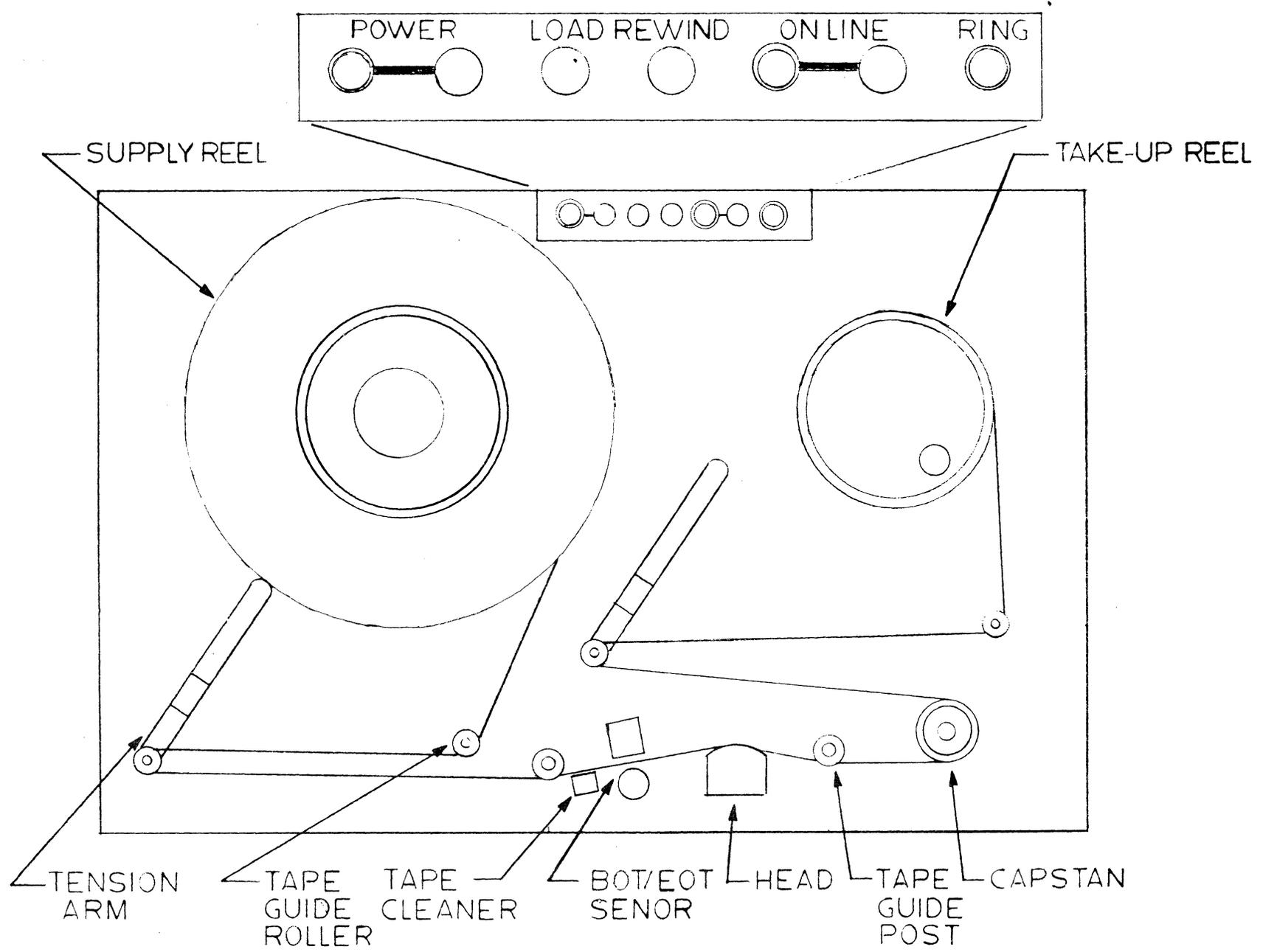


FIG 2-1A MIDIDEK TAPE TRANSPORT MODEL 1600

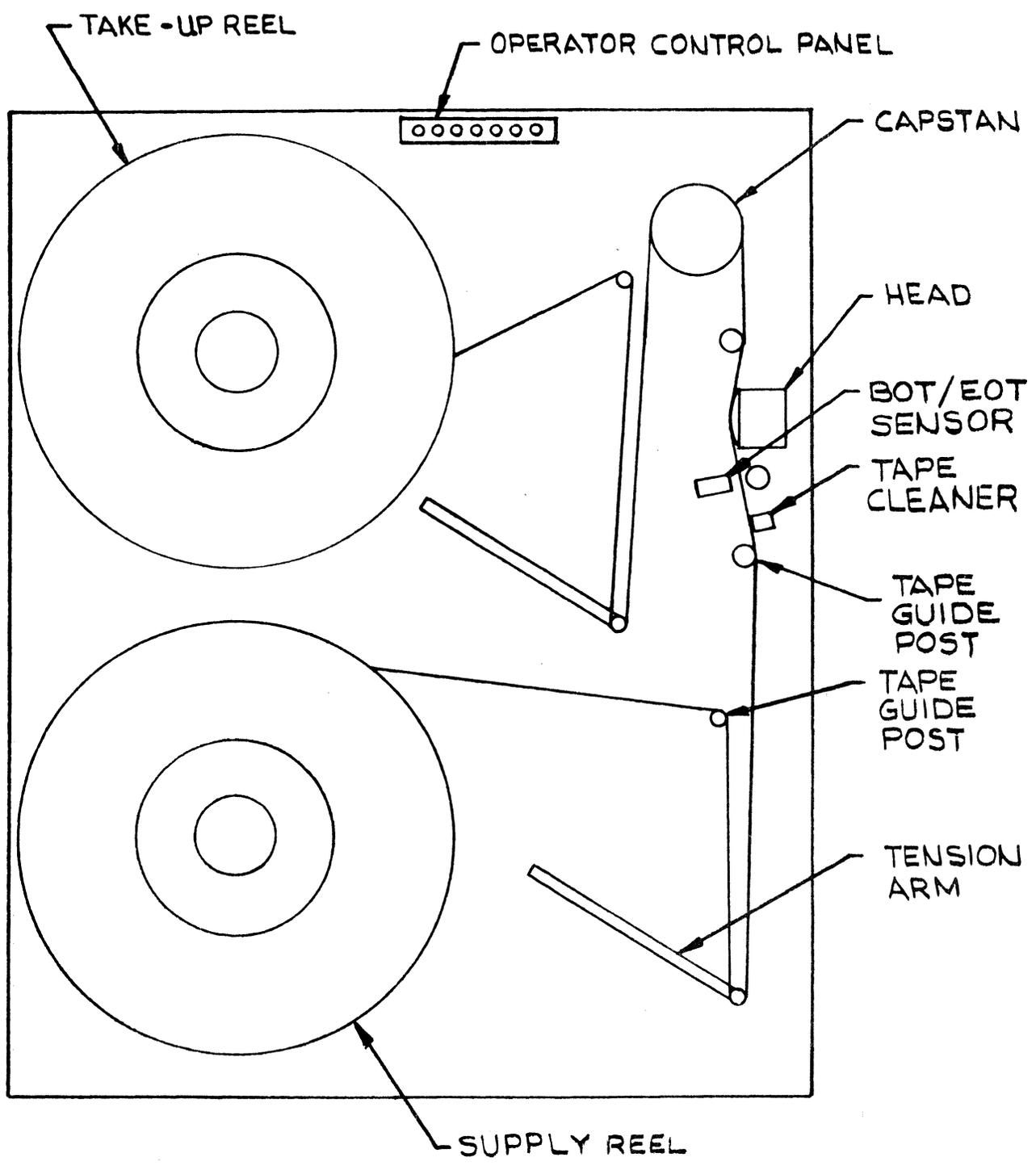


FIG 2-1B MODEL 1700 TAPE TRANSPORT

2.2 Operating Procedures

2.2.1 Turning Transport On

Press the POWER button on the operator control panel. The POWER indicator will light indicating that the machine is on.

To turn the transport off press POWER switch again.

2.2.2 Loading Tape

1. If recording is intended make sure that a write ring is installed on the reel.
2. Open the door.
3. Install the reel on the supply hub. The tape should unwind as the reel is turned clockwise. Pressure should be applied only near the inner edge of the reel to prevent wear on the edges of the tape. Seat the reel against the hub and press in the locking knob to lock the reel on the machine.
4. Thread the tape exactly as shown on the front panel diagram. If the machine has a spring loaded head shield it should be opened to thread the tape directly over the head.
5. Hold the end of the tape on the take-up reel and turn the reel for 2 or 3 turns.
6. Gently release the take-up reel so that no slack remains in the tape.
7. Visually check to see that the tape is properly threaded on the rollers and guides.
8. Close the door.
9. Press the LOAD button. The arms will move as the reels remove all slack from the tape. The tape will then move forward to the beginning of tape (BOT) marker and stop.

2.2.3 On Line Operation

Press the ON/OFF LINE button to permit the external system to control the transport. The ON LINE light should immediately come on. The ON/OFF LINE button may be pressed while the machine is loading. When the external system is finished with the tape it may place the recorder off line, turning out the ON LINE light as a signal to the operator.

The operator may also place the recorder off line at any time by again pressing the ON/OFF LINE button.

If the ON LINE feature is not desired the transport may be set permanently ON LINE (see paragraph 5.10.3). In this case the ON LINE light will come on when the tape reaches the BOT marker and the ON/OFF LINE button will have no effect on the machine.

2.2.4 Rewinding

To rewind the tape press the REWIND button. The tape will rewind to the BOT marker. Pressing the REWIND button also puts the recorder off line.

2.2.5 Unloading the Tape

1. If the tape has not been rewound, rewind it.
2. After the tape stops at the BOT marker, press the REWIND button again. The tape will rewind slowly and the arms will allow some slack to protect the tape from wear. When the tape is completely unloaded all motors will stop.
3. Open the door.
4. Wind the end of the tape onto the reel.
5. Remove the reel from the recorder.

2.2.6 Reloading from End of Tape

In the event that all tape is unwound from the supply reel the machine will immediately halt.

1. Thread the tape as shown on the threading diagram.
2. Turning the supply reel counter-clockwise, check for the presence of an end of tape reflective marker. It should be about ten turns in. If no marker is found apply one to the shiny side of the tape along the edge that is nearest the recorder.
3. Turn the take-up reel counter-clockwise until tape slack has been removed.
4. Visually check that the tape is properly threaded on all rollers and guides.
5. Close the door.
6. Press the LOAD and REWIND buttons and hold them down until the tape begins to rewind.

2.2.7 Power Failure Recovery

In the event of a power failure, the transport will stop smoothly and will not damage the tape in any way. When power has been restored the machine may be rewound for a new run or may be re-started.

To rewind the machine after a power failure, press the LOAD and REWIND buttons and hold them down until the machine starts rewinding.

To restart the machine at its present position press the LOAD button and then, while continuing to depress LOAD, push the ON/OFF LINE button. The machine will apply tension to the tape and then go on line. Since the tape will not be at precisely the same position as it was when the power failed the machine may have to be backed up a few inches to locate the original position.

2.3 Daily Cleaning

The tape head and other tape path components should be cleaned at the beginning of each shift or workday. Small oxide and dust particles are the greatest enemy of high reliability data recording.

The magnetic head, tape cleaner, arm rollers, guide posts and capstan should be cleaned with a dampened lint free cloth or cotton swab. Isopropyl alcohol, heptane, or a similar solvent is recommended. Wipe all surfaces carefully and thoroughly to remove accumulated tape oxide and dirt.

SECTION 111

INSTALLATION

3.1 Unpacking

Digi-Data tape transports are shipped in heavy, well padded packing cases which will protect the units during normal handling and transportation. These cases generally are reusable and should be retained if other shipment is planned.

The transport should be inspected immediately after receipt. Check for broken parts, dents or scratched surfaces. If the unit has been damaged in any way during shipment, a claim should be filed with the carrier and a copy of the claim forwarded to Digi-Data Corporation. We will then advise you of the best way to arrange for repairs of the damaged unit.

After visual inspection the transport should be operated and tested. All Digi-Data transports are thoroughly tested at the factory and should be in perfect working condition when received by the customer.

3.2 Repackaging for Shipment

All shipments of Digi-Data equipment should be made with the original containers or equivalent. Equivalent packaging includes not less than two inches of shock absorbing material surrounding the recorder. The machine should be packed in a double walled heavy duty corrugated cardboard container. This container should then be enclosed in a second box and well padded. Digi-Data Corporation assumes no responsibility for damage to recorders which have been improperly packed.

3.3 Mechanical Installation

The recorder is designed to be mounted in a standard EIA/RETMA 19 inch equipment rack. The recorder should be installed at a reasonable height above the floor to facilitate operations and servicing as well as to minimize dust contamination. A drawing of the transport outline dimensions and door arc is included in Section 7. The transport should be positioned to allow the operator easy access to the door and permit at least 100 degrees of door travel to facilitate tape loading and unloading access.

The transport contains power transistors and motors which normally run warm so installation planning should include provisions for allowing air to freely enter the bottom and leave the top of the machine.

1600

The mounting slides furnished with the 1600 transport are adaptable to a wide variety of equipment racks. The outer slide should be permanently attached to the front and rear of the rack.

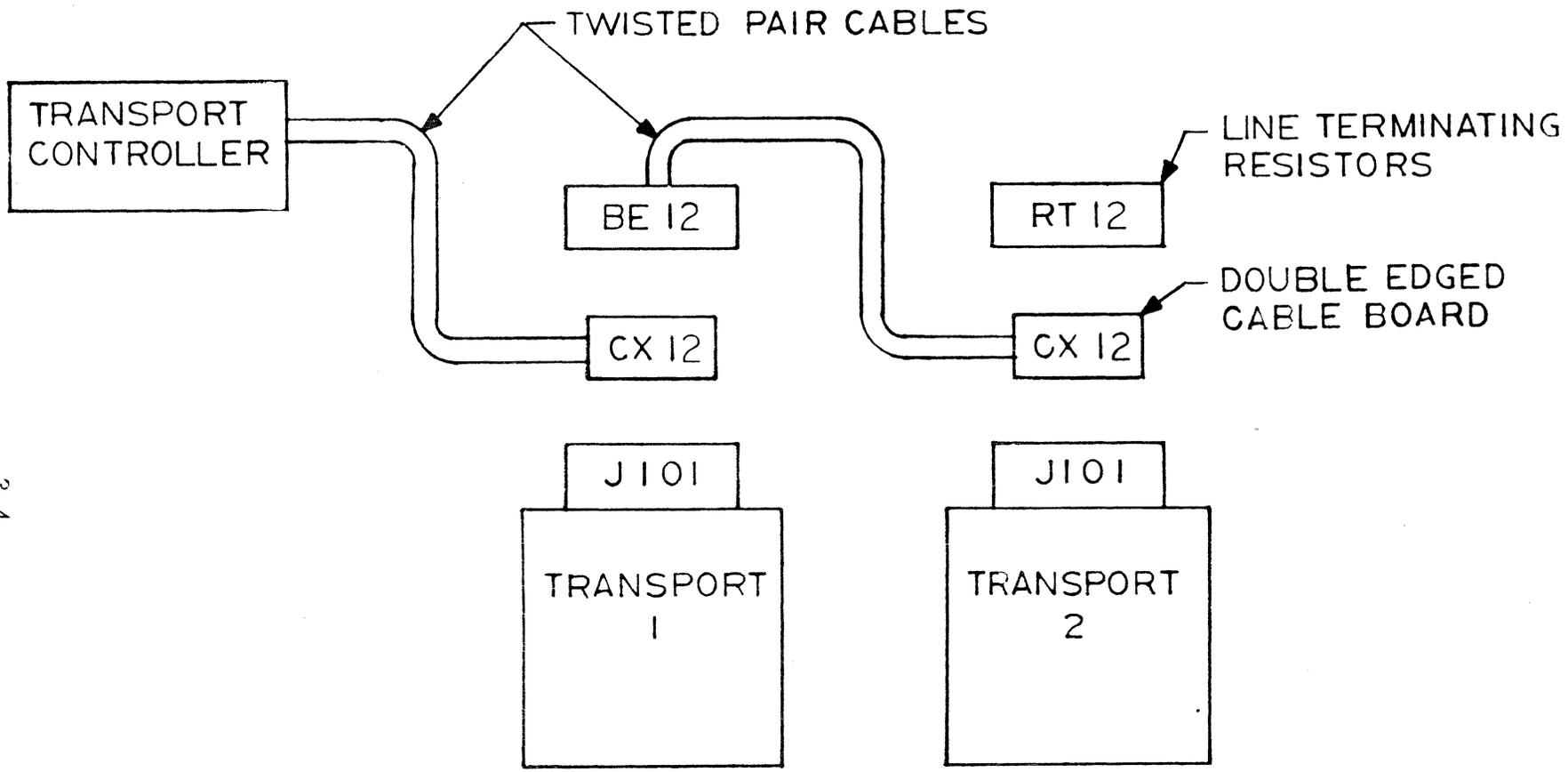
Holes are provided on the sides of the recorder for attaching the inner slide members. After the inner slides are fastened to the recorder and the outer (stationary) slides are mounted in the rack the machine will slide in. Force the inner member into the bearing in the outer member and slide the recorder back until its front panel is snug against the rack. Two knurled fasteners on the front plate lock the recorder into the rack. These fasteners should not be tightened more than finger tight.

The recorder can be removed from the rack by loosening the two knurled fasteners, sliding out to the detent position and then pulling further, with considerable more force, over the friction detent.

1700

Model 1700 recorders are supplied with hinge blocks which support the recorder and permit it to swing out of the rack for servicing. Install the two hinge blocks on the left rail of the rack with the four screws provided. The hinge blocks should be mounted with the hinge pin projecting upwards. See the 1700 installation drawing in Section 7 for information on proper positioning and spacing of the mounting blocks.

Mount the recorder on the hinge blocks by guiding the hinge pins into the corresponding holes in the recorder and gently lowering the recorder to rest on the hinge blocks. A restraining chain is provided to control how far the machine will swing out. One end of this chain slips into a notch near the transformer. The free end of the chain should be fastened to the inside of the rack on the right hand side and adjusted to a suitable length to prevent the recorder from hitting anything when swung open.



3-4

FIG. 3-1. MULTIPLE TRANSPORT CABLING

TABLE 3-1
UNFORMATTED TRANSPORT INTERFACE CONNECTOR

GROUND PIN	SIGNAL PIN	SIGNAL NAME	GROUND PIN	SIGNAL PIN	SIGNAL NAME
1	2	+5VDC (TRANSPORT RESISTORS)	51	52	DATA DENSITY INDICATOR (DDI)
3	4	+5VDC (TRANSPORT RESISTORS)	53	54	READ DATA P (RDP)
5	6	SYNC. REVERSE COMMAND (SRC)	55	56	
7	8	SYNC. FORWARD COMMAND (SFC)	57	58	
9	10		59	60	READ DATA 0 (RD0) *
11	12		61	62	READ DATA 1 (RD1) *
13	14		63	64	READ DATA 2 (RD2)
15	16		65	66	READ DATA 3 (RD3)
17	18	OVERWRITE (OVW)	67	68	READ DATA 4 (RD4)
19	20	READ THRESHOLD 1 (RTH 1)	69	70	READ DATA 5 (RD5)
21	22	READ THRESHOLD 2 (RTH 2)	71	72	READ DATA 6 (RD6)
23	24	WRITE DATA STROBE (WDS)	73	74	READ DATA 7 (RD7) (LSB)
25	26	WRITE AMPLIFIER RESET (WARS)	75	76	READ DATA STROBE (RDS)
27	28	SET WRITE STATUS (SWS)	77	78	DATA DENSITY SELECT (DDS)
29	30	SELECT (SLT)	79	80	WRITE DATA P (WDP)
31	32	NRZI (NRZ)	81	82	WRITE DATA 0 (WD0) *
33	34	END OF TAPE (EOT)	83	84	WRITE DATA 1 (WD1) *
35	36	LOAD POINT (LDP)	85	86	WRITE DATA 2 (WD2)
37	38	FILE PROTECT (FPT)	87	88	WRITE DATA 3 (WD3)
39	40	REWINDING (RWD)	89	90	WRITE DATA 4 (WD4)
41	42	ONLINE (ONL)	91	92	WRITE DATA 5 (WD5)
43	44	READY (RDY)	93	94	WRITE DATA 6 (WD6)
45	46	LOW SPEED (LSPD)	95	96	WRITE DATA 7 (WD7) (LSB)
47	48	SINGLE GAP (SGL)	97	98	OFF LINE COMMAND (OFFC)
49	50	7 TRACK (7TRK)	99	100	REWIND COMMAND (RWC)

* OMIT FOR 7 TRACK MACHINES

SECTION IV

INTERFACING AND CONTROL

4.1 General

This section describes procedures for writing and reading with unformatted transports. Machines equipped with a Digi-Data formatter or other specialized interface perform the operations described in this section automatically. This section may be entirely ignored for such systems. (Refer to the formatter or system manual for appropriate interfacing information).

4.2 Tape Format

For compatibility with IBM tape transports the data written and read by the transport must be formatted as shown in Figure 4-1A for 7-track machines, and Figure 4-1B for 9 track machines. The recording mode is non-return to zero, change on ones (NRZI). A "1" is recorded as a change in direction of magnetic flux on the tape, a "0" as no change. Each recorded character must contain at least one "1" to permit read synchronization.

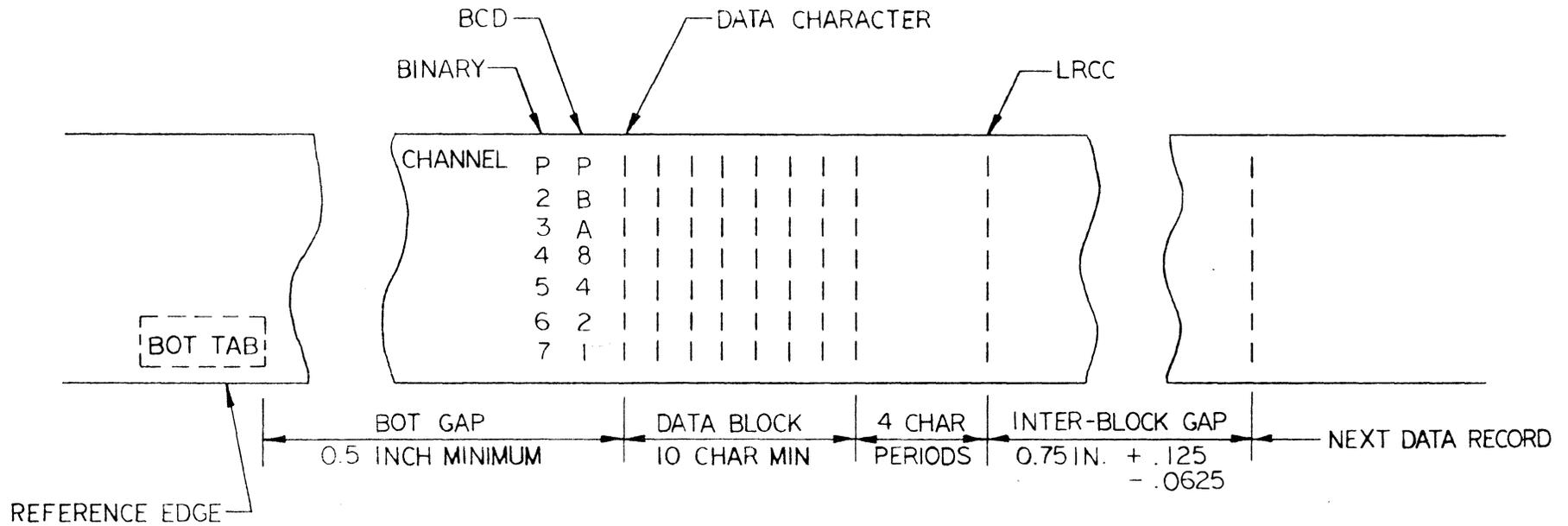
Nine-track systems always employ track P to write an odd parity bit, which will be a "1" in the case of an all zero data character.

Seven-track tapes may be recorded with either an odd or even parity bit written in track P. When written with odd parity, the tapes are binary tapes. Even parity produces BCD tapes. When writing a BCD (even parity) tape, the all zero data character must be converted to 001010 (binary ten).

Data is recorded on the tape in blocks (records) separated by erased areas created as the transport starts and stops. The erased area is referred to as an Inter-Block Gap (IBG). The length of the IBG should conform to the dimensions shown in Figure 4-1. The length of the blocks is not standardized and varies with the application. Block lengths of less than 10 characters are generally avoided.

Near the beginning and end of each reel of computer tape are reflective markers which are optically sensed by the transport. All tape before the Beginning of Tape (BOT) marker is considered leader. Data recording begins just beyond the BOT mark (load point) as shown in the diagrams. The End of Tape (EOT) marker gives a warning to the controlling system that the end is approaching.

FORWARD MOTION (HEAD RELATIVE TO TAPE) →

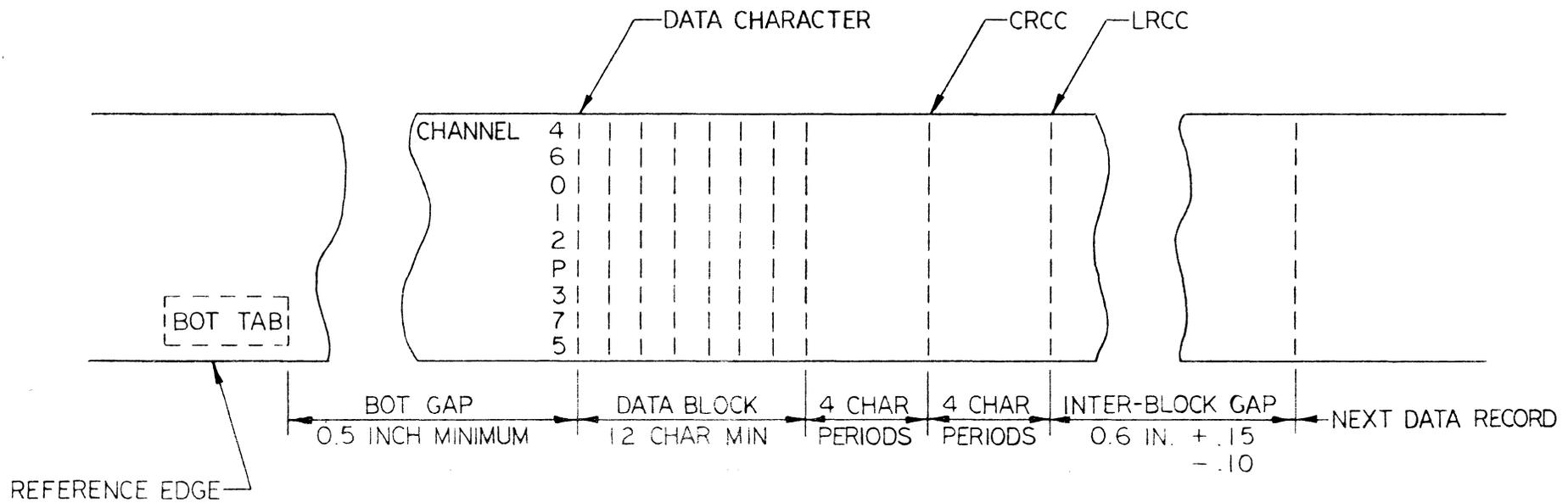


NOTES:

1. TAPE SHOWN WITH OXIDE SIDE UP.
2. CHANNELS 2 THROUGH 7 CONTAIN DATA BITS IN DESCENDING ORDER OF SIGNIFICANCE.
3. DATA PACKING DENSITY MAY BE 200, 556 OR 800 CHARACTERS PER INCH.

FIGURE 4-1A. 7 TRACK FORMAT

FORWARD MOTION (HEAD RELATIVE TO TAPE) →



4-3

NOTES:

1. TAPE SHOWN WITH OXIDE SIDE UP.
2. CHANNELS 0 THROUGH 7 CONTAIN DATA BITS IN DESCENDING ORDER OF SIGNIFICANCE.
3. DATA PACKING DENSITY IS FIXED AT 800 CHARACTERS PER INCH.

FIGURE 4-1B. 9 TRACK FORMAT

Following each block of data special error detection characters must be written in the positions labeled CRCC (9-track only) and LRCC. The CRCC (Cyclic Redundancy Check Character) is a coded cyclic parity check character which is developed in a special register while the block is being written. The character is required for IBM compatibility.

The LRCC (Longitudinal Redundancy Check Character) is composed of longitudinal even parity check bits for each track. The NRZI recording scheme is such that simply clearing the NRZI write register (in the transport) will produce the correct LRCC. A special transport input (Write Amplifier Reset) is provided to accomplish this. The LRCC should be in the eighth character position after the data (fourth character position on 7-track machines). The LRCC has odd vertical parity in 9-track transports. The LRCC may be even or odd parity in 7-track transports. Certain patterns of data on 7-track tape result in no LRCC character.

4.3 Interface Circuit

The circuits that interface the transport with the external controller will operate with twisted pair cabling over distances of up to twenty feet. All line drivers in the transport are open-collector DTL 844/944 power gates. Terminating resistors for these drivers must be employed at the controller. The resistors serve as collector pull-ups and line terminators to eliminate high frequency reflections and ringing. Figure 4-2 illustrates a typical transmitter/receiver pair. Terminating resistors which load the controller are installed on the transport interface connector.

The controller should terminate each transport output with the network shown in Figure 4-2. These resistors should be installed as close as possible to the controller end of the twisted pair interface cable. Power for these resistors should be provided by a heavy twisted pair from the controller power supply and bypass capacitors should be employed near the resistors. The controller should drive all transport inputs with open collector circuits capable of sinking at least 25 milliamps. The controller output driver circuits, especially the WRITE DATA outputs, should be located as close as possible to the interface cable and heavily grounded to it.

The interfacing scheme permits the connection of up to four unformatted transports to a single controller on a "wired-or" bus. Each transport receives an individual enabling line (SELECT)

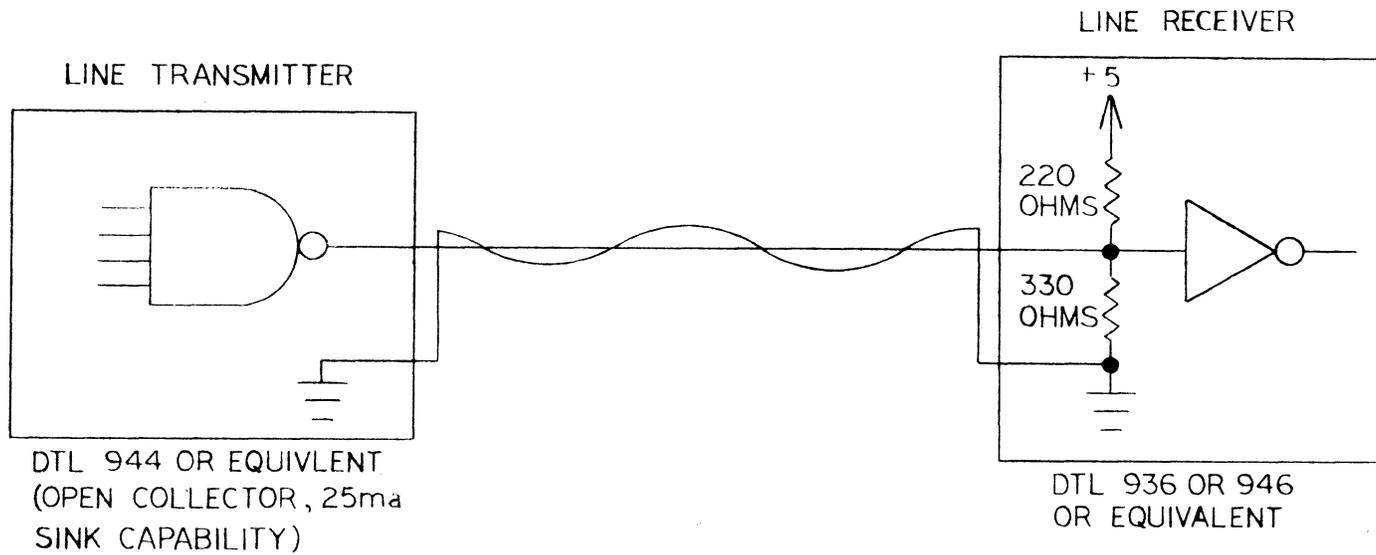


FIGURE 4-2 TRANSPORT/CONTROLLER INTERFACE CIRCUIT

DIGI-DATA CORP.
BLADENSBURG, MD.

SHEET OF

from the controller, but shares all other lines on the bus. Additional transports may easily be added to the bus at anytime as described in paragraph 3.4.

The minimum recommended pulse width on the interface lines is 2 microseconds. Transport inputs which elicit immediate confirming responses from the transport may be narrower if they go false upon detecting the transport response.

4.4 Interface Signals

Table 4-1 lists all interface signals to and from the transport. All signals at the interface connector are Low True DTL/TTL compatible lines.

Logic Levels

True 0 to +0.4 volts

False +2.5 to +5.5 Volts

4.5 Transport Control

The controller required to operate an unformatted transport generally provides the following functions:

- motion timing to control IBG length and head position
- generation of WDS pulses to record data at the desired packing density
- generation of the WDP vertical parity bit for each character
- generation of CRCC and EOF codes and appropriate timing to record them
- generation of a WARS pulse to record the LRCC Check Character
- error detection during read or read after write operations
- check character detection and segregation from data characters
- end of block detection
- EOF mark detection.

4.5.1 Motion Timing

Controlling the transport to create and/or read IBM and ANSI compatible tapes requires the generation of a number of time delays between events. These delays serve to create standard inter-block gaps (IBGs) and to position the tape at the optimum point for various operations.

The general sequence of all tape operations will be:

1. Determine that the transport is ready to begin the desired operation.
2. Begin the operation by setting the SFC, SRC, and SWS inputs to the appropriate levels.
3. Generate a pre-record delay. During this delay the tape is coming up to speed and moving toward the optimum point for the intended operation.
4. Commence reading or writing when the pre-record delay is completed.
5. When the block of data has been written or read activate circuitry to record or read and isolate the end of block check characters.
6. After the check characters generate a post-record delay. During this delay the tape is maintained at speed for a short time to avoid timing problems that can occur with certain combinations of operations.
7. At the conclusion of the post-record delay the SFC or SRC command line is set false and a deceleration delay is initiated.
8. When the deceleration delay is completed the transport is at rest and ready for the next operation.

The optimum values for the three time delays required for operation (pre-record delay, post-record delay and deceleration delay) depend upon tape speed, number of tracks and type of operation. Table 4-2 lists the recommended delays for 9 track machines at various speeds. Table 4-3 provides the same information for 7 track machines.

All of these time delays are inversely proportional to speed and represent a desired amount of tape travel. The actual distances involved are shown in the MOTION column of each table and are the same for all speeds. A controller which can easily adapt to any tape speed may be implemented by deriving all time delays from the WRITE DATA STROBE oscillator with counter techniques. The oscillator must change frequency when the tape speed changes in order to maintain the standard packing density. However, each oscillator period will then represent a fixed distance on the tape (1/800 inch for 800 bpi packing density) and counting these pulses will produce the proper time delay and tape movement at any tape speed.

The recommended time delays assure that all previously recorded data on the tape will be erased under any combination of write forward, read forward, and read backward commands. Table 4-4 illustrates the manner in which the various time delays contribute to the IBG length in a typical write operation. Table 4-5 presents similar calculations which show how the edit operation positions the tape for an update operation. The head to data distance calculated in the table is identical to the tape motion generated in a write operation as listed in Table 4-2 and 4-3.

4.5.2 Write Operations

The following sequence of events should occur when writing a block. A 9 track, 12.5 ips machine is used as an example, but tables 4-2 and 4-3 list the recommended delays at their standard speeds for both 7 and 9 track machines. Typical waveforms during a write operation are shown in Figure 4-3.

Writing a Block

1. Wait for deceleration delay associated with previous command to time out, thus ensuring that the tape is at rest.
2. Set SYNCHRONOUS FORWARD COMMAND (SFC) AND SET WRITE STATUS (SWS) inputs true, starting tape motion.
3. Generate a pre-record delay as follows:
 - (a) Writing from BOT: 510 msec.
 - (b) Writing an EOF: 280 msec.
 - (c) Writing, not at BOT:
 1. Single gap head machine: 46 msec.
 2. Dual gap head machine: 34 msec.
4. Following the pre-record delay apply WRITE DATA STROBE (WDS) pulses and WRITE DATA inputs to transport. Each WDS strobes in the 7 or 9 bit data character to be written on the tape. The WDS frequency should be 10.0 Khz $\pm 0.25\%$ at 12.5 ips for 800 bpi recording. Frequencies for other combinations can be calculated by multiplying tape speed by density. (ips x bpi = Hz)
5. When the data block has been recorded, suppress the first 3 unneeded WDS pulses.
6. During the fourth WDS apply the CRCC character to the WRITE DATA inputs. See below for information on generating the CRCC.
After writing the CRCC suppress WDS for the remainder of the operation.

Writing a Block (cont'd)

7. Four WDS intervals later (eighth pulse after data) generate a two micro-second pulse on the WRITE AMPLIFIER RESET (WARS) input. This writes the LRCC on the tape.
8. Proceed to step 9 for single gap machines. If the machine is a dual gap (read-after-write) unit, wait until the end of the block is observed by the read circuitry (approximately 12 milliseconds).
9. Generate a post-record delay of 6.0 milliseconds. This delay ensures erasure of any previously written data.
10. Set the SFC input false after the post-record delay. The tape will decelerate and come to rest within 32 milliseconds. Do not apply any motion commands during the deceleration period.

NOTE:

For 7 track machines the above procedure is modified by omitting the CRCC write operation and writing the LRCC at the fourth clock time. Additionally some of the recommended time delays change as shown in Table 4-3.

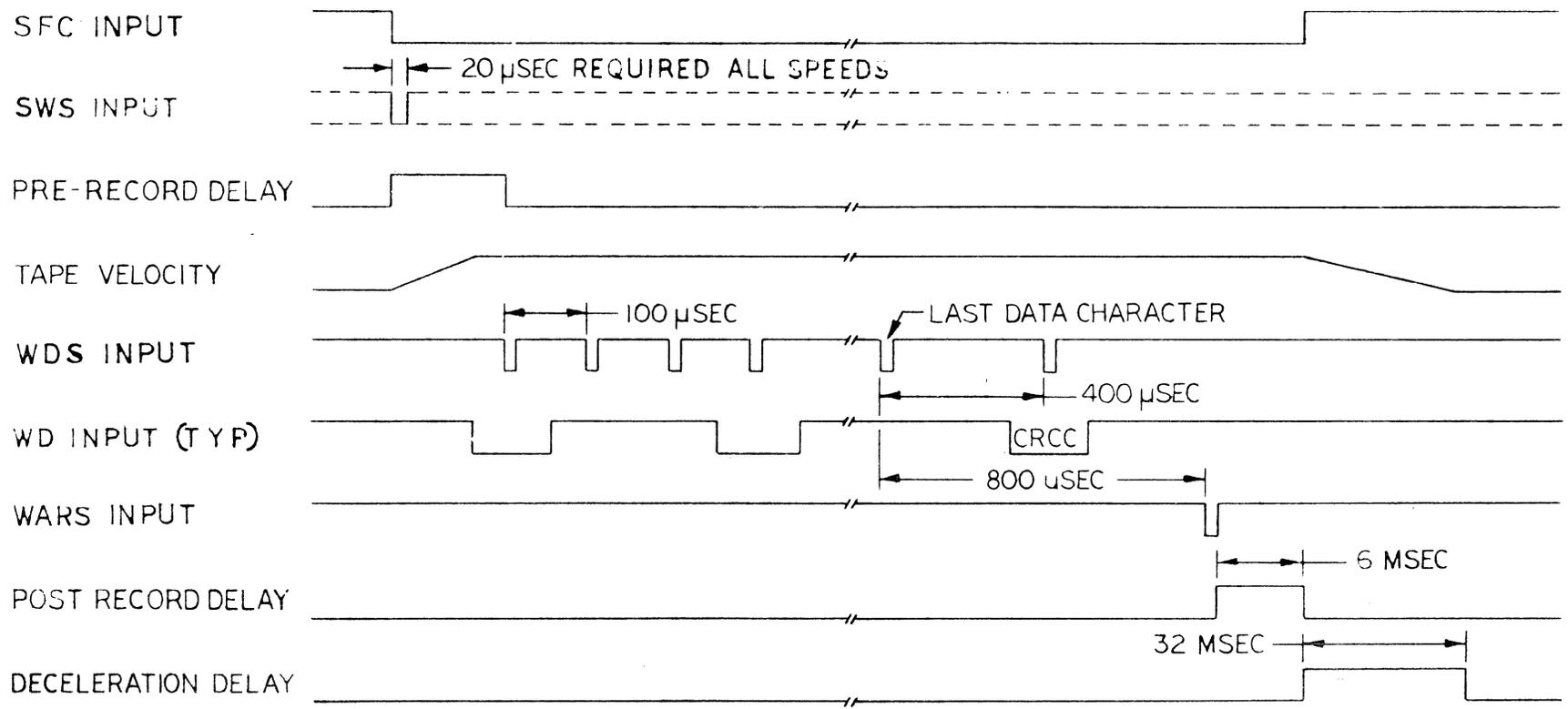
Writing an End of File

A 9 track End of File (EOF) mark is written by setting WRITE DATA bits 3, 6 and 7 true and writing a one character block. An EOF must not contain a CRCC but must include the LRCC eight spaces out.

A 7 track EOF is written by setting WRITE DATA bits 4, 5, 6 and 7 true and writing a one character block with its LRCC four spaces out.

Both 7 and 9 track EOF marks should be separated from the previous block by 3.5 inches of blank tape. This requirement is provided for in step 3 above by extending the pre-record delay.

4-10



NOTE: TIMES SHOWN ARE FOR 12.5 IPS

FIGURE 4-3 WRITE OPERATION TIMING DIAGRAM

Erasing

Erasing normally occurs automatically while writing. A special erase procedure is desirable for skipping over unusable areas of tape. Any of the following procedures may be employed:

1. Backspace over the improperly written block and re-write it. If all time delays are implemented as recommended, then each time this is done the block will be about one eighth inch further down the tape.
2. Backspace over the erroneous block. Re-write the block with the pre-record delay set to the write EOF delay. This operation is called a "skip-write" and skips about 3.5 inches of tape.
3. Backspace over the improperly written block and then write an EOF. Backspace over the EOF and re-write the block over the EOF. This operation will leave a 4 inch erased area on the tape.

The generation of extended gaps to avoid unusable areas of tape does not impair compatibility with IBM machines.

Editing

The OVERWRITE (OVW) input may be employed to update (re-write) an existing block provided that the old and new blocks are of the same length. This operation is performed as outlined below.

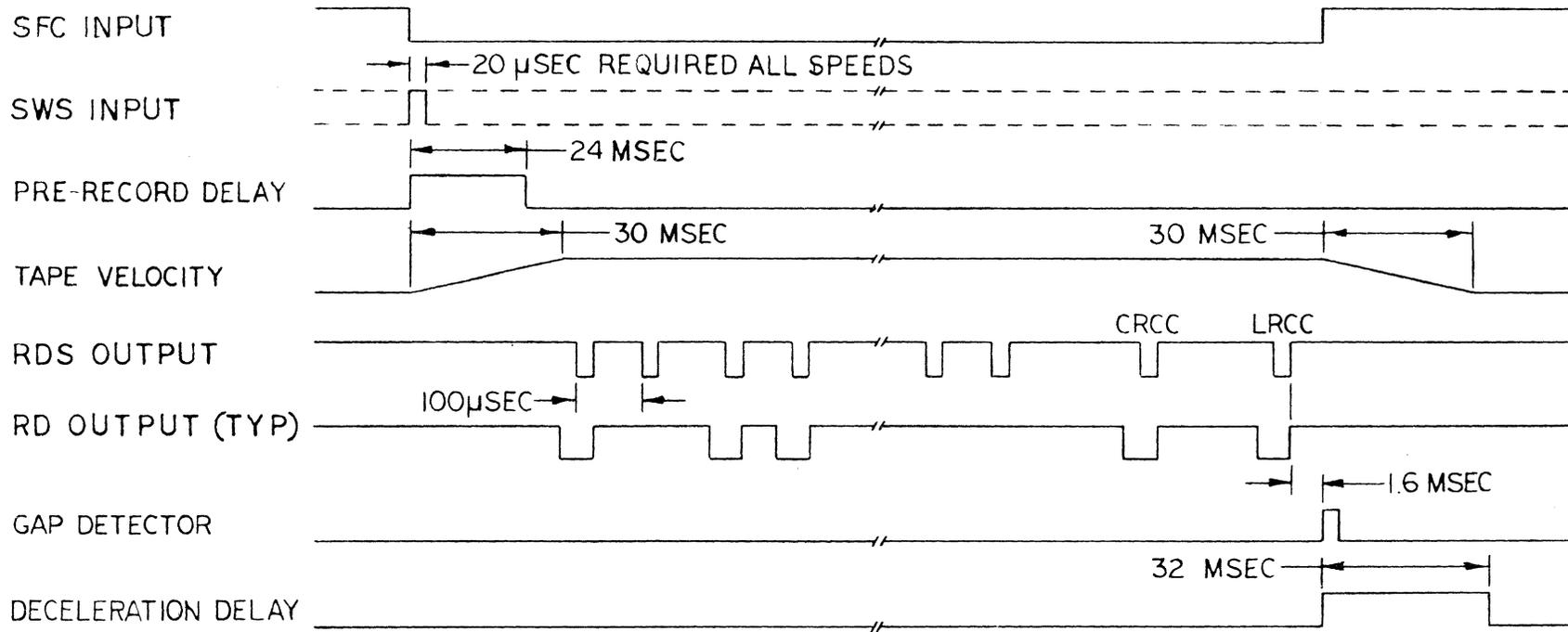
1. Locate the block to be changed and position the transport just beyond the block.
2. Backspace over the block to be updated with the Post-record delay set to the read reverse edit delay listed in Table 4-2 or 4-3. This positions the write head for the overwrite operation.
3. Write the new block by setting SWS, OVW, and SFC true and proceeding with the normal write sequence.

The new block of data cannot be located precisely over the old due to the tolerances on tape speed and start/stop distances. This problem is particularly restrictive if it is necessary to update a tape written by a different machine. Systems employing the overwrite feature should minimize the block length and number of times a block is re-written to insure reliable operation. If excessive updating of the same block is attempted an adjacent data block may be partially erased.

4.5.3 Read Operations

Figure 4-4 illustrates the waveforms associated with a read operation. The sequence of events is as follows:

1. Wait for the deceleration delay associated with the previous command to time out, thus ensuring that the tape is at rest.
2. Set the SFC input true with the SWS input held false.
3. Generate a pre-record delay as listed in Table 4-2 or 4-3. Any data appearing during this period is gap noise and should be suppressed.
4. Accept READ DATA STROBE (RDS) pulses and READ DATA characters from the transport. Process as desired. Each received character should be checked for proper vertical parity. The CRCC and LRCC characters may be employed for error detection if desired.
5. A missing pulse detector (retriggerable monostable multivibrator or equivalent) circuit should be employed to sense the end of data and suppress the end of block check characters. 2.5 to 3 RDS intervals during which no RDS pulses occur defines the end of data.
6. A second missing pulse detector set to approximately 16 RDS intervals should be employed to detect the physical end of block and set the SFC command false. If the operation is occurring in the reverse direction a post-record delay should be inserted between detection of physical end of block and the termination of the REVERSE command. Any data appearing after 16 intervals should be suppressed.



NOTE TIMES SHOWN ARE FOR 12.5 IPS

FIGURE 4 - 4 READ OPERATION TIMING DIAGRAM

7. The tape will decelerate and come to rest. No motion commands should be applied during the deceleration interval.

Reading in reverse or backspacing is handled similarly to reading forward. The LRCC and CRCC check characters will occur prior to the data when reading in reverse.

Single gap transports have a READ THRESHOLD 1 (RTH 1) input which should be held false during normal read operations. This input may be utilized to check the quality of data recorded in a system designed to write, backspace and then check the data just written. The RTH 1 input is held true only during the read-after-write check. This feature permits the detection of marginally written blocks. A similar threshold change is made automatically in dual gap read-after-write machines while writing. In addition, the transport includes a READ THRESHOLD 2 (RTH 2) input to assist in the recovery of data from severe dropouts. The RTH 2 input must be held true for the entire duration of the block containing the dropout.

Reading an End of File

The external controller should be able to identify an EOF when reading in either the forward or reverse direction. In addition to checking for the proper EOF character, the controller should verify that it has received only the EOF character and its associated LRCC. The LRCC character will be identical to the EOF character.

4.5.4 CRCC Generation

The CRCC written on 9 track tapes is developed by the circuit in Figure 4-5. Each 9 bit character written is also strobed into the CRCC register via the network of exclusive-or gates. After the last data character has been entered the register must be shifted one extra time with all inputs zero. The CRCC is obtained by utilizing the complement outputs of all bit positions except 2 and 4 as shown in the figure. This schematic is applicable for high true inputs and outputs.

The CRCC should always be written on the tape even if it is not intended to utilize its error detection capabilities. This will preserve tape compatibility with other systems.

The CRCC is employed for error detection by generating a CRCC during read operations and comparing the result with the CRCC recorded on the tape. This comparison will detect almost all combinations of read errors which can occur. In the event that errors have occurred on only one track the CRCC comparison result will indicate this condition as well as pointing to the track in error. With this information it is possible to re-read the block while employing the redundancy available in the vertical parity bit to regenerate the data in the track in error. Further information on CRCC error correction is available in the manuals for all IBM 9 track NRZI tape transports and tape controllers.

4.5.5 Non-Stop Operation

It is possible to increase system throughput by reading or writing successive blocks without stopping the tape. The transport may also be forced back up to speed when decelerating. In either case the controller should assure that successive operations are of identical type and direction. The transport should be allowed to come to a halt before changing direction or read/write status.

For continuous operations the controller simply maintains the SFC or SRC input true and initiates a standard pre-record delay at the conclusion of each block. The amount of tape moved during the pre-record delay is almost identical to the amount that would have moved if the transport had halted and then started again.

If the previous motion command has been set false and it is desired to re-start the transport in the same mode and direction, set the motion command true and initiate the standard pre-record delay. At the conclusion of this delay the tape will be at synchronous speed and very close to the position it would be at if the machine had been halted and then started again.

TABLE 4-1

OEM NRZI INTERFACE SIGNALS

Signal Name	Description	-	Signal Type
SELECT (SLT)	This input gates all Transport inputs and outputs. A false SELECT line will immediately terminate any tape motion except rewind.		Input Level
SET WRITE STATUS (SWS)	This input must go true concurrently with the forward command, and remain true for a period of at least 20 microseconds following initiation of a SYNCHRONOUS FORWARD or REVERSE command to energize the Transport write and erase circuitry. The circuitry will remain energized until initiation of a SYNCHRONOUS FORWARD or REVERSE command with the SET WRITE STATUS input held false or until receipt of a REWIND or OFF LINE command. The transport will not write unless a write ring is installed on the tape reel.		Input Level or Pulse
SYNCHRONOUS FORWARD COMMAND (SFC)	The transport moves in the forward direction as long as this input is true. The command is blocked if the transport is not in READY status.		Input Level
REWIND COMMAND (RWC)	This input causes the transport to move in the reverse direction at high speed until reaching the BOT mark. At the completion of a rewind the transport will move the tape forward to the BOT mark and stop. Write current is turned off. A REWIND COMMAND will be ignored if the transport is already at BOT.		Input Pulse
OFF-LINE COMMAND (OFFC)	This input will place the transport off line, disabling remote control and turning off the front panel ON LINE indicator. The transport will remain off line until the operator presses the ON LINE button. This input is gated only by SELECT, permitting the transport to accept an OFF-LINE COMMAND while rewinding.		Input Pulse

Signal Name	Description	Signal Type
WRITE DATA STROBE (WDS)	The WRITE DATA STROBE input strobes the information on the WRITE DATA lines into the transport write circuitry. A pulse width of approximately two microseconds is recommended. The frequency is determined by tape speed and density and should be 10.0 Khz for 12.5 ips, 800 bpi operation.	Input Pulse
SYNCHRONOUS REVERSE COMMAND (SRC)	The transport moves in the reverse direction at normal speed when this input is true. The command is blocked if the transport is not in READY status. If the BOT marker is sensed while in REVERSE, the transport will halt with the marker positioned approximately 0.6 inch closer to the head than the normal load point.	Input Level
WRITE AMPLIFIER RESET (WARS)	This input will reset the transport NRZI flip flops. This automatically writes the LRCC character on the tape. The character should be written in the eighth character position after the last data character of a record. (Fourth character position on 7-track machines). No WRITE DATA STROBE should be supplied when writing the LRCC.	Input Pulse
WRITE DATA 7 or 9 LINES (WDP, 0-7)	A true level spanning the WRITE DATA STROBE pulse causes a "one" to be recorded on the tape in the associated track. The data character should be present prior to the WRITE DATA STROBE leading edge and remain stable until the trailing edge.	Input Level
READ THRESHOLD 1 (RTH 1)	This input raises the read amplifier threshold level so that marginal recording may be detected in read-after-write checks. Dual gap machines perform threshold switching automatically in read-after-write.	Input Level
READ THRESHOLD 2 (RTH 2)	A true level on this input will increase the read amplifier sensitivity as an aid to data recovery in severe dropouts.	Input Level

Signal Name	Description	Signal Type
OVERWRITE (OVW)	This input is employed to place the transport in the overwrite mode. If the OVERWRITE and SET WRITE STATUS inputs are true for a period of at least 20 microseconds following initiation of a SYNCHRONOUS FORWARD or REVERSE COMMAND the transport will go into the overwrite mode, causing the write and erase heads to be slowly turned off after the LRCC is written.	Input Level or Pulse
DATA DENSITY SELECT (DDS)	This input is available only on machines equipped with the 7-track dual density option. The input must be held true during read operations to select the higher of the two possible densities.	Input Level
ON LINE (ONL)	A true output indicates that the operator has placed the transport under remote control.	Output Level
READY (RDY)	When this line is true, the transport is on line, selected, loaded with tape and not rewinding. Motion commands will be ignored if READY is false.	Output Level
LOAD POINT (LDP)	A true output indicates that the tape is positioned at the BOT marker.	Output Level
END OF TAPE (EOT)	A true output indicates that the EOT marker is being sensed. This output may be noisy if the transport stops at the edge of the marker.	Output Level
FILE PROTECT (FPT)	A true output indicates that no write ring has been installed on the reel. The transport will not write when this output is true.	Output Level
REWINDING (RWD)	A true output indicates that the transport is in the rewind or advance to load point mode.	Output Level
READ DATA STROBE (RDS)	A true 2 microsecond pulse occurs when a character has been assembled in the read register.	Output Pulse
READ DATA OUTPUT 7 or 9 lines (RDP, 0-7)	A true level during the READ DATA STROBE pulse indicates a "one" bit was read in the associated track. The READ DATA outputs will appear prior to the READ DATA STROBE pulse and remain present until after its trailing edge.	Output Level

Signal Name	Description	Signal Type
DATA DENSITY INDICATOR (DDI)	On machines equipped with the 7-track dual density option this output will be true while the machine is in the higher of the two possible densities. On other machines the output may be connected with internal jumpers to be true or false. It may be employed to indicate tape speed, density, unit number, etc. in multiple unit installations.	Output Level
LOW SPEED	May be connected with an internal jumper to go true when the transport is selected.	Output Level
SINGLE GAP	This output will go true when a single gap transport is selected.	Output Level
NRZI	This output will go true when any NRZI transport is selected.	Output Level
7 TRACK	This output will go true when any 7 track transport is selected.	Output Level

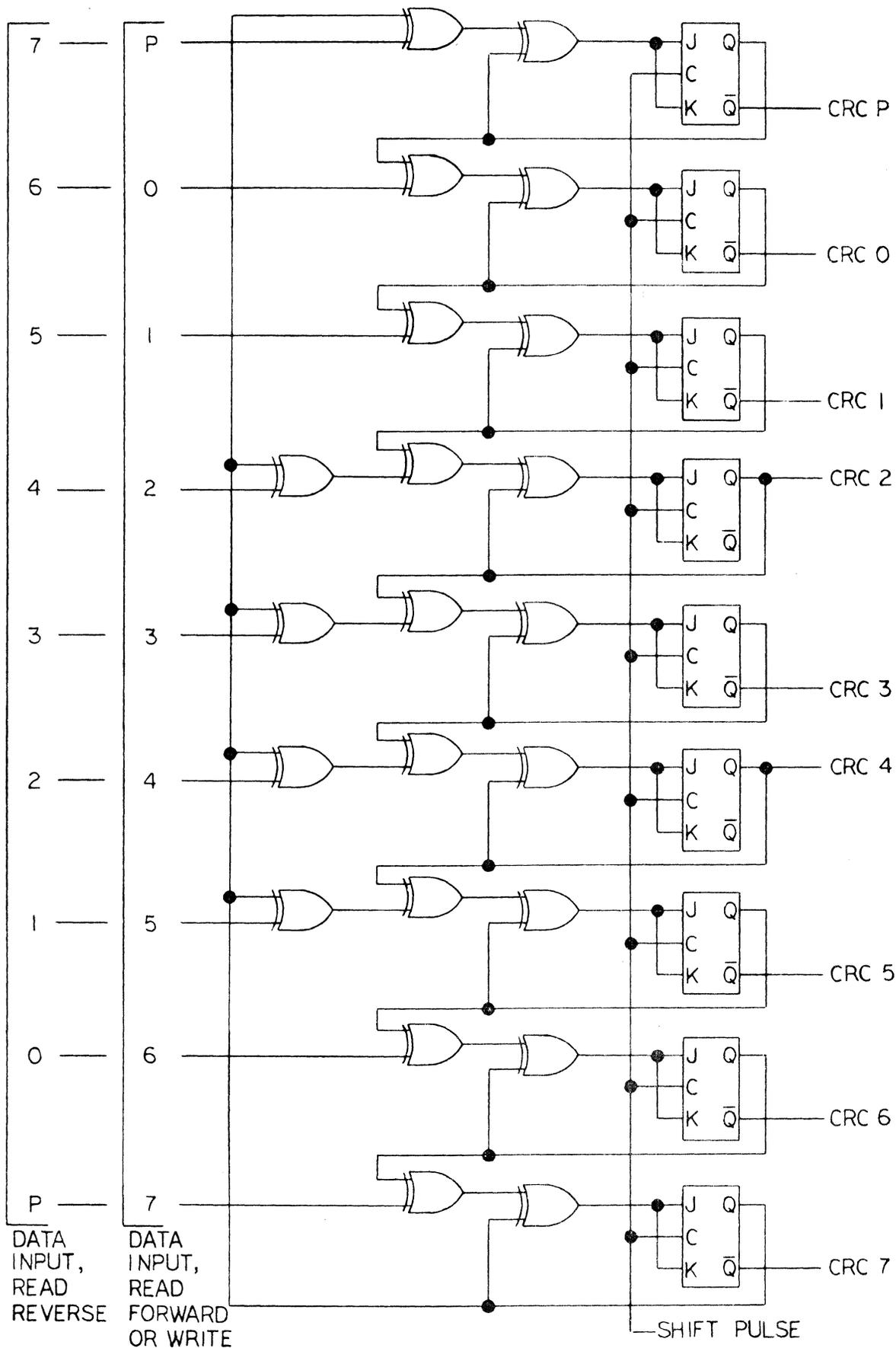


FIGURE 4-5 CRCC GENERATOR

TABLE 4-2
MOTION CONTROL DELAYS (9 TRACK)

	OPERATION	MOTION (Inches)	TAPE SPEED (ips)						
			6.25	12.5	18.75	25.0	37.5	45.0	
PRE- RECORD DELAYS (msec)	READ FROM BOT	1.32	240	120	80	60	40	33.33	
	READ FWD OR REV	.152	48	24	16	12	8	6.66	
	WRITE FROM BOT	6.2	1020	510	340	255	170	140	
	WRITE EOF	3.32	560	280	187	140	93.3	77.77	
	WRITE NORMAL (SINGLE GAP HEAD)	.390	92	46	30.66	23	15.3	12.77	
	(DUAL GAP HEAD)	.240	68	34	22.66	17	11.3	9.44	
POST- RECORD DELAYS (msec)	READ FORWARD	0	0	0	0	0	0	0	
	READ REVERSE	.075	12	6	4	3	2	1.66	
	READ REVERSE (EDIT)	.180	28.8	14.4	9.6	7.2	4.8	4.0	
	WRITE OR ERASE	.075	12	6	4	3	2	1.67	
DECEL- ERATION DELAY (msec)	ALL MOTIONS	.190	64	32	21.33	16	10.67	8.88	
	TRANSFER RATE (KHz at 800 bpi)		5.0	10.0	15.0	20.0	30.0	36.0	

TABLE 4-3
MOTION CONTROL DELAYS (7 TRACK)

	OPERATION	MOTION (inches)	TAPE SPEED (ips)						
			6.25	12.5	18.75	25.0	37.5	45.0	
PRE- RECORD DELAYS (msec)	READ FROM BOT	1.32	240	120	80	60	40	33.33	
	READ FWD OR REV	.152	48	24	16	12	8	6.66	
	WRITE FROM BOT	6.2	1020	510	340	255	170	141.66	
	WRITE EOF	3.32	560	280	187	140	93.3	77.77	
	WRITE NORMAL (SINGLE GAP HEAD)	.515	112	56	37.3	28	18.7	15.55	
	(DUAL GAP HEAD)	.215	64	32	21.3	16	10.7	8.88	
POST- RECORD DELAYS (msec)	READ FORWARD	0	0	0	0	0	0	0	
	READ REVERSE	.200	32	16	10.7	8	5.33	4.44	
	READ REVERSE (EDIT)	.305	48.8	24.4	16.27	12.2	8.13	6.78	
	WRITE OR ERASE	.075	12	6	4	3	2	1.66	
DECEL- ERATION DELAY (msec)	ALL MOTIONS	.190	64	32	21.33	16	10.67	8.88	
	TRANSFER RATE (KHz at 800 bpi)		5.0	10.0	15.0	20.0	30.0	36.0	

TABLE 4-4
TYPICAL IBG LENGTH CALCULATIONS

<u>SINGLE GAP HEAD:</u>	7 TRACK (inches)	9 TRACK (inches)
MOTION DURING POST-RECORD DELAY	.075	.075
STOP DISTANCE	.190	.190
START DISTANCE	.190	.190
MOTION DURING REMAINDER OF PRE-RECORD DELAY	.325	.200
TOTAL IBG LENGTH	<hr style="width: 100%; border: 0.5px solid black;"/> .780	<hr style="width: 100%; border: 0.5px solid black;"/> .655
<u>DUAL GAP HEAD:</u>	7 TRACK (inches)	9 TRACK (inches)
WRITE TO READ GAP	.300	.150
MOTION DURING POST-RECORD DELAY	.075	.075
STOP DISTANCE	.190	.190
START DISTANCE	.190	.190
MOTION DURING REMAINDER OF PRE-RECORD DELAY	.025	.050
TOTAL IBG LENGTH	<hr style="width: 100%; border: 0.5px solid black;"/> .780	<hr style="width: 100%; border: 0.5px solid black;"/> .655

TABLE 4-5
OVERWRITE POSITIONING CALCULATIONS

<u>SINGLE GAP HEAD:</u>	7 TRACK (inches)	9 TRACK (inches)
IBG DETECTOR DELAY (16 characters at 800 bpi)	.020	.020
MOTION DURING POST-RECORD DELAY (EDIT)	.305	.180
STOP DISTANCE	.190	.190
	<hr/>	<hr/>
HEAD TO DATA DISTANCE	.515	.390
<u>DUAL GAP HEAD:</u>	7 TRACK (inches)	9 TRACK (inches)
READ HEAD TO DATA DISTANCE (same as single gap calculation)	.515	.390
LESS READ TO WRITE GAP SEPARATION	.300	.150
	<hr/>	<hr/>
WRITE HEAD TO DATA DISTANCE	.215	.240

SECTION V

THEORY OF OPERATION

5.1 Mechanical Operation

All tape path hardware in the transport is mounted on a monolithic drive plate fabricated from tool and jig plate which is precision machined and ground to provide an extremely accurate surface on which to mount tape guiding components. The tape guiding components are aligned at the factory to produce virtually perfect perpendicularity between the tape and the head. This alignment is maintained through the use of spring loaded tape guides on each side of the head.

All tape motion in the machine is controlled by the servo-controlled capstan. Friction between the capstan and the tape is employed to move the tape, eliminating pinch rollers and idler wheels. Two spring loaded tension arms provide tape storage and buffering to permit the reels to follow the average, rather than peak, tape accelerations and decelerations. The tension arms also serve to maintain a constant tension in the tape under all conditions of motion, resulting in a constant pressure between tape and head without the use of pressure pads.

5.2 Transport Block Diagram

The circuitry in the transport consists of six functional blocks. Figure 5-1 is a block diagram of the transport electronics illustrating the basic interconnections between the subsystems.

All of the transport interface signals are available at a single connector, J101. These signals connect the transport to the controlling system. In machines equipped with the optional formatter J101 connects to the formatter card. The SELECT input at J101 indirectly gates all other transport interface signals. When SELECT is false all transport outputs will go high, thus permitting another transport on the same cable to control the lines.

All transport inputs are ignored when SELECT is false. All of the input mode and motion commands go to the control logic section of the recorder, as shown in the block diagram. If the transport is ready, on line and selected the control logic passes the FORWARD and REVERSE input commands on to the capstan servo to generate the desired motion.

A REWIND command input pulse sets a latch in the control logic which generates the rewind command to the capstan servo. The transport READY output goes false during the rewind operation. The control logic monitors the BOT sensor and generates the commands required to return the tape to the load point.

The control logic also contains a read/write flip-flop which stores the desired mode of operation at the beginning of each motion command. If a write operation is commanded the control logic checks the status of the transport and write ring detector and, if writing is permitted, turns on the write power and erase head.

Additional circuitry included in the control logic section interfaces the operator control panel with the motor servos and generates the transport status outputs.

The write circuitry portion of the transport receives binary characters and a write clock from the external system, converts each character to the NRZI code and records the character on the tape.

The read circuitry amplifies the low amplitude signals from the head, electronically de-skews each character and stores it in an output register. The READ DATA STROBE output generates a pulse each time a complete character has been stored.

All of the functions described above are performed by the RC11 card. The MC17 card contains the power regulators and motor drive circuitry.

5.3 Power Supplies

The transport contains three diode-capacitor rectifiers which produce outputs of +20 VDC, +8 VDC and -20 VDC. The + and -20 VDC supplies are fused and fed to all three motor servos as well as to +12 VDC and -12 VDC regulators. The +8 VDC provides power to a +5 VDC regulator.

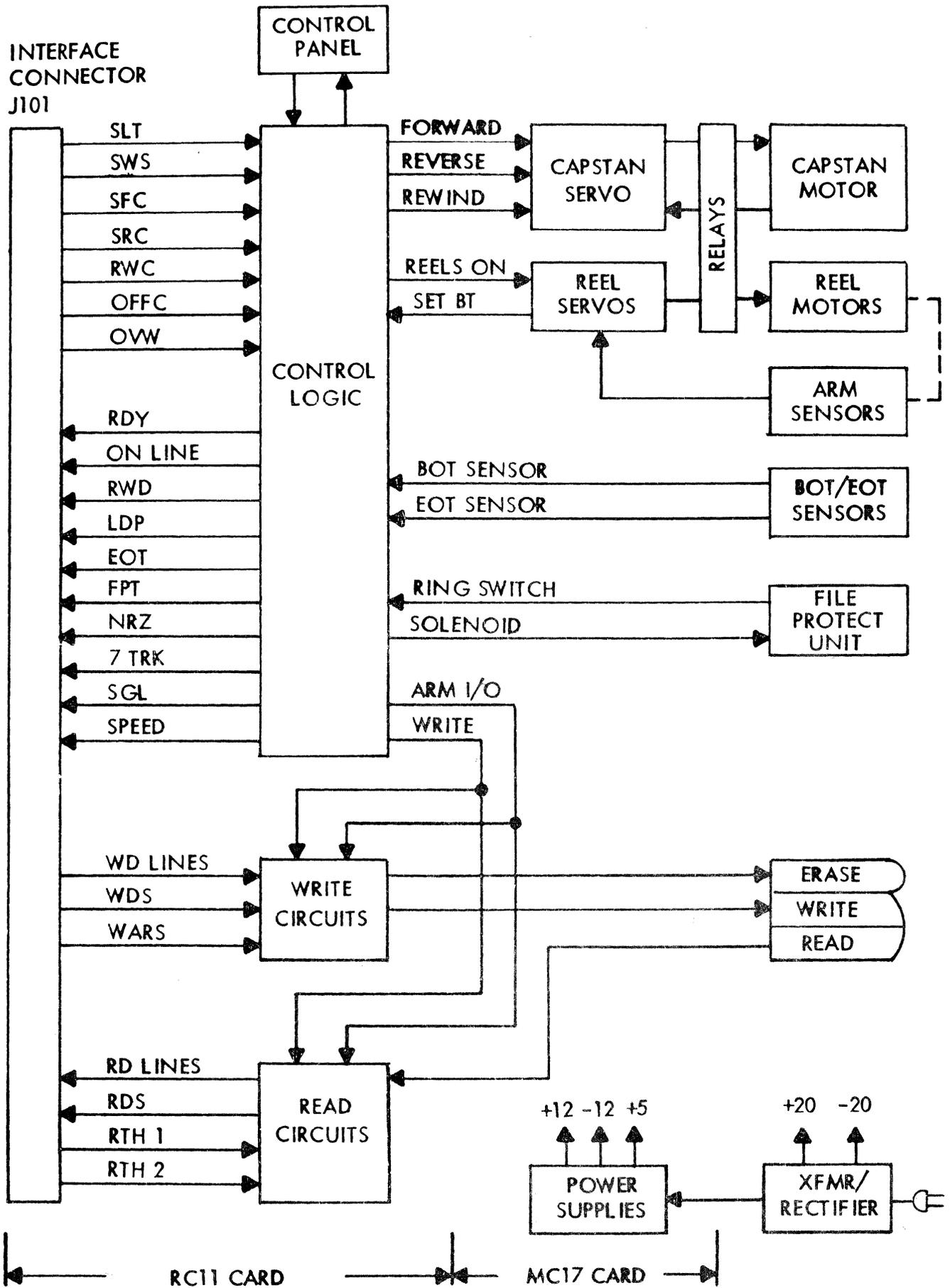


FIGURE 5-1 TRANSPORT BLOCK DIAGRAM

The three regulators are located on the MC17 card. Jumper wires on the card permit the isolation of any of the regulators from its load to facilitate troubleshooting. The +12 VDC regulator produces voltages employed by the +5 VDC and -12 VDC regulators. In the event of a failure or overload of the +12 VDC regulator the other two regulators will thus appear to be inoperative. All three regulators include overload and short circuit protection.

The +12 regulator output and zener reference are employed by two emitter follower supplies to provide +5.6 VDC and +5.0 VDC outputs. The +5.6 VDC output powers the arm position sensing photocells. The +5(s) output is employed in the capstan and reel servo circuits to keep them independent of the +5 volt regulator during a power failure sequence.

A potentiometer permits setting the +12 VDC regulator to precisely 12 volts. The +5 and -12 regulators track the +12 volt output and will be within 5% of their nominal voltages if the +12 regulator is properly adjusted.

5.4 Capstan Servo System

As indicated in Figure 5-2, the capstan servo consists of ramp generators, a servo amplifier and a motor-tachometer. Forward and reverse commands cause the FWD/REV RAMP GENERATOR to produce trapezoidal waveforms with rise and fall time corresponding to the specified start/stop time for the transport. The CAPSTAN SERVO AMPLIFIER drives the capstan motor in a manner to make the tachometer output equal to the output of the FWD/REV ramp generator. Figure 5-3 illustrates the waveforms occurring at each stage of the capstan servo during forward and reverse operation.

The FORWARD and REVERSE input lines are converted by Z5 into a bipolar command signal which appears at TP1. The circuitry which includes Z1 and Z3 is a unity gain inverter which has an adjustable linear rise and fall time. This circuit adds the trapezoidal ramps to the TP1 signal which force the capstan to start and stop in a controlled and constant time and distance. The resultant waveform (TP2) is applied to polarity splitter Z2. This circuit separates the forward and reverse ramps to permit independent speed adjustments. The forward (negative) ramps appear at TP3 and reverse (positive) ramps at TP4. These ramps are applied to the input of the DC servo amplifier via speed setting potentiometers. The servo amplifier always generates a voltage which causes the

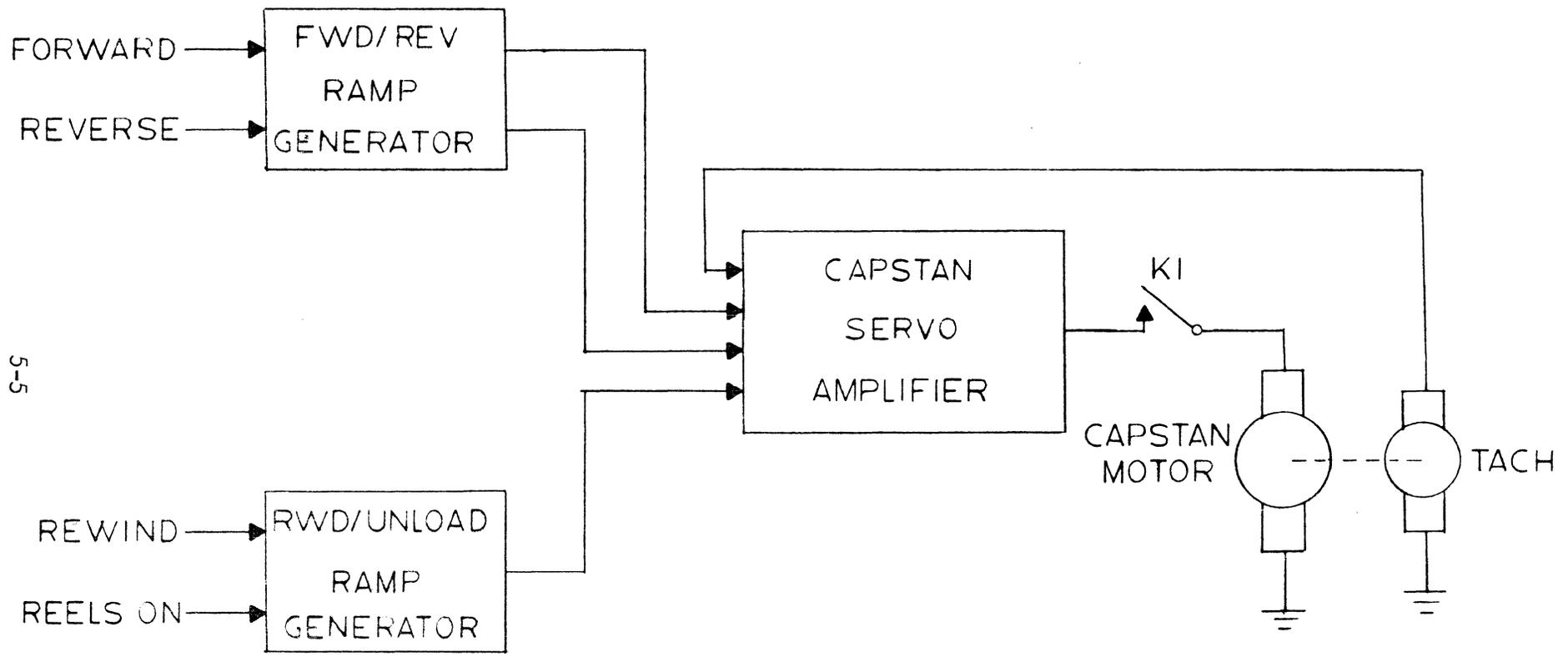


FIG.5-2 CAPSTAN SERVO BLOCK DIAGRAM

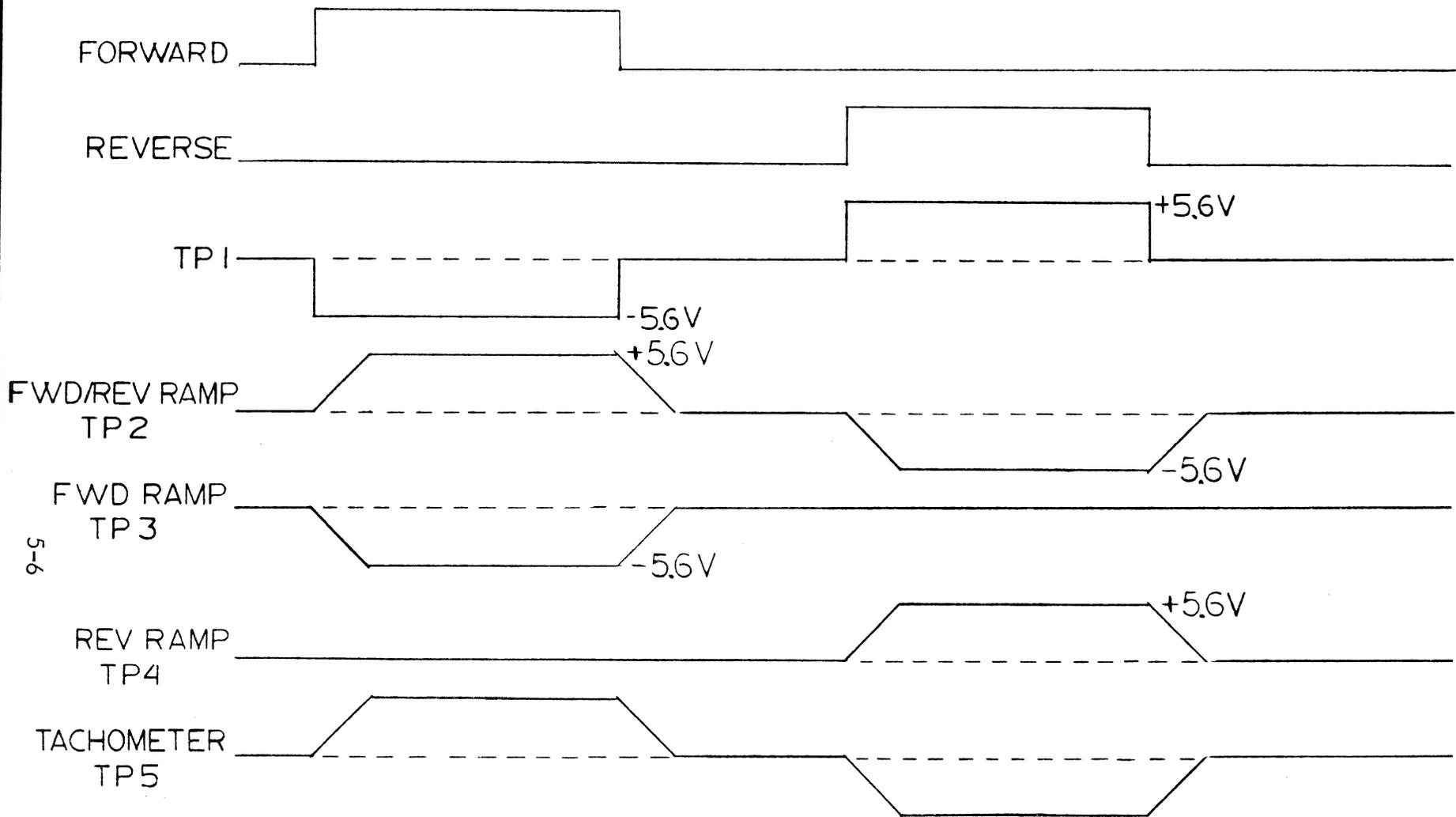


FIG.5-3 CAPSTAN SERVO WAVE FORMS

tachometer output voltage to be equal and opposite in polarity to the input ramp (except for a scale factor).

The rewind ramp generator consists of Z7 and Q18. A rewind input causes Z7 pin 3 to go high, creating an exponential ramp at the base of Q18. This waveform is buffered by Q18 and applied to the servo amplifier through isolation diodes. The output of the rewind ramp generator may be monitored at TP6. At the conclusion of the rewind Z7 pin 3 goes low, creating an exponential decay which stops the capstan.

If the rewind button is depressed with the tape at the BOT marker the REELS ON signal goes low but REVERSE goes high (+5 V). When this combination occurs Z7 pin 8 goes low. This signal causes the rewind ramp generator to operate at a much lower voltage, resulting in a slow speed unload operation.

5.5 Reel Servo System

Each reel motor is powered by a bipolar DC servo amplifier which monitors the position of the associated tension arm and drives the reel motor with a voltage sufficient to keep the tension arm within its operating area, approximately a 60 degree arc. Within this arc the tension arm provides a constant tape tension, irregardless of arm position.

Since the reels cannot be accelerated as rapidly as the capstan, when the capstan starts it will pull tape from the tension arm, causing the arm to move. The position of each arm is sensed by a differential photocell which is masked with an eccentric slit in a shutter attached to the arm shaft. The servo amplifier produces an output voltage proportional to desired arm position, arm position error and arm velocity. This voltage will accelerate the reel motor up to speed before the tension arm has moved out of its 60 degree arc. The system is stable for any combination of forward/reverse operations at any frequency.

Each servo amplifier includes a ramp generator (Z9 and Z14) driven by the capstan ramps which specifies desired arm position. As the reel achieves full speed this ramp generator brings the tension arm away from the center of the operating region so that the full 60 degree arc will be available should the capstan suddenly reverse direction.

Each servo amplifier also includes a current limiting circuit. Current through the reel motor is monitored by an 0.1 ohm resistor and the resulting voltage is amplified by Z11 or Z13. If the voltage generated by Z11 or Z13 is sufficient to cause the associated diodes to conduct, the servo current limits, providing protection to the amplifier components as well as more efficient operation of the motors during acceleration.

The servo amplifiers have only one control input, REELS ON. When this signal is high (+5 VDC), Q54 and Q55 are off and the amplifiers are in normal operating mode. When REELS ON is low Q54 and Q55 turn on, causing the arm position ramp generators to move the tension arms close to the mechanical rest. This mode occurs when the reels are first activated by the LOAD button, or when the REWIND button is pressed with the tape at the BOT mark, initiating an unload operation.

When the machine is first turned on or is not in operation the servo amplifiers are disconnected from the motors by the servo relay K1. When REELS ON goes high, indicating the LOAD button has been depressed, K1 is activated and the reels apply tension to the tape and move the tension arms to the center of their operating areas.

5.6 Tape Protection System

The transport includes sensing, timing and energy storage elements which provide complete control of the transport if a power failure occurs. This feature provides assurance that no damage to a tape can occur as a result of a power failure. Additional circuitry monitors the tension arm operation and physically disconnects the motors from the servo amplifiers if a reel servo fails.

Upon detecting a power failure the transport locks out external commands and brings the tape to a halt under servo control, as if a normal stop were being performed. When the tape has been halted the tension arms are gently moved to the stops. The tape is maintained under normal tension until after the tension arms have been relaxed, thus keeping the tape properly threaded and ready to resume operations when power is available.

The AC power line is monitored by the circuit including Q44. The power transformer

secondary is coupled through a 10 volt zener diode to a rectifier. The zener diode makes line voltages below approximately 80 volts look like a total power failure to the circuit. Each cycle of line voltage deposits a charge on Q44's base capacitor, holding Q44 on. If this charge is not renewed within approximately 3 cycles, Q44 will turn off, initiating the power failure sequence.

When Q44 turns off its collector rises to approximately +20 volts. This causes SET BT to go high, clearing all flip flops in the control logic. Q44 also causes the circuit composed of Q42 and Q43 to generate a 300 millisecond pulse. This pulse holds the servo relay on to permit the reels and capstan to be stopped. Sufficient energy is stored in the power supply filter capacitors to stop any motion within 300 milliseconds. Q42 also clamps to ground all motion commands and the REELS ON command. When REELS ON is pulled low Q54 and Q55 turn on, causing the reel servo ramp generators to move the tension arms to the operating position nearest the mechanical stop. Thus at the end of the 300 millisecond pulse all motion has stopped and the arms are very near the rest positions. At the conclusion of the pulse the servo relay is released.

The circuit containing Q51, Q52, Q53, and Q59 is an exponential ramp generator which is connected to the reel motors through the servo relay any time the motors are disconnected from the servo amplifiers. During the 300 millisecond power failure pulse this ramp generator is charged via Q51. At the conclusion of the pulse when the servo relay is released, the motors are connected to the "relaxer" ramp generator. All energy remaining in the main filter capacitors is employed by the relaxer to gradually move the tension arms to the mechanical stops while maintaining sufficient tape tension to keep the tape threaded. The power failure control circuitry is highly immune to any noise or extraneous voltages occurring on the power lines before, during or after a power failure occurs and has been designed and tested for use in applications requiring an unattended restart capability.

The tape protection system also includes a microswitch which monitors the position of the tension arms. Should a servo or motor failure occur, the reel will generally lose all tension or attempt to apply excessive tension. In either case the tension arm will move

outside of its normal operating area, activating the microswitch via a cam. If this occurs the tape protection circuitry immediately disconnects the motors from the servo amplifiers by opening servo relay K1. The SET BT signal is also activated, placing the transport off line and clearing all flip flops in the control logic.

5.7 File Protect Feature

When a reel of tape containing a write ring is installed the ring actuates a small plunger in the tape deck which throws a microswitch. When the LOAD button is depressed the plunger is pulled away from the write ring by the write ring solenoid and the RING IN lamp illuminates. If a write ring is not installed on the reel none of the above occurs and no power is available to the transport's write and erase circuits.

5.8 Recording Circuitry

A simplified schematic of the data handling circuitry is presented in Figure 5-4 for one channel of data electronics. The leading edge of each SFC and SRC input command creates a slightly delayed pulse which strobes the state of the SWS input into the read/write status flip flop. If the SWS input is true (low) the status flip flop will be set to the write state unless the flip flop is held off by one of the four "clear write" conditions.

With the status flip flop in the write mode transistor Q10 is on and power is applied to the erase head and write circuitry. If the transport is a single gap read/write unit the write power is also connected to the read enable gate to disable the transport read outputs during write operations.

Transports equipped with the overwrite option store the state of the OVERWRITE input in the OWW flip flop (Z4), at the same time as the SWS input is stored. When set, this flip flop causes the read/write status flip flop to clear after the LRCC is written, thereby turning off the write and erase heads while the tape is still in motion. This avoids erasing the following record when performing an overwrite (updating) operation.

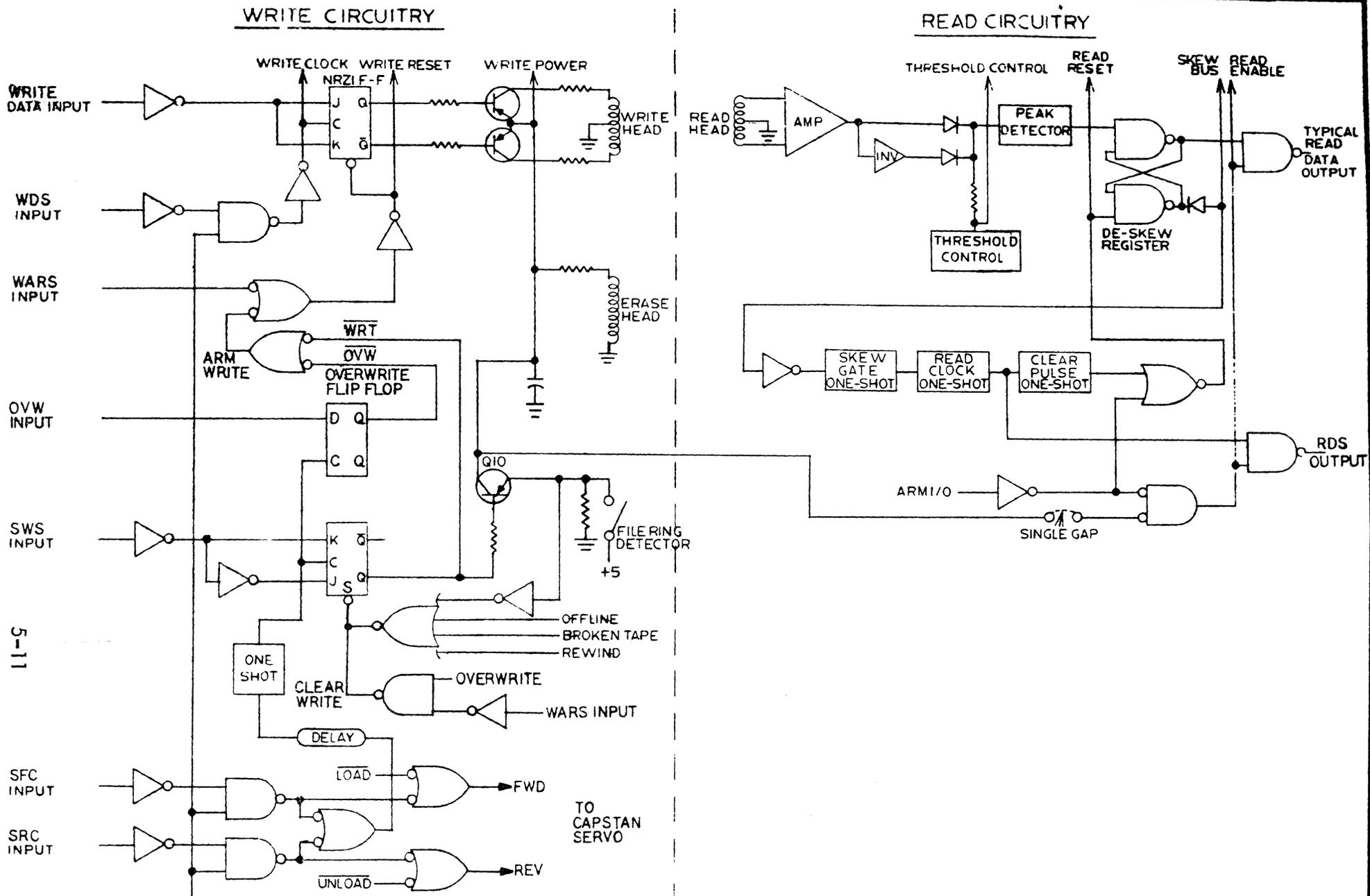


FIGURE 5-4
WRITE AND READ CIRCUITRY
SIMPLIFIED SCHEMATIC

DIGI-DATA CORP.

The operation of a typical channel of write and read circuitry is illustrated in Figure 5-5. Each WDS input pulse strobes the NRZI flip flops. If the WRITE DATA input is true (low) the J and K inputs of the associated NRZI flip flop will be high and the flip flop will toggle, switching the current in the write head to the opposite winding. This records a "one" by reversing the flux direction on the magnetic tape.

A pulse on the WRITE AMPLIFIER RESET input line sets all of the NRZI flip flops to the high state, thereby aligning all tracks in the same flux direction and writing a "one" in those channels which have toggled an odd number of times. The character thus written is the LRCC.

5.9 Read Circuitry

The simplified schematic in Figure 5-4 and the associated waveforms in Figure 5-5 illustrate the overall operation of a typical channel of read electronics. The voltage induced in the read head by the recorded data is amplified by a controlled bandwidth differential amplifier for maximum noise immunity. Each amplifier includes a gain adjustment to compensate for track-to-track variations in the head windings. Following each data amplifier is a unity-gain inverter. The original and inverted waveforms are employed by the data rectifier to produce the full wave rectified signal shown in Figure 5-5. Each half-cycle signal at the data rectifier output represents a "one" on the tape.

The actual bit location on the tape corresponds to the peak of the data rectifier output waveform. A peak-detecting circuit is employed to sense this point in order to minimize inter-track skew and to make this skew independent of signal amplitude. The output of the peak detector is a pulse of fixed duration which sets the flip flop in the de-skewing register to the one state. If a zero was recorded no signal is induced in the read head and the flip flop is not set.

The format of the data written on the tape insures that each character will contain at least one "one". Thus if all tracks are "ored" together the resultant signal serves to indicate when a character is being read. This function is accomplished by the skew bus shown in Figure 5-4. The waveforms in Figure 5-6 illustrate the operation of the synchronization and de-skewing circuitry. The first "one" to arrive in each character sets its flip flop and pulls down the skew bus through an isolating diode.

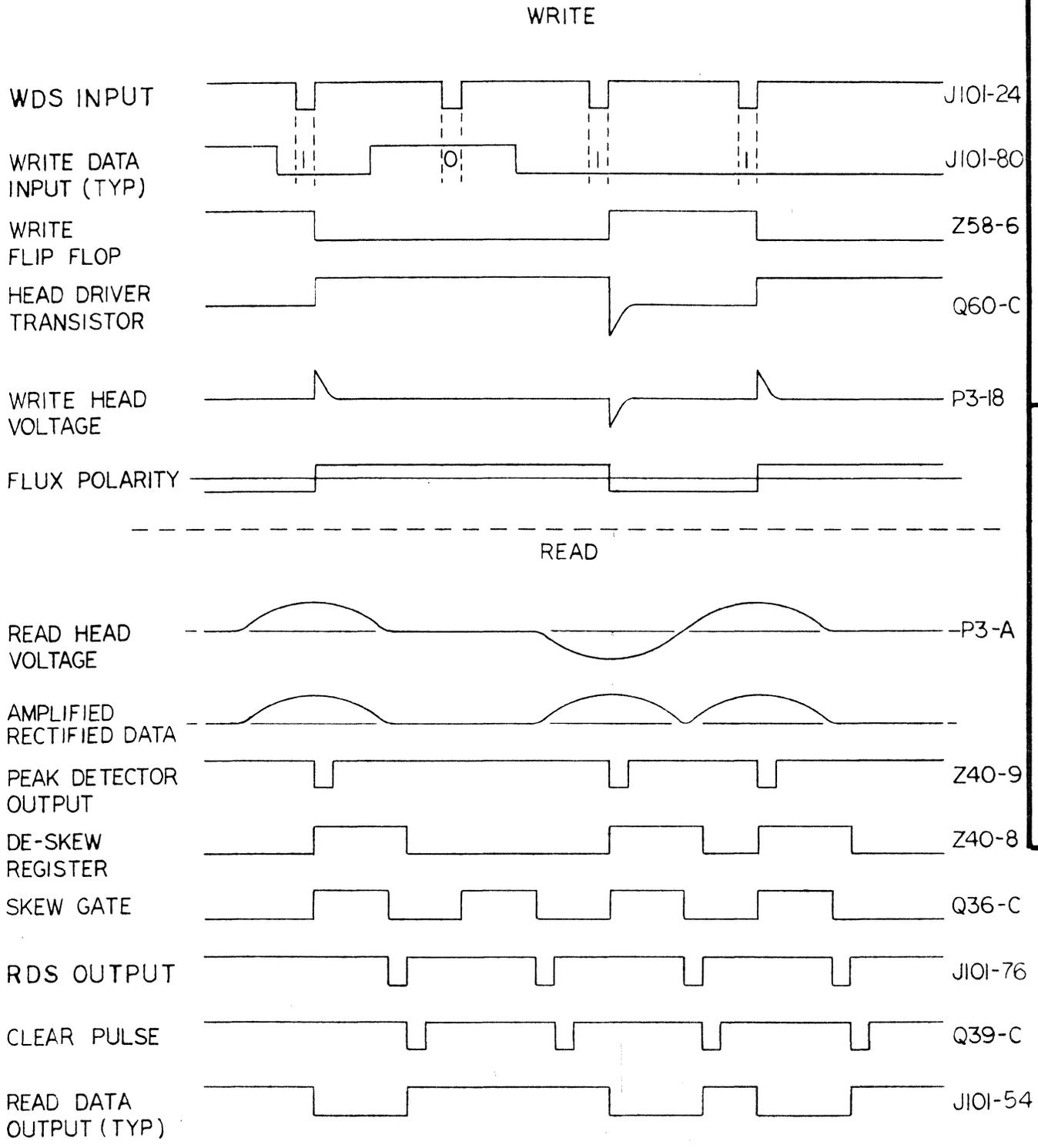


FIGURE 5-5 WRITE AND READ CIRCUITY WAVEFORMS

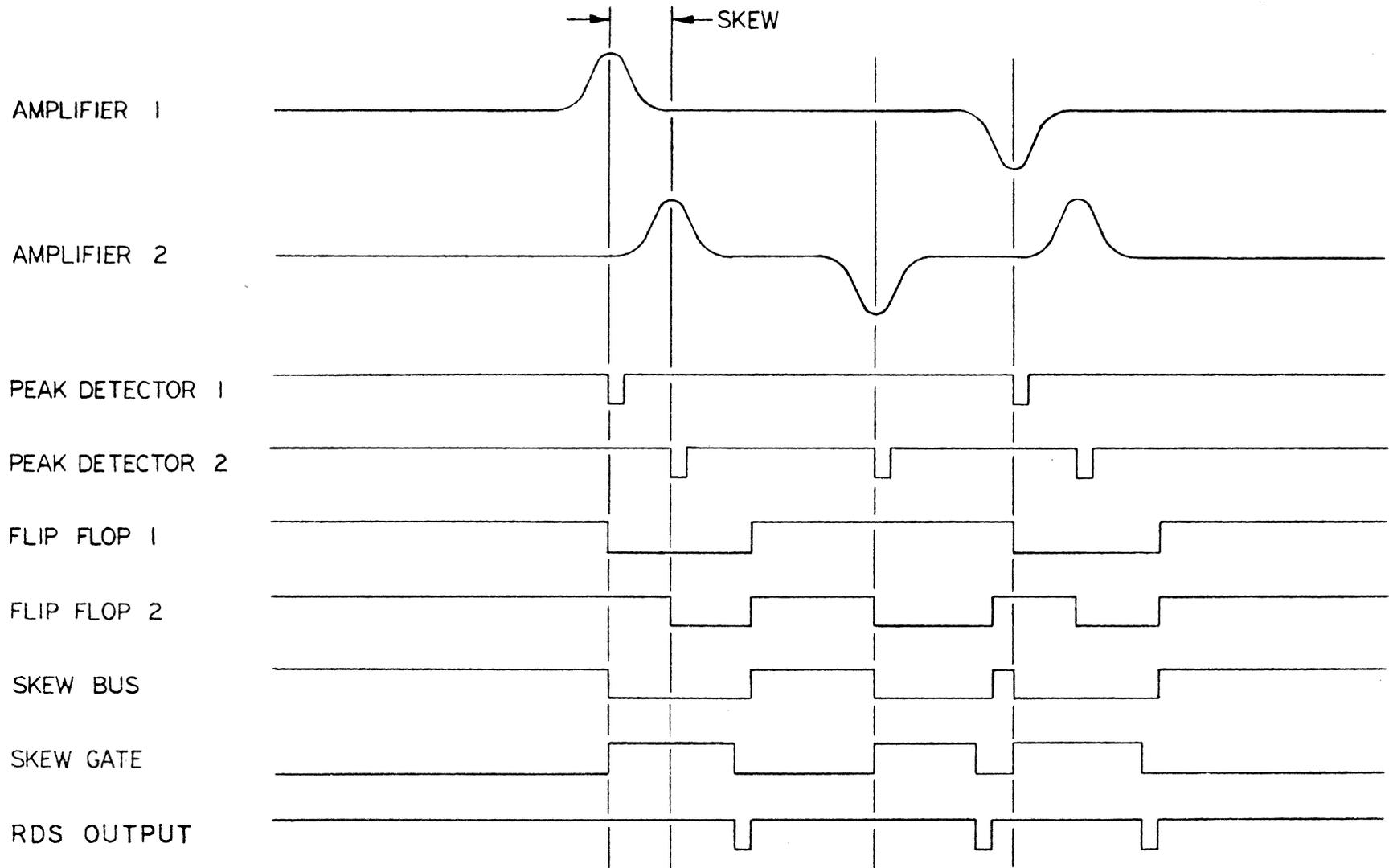


FIGURE 5-6 DESKEWING OPERATION WAVEFORMS

When the skew bus drops the skew gate one-shot generates a pulse nominally equal to one-half of the character period. At the end of this interval all "ones" in the character will have arrived and set the appropriate flip flops in the de-skewing register and it can safely be assumed that the remaining channels are reading zeros. In practice, all bits in a character generally arrive within fifteen per cent of the character period. The trailing edge of the skew gate pulse triggers the read clock one-shot. This circuit produces a 2 microsecond pulse at the recorder RDS output which informs the external system that a de-skewed character is available at the READ DATA outputs. Shortly after the trailing edge of the read clock pulse the de-skewing register is cleared and is then ready for the next character.

The 9 data rectifier circuits are connected to a common line controlling the clipping level of the playback amplifiers. When this line is at ground potential normal reading occurs. For read-after-write operations the line is raised to +1.3 volts, thereby raising each channels threshold level. In dual gap recorders the threshold level is controlled by the transport read/write status flip flop. Single gap machines have a RTH1 input which permits the external system to control the threshold.

Another input, RTH2, causes the data rectifier control line to switch to negative, thereby defeating the level discrimination normally provided by the data rectifier. This feature aids in the recovery of severely degraded data. The three read threshold levels control the amplitude required from the read head to trigger the peak detector circuit. The high level requires at least 50 per cent of nominal amplitude and is employed when checking the quality of data after it is written. Dual gap read-after-write machines automatically employ the high level when in read-after-write mode. The normal read threshold will reliably detect data at 20 per cent of the nominal amplitude while offering a maximum of noise discrimination. In the low threshold mode the machine sensitivity is approximately 10 per cent of the nominal amplitude, enabling recovery of data in severe dropouts.

5.10 Control Circuitry

The transport control circuitry interfaces the machine inputs and outputs to the motor circuitry, photo-electric sensors, etc. The control circuitry also generates the rewind to load point sequence.

5.10.1 Photo-electric sensors

The BOT (Beginning of Tape) and EOT (End of Tape) sensors pull current through the level setting potentiometers while viewing the reflective tabs on the tape. While the tab is sensed the sensor line will be below one volt, causing the associated logic signal (Z20-11 for BOT, Z20-3 for EOT) to go high. The two signals are buffered and gated by Z16 which creates the LOAD POINT and END OF TAPE machine outputs.

The simultaneous occurrence of BOT and EOT indicates that the photo-sensors are viewing a mirror which is normally hidden when tape is threaded on the machine. This condition is detected at Z20-8 and employed to set signal BT (Broken Tape) high. BT is also set high by Q5 when power is applied to the machine. When BT is high all control flip flops are cleared and the machine will not go on line. The REELS ON signal at P4-J will be low, killing power in all motors.

5.10.2 LOAD Sequence

The BT line can be set low only by pressing the LOAD button with tape threaded on the machine. Refer to Figure 5-7 which illustrates the signals described below. When BT goes low the REELS ON line goes high and the reel servos apply tension to the tape. The delay circuit consisting of Z15, Q11, Q12, and Q13 fires and produces a positive pulse at Q13 after a delay of approximately half a second.

This pulse sets the LOAD signal (Z14-8) high, causing FORWARD (P4-B) to go high and the tape to move forward searching for the BOT mark.

When the BOT marker is sensed the LOAD signal is cleared by Z14-6, halting tape motion. The Q11, Q12, Q13 delay circuit is again fired and the delayed pulse from Q13 is steered into the RDY latch via Z19-8, setting RDY high. At this time the machine is at rest at the BOT mark and the ARM I/O signal (Z18-8) and READY output (Z17-8) will go true if the machine is selected and on line. The ARM I/O signal gates all motion command inputs and all machine outputs.

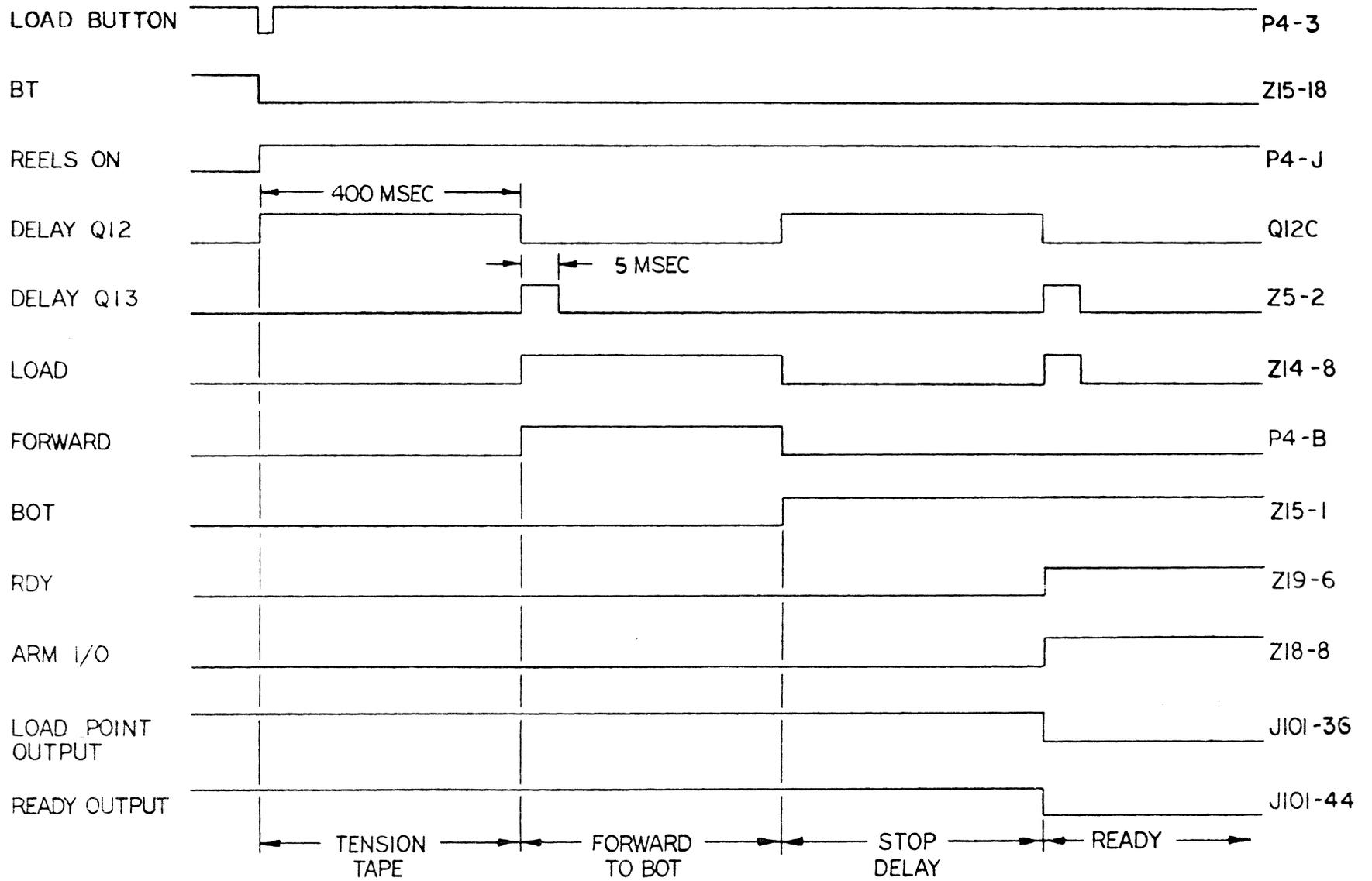


FIGURE 5-7 LOAD SEQUENCE TIMING DIAGRAM

5.10.3 ON/OFF LINE Control

The ON/OFF LINE pushbutton permits the operator to control access to the recorder by placing the machine either on line or off line. The gate output at Z61-11 generates a low going pulse each time the pushbutton is depressed. This pulse toggles the ON LINE flip flop unless it is being held off by a broken tape condition via Z7-6. Note that the ON LINE flip flop may also be reset by the REWIND button (via Z7-3) and by the OFF LINE input command via Z7-8. The machine may be placed permanently on line by removing the 1-2 and 3-4 jumpers on the RC11 card and installing the 5-6 and 7-8 jumpers.

5.10.4 Rewind

A rewind operation returns the tape to the load point. Rewind operations may be initiated by the REWIND pushbutton or the REWIND input command. Figure 5-8 illustrates the waveforms occurring during a rewind. When a rewind is initiated the RWD signal (Z9-3) is set high, causing a rewind command to the motors to go high (P4-H). The tape moves backwards at high speed until the BOT marker is sensed. When Z15-3 goes low the Q11, Q12, Q13 delay circuit is armed and fires when Z15-3 returns high at the trailing edge of the BOT marker. The half-second delay created by this circuit permits the tape to decelerate. Following the delay a positive pulse from Q13 initiates the return to the BOT mark. The remainder of the sequence is identical to that described in paragraph 5.10.2 for a load operation.

5.10.5 Unload

If the REWIND button is depressed while the tape is at the load point the machine enters the unload mode and slowly rewinds the tape leader onto the supply reel. Point Z10-8 is the logical and of REWIND button and BOT and sets the UNLOAD flip flop. The REELS ON signal drops and REVERSE at P4-3 goes high, causing reverse motion. When the tape has been completely rewound the BT (Broken Tape) line goes high, clearing all flip flops and shutting down the motors.

5.10.6 Input Commands

The FORWARD, REVERSE, and REWIND input commands are gated by ARM I/O, thus blocking the commands if the machine is not ready, selected and on line.

5-19

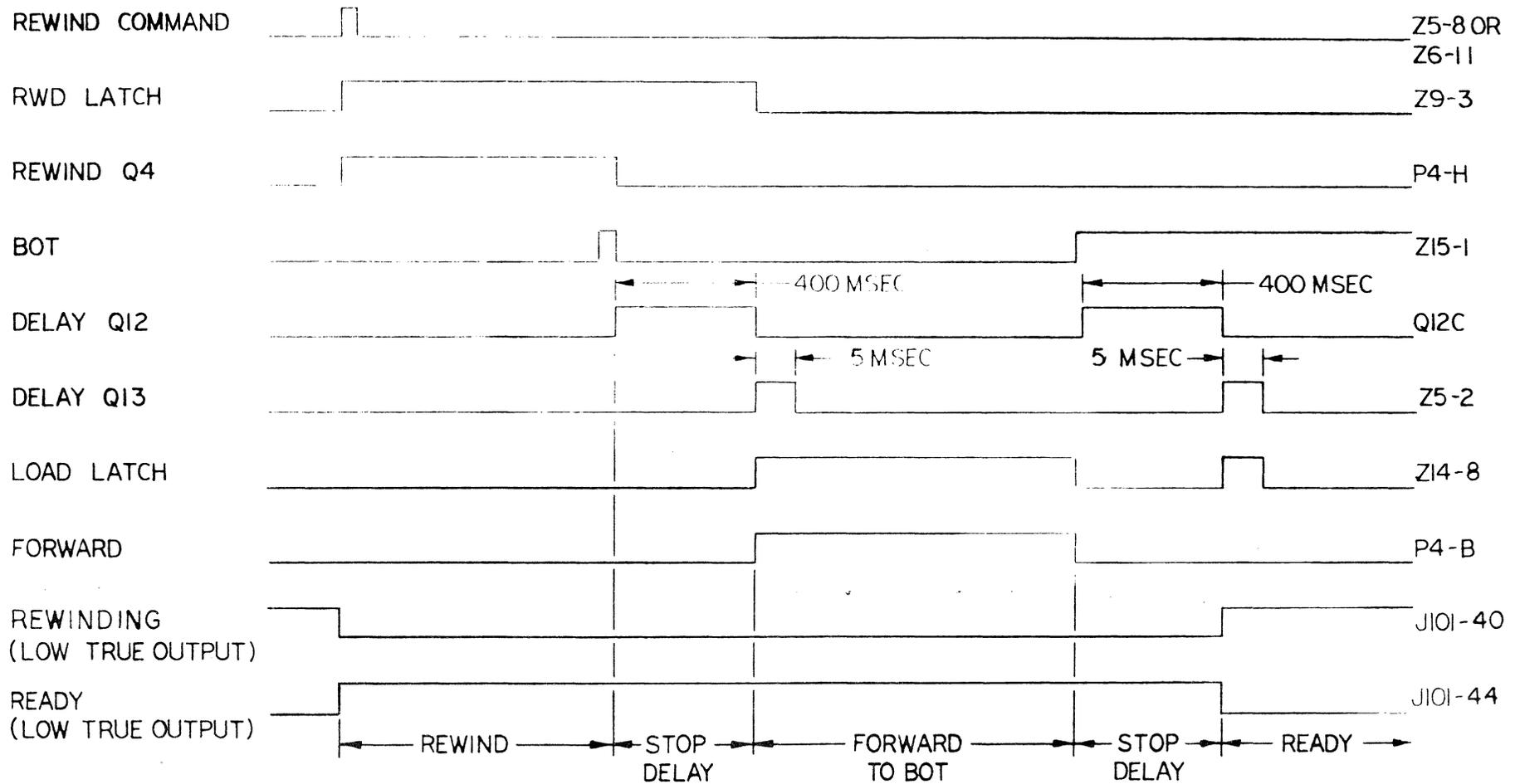


FIGURE 5-8 REWIND SEQUENCE TIMING DIAGRAM

The REVERSE and REWIND inputs are also blocked if BOT is high.

The circuitry associated with Q3 generates a positive pulse at Z8-13 and Z4-3 shortly after the leading edge of all FORWARD and REVERSE commands. This pulse strobbs the SWS input into the ARM WRITE flip flop and the OVERWRITE input into the Ovw flip flop. When the ARM WRITE flip flop is set power for the write and erase heads is activated via Q10. The ARM WRITE flip flop will not set unless the tape reel has a write ring inserted. The flip flop is automatically cleared by a rewind, offline or no tape condition.

If the Ovw flip flop is set at the beginning of a write operation the write power will be shut off when the WRITE AMPLIFIER RESET input goes true. This feature permits the write and erase heads to be de-energized as soon as possible after replacing a block in order to avoid erasing the succeeding block. When de-energized, the write power will decay smoothly to avoid recording a transient on the tape.

SECTION VI MAINTENANCE AND REPAIR

6.1 Introduction

This section provides information on electrical and mechanical adjustments, parts replacement and problem isolation. In the event of a malfunction of the transport refer to paragraph 6.3 for suggestions on how to localize the problem. The transport block diagram (Figure 5-1) should be consulted when attempting to localize a failure.

6.2 Preventive Maintenance

It is absolutely necessary to periodically clean the tape head, tape cleaner, tape guides, arm rollers and capstan to remove dust and accumulated tape oxide particles. Any small particle between the tape and head is capable of causing a "dropout" which may obscure hundreds of data bits. Such dropouts are by far the most prevalent cause of tape errors.

DAILY:

Tape transports which are in regular use should be cleaned daily or after the equivalent of 10 full reels have been run through the machine. Machines which are used infrequently should be cleaned before each use.

Cleaning is best accomplished with a cotton swab or lint-free cloth moistened with isopropyl alcohol. Do not use carbon tetrachloride or other strong solvents on the machine. Do not use abrasive materials or rough cloths.

Thoroughly clean and wipe all surfaces which touch the tape. Rotate the capstan and arm rollers while cleaning to assure complete removal of all contaminants. Once cleaned, a surface should not be touched with fingers. The stationary tape guides near the head, the tape cleaner and the head itself (including the small erase head) should be particularly clean. Following cleaning allow sufficient time for the alcohol to evaporate or dry the machine with a soft lint-free cloth before using.

QUARTERLY:

At quarterly intervals a complete cleaning of the machine is recommended to remove all buildups of dust, dirt and tape oxide. The bottom flange of the tape guides is normally rotated in the cleaning process and should last indefinitely. The upper flange

is fixed and should be removed and rotated periodically. Removal of this flange permits better access to the tape guide for cleaning as well as providing a new wear surface when the flange is replaced. The flange should be removed by loosening the socket screw accessible from the front of the machine.

The door and major surfaces of the transport should be cleaned with a commercial non-abrasive cleaner such as Windex and a soft cloth.

2000 HOUR CHECK

Regular preventive maintenance checks at 2000 operating hour intervals are recommended.

1. Clean machine and rotate upper flange of tape guides as described under quarterly checks.
2. Check tape guides, tape cleaner, hubs, etc. for loose screws by wiggling them.
3. Inspect rubber rings on reel hubs for excessive wear and replace as necessary.
4. Inspect tape head for excessive wear. The head has flat gutters on each side of the tape area. When the head wears down to the depth of the gutters it must be replaced. Head life is expected to be 5,000 hours of continuous operation, corresponding to approximately 10,000 full reels of tape.

Worn heads may have a trade-in value. Consult factory for details.
5. Remove and inspect at least one capstan motor brush and one reel motor brush. If the brush is less than 3/16 inch (5 mm) in length or appears chipped, cracked or burnt the motor should be replaced. Expected motor life is 5,000 hours of continuous operation.
6. Check tension arm positions and readjust if necessary. See paragraph 6.4.3.
7. Check tape speed and start/stop times and readjust as necessary. See paragraph 6.4.4.
8. Check BOT/EOT adjustments. See paragraph 6.5.2.
9. Check read amplifier gains. See paragraph 6.5.3.
10. Check read skew. See paragraph 6.16.

6.3 Troubleshooting Guide

The following paragraphs describe troubleshooting procedures and techniques for localizing and replacing faulty components. Repair of electronic problems may be done by replacing the MC17 or RC11 cards or by troubleshooting down to the component level. After locating and replacing the faulty component, some readjustment may be required. Table 6-1 indicates which adjustments should be checked after replacing any of the listed components.

Check the following list for the most likely failures.

6.3.1 Power Supplies

The three regulated power supply voltages should be checked as a preliminary step under almost all circumstances. See paragraph 6.6.

1. Blown fuse: See paragraph 6.6.
2. Overvoltage: Faulty power supply component. Isolate with DC voltage measurement.
3. Undervoltage: Faulty power supply component or excessive load. Open load jumpers on MC17 card to isolate problem. Note that if the +12 supply fails the +5 and -12 supplies may not operate properly until the failure in the +12 supply is corrected.

6.3.2 Improper Response to Operator Controls

1. Motors start when power is applied.
Component failure. If more than one motor is affected check RC11 card control logic, particularly Q5, Q9, and Z15. If only one motor spins check components in associated servo circuitry. Possible dirty PC board contact or improperly inserted RC11 card.
2. No response from LOAD button.
 - A. Check tape path and insure that tape is properly threaded.
 - B. Check BOT/EOT sensor adjustments. See paragraph 6.5.2.
 - C. Check power supplies.

- D. Check BT latch in control logic. Z15 pin 9 should be high and Z15 pin 12 should go low when LOAD button is depressed.
 - E. Check arm limit microswitch for proper operation.
3. Tape "takes off" when LOAD is pressed.
 - A. Tape not threaded around an arm roller. Check tape path.
 - B. Component failure in one reel servo system. Check arm sensor assembly and lamp. Check DC voltages in reel servos.
 4. Capstan does not start when LOAD is pressed.
 - A. Tape at BOT mark or BOT sensor out of alignment.
 - B. Service switch in reverse position.
 - C. Component failure in capstan servo circuitry. Check DC voltages.
 5. Tape does not stop at BOT mark.
 - A. BOT marker missing or dirty.
 - B. Service switch in forward position.
 - C. BOT sensor out of adjustment. See paragraph 6.5.2.
 - D. BOT/EOT sensors or lamp defective. Indicated by +5V at BOT test point, unaffected by pot adjustment. Replace assembly.
 - E. Z20 on RC11 defective.

6.3.3 Improper Response to Input Commands

1. Transport does not respond to motion commands.
 - A. Interface cable fault. Check input levels on RC11 card.
 - B. Transport is not READY. Check components in control logic on RC11 card.
2. Tape moves but transport does not write.
 - A. Check for presence of write enable ring on supply reel. RING IN lamp should be lit.
 - B. Check SWS input on RC11 card at Z1 pin 1. Should be low.
 - C. Check ARM WRITE and WRITE POWER signals on RC11 card. Both should be +5 volts.
 - D. Check WDS input on RC11 card at Z51 pin 4.

3. Data improperly written.
 - A. Review interface requirements in Section 4. Check WRITE CLOCK frequency and pre-data and post-data time delays. Check parity generator.
 - B. Check write circuitry and head by writing all ones while checking waveforms on the RC11 card at all 18 head wires. See paragraphs 5.8 and 6.10.
 - C. Check for presence of the WARS input pulse on the RC11 card at Z51 pin 9.
 - D. Check operation of erase head by verifying that P3 pin 21 is at approximately 0.5 volts while writing. Verify that this voltage drops to zero when the REWIND and/or OFF LINE buttons are pressed.
 - E. Dip "all ones" tape in "Magna-See" (trademark of Soundcraft) solution and inspect tape for any indication of a worn or damaged head.
4. Machine reads incorrectly.
 - A. Thoroughly clean head, capstan, tape guides, and arm rollers. See paragraph 6.2.
 - B. Check tape path against tape path diagram.
 - C. Defective component. Check for presence of data at all 9 READ DATA outputs while reading all ones tape. Check waveforms in READ DATA STROBE generation chain. See paragraph 5.9.
 - D. Open head lead. Check continuity from ground to each of 18 read amplifier inputs.
 - E. Tape tracking or skew is out of specifications. Check for loose mechanical components then re-adjust following procedure of paragraph 6.16.
 - F. Check read amplifier gain settings per paragraph 6.5.3.
 - G. Shorted write circuitry (in single gap read/write machines) passes current to read circuitry. DC voltage at read amplifier inputs should be zero.

- H. Improperly adjusted flux gate. (Dual gap read-after-write machines only) Check crosstalk and adjust if out of specification. See paragraph 6.10.
- I. Incorrect tape speed.
Measure READ DATA STROBE frequency with oscilloscope. If maximum observed frequency error exceeds 10 per cent check power supplies for proper voltages and regulation. Re-adjust capstan speed and START/STOP ramps if necessary. See paragraphs 5.3 and 6.4.4.
- J. Motor brush noise pick-up. Read a thoroughly bulk erased tape while monitoring RDS output. If any pulses occur isolate defective motor by removing tape from capstan (paragraph 6.9) and electrically and/or manually manipulating each motor.

6.4 MC17 Replacement Procedure

The MC17 card (the one with the large finned heatsink) contains the power regulators and motor control circuitry. If this card is changed the new card must be aligned as described below.

MC17 cards cannot be interchanged from one model (1600, 1700) to another due to a different heatsink orientation. Boards manufactured for one tape speed cannot be installed in a unit designed for another speed unless several components are changed.

CAUTION:

Do not remove the MC17 card immediately after removing power from the recorder. Wait for at least one minute after removing power before removing the board.

MC 17 BOARD REPLACEMENT

6.4.1 Replacing Card.

1. With power off and tape not loaded, attach four (4) pieces of masking tape to the face plate under each tension arm and mark the tape at the measurements shown at the forward and reverse positions of each arm. Refer to Figure 6-1, Tension Arm Operating Positions.
2. Verify that the four (4) potentiometers on the new card marked TU ARC, TU CEN, SUP CEN, and SUP ARC are in the center of their rotation.
3. The card chassis may be hinged open by removing two screws to improve access to the MC17 card mounting screws.
4. Remove the two (2) screws, one at each end of the MC17 heatsink.
5. Remove the defective board and install the new board.
6. Verify that the new MC17 board is firmly seated in its two connectors and reinstall the two hold down screws.
7. Apply power to the unit and verify power supply voltages at the fuses (+20 and -20 VDC) and at the jumpers of the MC17 (+12, -12, +5, +5s VDC).
8. Place a piece of tape between the BOT/EOT Sensor assembly and the mirror post to prevent the unit from seeing the mirror.

6.4.2 Preliminary Reel Servo Setup

1. Depress LOAD button. The take up and supply reel motors should rotate as long as the button is depressed.
2. Hold the supply tension arm in the center of available arc.
3. Depress LOAD and ON LINE simultaneously. Verify that this causes the capstan motor to halt.
4. With supply motor turning and the arm held center, adjust SUP CEN potentiometer to make the supply reel motor stop turning. See the MC17 Card drawing in section 7 for the location of all pots and test points.

5. Secure the supply arm so it cannot return to the rest position. A write ring looped around the arm roller and the nearby tape guide is a convenient way to accomplish this.

NOTE: If the supply arm is accidentally moved to either extreme of the operating arc it will trip a microswitch which shuts down all motors. If this occurs secure the supply arm, press LOAD to start the motors, then press LOAD and ON LINE to halt the capstan motor. The capstan motor must be halted to properly perform the preliminary arm centering adjustment.

6. Hold the take up tension arm in the center of its available arc and adjust the TU CEN pot to make the take up reel motor stop turning.
7. Load a scrub tape and press LOAD. The tape should advance to BOT and halt. If the arms move out of range and shut down the machine, adjust the TU ARC and/or SUP ARC pots counterclockwise to keep the arms within the operating area.
8. Run the machine forward and reverse with the service switch or a TC-12 maintenance card. If the arms move out of range, adjust the pots to keep the arms within the operating area. This is a preliminary adjustment.

6-9

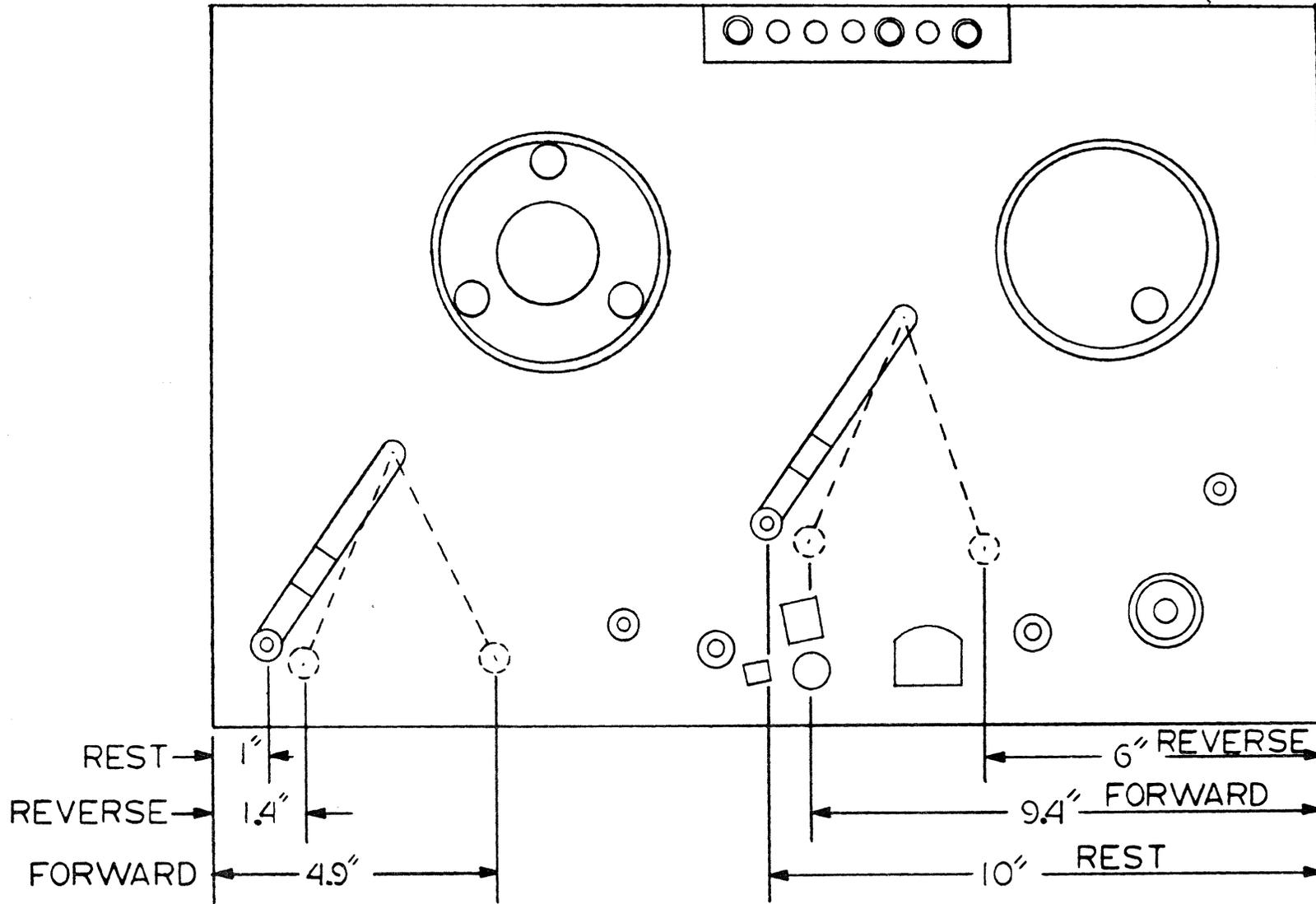


FIG.6-1A TENSION ARM OPERATING POSITIONS-MODEL 1600

	DIGI-DATA CORPORATION	
	SHEET	OF

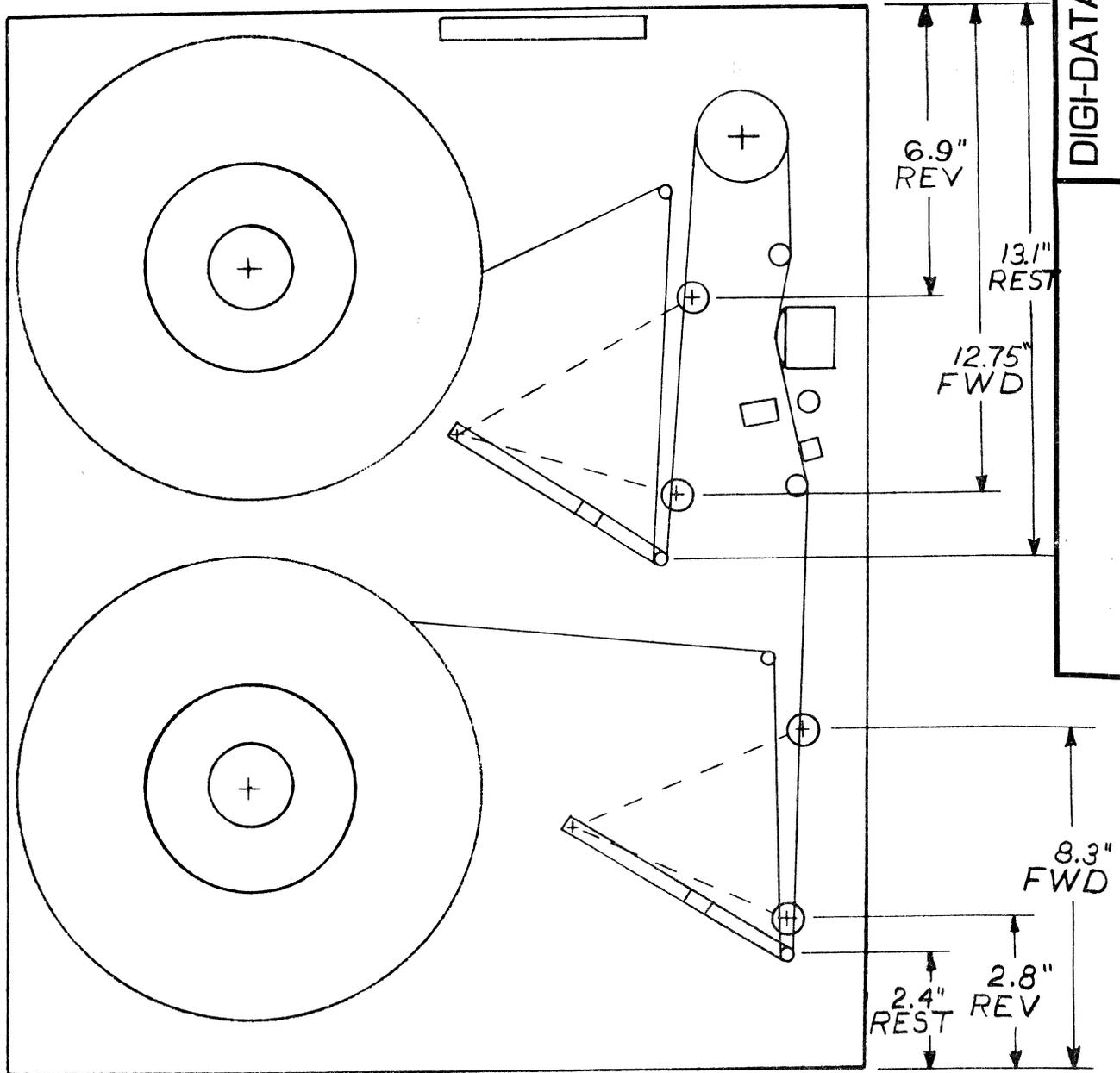


FIG 6-1BTENSION ARM OPERATING POSITIONS
MODEL 1700

6.4.3 Reel Servo Adjustments

1. If not already done, attach masking tape to the face plate and mark the forward and reverse positions of each arm. The locations are shown in Figure 6-1.
2. Load the transport with a small or practically empty reel of tape. Press LOAD. The tape should advance to BOT and halt.
3. Run the machine forward and reverse with the service switch or a TC-12 maintenance card. Adjust the CEN and ARC pots for each arm to position them exactly at the positions shown in Figure 6-1. Make repeated small adjustments of the two pots, checking the forward and reverse position of the arm after each adjustment. The ARC pot is used to move the two arm positions apart, the CEN pot to shift both positions in a common direction.

6.4.4 Capstan Servo Adjustments

The following adjustments must be performed following replacement of the capstan motor - tachometer or the MC17 card.

1. Connect a voltmeter or oscilloscope to the right end of R134. This point is indicated on the MC17 card drawing in Section 7. This drawing also shows all test points and potentiometers used in this procedure.
2. Turn on the tape transport.
3. Adjust the ZERO pot to get zero volts on the meter or scope.
4. Forward Speed
Load a tape on the machine, press LOAD and wait for the tape to halt at BOT. Then place the service switch in the forward position. Adjust the FWD SP pot for the proper speed.

SPEED MEASURING TECHNIQUES

- A. The most accurate method of speed measurement is to read a tape known to be accurate in density. A frequency counter or oscilloscope is connected to a read amplifier test point (on the RC11 card) and the speed adjusted to provide the

correct frequency. The frequency should be equal to the product of the tape speed and the known tape density. For example, 25 ips x 800 cpi = 20,000 characters per second.

B. A round stick-on label will be found on the capstan motor-tachometer or near the recorder nameplate. The tachometer output voltage corresponding to the recorder's forward, reverse and rewind speed is listed on the sticker. These readings were taken at TP5 on the MC17 card. The speed pots may be adjusted to duplicate these readings by monitoring TP5 with an accurate voltmeter.

5. Reverse Speed

Move the service switch to the reverse position. Adjust the REV SP pot for the proper speed.

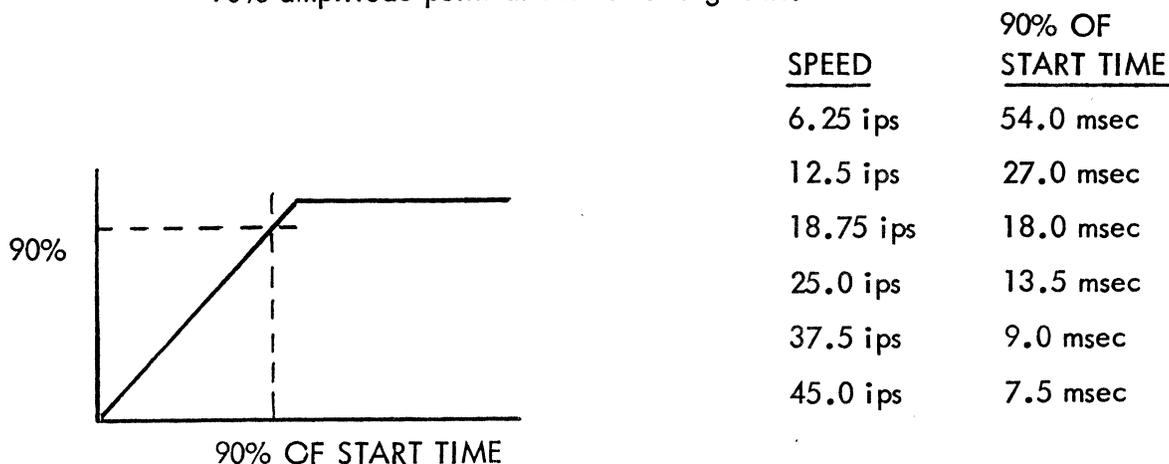
6. Rewind Speed

Run the tape forward a while so the rewind will last long enough to adjust the speed. Monitor TP5 with a voltmeter or scope and press REWIND. Adjust the RWD SP pot to duplicate the reading found on the sticker for "RW".

7. Start/Stop Ramps

Operate the machine in a start-stop mode in the forward direction by generating appropriate commands in the controlling system. Alternatively, this operation may be produced by a Digi-Data TC12 test card or by grounding J101 pin 30 (SELECT) and applying a 5 volt square wave at 10 Hz or less to J101 pin 8 (SYNCHRONOUS FORWARD COMMAND). Connect an oscilloscope with a calibrated time base to J2 pin 17 or to TP5 on the MC card. Synchronize the oscilloscope to the SFC input or to TP1 so that triggering occurs at the beginning of each waveform shown below. The RAMPS potentiometer controls the duration of the start and stop ramps and should be adjusted to bring the tape to 90% of full speed in 90% of the nominal specified start/stop time. Thus the potentiometer should be set to place the

90% amplitude point at the following time:



If the capstan servo system is operating properly the start and stop times in both the forward and reverse directions will all be equal. Any significant difference indicates a defective component in the ramp generation circuitry.

6.5 RC11 Replacement Procedure

6.5.1 Replacing Card

1. Remove power from the unit.
2. Disconnect the I/O connector from the RC11 board.
3. The card chassis may be hinged open by removing two screws to improve access to the RC11 card mounting screws.
4. Remove the two hold down screws and remove the RC11 board.
5. Install the new RC11 board, insuring that the two connectors are firmly seated.
6. Replace the two hold down screws.
7. Replace the two screws to secure the hinged chassis to the recorder.

6.5.2 BOT/EOT Adjustment:

1. Load a new brown tape (not black) on the unit.
2. Connect a voltmeter or oscilloscope to the BOT test point on the RC11 card. See Section 7 for a drawing of the RC11 card illustrating all testpoints and adjustment locations.
3. Advance the tape beyond the BOT marker so the BOT/EOT sensor block is looking at the tape.

4. After at least one minute warm up, set the BOT pot to give a +2.5 volt reading.
5. Obtain the same reading at the EOT test point by adjusting the EOT pot.

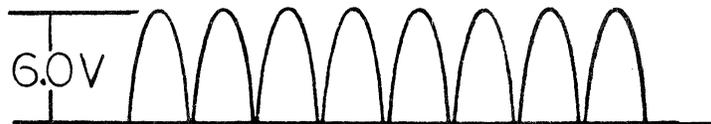
The operation of the sensors may be checked by inserting a reflective surface between the sensor housing and the tape. If both BOT and EOT are sensed properly, the tension arms will completely relax.

6.5.3 Read Amplifier Adjustments

The gain of each of the 9 (or 7) read amplifiers must be adjusted following replacement of the tape head or RC11 card. The test points and pots are easily accessible from the rear of the machine.

The gains should be adjusted while reading a standard reference level tape recorded at 800 bpi with an all ones pattern. Do not employ a master skew tape for this adjustment. A new high quality freshly recorded tape may be employed if necessary.

1. Connect an oscilloscope to one of the 9 read data test points (See RC11 card drawing in Section 7).
2. Load the reference tape.
3. After the tape halts at BOT move the service switch to the forward position.
4. Adjust the read amplifier pot to obtain 6.0 volts peak-to-valley on the oscilloscope.



5. Repeat the adjustment for each track.

6.6 Power Supply Troubleshooting

The power supply circuitry located on the MC card generates five output voltages. These are provided by regulators for +12, -12, and +5 volts and emitter follower

TABLE 6-1
TRANSPORT ADJUSTMENTS

Part Replaced	Related Adjustments	Paragraph
MC Card	Arm Position potentiometers Capstan potentiometers	6.4
RC Card	BOT/EOT potentiometers Read Amplifier Gains	6.5
BOT/EOT SENSOR	BOT/EOT potentiometers	6.5.2
Arm Position Sensor	Sensor Alignment Arm Position potentiometers	6.17 6.4.2
Head or Tape Guide	Skew Adjustment Read Amplifier Gains Flux Gate	6.18 6.5.3 6.10
Power Supply Component	+12V Regulator potentiometer	6.7
Capstan Motor	Skew Adjustment Capstan potentiometers	6.18 6.4.4
Reel Motor	Hub Height Arm Centering potentiometers	6.14 6.4.3

circuits for the +5(S) and +5.6 volt outputs. The +12 volt regulator output is employed by all of the other power supplies. Thus if the +12 regulator malfunctions all of the supplies will appear to be inoperative. A potentiometer permits setting the +12 volt output to precisely +12.00 volts. The +5 and -12 volt regulators track the +12 output so the potentiometer will actually set all three regulators.

If the tape transport is malfunctioning, the following tests should be performed to check for proper behavior of all power supplies.

1. Check the rectified DC supplies.
J2 pin 11: +20 VDC (16 to 25 V range)
J2 pin 13: -20 VDC (16 to 25 V range)
J2 pin 12: +8 VDC (7 to 10 V range)
If these voltages are incorrect check fuses, rectifiers and capacitors.
2. Regulators
The +12, +5, and -12 VDC outputs can be measured at the load isolation jumpers on the MC card or at J1 pins T, R and N respectively. A reading greater than 5% off the nominal indicates a malfunction.
3. +5(S) Supply
This supply is used on the MC card only and can be checked at the load isolation jumper labeled +5(S). The voltage should be between +4.5 and +5.5 volts.
4. +5.6 Supply
This supply powers the arm position sensor photocells. It should produce between +5.0 and +6.2 volts at J2 pins 7 and 8.

If any power supply output is abnormal, isolate the faulty component(s) with DC voltage measurements. Each regulator includes a protective current limiter which will reduce the output voltage in case of severe overload. To check for this possibility the loads may be removed from each supply by opening the associated jumper on the MC card. A blown transistor can be detected by determining the voltage between emitter and base. A forward voltage in excess of 1 volt across base-to-emitter indicates

that the transistor has opened. If a bad transistor is found all other transistors in the associated circuit should be carefully checked before turning the circuit on.

If the DC fuses have blown then all power transistors on the heat sink should be checked with an ohm meter for collector - emitter short circuits before replacing the fuses.

6.7 Power Supply Adjustment

The +12 volt regulator includes a potentiometer to set the output voltage. Since the +5 and -12 volt regulators are referenced to +12, this potentiometer will simultaneously set all three regulators to the proper voltages. The potentiometer is factory set to provide exactly +12.00 volts and should not require re-setting unless the 5.6 volt zener, Q26 or Q27, or a resistor associated with the potentiometer is changed. If it is necessary to set the potentiometer the +12 should be set as accurately as possible. Following this the arm centering potentiometers (paragraph 6.4.3) and capstan zero adjustments (paragraph 6.4.4) should be checked as these circuits employ the 12 volt regulator as a reference source.

If the zener diode or any component in the +5(S) emitter follower circuit is changed the capstan speed and ramp adjustments should be checked and reset if required.

6.8 Capstan Servo Troubleshooting

The capstan servo provides control of the capstan start and stop operations and holds the tape speed constant during forward, reverse and rewind operations. The servo amplifier includes five potentiometers which set forward, reverse and rewind speeds, amplifier zero and start/stop time.

Troubleshooting of the capstan servo may be performed by signal tracing with a voltmeter or oscilloscope. The capstan servo schematic diagram in section 7 shows the DC voltages occurring at various points throughout the ramp generator and servo amplifier circuitry.

Thread the machine and then press the LOAD button. This will generate a forward command, creating the indicated voltages. Depressing the LOAD button also actuates relay K1, which connects the capstan and reel motors to their respective servo amplifiers. With K1 activated, the capstan may be run forward and reverse with the service switch.

If a power transistor in the capstan servo power amplifier is found to be bad the other power transistors in the amplifier should be carefully checked before applying power. Also check the diodes located on the RP power card which protect the servo transistors from inductive voltages generated by the motor.

The speed and start/stop control circuits of the servo depend upon the +5(S) power supply, all 1% resistors in the servo, the timing capacitor at Z1 and the four diodes connected to the capstan +5(S) lines. Changing any of the above mentioned components or the motor/tachometer will change the tape speed or start/stop time, necessitating re-adjustment of the capstan potentiometers as described in 6.4.4. If it is necessary to replace other components such as transistors or operational amplifiers the servo should not require readjustment.

6.9 Reel Servo Troubleshooting

The two reel servos photoelectrically sense the position of the tension arms and control the reel motors to maintain the tension arms within a specified operating area. Each servo includes potentiometers which set the center and width of the operating area.

The reel servos may be easily checked and exercised without tape on the machine by defeating certain interlocks and manipulating the tension arms. This may be accomplished by hanging a small piece of tape in front of the BOT/EOT sensor to block its view of the mirror post. Pressing the LOAD button will then activate all motors as long as the button is held down. If the motors do not come on check the fuses, power supplies, control logic and relay K1. If a DC fuse has blown all power transistors on the heat sink should be checked with an ohm meter for collector-emitter short circuits.

To keep the motors on after releasing the LOAD button the tension arm limit switch must be defeated by holding the supply reel tension arm within its operating range or by grounding P1 pin 21.

With the machine in this mode the capstan should be going forward and each reel should be spinning in a direction which would wind tape onto it. Pressing the LOAD and ON/OFF LINE buttons simultaneously should halt the capstan and condition the reel servos for normal operation.

With the capstan stopped, move the tension arm back and forth through the available operating arc. The reel motor should reverse direction each time the tension arm goes through the center of the arc. If this occurs the arm position sensor and servo power amplifier are operating correctly. If a motor will not rotate, trace through the associated servo circuitry with a voltmeter to isolate the defect.

With no tape on the machine and the capstan stopped the outputs of operational amplifiers Z9, Z11, Z13 and Z14 should be zero volts and the circuit is reduced to a straight forward DC amplifier. The amplifier output should go positive when the arm sensor voltage input is lower than 3 volts and negative when it is above 3 volts. If a power transistor is found to be defective the other power transistors in the same amplifier should be carefully checked before applying power. Also check the diodes on RP power card which protect the servo amplifier from motor transients.

6.10 Flux Gate Adjustment

The flux gate is installed only on machines with dual gap read-after-write heads. It is a hinged shield located directly in front of the tape head and provides magnetic shielding between the write and read head gaps. Its adjustment should be checked following head replacement or if errors are occurring in the read-after-write mode.

The recorder must be operating and writing "all ones" patterns to properly check the flux gate position. If a TC-12 card is not available this mode of operation may be set up by grounding the recorder SELECT, SFC, and SWS inputs at the interface connector (J101 pins 8, 28 and 30). Apply a 5V pulse train at 10KHz to the WDS input (J101 pin 24). Ground Z51 pin 2 on the RC11 board to create the "all ones" condition.

Load a scratch tape on the machine and press LOAD. When the tape has reached the load point and halted carefully remove the tape from the capstan, permitting it to wrap around the right hand tape guide instead of the capstan. Now when the ON/OFF LINE button is pressed the capstan will move forward and the write circuits will be writing all ones, but the tape will not move.

Observe the read amplifier output voltage on any track at the anode of any of the diodes located immediately adjacent to the nine gain pots. The waveform observed must be less than 1.5 volts peak-to-peak.

If the waveform exceeds the specification re-adjust the flux gate by loosening the two screws securing it to the front plate and moving it to obtain the smallest possible peak-to-peak signal. The shielding material must not touch the tape. The top of the flux gate rests against the top of the head. Adjust the assembly so that it is parallel to the head and as close as possible without interfering with tape motion. Tune for minimum cross talk amplitude by shifting the assembly from side to side very slowly to locate the optimum position.

Then carefully tighten the two mounting screws and verify that the assembly is still at the optimum position.

6.11 Tape Tension Measurement

The tape tension is controlled by the spring attached to the two torque arms mounted on the tension arm shafts. This spring is a precision unit and should not be replaced with a commercial stock unit.

The tape tension is measured as shown in Figure 6-2. A length of tape or string is tied to the tape guide closest to the take-up reel and threaded as shown. Attach a 1 pound spring gauge to the tape and pull the gauge until the tension arm is in the position shown. The gauge must be pulled in the direction shown. The tape tension should be 7 ± 1 ounces (198 ± 28 grams).

If the tape tension is incorrect check the position of the tension arms when they are resting against the mechanical stop. They should be within 1/8 inch of the "rest" position shown in Figure 6-1. The arm positions may be adjusted by loosening the clamping screw located on the internal torque arm, rotating the tension arm to the specified position and then tightening the clamping screw very firmly. Let the arm snap against the stop several times and re-check its position to verify that the screw is tight enough to prevent slippage. Check each end of the spring to insure that no binding is occurring. After performing the mechanical adjustment check the tension arm sensor adjustments described in paragraph 6.4.3.

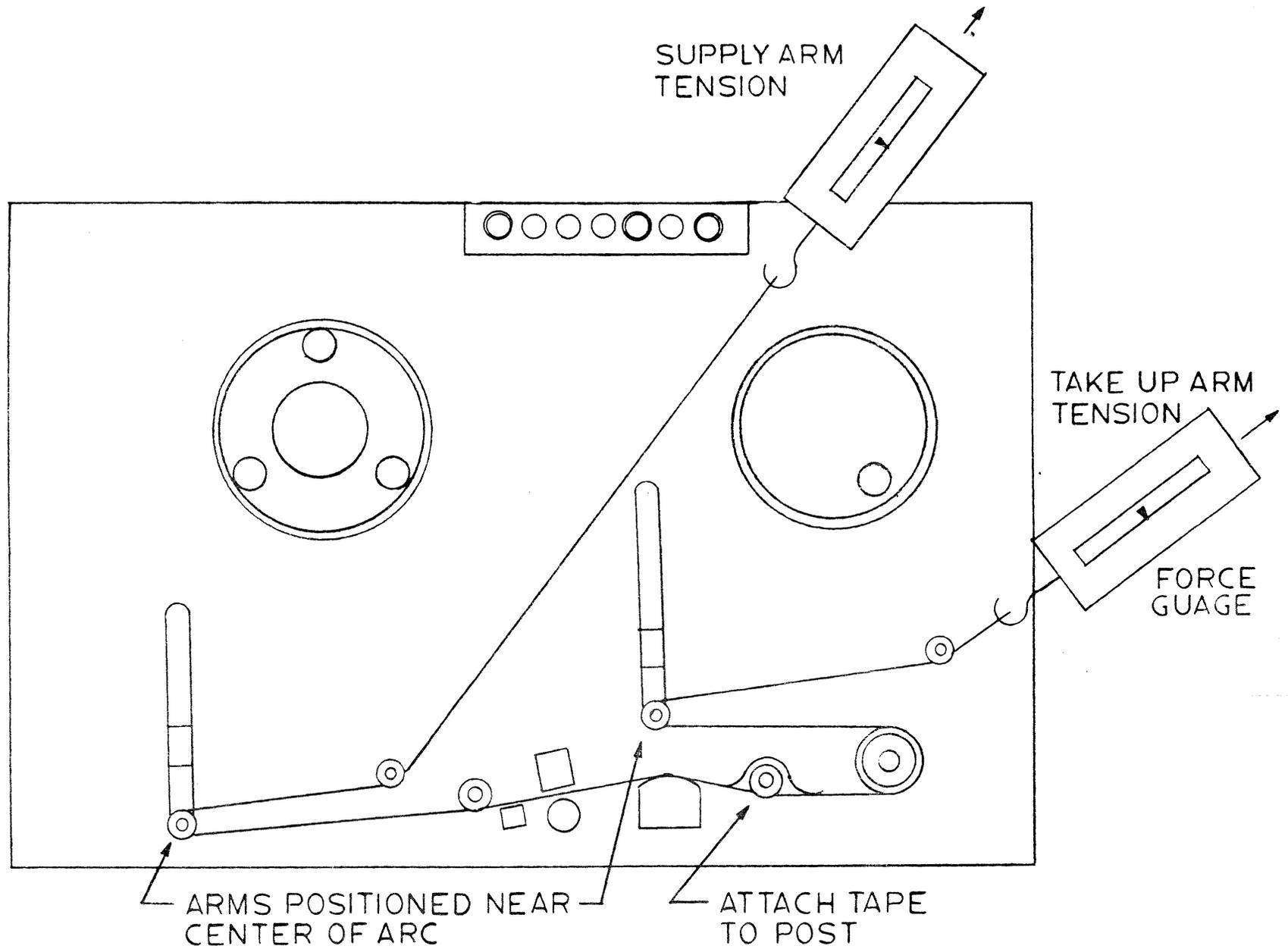


FIG. 6-2 TAPE TENSION MEASUREMENT-MODEL 1600

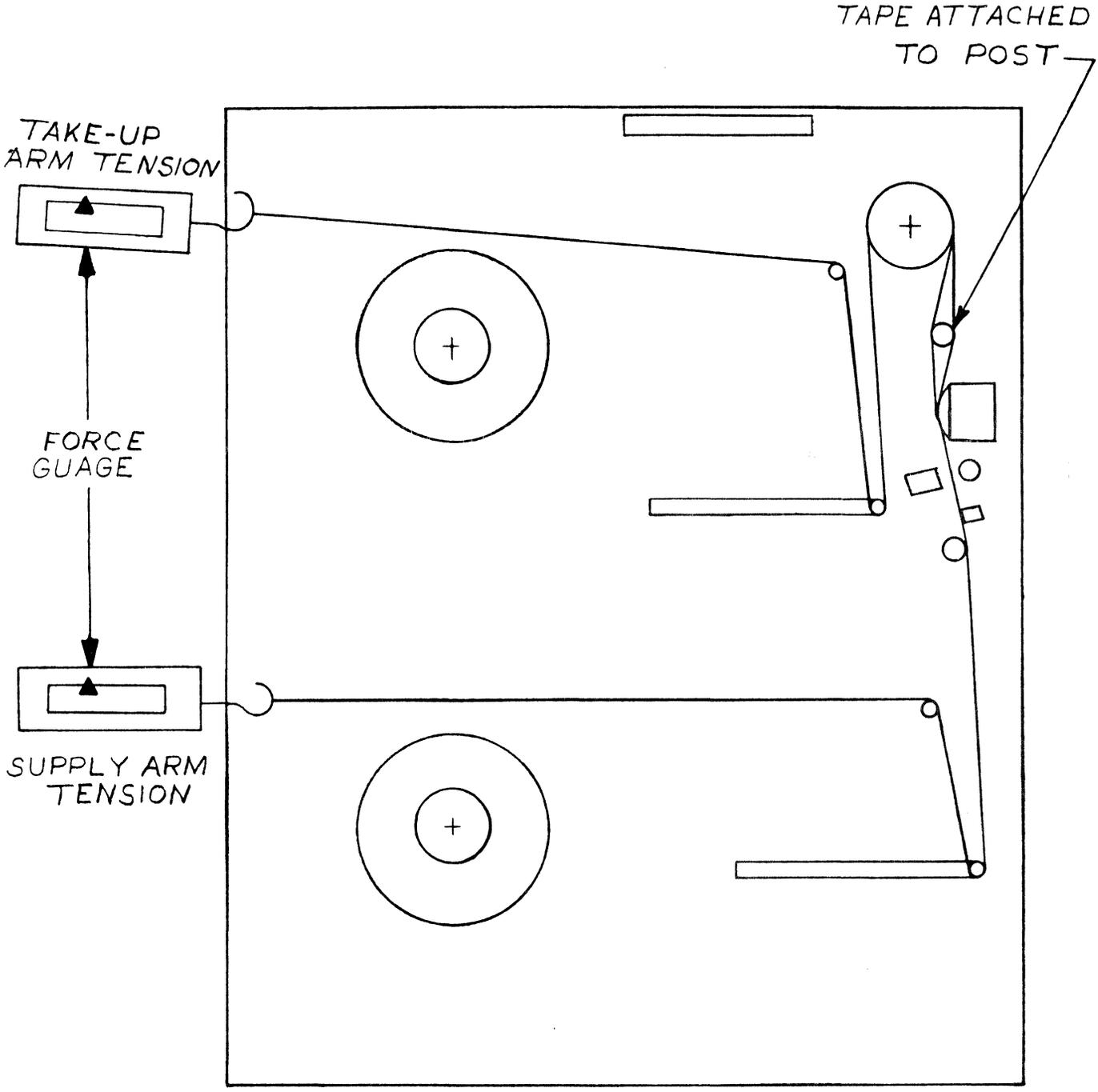


FIG. 6-2 TAPE TENSION MEASUREMENT
MODEL 1700

6.12 Head Replacement

The tape head may require replacement after prolonged use or in event of an internal wiring problem. The head should be inspected occasionally for signs of wear. If the head crown is worn down to the depth of the side gutters the head should be retired.

Replacement heads are available from Digi-Data. Prior to shipping they are tested and all wiring is properly shielded, stripped and tinned. If the machine is returned to the factory for head replacement the wiring, testing and alignment can be done in the transport instead of a test jig at no additional expense.

To replace a head in the field unsolder the head leads from J3, remove the two head retaining screws and pull the head leads through the hole in the plate.

Insert the new head leads through the hole and attach the new head with the two screws, including all washers in the proper order. Run the head leads to P3 following the same path that the old wires followed and attach the leads to connector P3. The head leads break out of the shielding in the proper sequence for attachment to P3. Consult the instructions packed with the new head for proper color coding. Figure 6-3 is a head wiring diagram listing the pin numbers assigned to each track.

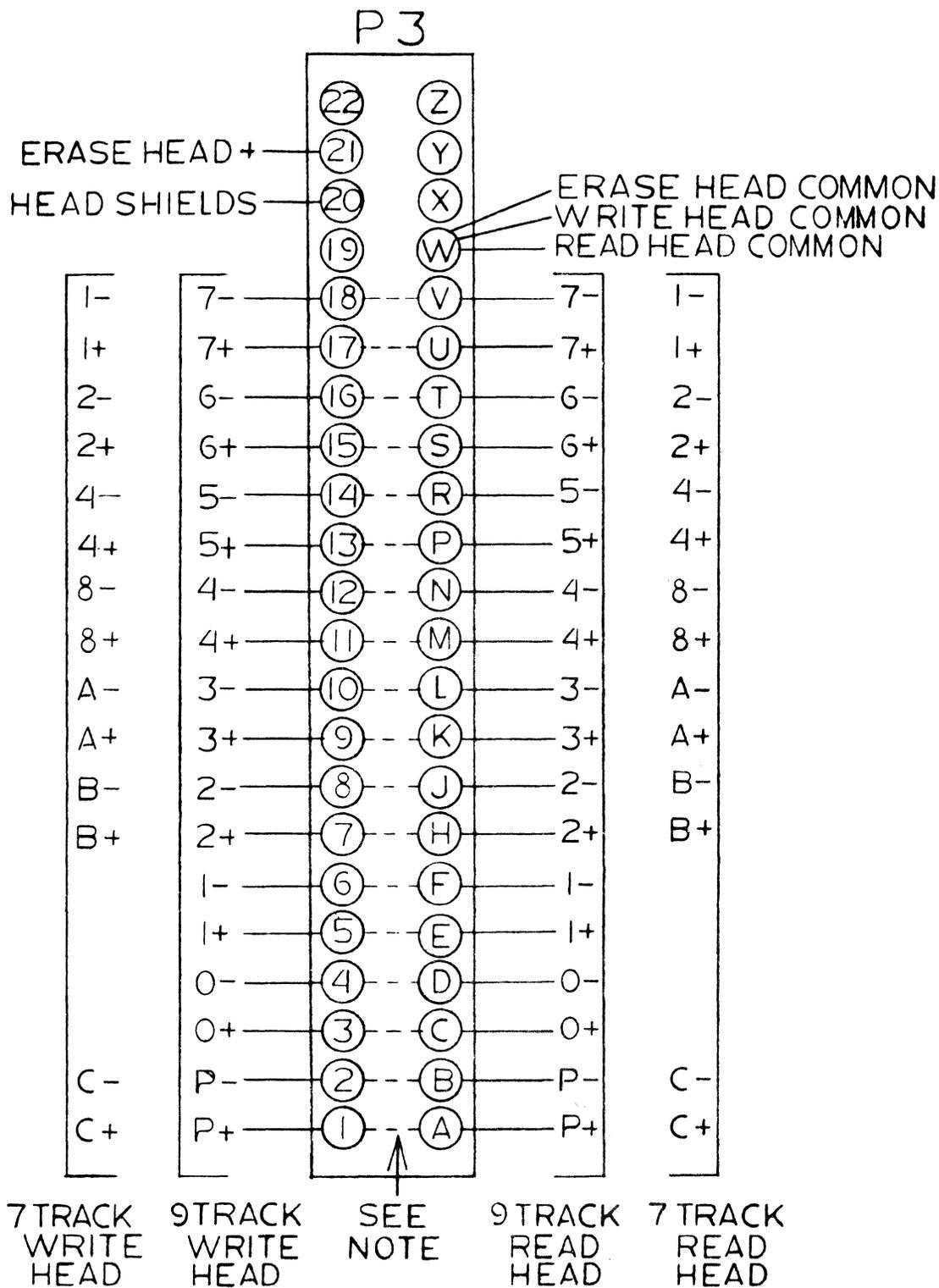
Following head replacement adjust the read amplifier gains (paragraph 6.5.3) and check the read skew following the procedure in paragraph 6.16. If the machine has a flux gate its adjustment should be checked as described in paragraph 6.10.

6.13 Capstan Motor Replacement

The capstan motor is attached to the tape transport by four screws accessible from the front of the machine. The capstan is attached to the motor shaft with a set screw and must be removed before changing the motor. The capstan motor wires unplug from the power board.

When installing the new motor check to insure that the mounting surface and motor are clean to avoid any perpendicularity problems between the capstan and tape. After replacing the motor the capstan adjustments outlined in paragraph 6.4.4 must be performed and the read skew should be checked as described in paragraph 6.16.

NOTE: SINGLE GAP READ/WRITE HEADS ARE WIRED TO PINS A THRU V WITH JUMPERS INSTALLED FROM PIN A TO PIN 1, B TO 2, V TO 18



SHEET OF
DIGI-DATA CORP.
 BLADENSBURG, MD.

FIGURE 6-3 HEAD WIRING DIAGRAM

6.14 Reel Motor Replacement

Each reel hub is attached to the reel motor shaft with a set screw. On model 1600, remove the rubber covering from the take-up hub to expose the take-up hub set screw. After removing the reel hub the four motor mounting screws are accessible from the front of the machine. Unplug and remove the motor. When installing the new motor insure that the mounting surface and motor face are clean. Connect the motor plug and tighten the four mounting screws and replace the reel hub on the motor shaft. Be sure that the hub is oriented so that its set screw is aligned with the flat on the motor shaft.

The height of the hub may be adjusted with a Digi-Data hub height gauge or by loading a reel of tape on the machine and observing the tape as it travels from one end to the other. The tape must not touch the reel or hub flanges on either side at either end.

Following reel motor replacement the arm position centering adjustment should be checked (paragraph 6.4.3).

6.15 BOT/EOT Sensor Replacement

The BOT/EOT sensor assembly contains two phototransistors and the lamp. If any of these components fail the sensor block should be replaced. Disconnect the four wires and remove the sensor assembly by removing the mounting screw from the rear of the panel.

To install the new unit insert the four wires through the hole in the recorder front panel. Position the face of the sensor housing parallel to the tape path and tighten the mounting screw. Connect the four wires as shown in Figure 6-4.

The BOT and EOT sensor adjustments described in paragraph 6.5.2 must be performed after replacement of the sensor block.

6.16 Read Skew Measurement and Adjustment

Skew occurs if the tape is not exactly perpendicular to the head. The skew must be checked and corrected if necessary following replacement of the tape head or tape guides. A master skew tape is read and the tape path adjusted so that all

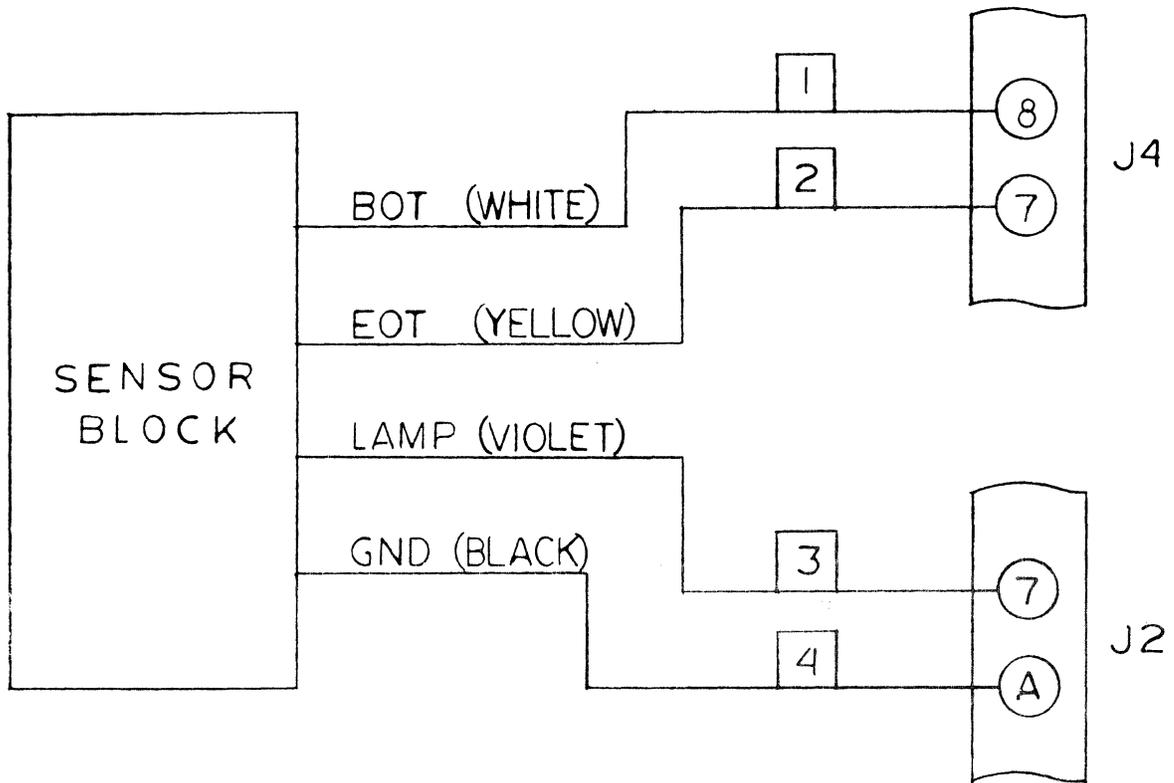


FIGURE 6-4 BOT/EOT SENSOR WIRING DIAGRAM

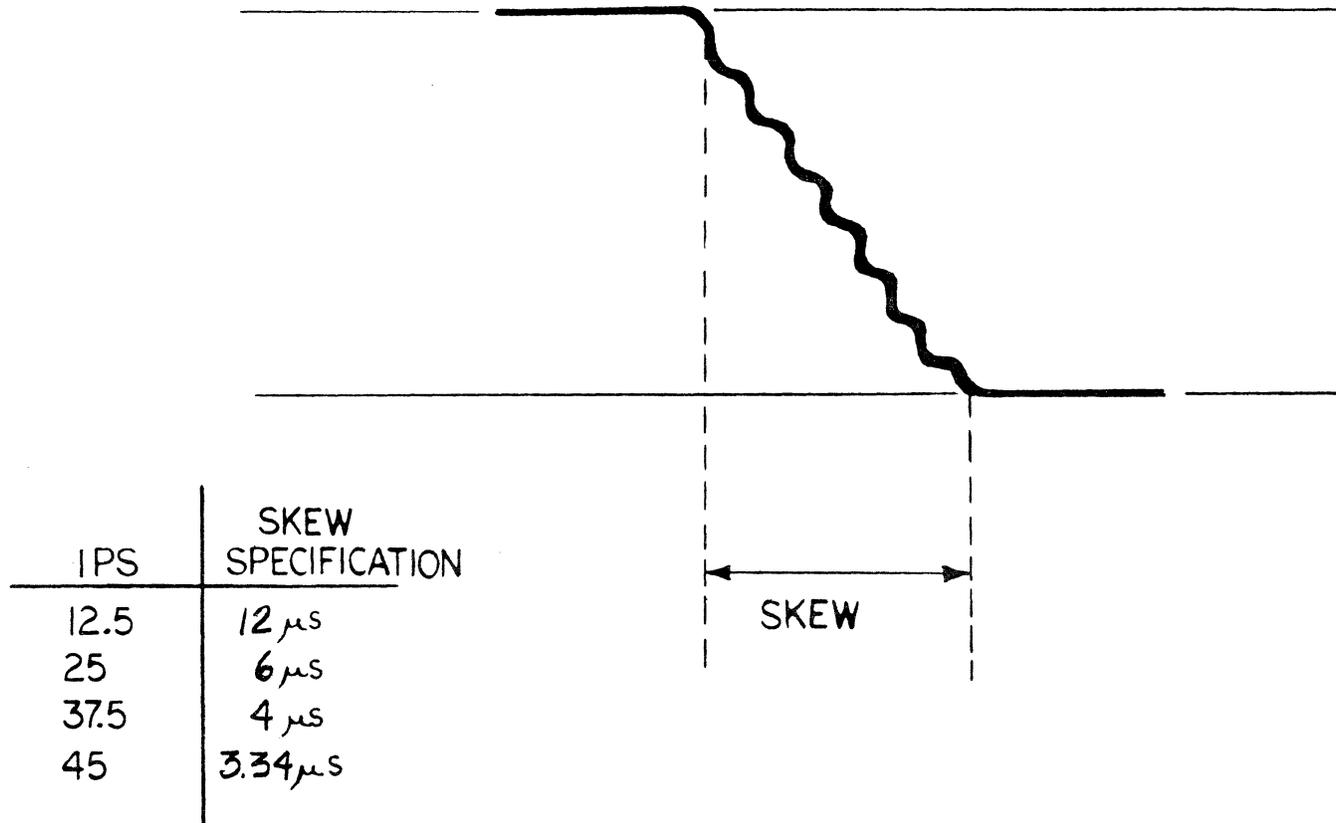


FIGURE 6-5 SKEW MEASUREMENT WAVEFORM

bits of a character will be read simultaneously.

The RC11 card includes a skew test point (STP) which generates a waveform with a fall time corresponding to the transport's skew. A similar testpoint is provided on the TC-12 maintenance card. Figure 6-5 presents the oscilloscope waveform at these test points and lists the specification limits for the standard tape speeds.

Read the master skew tape and measure the skew time between the first and last transitions as shown in Figure 6-5. If the skew time exceeds the specification determine which tape guide needs to be raised by lightly pushing the tape against the spring-loaded flange of each guide. The guide which increases the skew should be raised by installing shims between it and the main plate. A .0005 inch shim will change the skew by approximately 50% of the skew time specification. Shim only one guide. Tighten the tape guide mounting screw and make sure that the skew is now within the specification.

6.17 Arm Position Sensor Adjustment

If replacing the arm position sensor or lamp, see Figure 6-6. Following replacement the sensor must be aligned.

Sensor Alignment

1. The slotted black shutter should be mounted so that the slit appears to move inward as the arm is pulled away from the rest position. If the slit moves outward, reverse the shutter. All washers must be installed as they were.
2. Connect a voltmeter or oscilloscope to:
Supply servo: P1-1 or TP7 on MC17 card
TU servo: P1-11 or TP8 on MC17 card
3. Turn the recorder on and, with the shutter mounting screw loose, rotate the shutter to produce a reading of ± 1.8 volts on the voltmeter.
4. Lightly tighten the shutter mounting screw.
5. The operation of the sensor assembly may be checked by moving the tension arm through approximately a 60 degree arc while observing the voltmeter. The voltage should rise smoothly to approximately 4 volts.

6. Tighten the shutter mounting screw, making sure that the voltmeter reading is between +1.7 and +2.0 volts after tightening. The screw should then be secured with a daub of glyptal or epoxy.
7. The two microswitch actuators on the supply arm shutter should be positioned so that the microswitch is actuated just before the arm hits the mechanical stop. If the cams require re-adjustment loosen them with an allen wrench, slide them to the appropriate position and then tighten the screw.
8. Adjust the arm position per as described in paragraph 6.4.2.

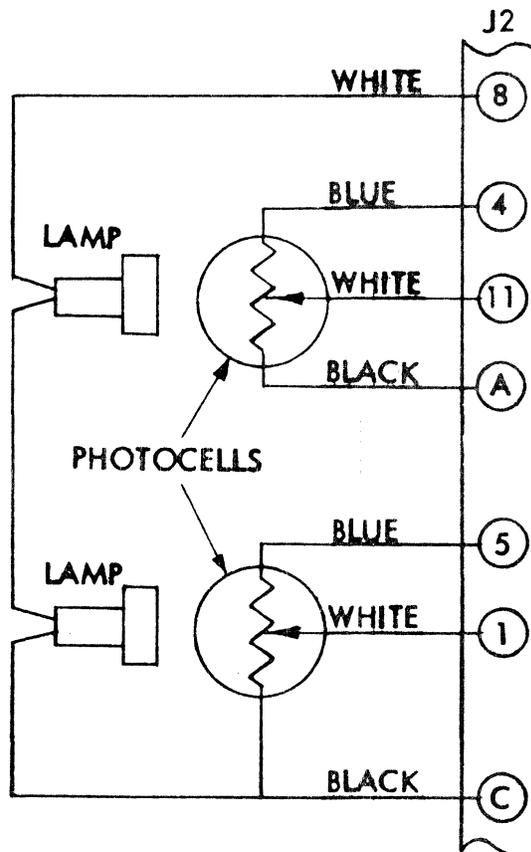
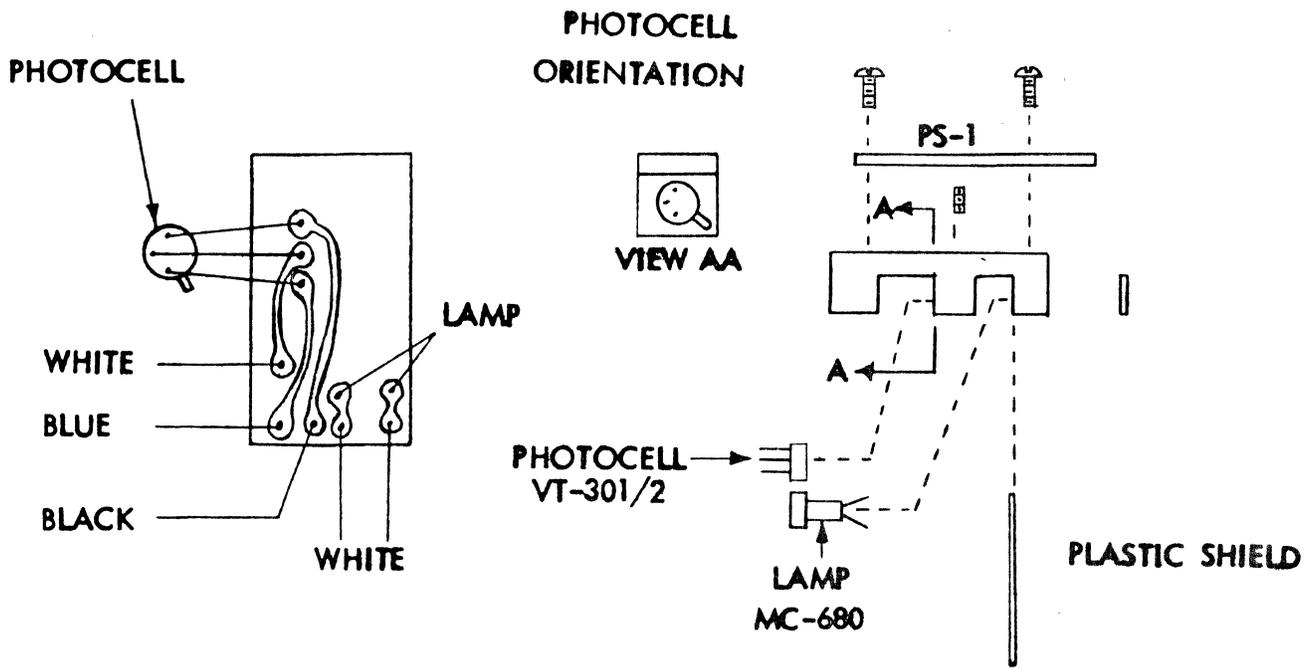
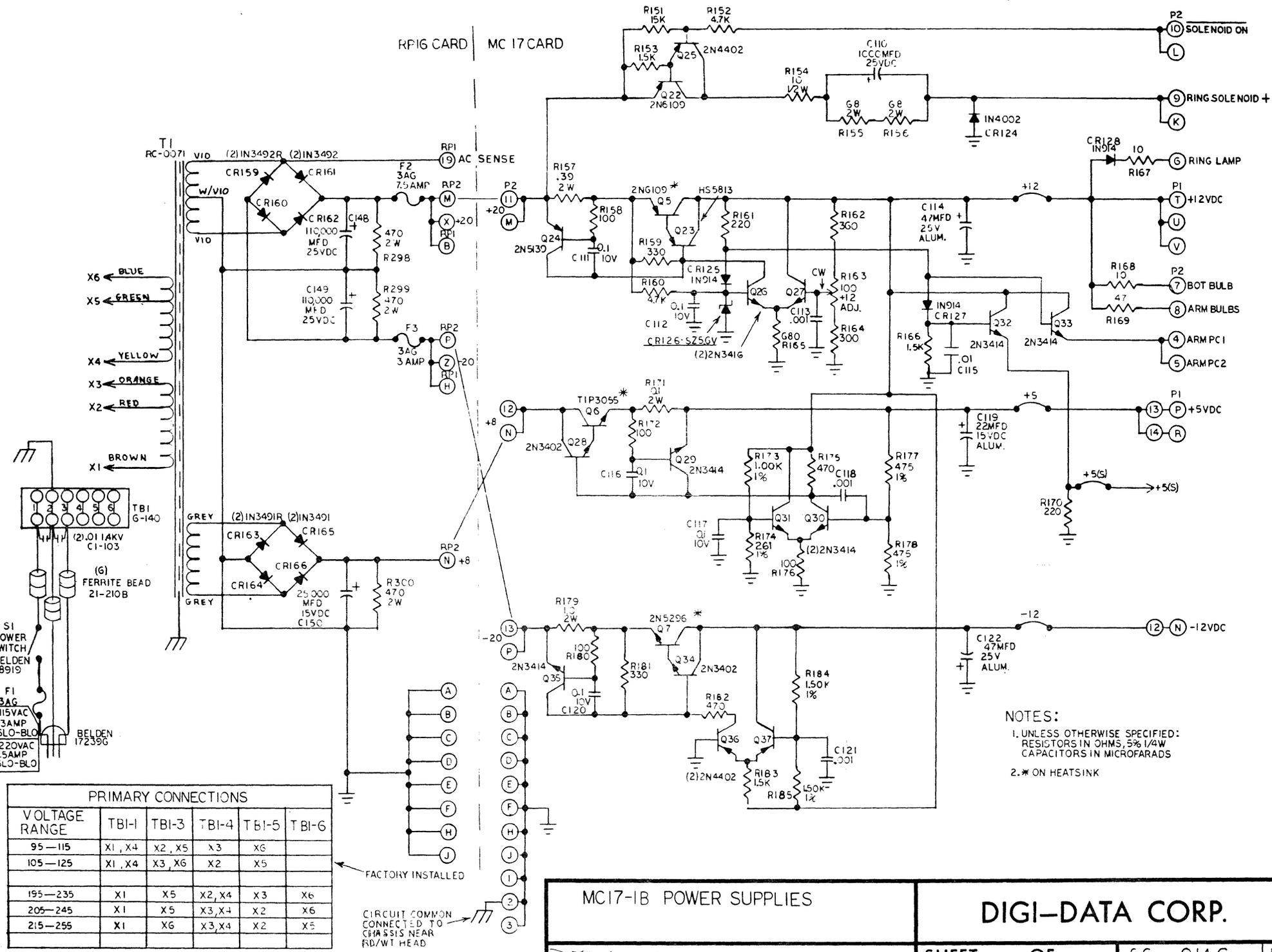


FIGURE 6-6 ARM SENSOR ASSEMBLY WIRING

SECTION VII
DRAWINGS (NRZI)

		<u>DWG. NO.</u>
1.	Schematic, MC17 Power Supplies	SC-0146
2.	Schematic, MC17 Capstan Servo	SC-0147
3.	Schematic, MC17 Reel Servo	SC-0159
4.	Schematic, Relay Control	LD-0011
5.	Assembly, MC17 Card	CD-0035
6.	Version Table MC17 Card	CA-0044
7.	Assembly RP16 Card	CD-0036
8.	Schematic RC11 Control Logic	LD-0002
9.	Schematic RC11 Write Circuitry	SC-0153
10.	Schematic, RC11 Read Circuitry	SC-0154
11.	Assembly RC11 Card	CD-0037
12.	Version Table RC11 Card	CA-0026
13.	Plug Location Diagram 1600:	RA-0068
14.	1700:	RA-0069
15.	Card Location Diagram 1600:	RA-0067
16.	1700:	RA-0070
17.	Transport Outline 1600:	RA-0071
18.	1700:	RA-0072
19.	Schematic IC-12 Interface Connector	SA-0031
20.	Assembly IC-12 Card	CB-0095
21.	Daisychain Interface Connector CX12	LB-0038
22.	120/220 Volt Connections	RA-0094
23.	Installation 1700 Recorder	RC-0073

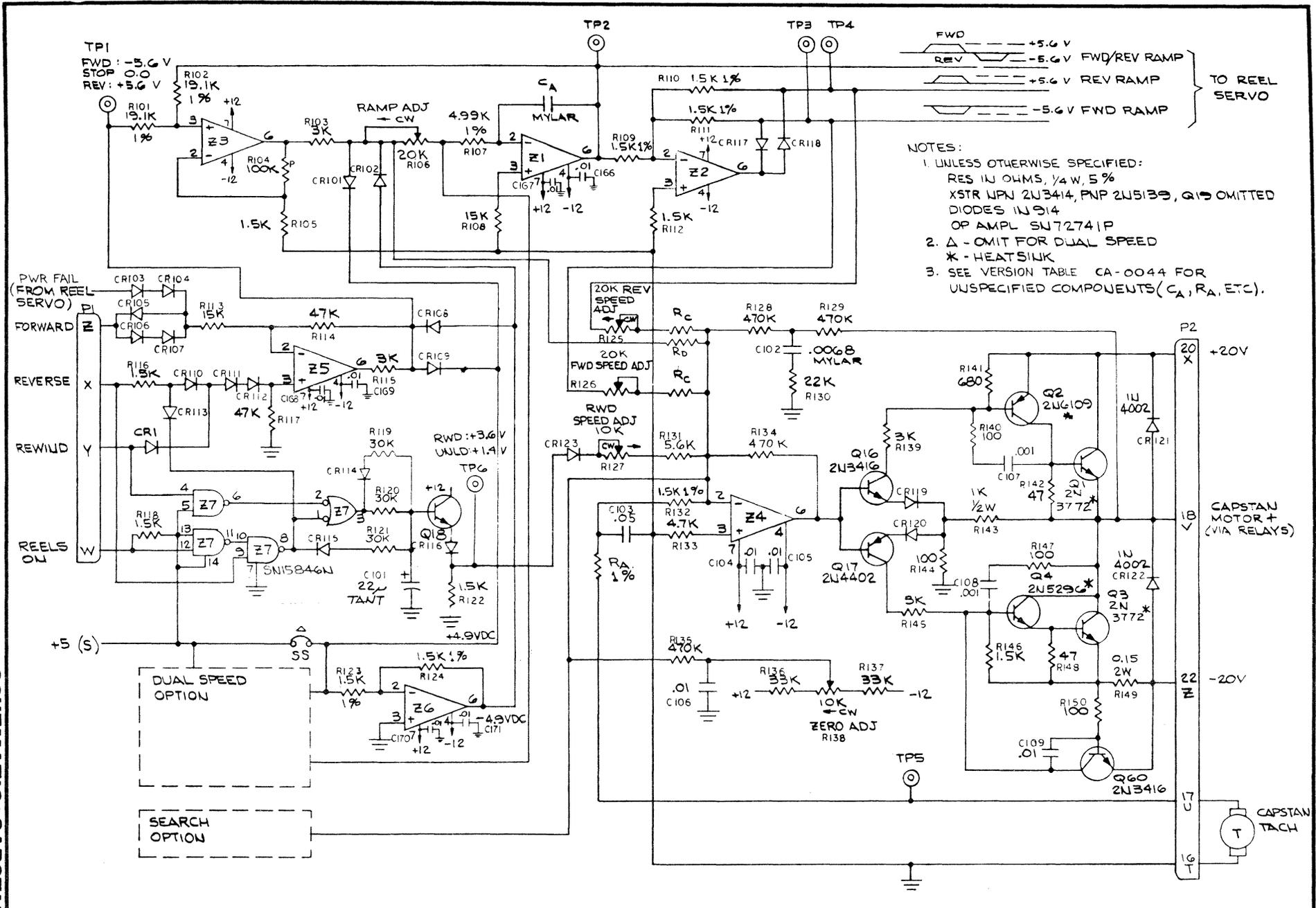
RF16 CARD MC 17 CARD



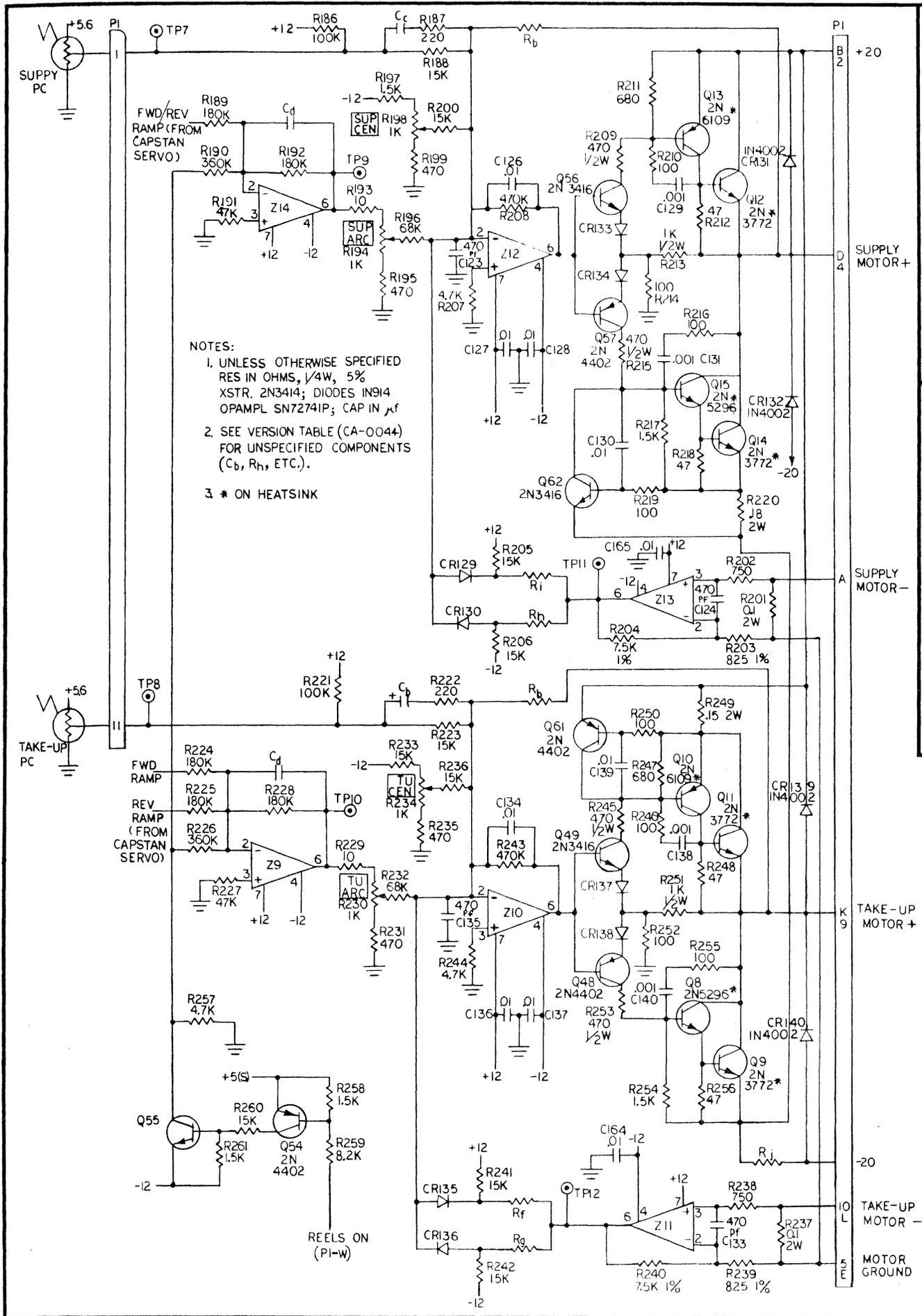
PRIMARY CONNECTIONS					
VOLTAGE RANGE	TBI-1	TBI-3	TBI-4	TBI-5	TBI-6
95-115	X1, X4	X2, X5	X3	X6	
105-125	X1, X4	X3, X6	X2	X5	
195-235	X1	X5	X2, X4	X3	X6
205-245	X1	X5	X3, X4	X2	X6
215-255	X1	X6	X3, X4	X2	X5

CIRCUIT COMMON CONNECTED TO CHASSIS NEAR RD/WT HEAD

- NOTES:
1. UNLESS OTHERWISE SPECIFIED: RESISTORS IN OHMS, 5% 1/4W CAPACITORS IN MICROFARADS
 2. * ON HEATSINK



022-ELLIOTT, INC., PHOENIX, PA. REORDER 10-20197A



NOTES:

1. UNLESS OTHERWISE SPECIFIED RES IN OHMS, 1/4W, 5% XSTR. 2N3414; DIODES IN914 OPAMPL SN7274IP; CAP IN μ f
2. SEE VERSION TABLE (CA-0044) FOR UNSPECIFIED COMPONENTS (Cb, R_h, ETC.).
3. * ON HEATSINK

SCHEMATIC: REEL SERVO AMPS

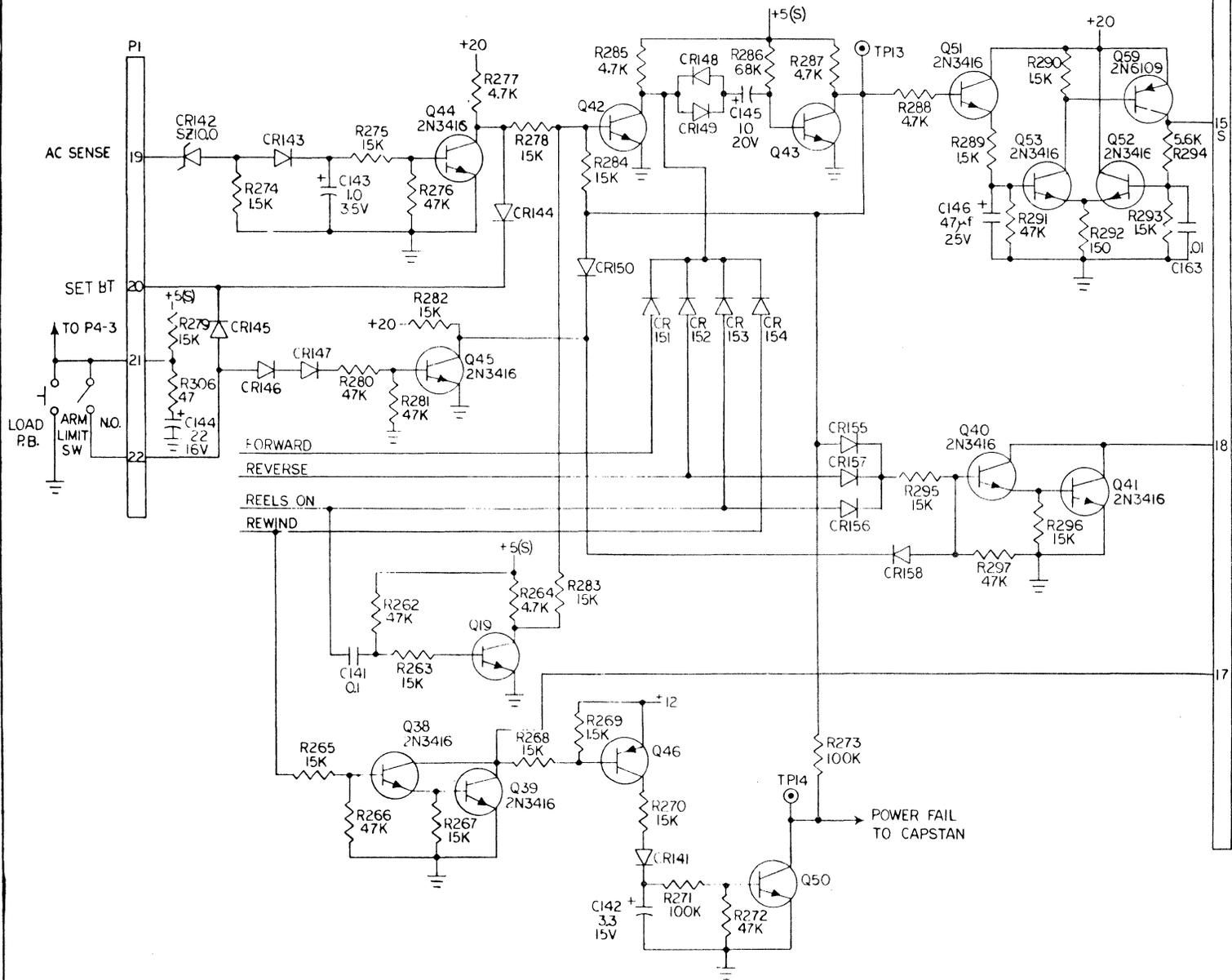
GCE ELECTRONIC INC. P.O. BOX 100 BOSTON 19 MASS.

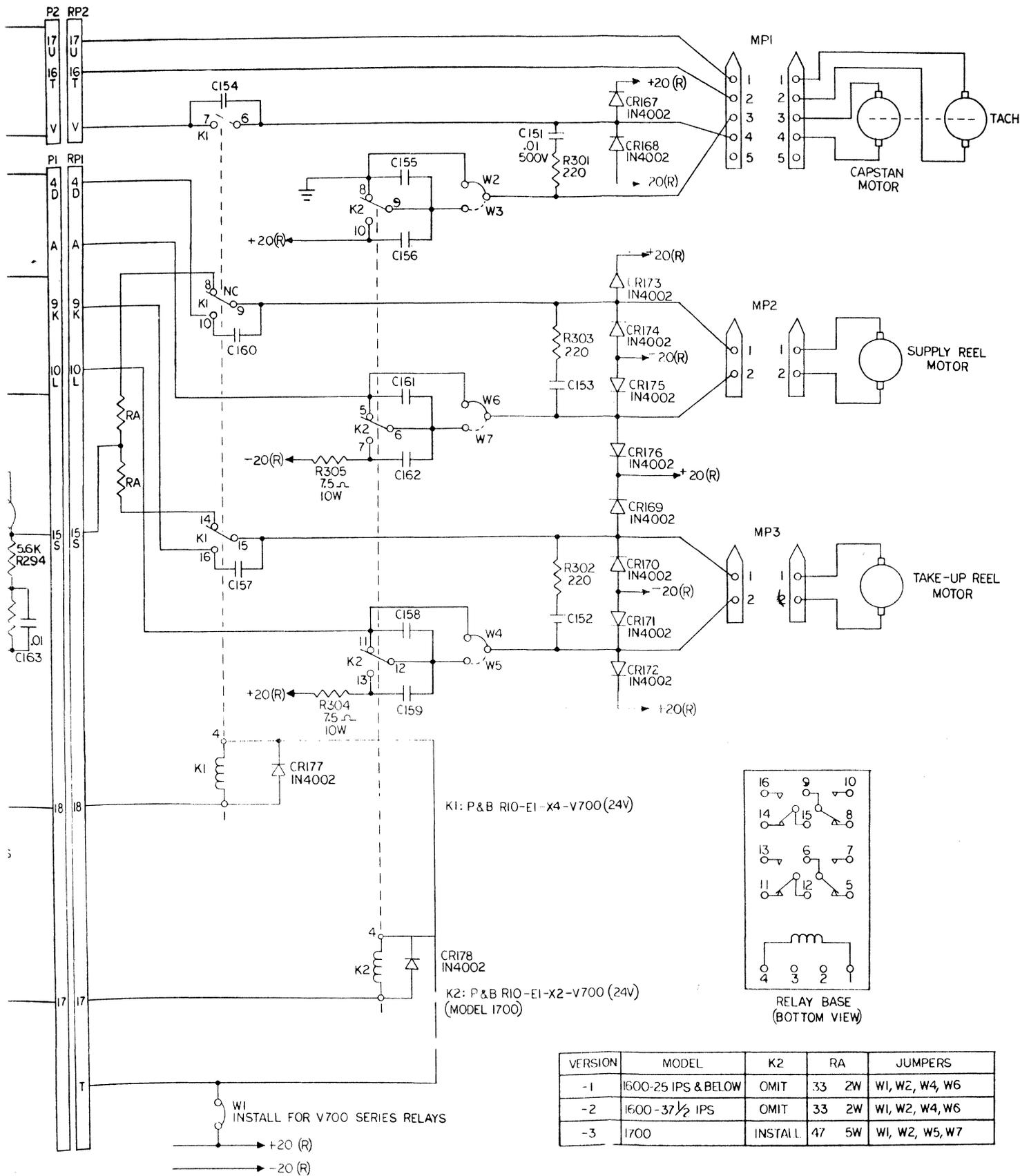
NOTES:

1. UNLESS OTHERWISE SPECIFIED
RES IN OHMS, 1/4 W, 5% XSTR. 2N3414;
DIODES IN914;
CAPS IN μ f

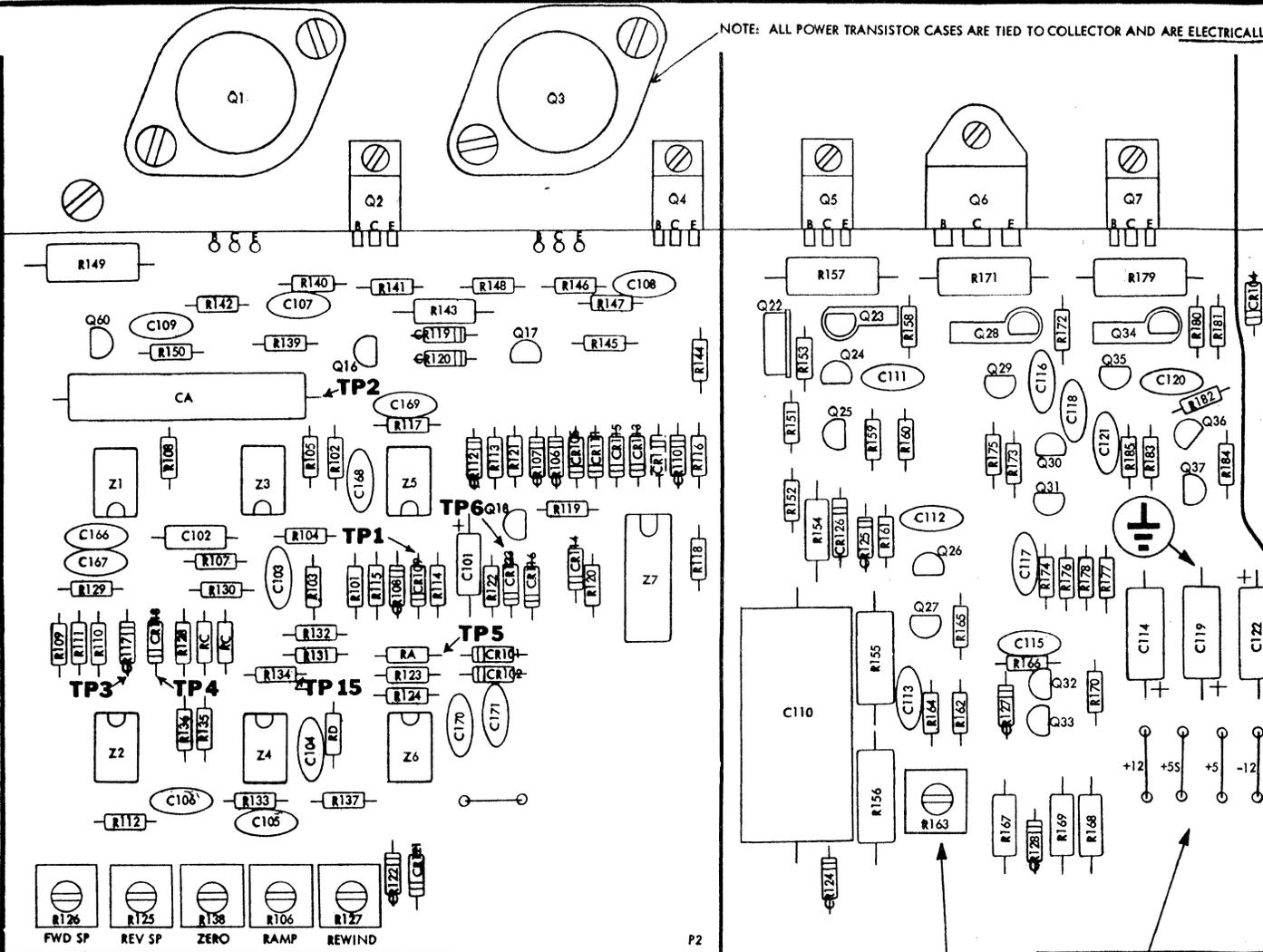
2. CAPS C151 THROUGH C162 ARE 0.1 μ f 500V

CAPSTAN SERVO SEE SC-0147	P2 17 U 16 T V
SUPPLY MOTOR SERVO SEE SC-0159	PI 4 D A
TAKE-UP MOTOR SERVO SEE SC-0159	9 K 10 L





NOTE: ALL POWER TRANSISTOR CASES ARE TIED TO COLLECTOR AND ARE ELECTRICAL



FWD SP REV SP ZERO RAMP REWIND

- REWIND SPEED ADJUSTMENT
- CAPSTAN RAMP ADJUSTMENT
- CAPSTAN SERVO ZERO ADJUSTMENT
- REVERSE SPEED ADJUSTMENT
- FORWARD SPEED ADJUSTMENT

- TP1 - RAMP GENERATOR INPUT
- TP2 - RAMP GENERATOR OUTPUT
- TP3 - FORWARD RAMP
- TP4 - REVERSE RAMP
- TP5 - TACHOMETER
- TP6 - REWIND RAMP
- TP15 - CAPSTAN ZERO

CAPSTAN SERVO

POWER SUPPLIES

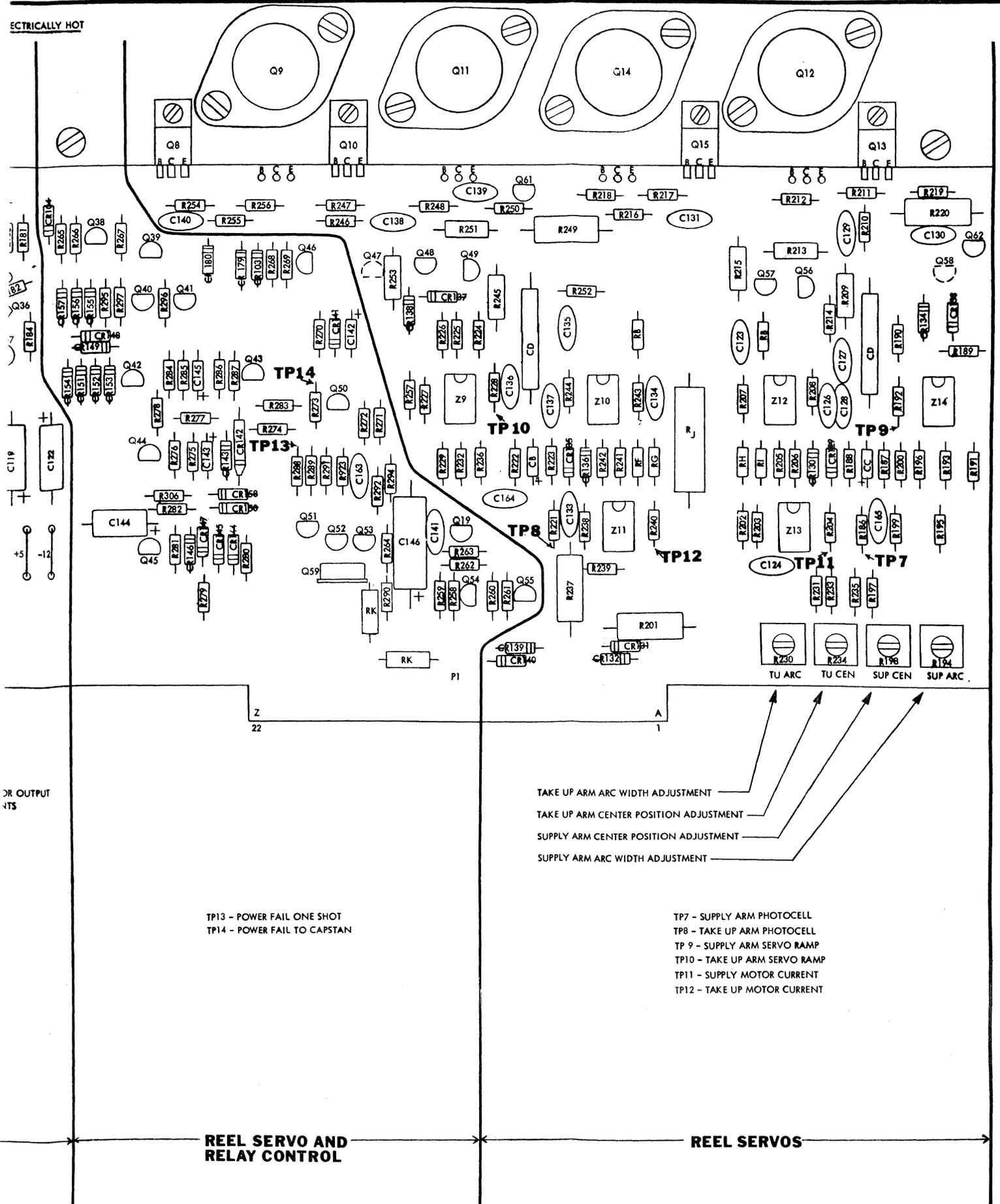
REF. DESIG	DELETED
LAST USED	C147
R306	Q47
C163	Q58
CR 160	
Q62	
Z14	

+12V ADJUSTMENT

REGULATOR OUTPUT TEST POINTS

+12 +5 +5 -12

ELECTRICALLY HOT



TP13 - POWER FAIL ONE SHOT
 TP14 - POWER FAIL TO CAPSTAN

TP7 - SUPPLY ARM PHOTOCCELL
 TP8 - TAKE UP ARM PHOTOCCELL
 TP9 - SUPPLY ARM SERVO RAMP
 TP10 - TAKE UP ARM SERVO RAMP
 TP11 - SUPPLY MOTOR CURRENT
 TP12 - TAKE UP MOTOR CURRENT

REEL SERVO AND RELAY CONTROL

REEL SERVOS

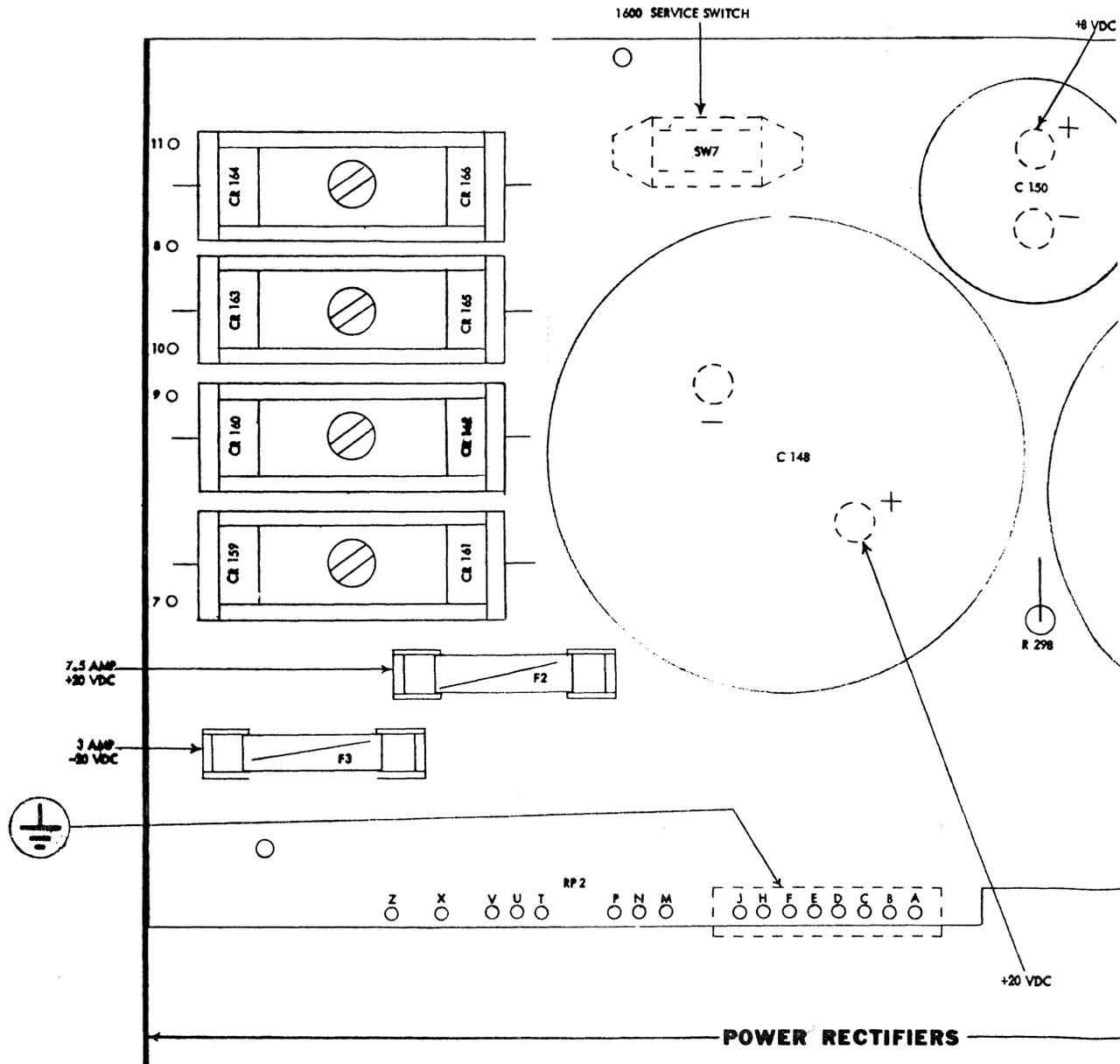
MODEL 1600

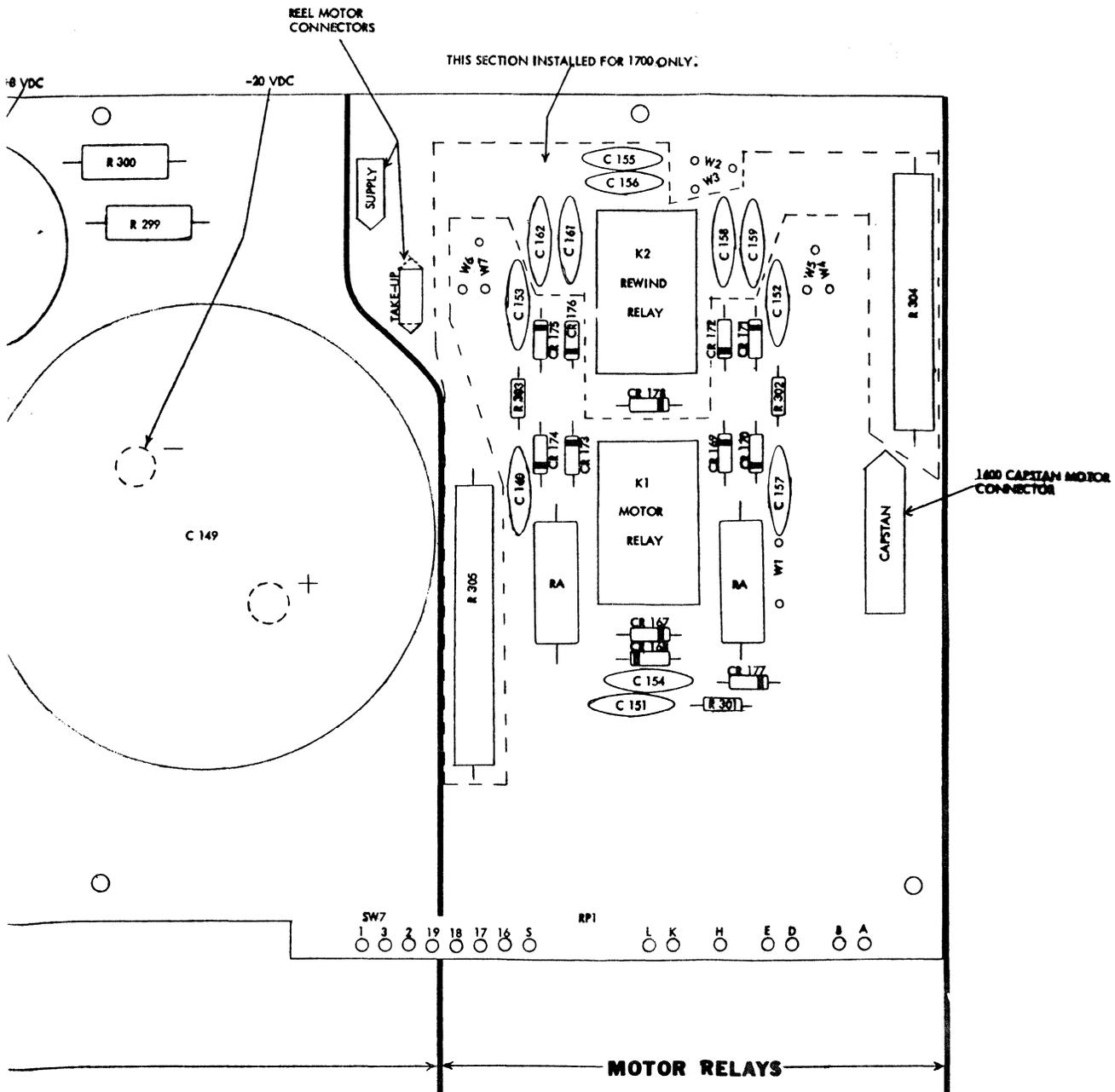
MODEL 1700

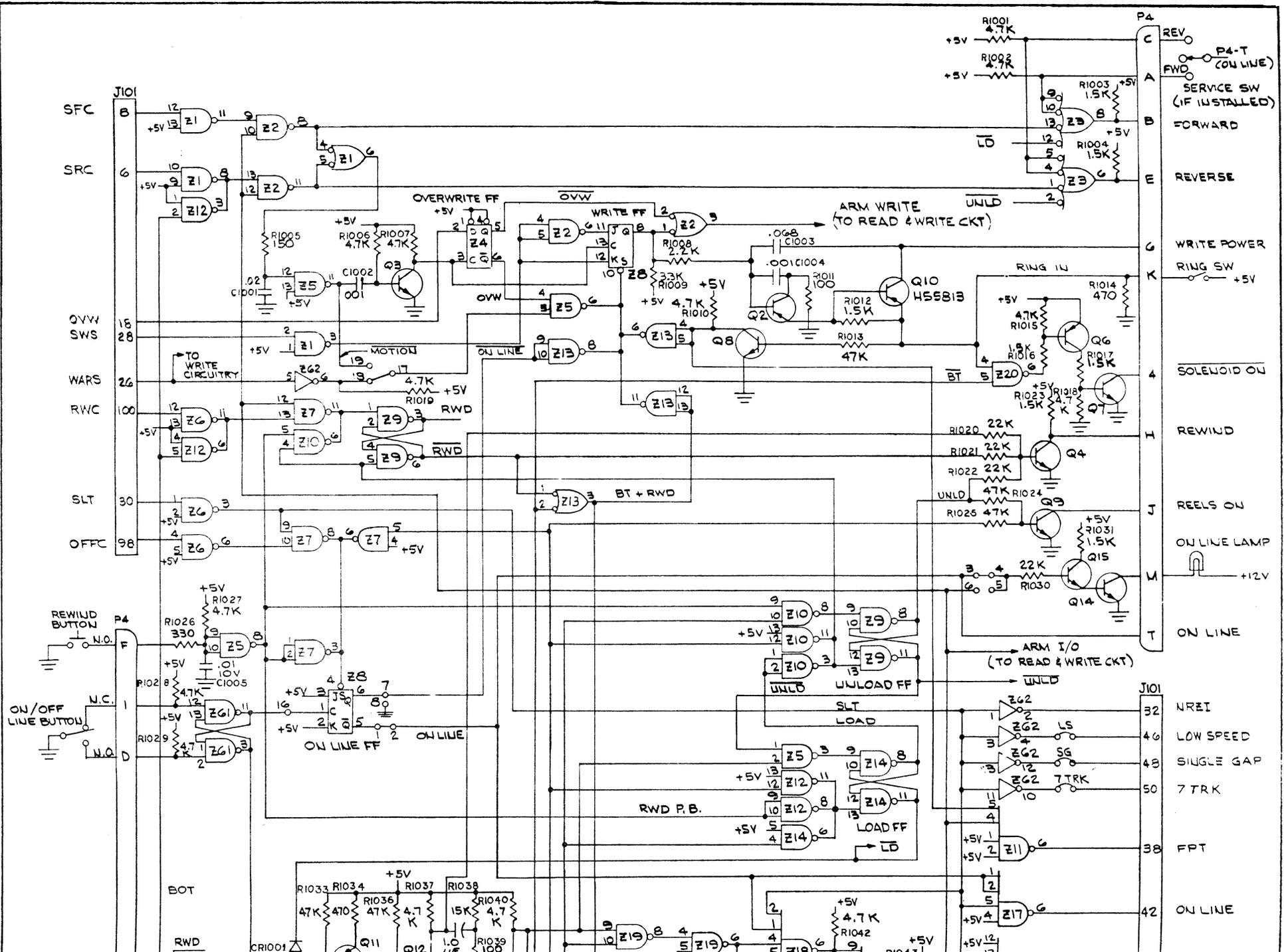
SPEED	12.5	18.75	25	37.5	12.5	18.75	25	37.5	45
RA			10K 1%	14.7K 1%			10K 1%	7.5K 1%	10K 1%
RB			470K	470K			750K	750K	750K
RC			47.5K 1%	47.5K 1%			47.5K 1%	47.5K 1%	47.5K 1%
RD			1 MEG	1 MEG			1 MEG	1 MEG	1 MEG
RE									
RF			1.5K	1.5K			1.5K	1.5K	1.5K
RG			3.3K	3.3K			4.7K	4.7K	4.7K
RH			3.3K	1.8K			3.3K	3.3K	3.3K
RI			2.2K	1.5K			2.2K	2.2K	2.2K
RJ	-----5.1	Ω 5W	PW5	-----	-----6	Ω 10W	PW10	-----	-----
RK	33 Ω	33 Ω	33 Ω	33 Ω			47 Ω	47 Ω	47 Ω
CA			1.0 uf	1.0 uf			1.0 uf	1.0 uf	1.0 uf
CB			4.7 uf	6.8 uf			4.7 uf	4.7 uf	4.7 uf
CC			6.8 uf	3.3 uf			4.7 uf	4.7 uf	4.7 uf
CD			.27 uf	.27 uf			.68 uf	.27 uf	.27 uf
CR 1			OMIT	OMIT			1N914	1N914	1N914

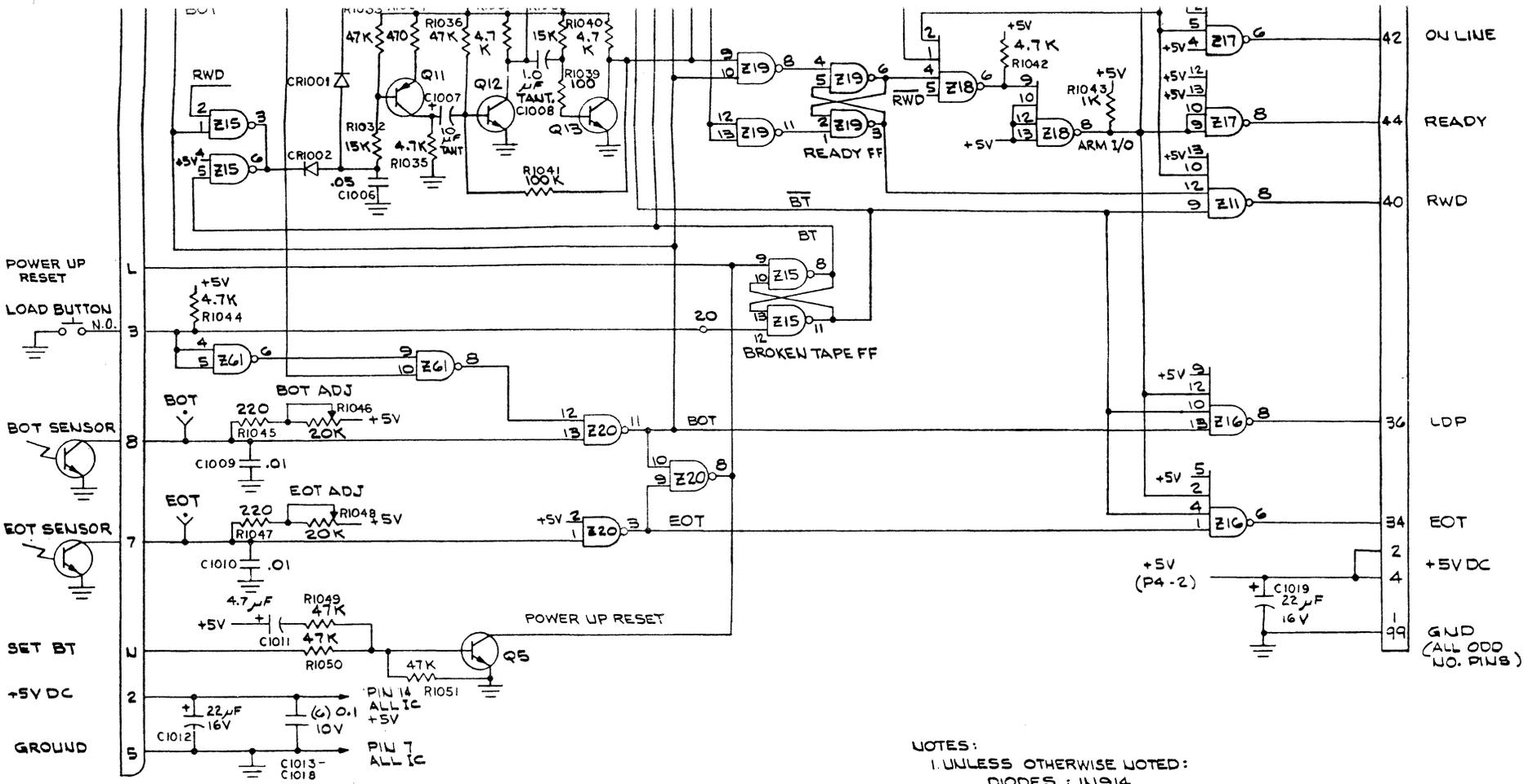
MYLAR 10%
TANT.
TANT.
TANT.

UNLESS SPECIFIED RESISTORS
ARE 1/4W 5%

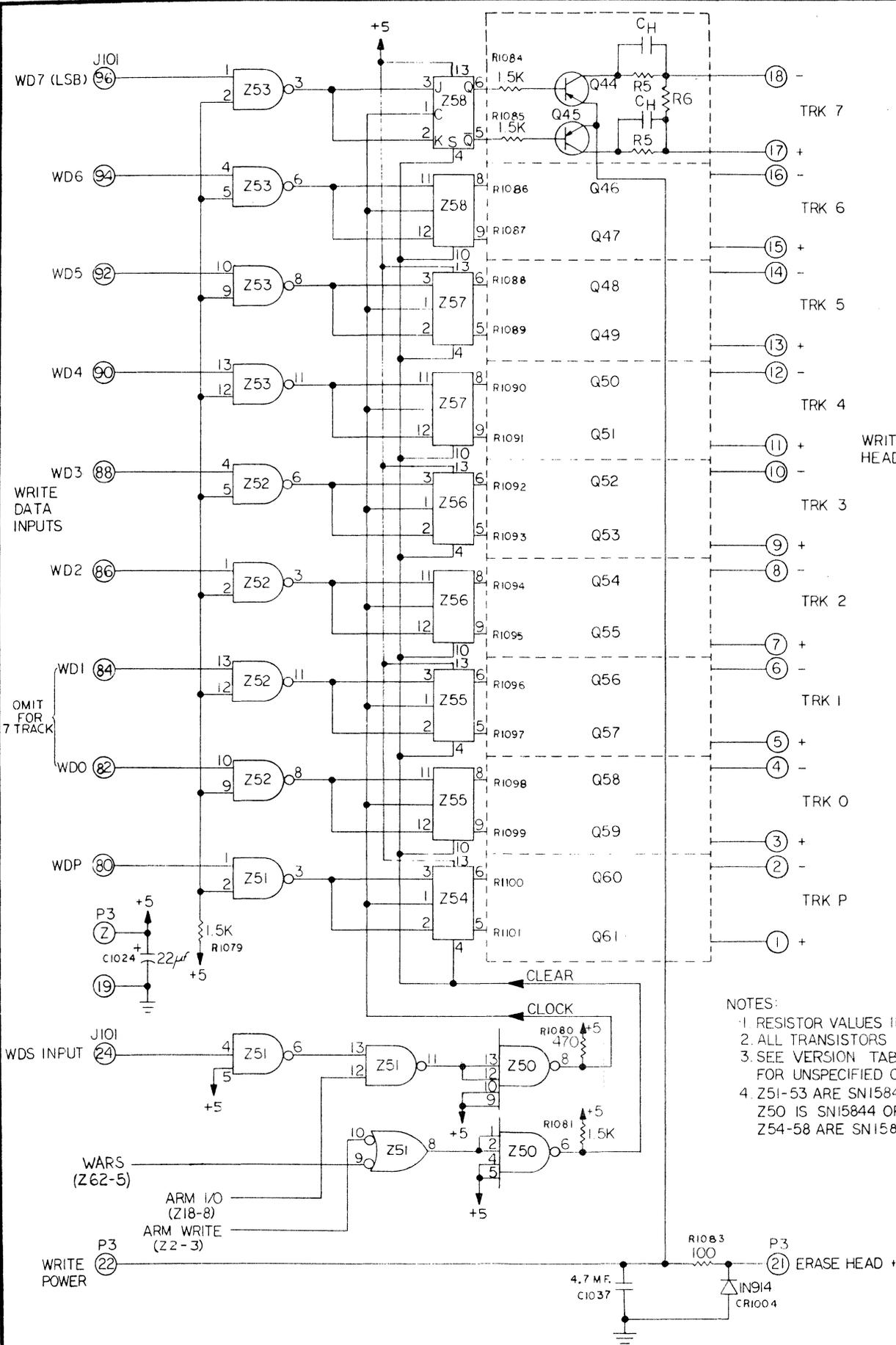






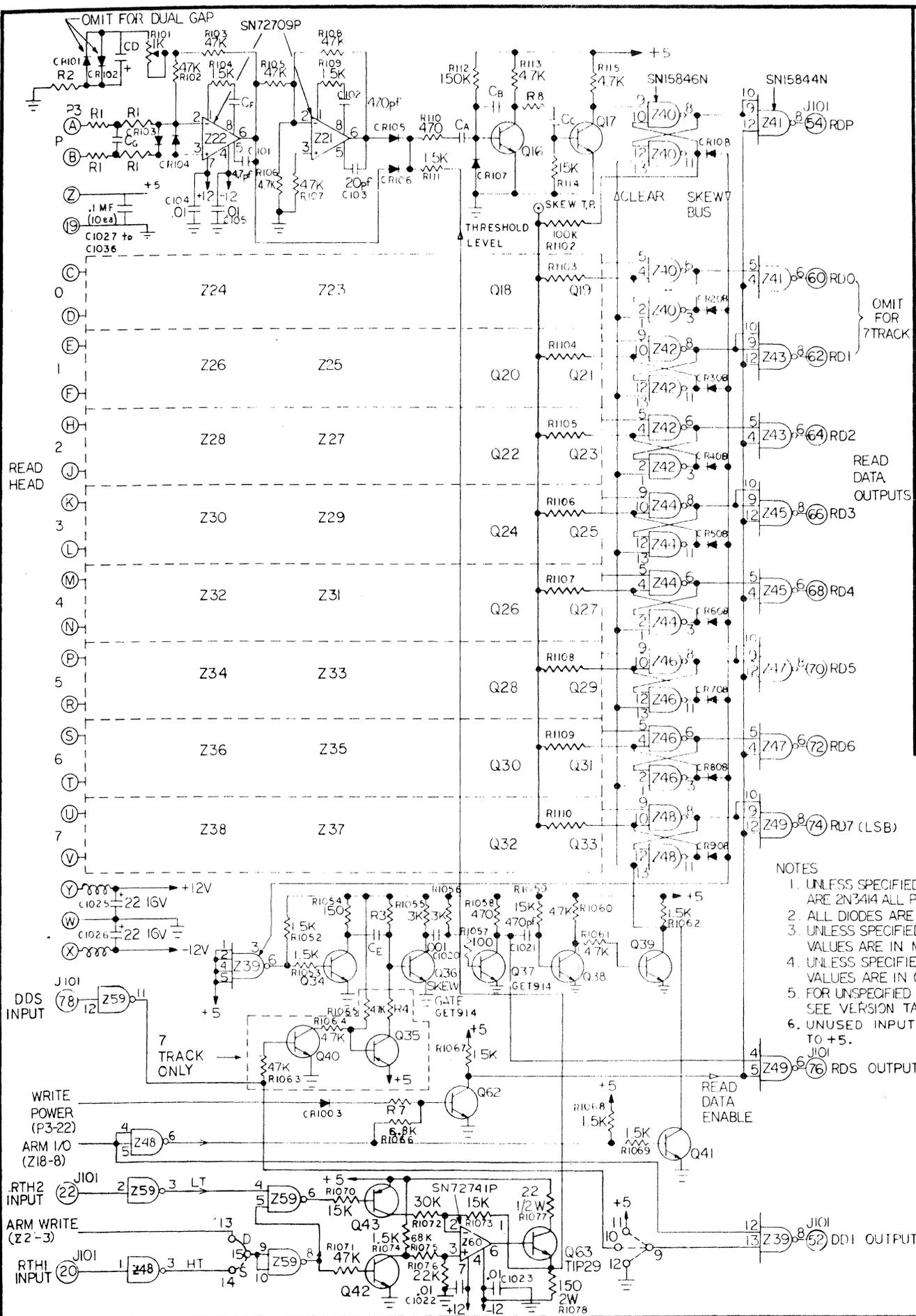


- NOTES:
1. UNLESS OTHERWISE NOTED:
DIODES : 1N914
XSTR LPM : 2U3414
XSTR PNP : 2N5139
2-INPUT GATES : SN7414N
4-INPUT GATES : SN7414N
Z4 : SN7474N
Z8 : SN7474N
Z22 : SN7406N



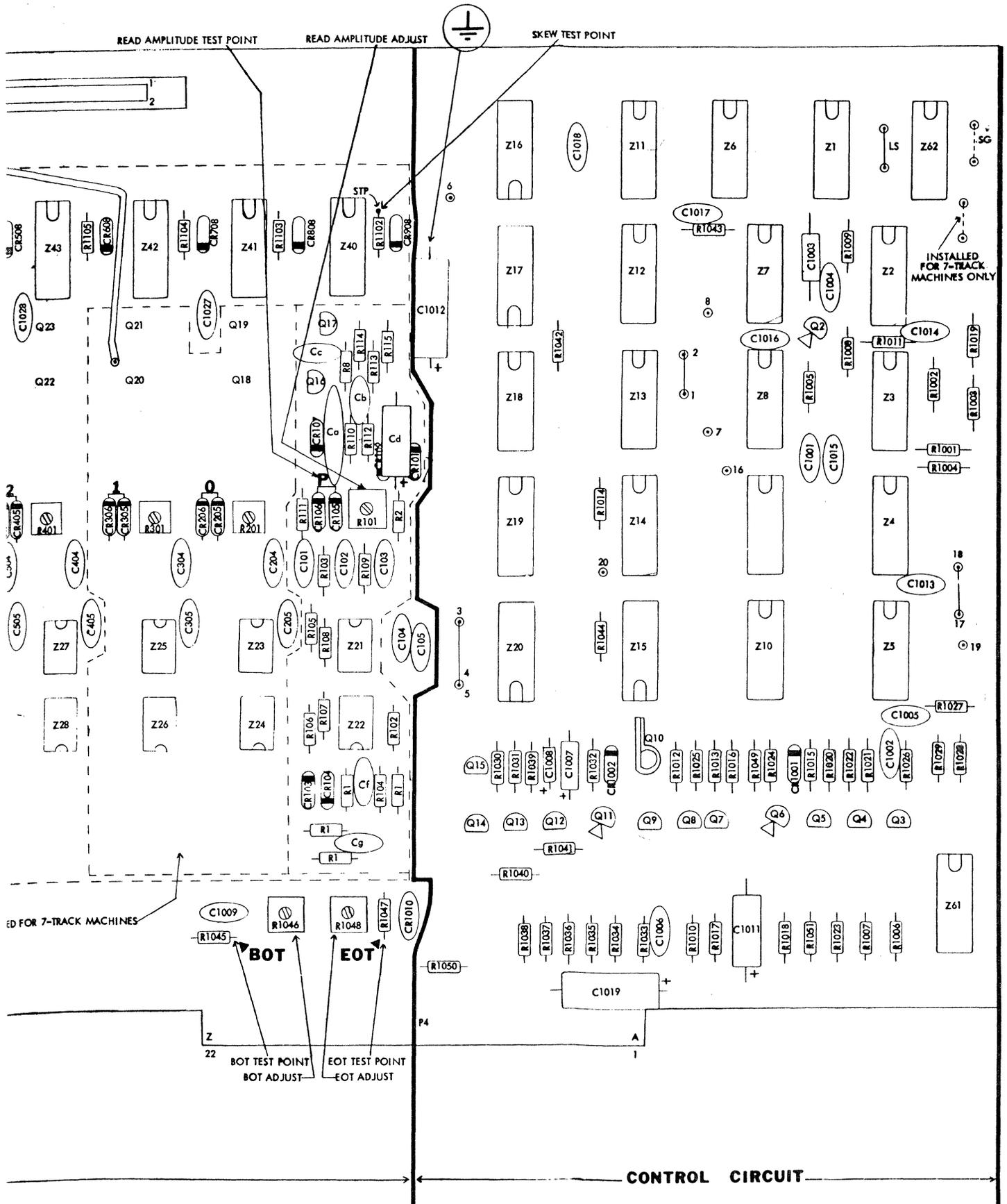
- NOTES:
1. RESISTOR VALUES IN OHMS.
 2. ALL TRANSISTORS 2N5139.
 3. SEE VERSION TABLE CA-C026 FOR UNSPECIFIED COMPONENTS.
 4. Z51-53 ARE SN15846 OR EQUIV. Z50 IS SN15844 OR EQUIV. Z54-58 ARE SN158099 OR EQUIV.

SCHEMATIC: WRITE CIRCUITS



SCHEMATIC:READ CIRCUITS

F. E. MULLER CO., INC., PH. 74, BOSTON, MASS.

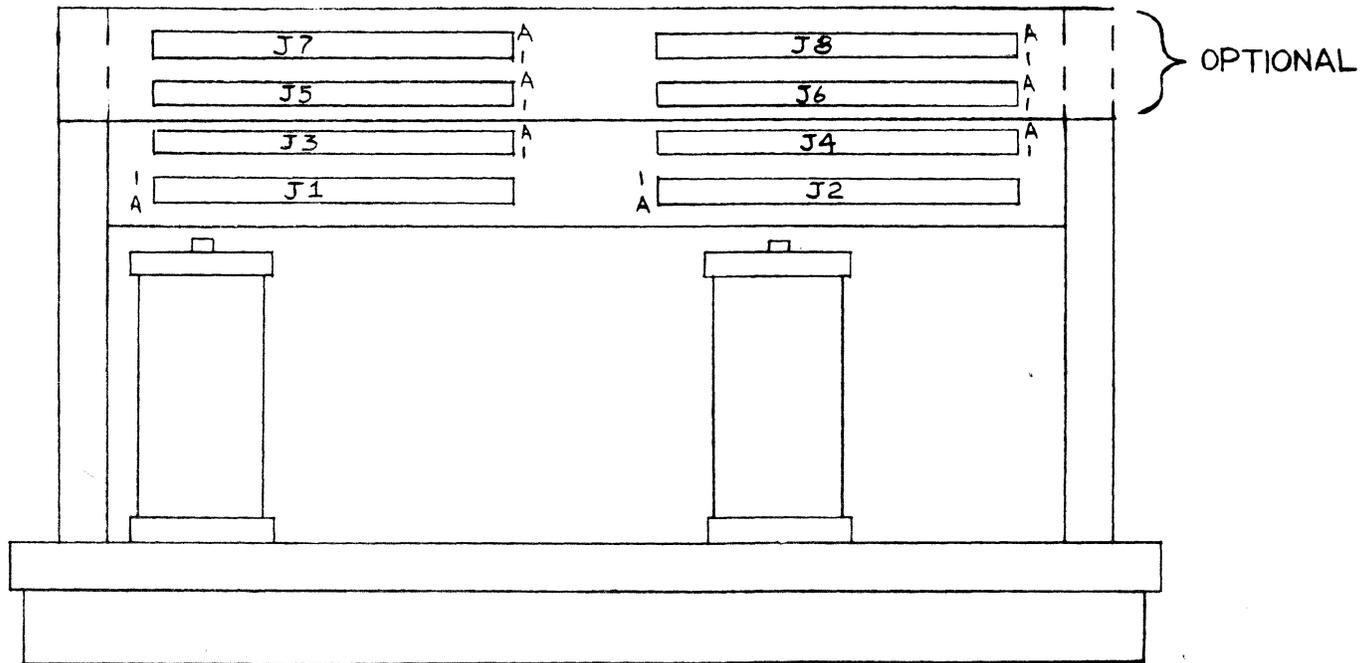


9 TRACK

VERSION	12.5 S	12.5 D	18S	18D	25S	25D	37.5S	37.5D	45S	45D
CA MYLAR	.01	.01			.0047	.0047	.001	.001	.001	.001
CB	.001	.001			470 pF	470 pF	20 pF	20 pF	20 pF	20 pF
CC	470 pF	470 pF			220 pF	220 pF	100 pF	100 pF	100 pF	100 pF
CD	1.0	1.0			0.47	1.0	0.47	1.0	0.47	1.0
CE MYLAR	.0068	.0068			.0033	.0033	.0015	.0015	.001	.001
CF	100 pF	100 pF			100 pF					
CG	.001	.001			.001	.001	.001	.001	.001	.001
CH	—	—			—	—	—	—	—	—
R1	750	750			1.5K	1.5K	750Ω	2.2K	1.0K	2.2K
R2	470	470			470	470	470	470	470	470
R3 1%	10.7K	10.7K			10.7K	10.7K	16.5K	16.5K	17.4K	17.4K
R4	—	—			—	—	—	—	—	—
R5	390	100			300	100	150	100	150	100
R6	1.5K	100			4.7K	1.5K	4.7K	4.7K	4.7K	4.7K
R7	1.5K	—			1.5K	—	1.5K	—	1.5K	—
R8	4.7K	4.7K			4.7K	4.7K	4.7K	4.7K	4.7K	4.7K

7 TRACK: AS ABOVE EXCEPT:

R3 1%	15.4K	15.4K			15.4K	15.4K	23.7K	23.7K	25.5K	25.5K
R4 1%	33.2K	33.2K			33.2K	33.2K	52.3K	52.3K	56.2K	56.2K

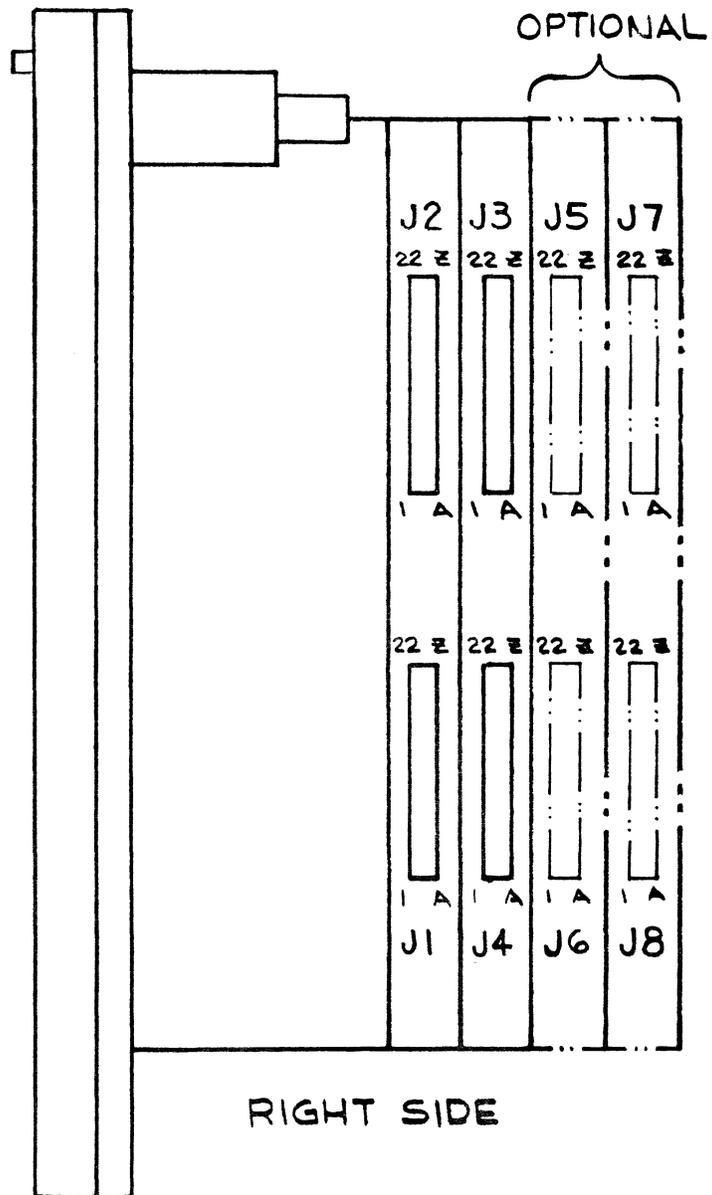


BOTTOM VIEW

PLUG LOCATION DIAGRAM
1600 RECORDER

DIGI-DATA CORPORATION

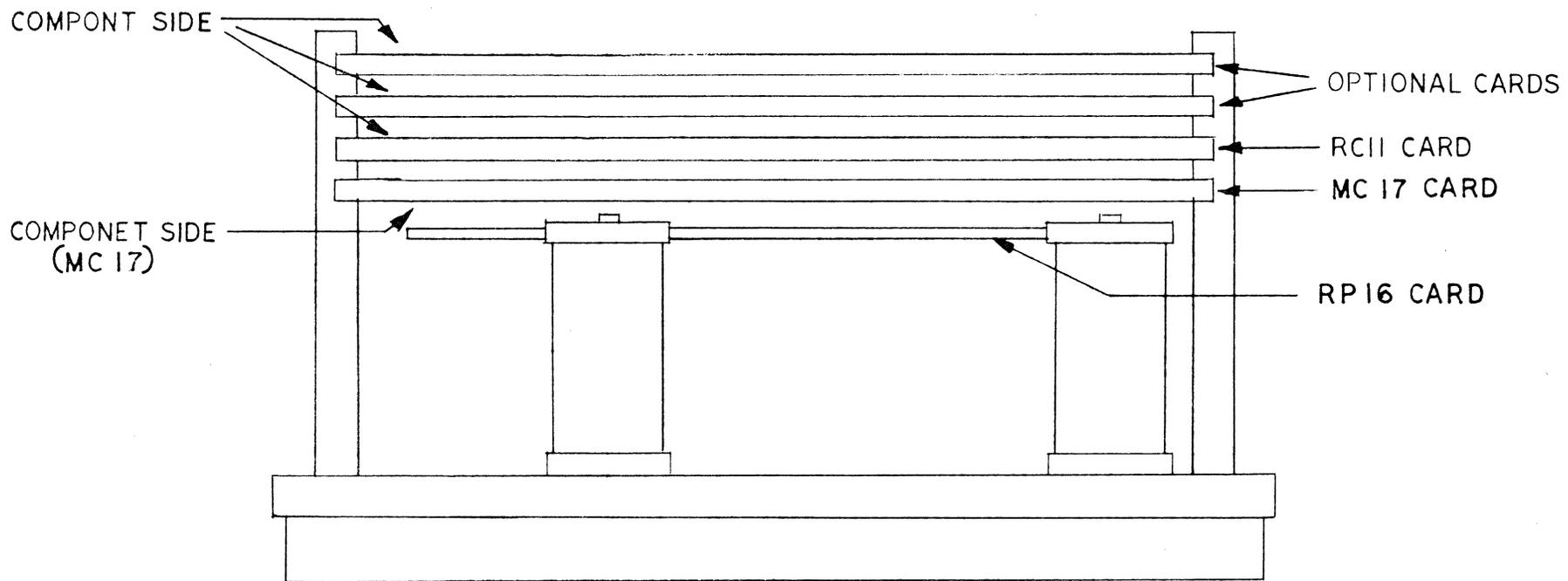
SHEET 1 OF 1 RA-0068



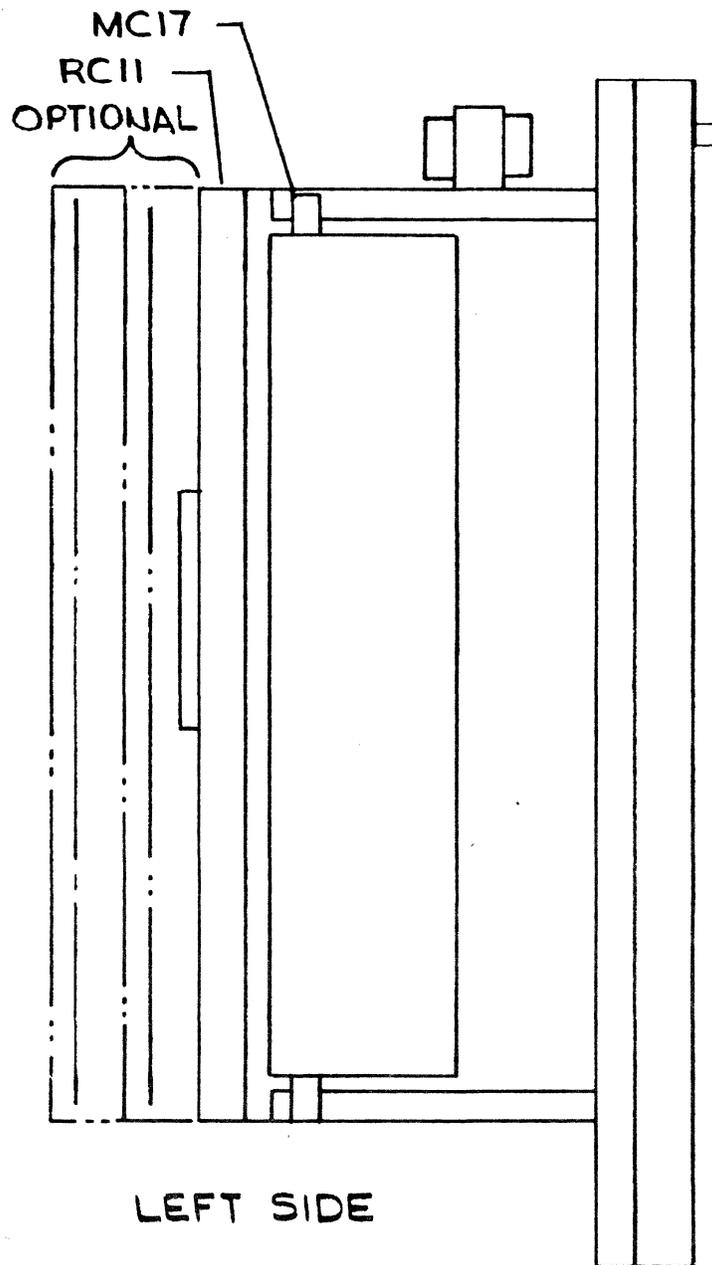
PLUG LOCATION DIAGRAM
MODEL 1700

DIGI-DATA CORPORATION

SHEET 1 OF 1 RA-0069



TOP VIEW



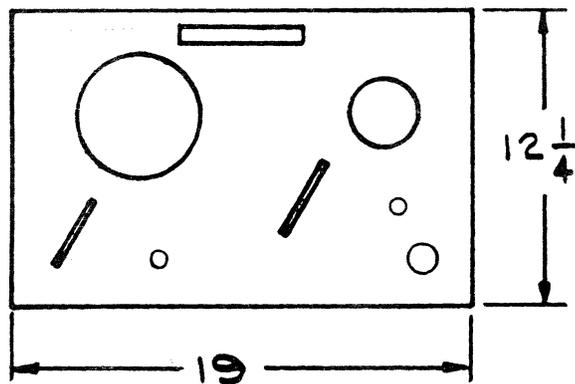
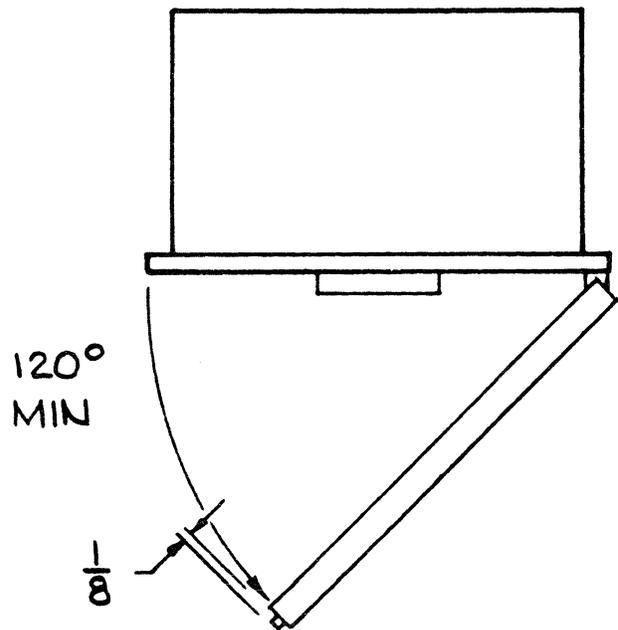
COMPONENT
SIDE TO
REAR OF
MACHINE
FOR ALL
CARDS

LEFT SIDE

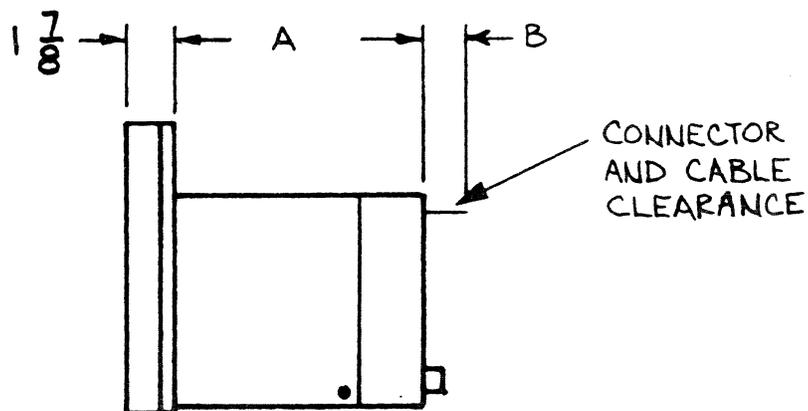
CARD LOCATION DIAGRAM
MODEL 1700

DIGI-DATA CORPORATION

SHEET 1 OF 1 RA-0070



DEPTH DIMENSIONS			
CONFIGURATION	A	B	TOTAL REQ'D
OEM (2 CARDS)	$9\frac{3}{4}$	$1\frac{5}{8}$	$11\frac{3}{8}$
FORMATTER IN UNIT (4 CARDS)	$10\frac{7}{8}$	$1\frac{3}{4}$	$12\frac{5}{8}$
1600 BPI OEM (3 CARDS)			



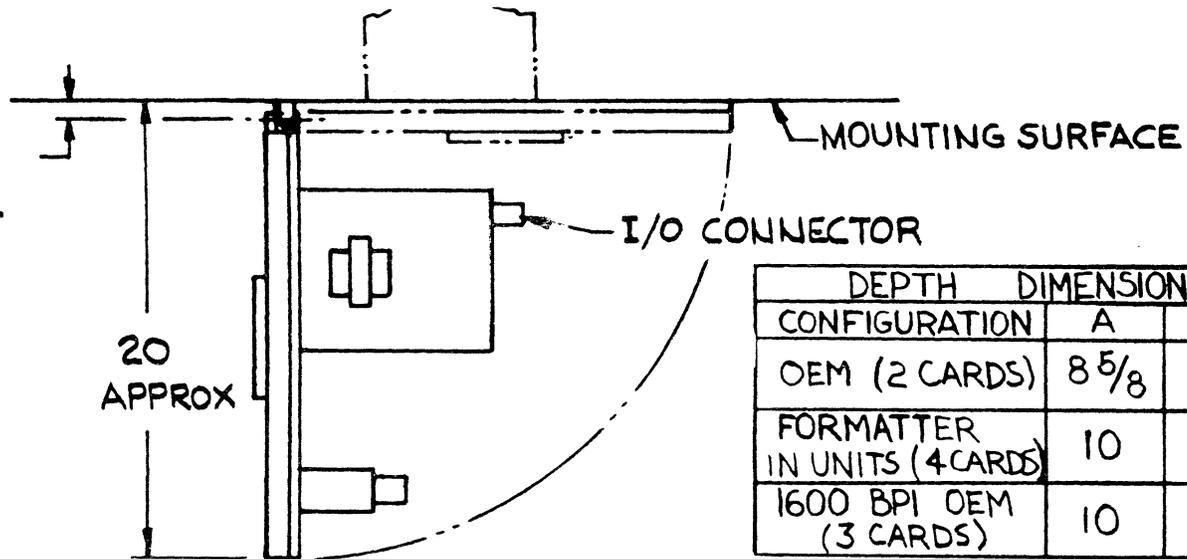
TRANSPORT OUTLINE
MODEL 1600

DIGI-DATA CORPORATION

SHEET 1 OF 1 RA-0071 A

HINGE PIN IS 1.036
FROM MTG SURFACE

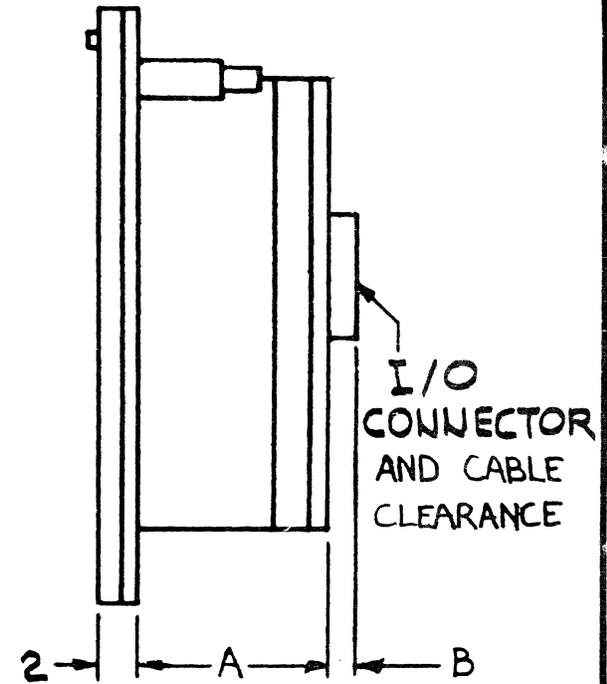
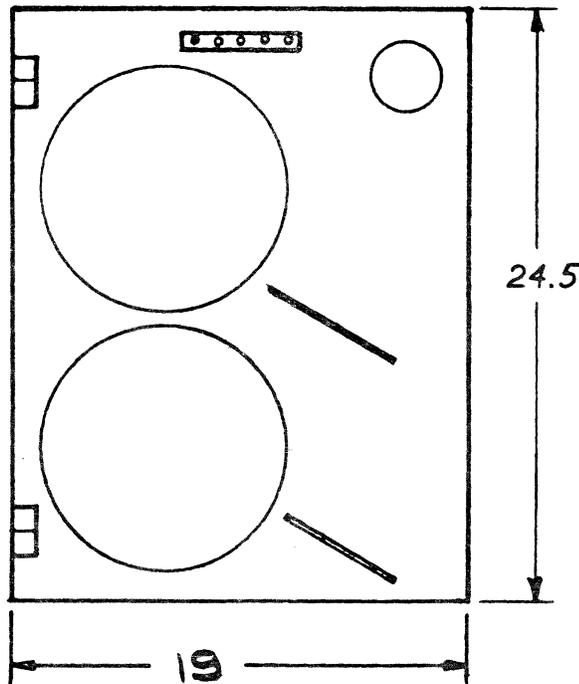
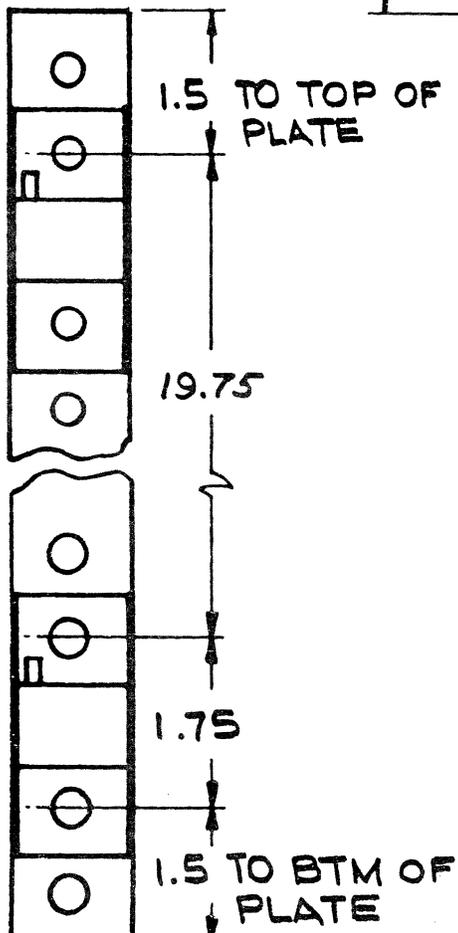
HINGE BLOCK
MTG LOCATION



DEPTH DIMENSIONS			
CONFIGURATION	A	B	TOTAL REQ
OEM (2 CARDS)	8 5/8	1 1/2	10 1/8
FORMATTER IN UNITS (4 CARDS)	10	1 3/4	11 3/4
1600 BPI OEM (3 CARDS)	10	1/2	10 1/2

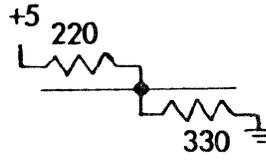
FRONT
PLATE
HINGE

FRONT
PLATE
HINGE



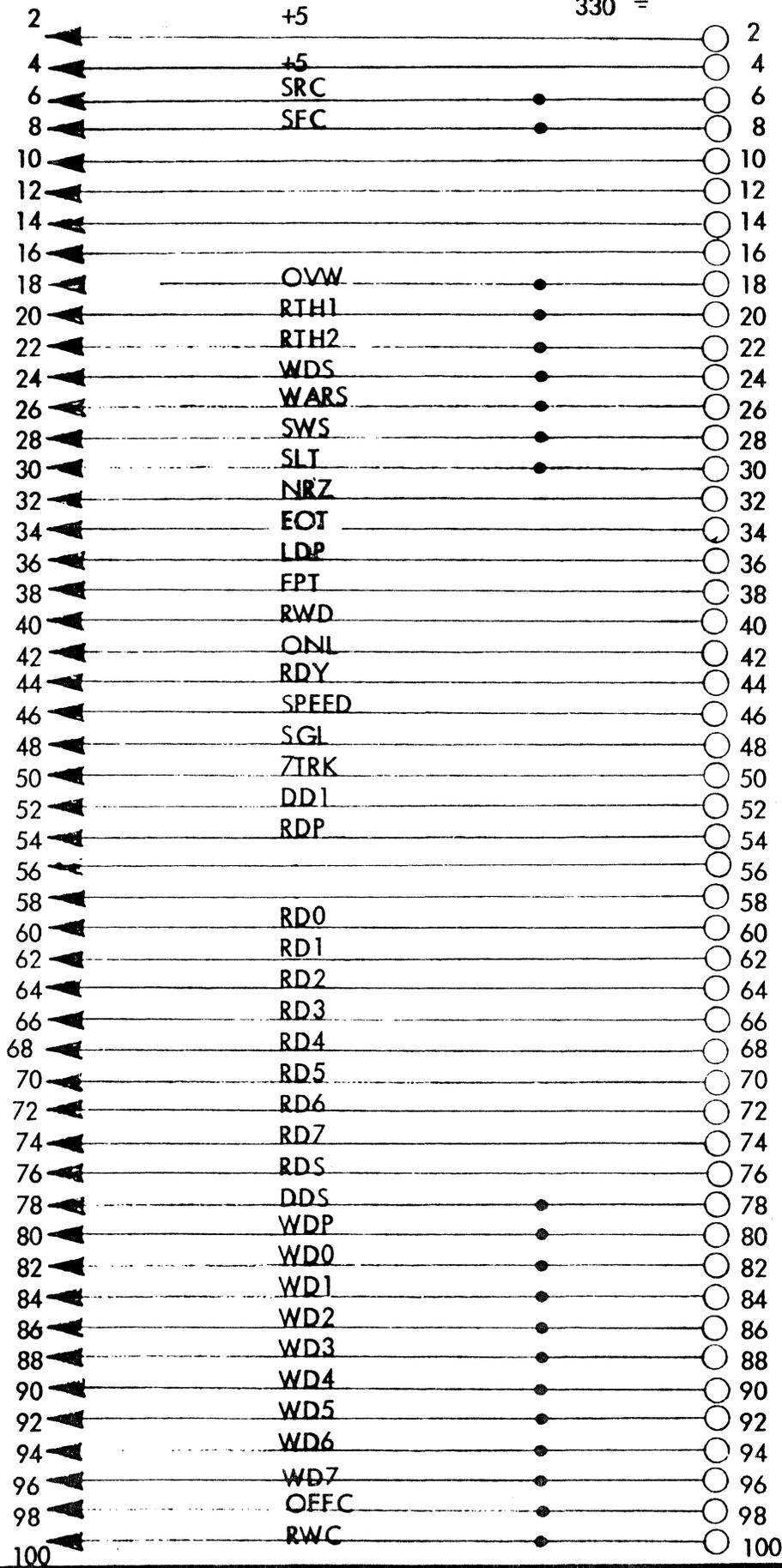
OUTLINE DIMENSIONS
MODEL 1700

DIGI-DATA CORPORATION



THIS NETWORK
INSTALLED ON
ALL INPUTS

TO TRANSPORT J101

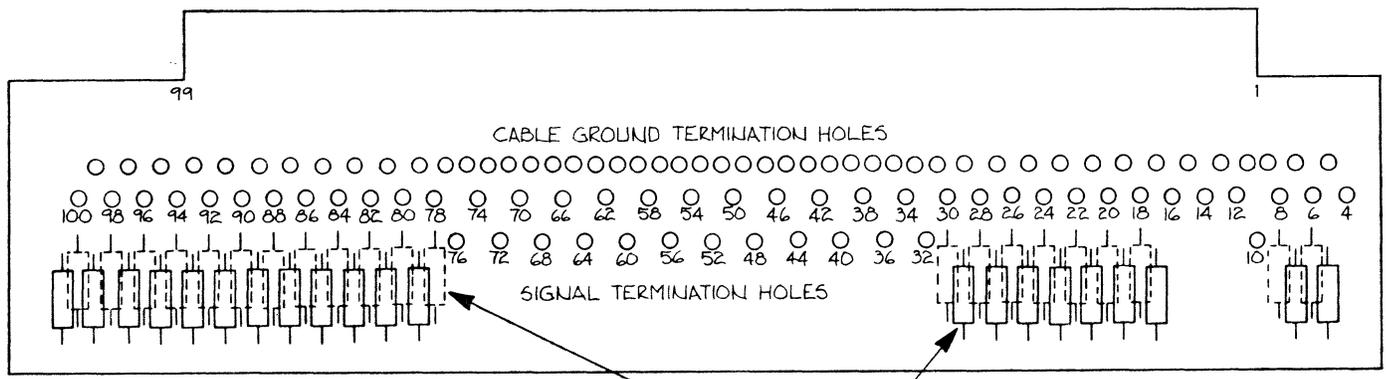


SIGNAL TERMINATION HOLES

NOTE:
EACH GROUND WIRE WILL
BE TERMINATED IN THE ODD
NUMBERED HOLE ASSOCIATED
WITH ITS SIGNAL. EXAMPLE:
SRC-PIN 6, GND - PIN 7

SCHEMATIC IC-12

DIGI-DATA CORP.
BLADENSBURG, MD.

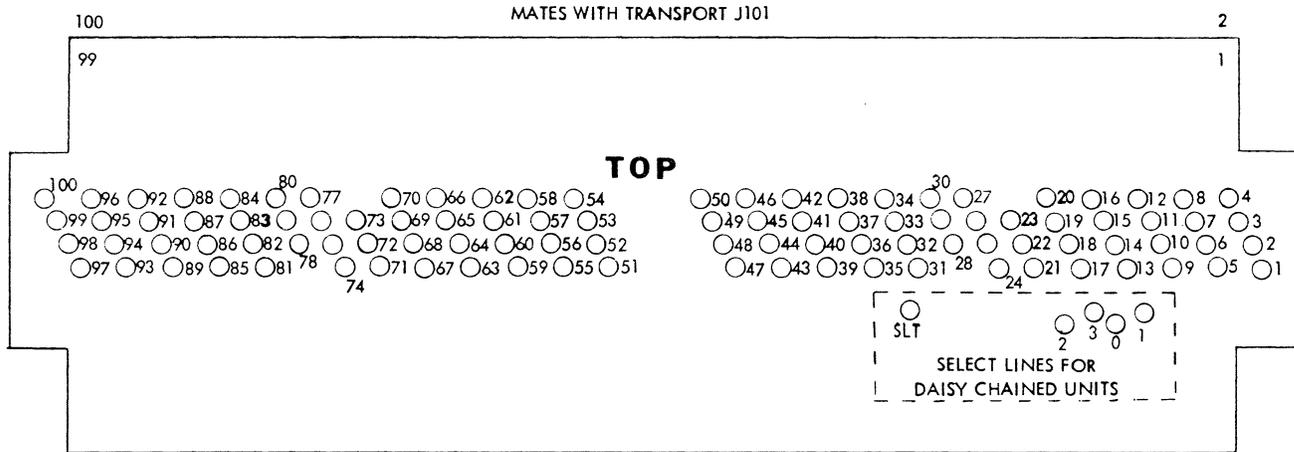


ALL 330 Ω RESISTORS ARE MOUNTED ON UNDERSIDE OF BOARD

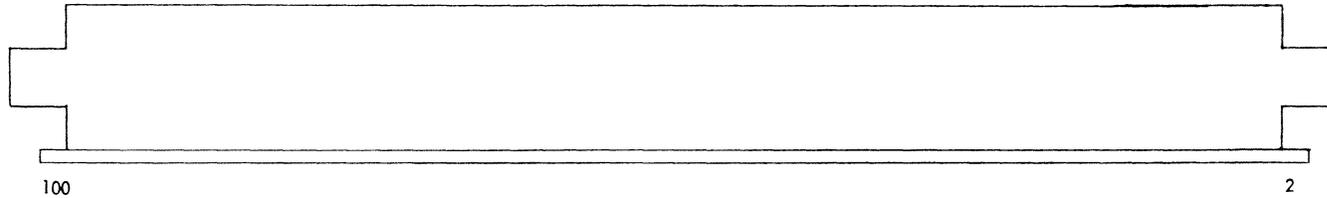
ALL 220 Ω RESISTORS ARE MOUNTED ON TOP OF BOARD

ASSEMBLY IC - 12		DIGI-DATA CORPORATION	
SHEET	OF	CB-0095	

CX12 INTERFACE
CONNECTOR BOARD

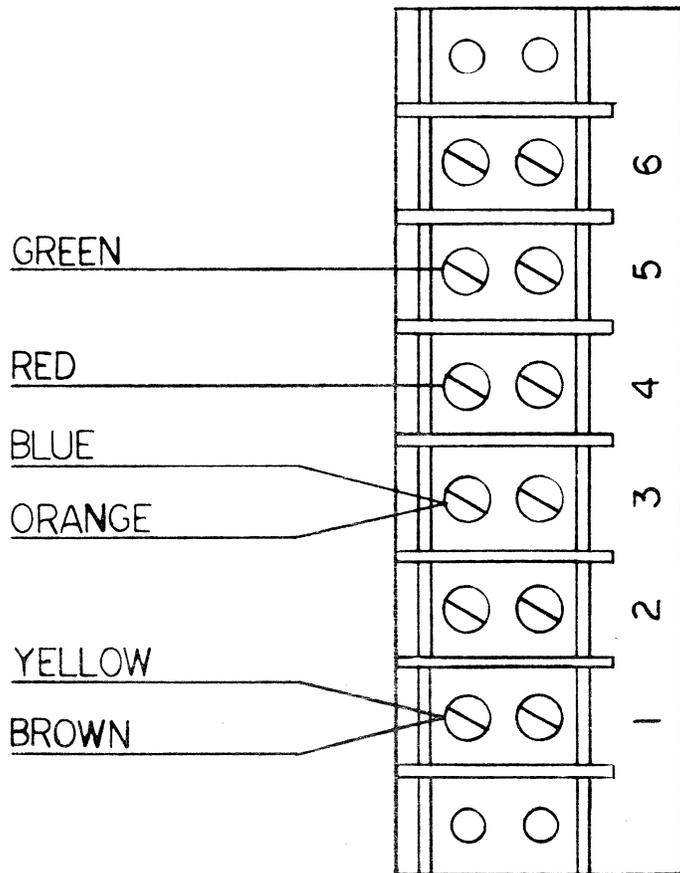


RT-12 RESISTOR
TERMINATOR BOARD

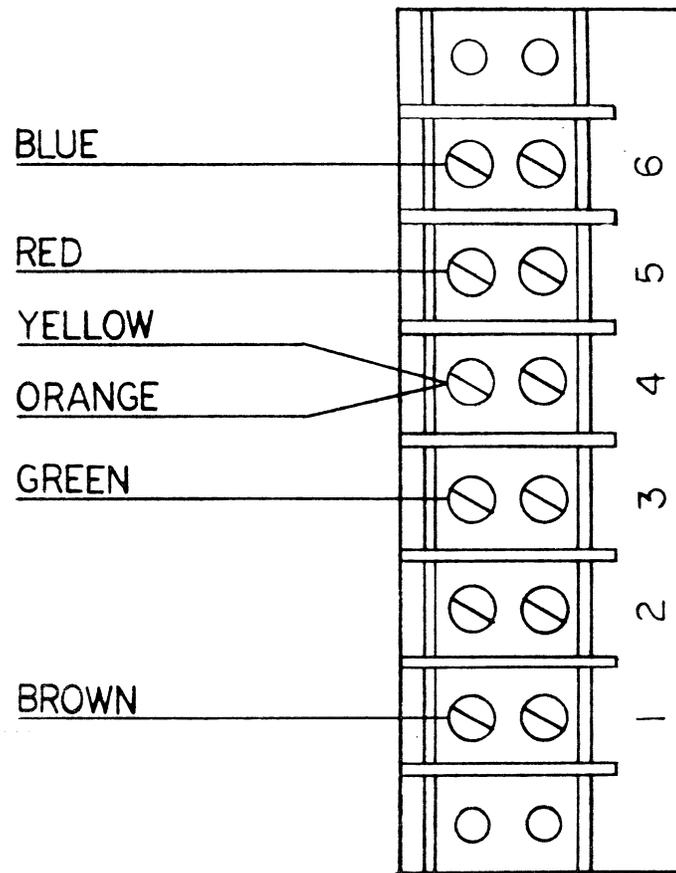


NOTE: HOLE PATTERN IN CX12 WILL MATE WITH 3M PCB TO FLAT
CABLE TRANSITION #3426 (50 POSITION) TO PERMIT USE
OF 3M FLAT CABLE #3365 (50 CONDUCTOR).

DAISY CHAIN INTERFACE CONNECTOR	DIGI-DATA CORPORATION
	SHEET 1 OF 1 LB-0038



120 VOLTS



220 VOLTS

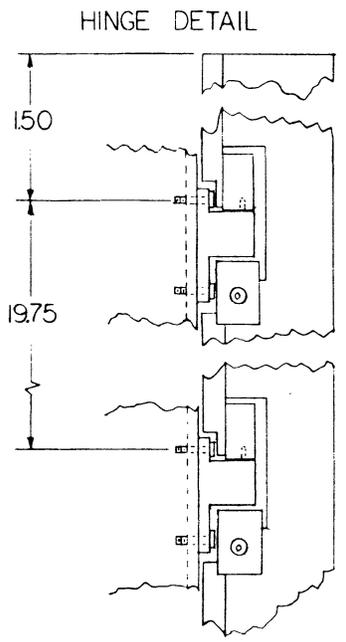
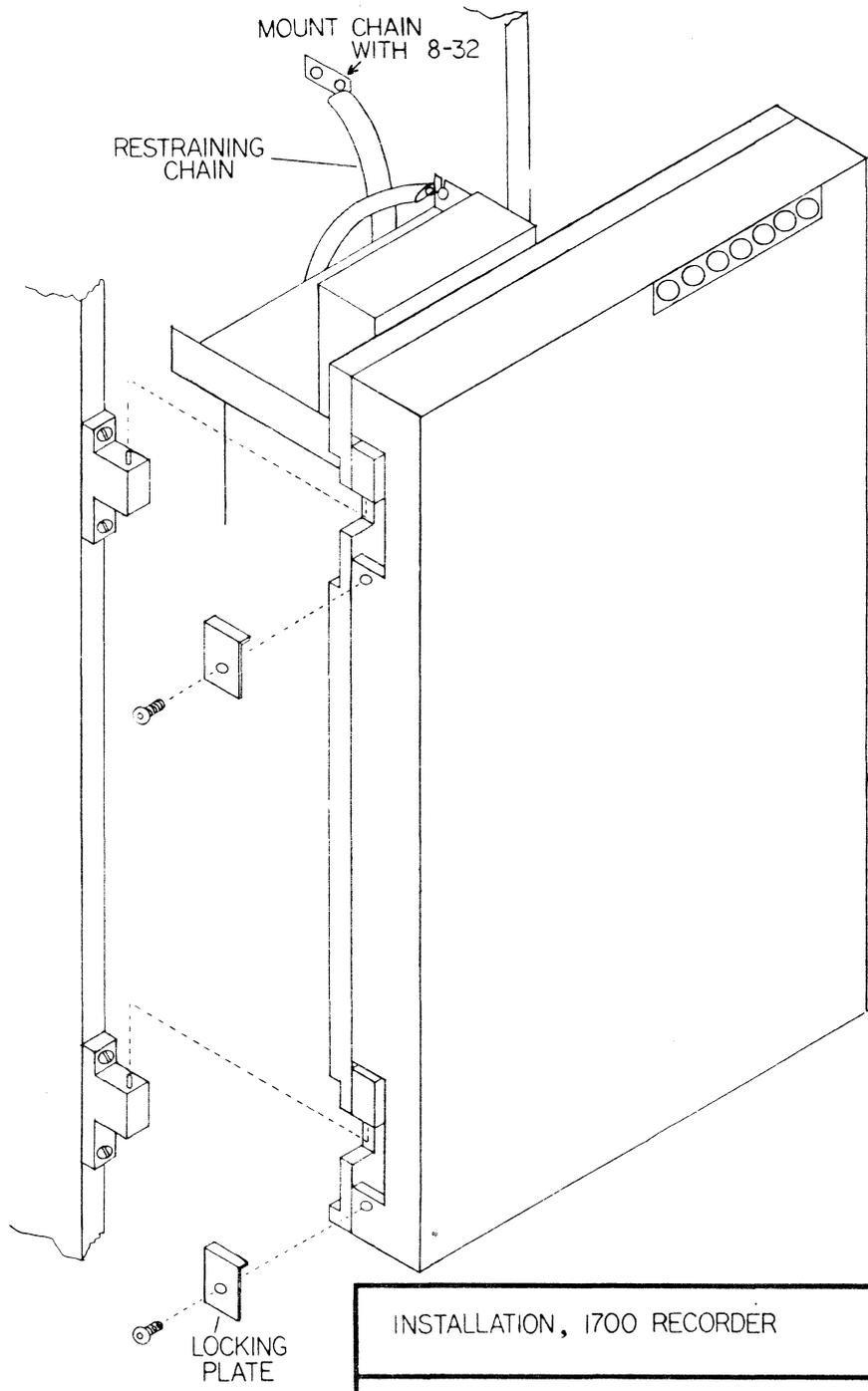
120/220 VOLT CONNECTIONS
1600 AND 1700 RECORDERS

DIGI-DATA CORPORATION

SHEET

OF

RA-0094



INSTALLATION, 1700 RECORDER

DIGI-DATA CORP.
 SHEET OF RC-0073

LED BOT SENSOR ADDENDUM
FOR
1100, 1600 AND 1700
OPERATION AND SERVICE MANUALS

TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>
I	Theory of Operation
II	Adjustment Procedure
III	BOT-EOT Sensor Assembly Replacement
IV	Drawings

I. THEORY OF OPERATION

The BEC-BES assembly is a high reliability unit utilizing an infrared LED as a light source for detecting the BOT and EOT markers on tape. The BES is the BOT-EOT sensor assembly mounted on the front plate of recorder. The BEC card is mounted on two stand offs on the back of the front plate directly behind the BOT sensor assembly (See Fig. 1).

Refer to the schematic diagram of LED sensor assembly in section 4 of this addendum. Operation for BOT and EOT is identical and hence only BOT will be discussed. When the BOT marker is in front of the BOT-EOT sensor assembly, the BOT sensor conducts dropping the voltage on pin 5 of the comparator below the threshold established by the voltage divider on pin 4. At this time, the comparator output switches to ground making $\overline{\text{BOT}}$ true. $\overline{\text{BOT}}$ is an input to the recorder control board (RC-11 for NRZI transports, RA-16 for P.E. or P.E./NRZI) of the transport.

II. BOT/EOT ADJUSTMENT PROCEDURE

NOTE: The following procedure must be performed with the door of the recorder open.

1. Thread a new brown tape (not black) on the unit.
2. Connect a voltmeter or oscilloscope to BOT test point (See Fig. 1 for test points and adjustment locations).
3. After at least a one minute warm up, adjust the BOT pot for +8.0 volts.
NOTE: If a brown tape is not available, use a black tape and adjust pot for +9.0 volts.
4. Repeat steps 2 and 3 for the EOT test point.
5. Check operation of sensors by inserting a reflective surface between the BOT-EOT sensor assembly and the tape. If both BOT and EOT are sensed properly, the tension arms will completely relax.

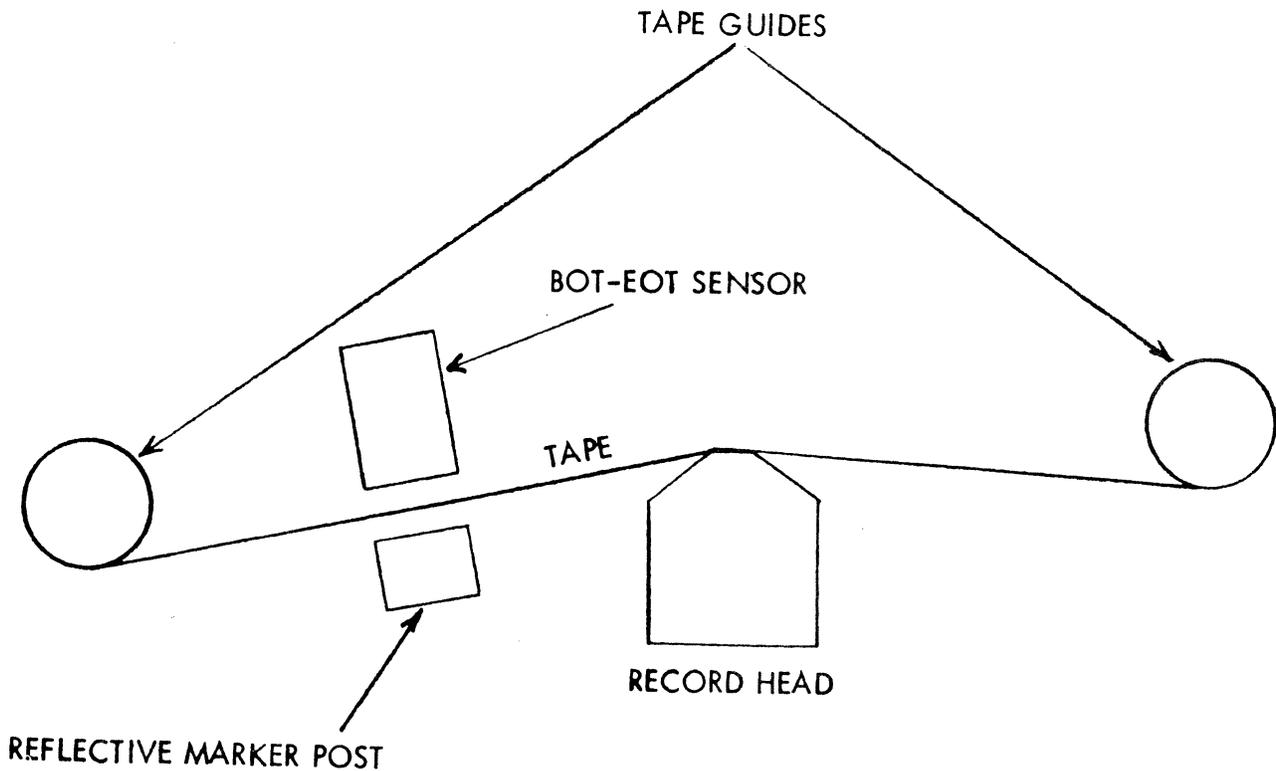
III. BOT-EOT SENSOR ASSEMBLY REPLACEMENT

Refer to Fig. 1 for pictorial view of BOT-EOT sensor assembly

1. Remove the four wires connected between the BOT-EOT sensor assembly and the BEC card by pulling the PCV connectors from the wire wrap pins.
2. Remove the two 6-32 screws and associated hardware from the BEC

card and remove the card.

3. Remove the stand off from the BOT-EOT sensor assembly with a 1/4" wrench and remove the assembly by pulling the four wires thru the front plate.
4. Obtain a replacement unit. Thread the wires from the new unit thru the same hole as wires where removed in step 3.
5. Insert BOT-EOT sensor assembly stud thru the front plate, attach the stand off, and tighten it finger tight.
6. Thread a scrub tape on unit; do not apply power.
7. Align BOT-EOT sensor assembly parallel to tape (See following figure)



FRONT PLATE TOP VIEW

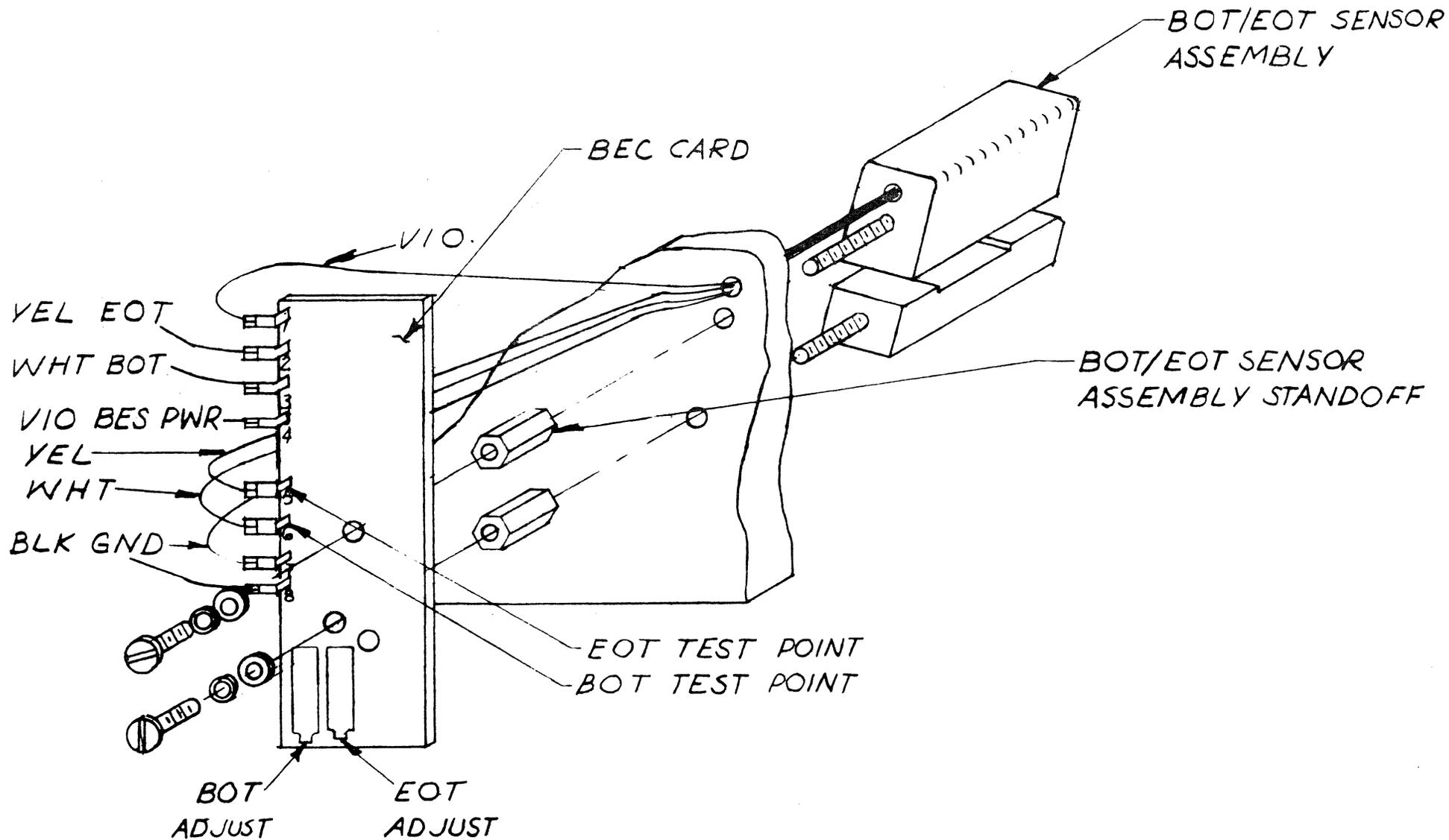
8. Tighten stand off with a 1/4" wrench.
9. Reinstall BEC card with the two 6-32 screws and hardware removed in step 2.

10. Connect the four wires from the BOT-EOT sensor assembly to the wire wrap pins on the BEC card. (Refer to Fig. 1 for wire locations)
11. Perform the BOT-EOT adjustment procedure in section II of the addendum.

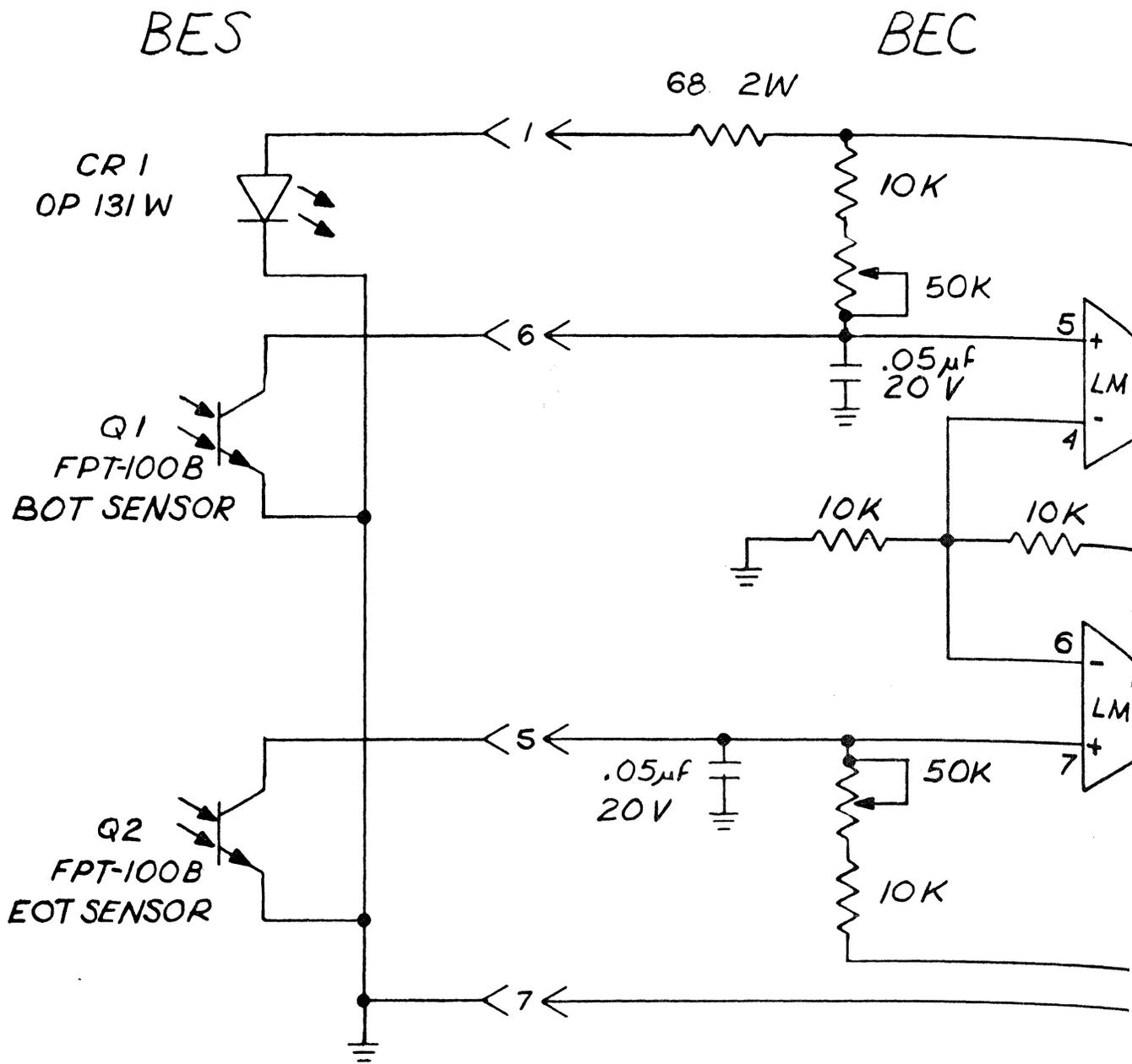
IV. DRAWINGS

Figure 1 - BOT/EOT SENSOR WIRING DIAGRAM

Schematic diagram BOT sensor, BES and BEC (DDC-SB-0028)

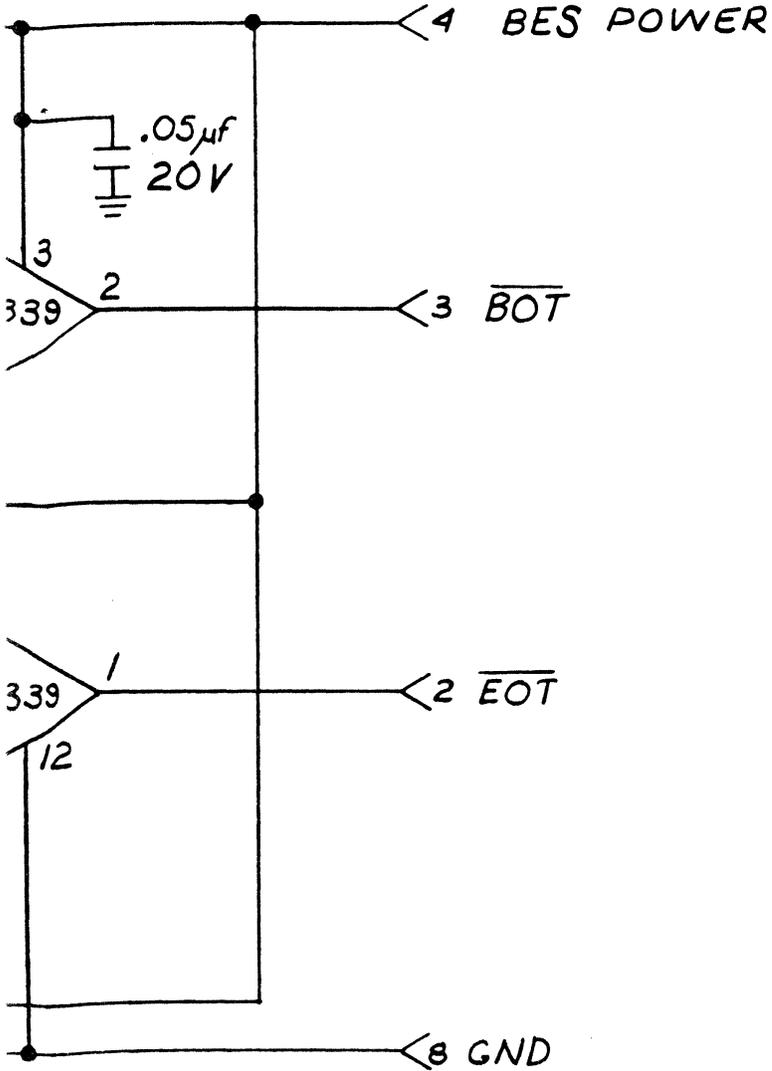


BOT/EOT SENSOR WIRING DIAG. FIG. 1		DIGI-DATA CORPORATION	
J. EUSTIS 11/19/74		SHEET 1	OF 1

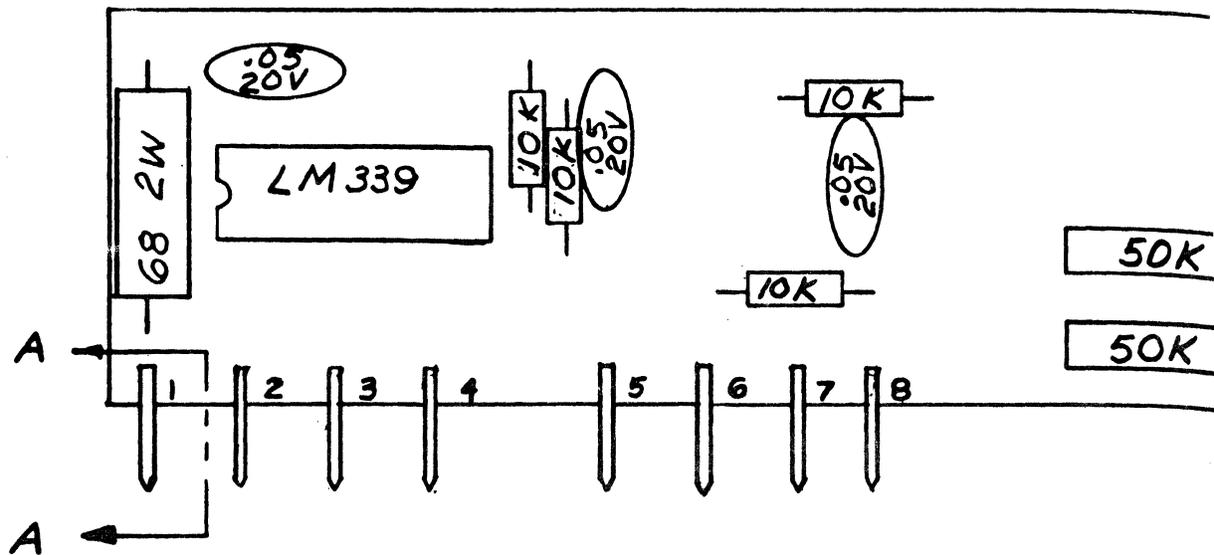


		MATER
		FINISH
		TOLER.
		OTHER
		3 PLA
		2 PLA
		FRACTI
		ANGLES
		DO. NO
NEXT ASS'Y	USED ON	PRINT

REV	ECN NO	DATE	APP
A	0362	11/20/74	J.d
B	0426	1-31-75	DDW



AL-	SIGNATURE	DATE	DIGI-DATA CORPORATION 8580 DORSEY RUN ROAD JESSUP, MD. 20794	
	DR- J. EUSTIS	11/12/74		
UNLESS UNLESS SPECIFIED RESISTANCE ±.005 DIMENSIONS ±.010 ANGLES ± 1/64 ± 1/2°	CHK- D. WILSON	11/19/74	SCALE:	SHEET 1 OF 1
	ENG- SPITLER	11/22/74	DNA	
	CUST-			
SCALE THIS			SCHEMATIC DIAGRAM BOT SENSOR, BES & BEC	
			size B	rev B dwg no SB-0028

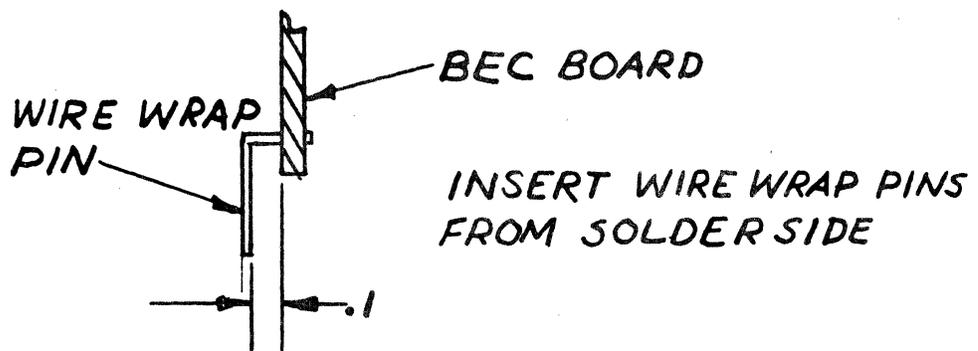


NOTES:

1. PARTS LIST PC-A00694
2. EXCEPT WHERE NOTED: ALL RESISTOR VALUES IN OHMS, 5% 1/4 W, ALL CAPACITOR VALUES ARE IN MFD.

		MATER
		FINISH
		TOLER
		OTHER
		3 PLAC
MC-0073	1700	2 PLAC
MB-0053	1600	FRACTI
MC-0083	1120	ANGLES
MB-0063	1100	DO. NO
NEXT ASS'Y	USED ON	PRINT

REV	ECN NO	DATE	AP
A	0362	11/20/74	PL
B	0426	11/31/75	DDW



SECTION A-A

UNLESS SPECIFIED ±.005 ±.010 S ± 1/64 ± 1/2° SCALE THIS	SIGNATURE	DATE	DIGI-DATA CORPORATION 8580 DORSEY RUN ROAD JESSUP, MD. 20794	
	DR-J.EUSTIS	11/20/74		
	CHK-		SCALE:	SHEET 1 OF 1
	ENG- P SPILLER	11/22/74	2/1	
	CUST-		ASSY BEC (BOT/EOT)	
		size	dwg no	REV
		B	PC-B00693	B