EK-2TU77-TM-002

TU77 Magnetic Tape Transport

Technical Manual
Volume 2

digital

EK-2TU77-TM-002

TU77 Magnetic Tape Transport

Technical Manual

Volume 2

Prepared by Educational Services
of
Digital Equipment Corporation

1st Edition, February 1979
2nd Edition, January 1984

NOTICE: This equipment generates, uses, and may emit radio frequency. The equipment has been type tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such radio frequency interference. Operation of this equipment in a residential area may cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

CONTENTS

CHAPTER 6 MAINTENANCE AND TROUBLESHOOTING

FIGURES

TABLES

CHAPTER 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The TU77 is a magnetic tape transport that records and reads data in 9-track nonreturn to zero (NRZI) or phase encoded (PE) format. Bit density is 800 bits per inch (BPI) for the NRZI format and 1600 BPI for the PE format. The transport can read data in the forward or reverse direction. The read/write tape speed for both the forward and reverse directions is 125 inches per second (IPS). The nominal rewind time for a 731.5 m (2400 ft) reel is 65 seconds.

The TU77 transport interfaces with the system processor via the Massbus, a Massbus controller, and a TM03 tape formatter. Up to four TU77s may be driven from one TM03 formatter. Figure 1-1 shows the basic system configuration for a TU77. The TM03 tape formatter and its associated power supply (H740-DA) are housed in the TU77 cabinet (H9500* corporate cabinet). Those TU77s containing a TM03 are called master units. TU77s without the TM03 are slave units.

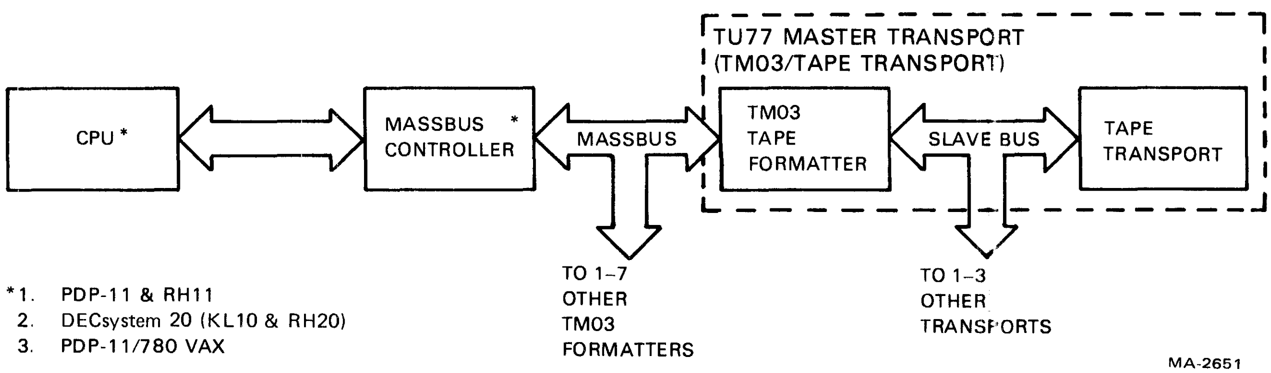


Figure 1-1 Basic System Configuration

* The specific model of the H9500 cabinet series used for the TU77 is H9602KA; however, the cabinet is referred to as the H9500 in this manual.

All Digital tape drive products are designed and manufactured for high performance and reliability. One important consideration in producing such products is the tape media used on them.

The TU77 meets the format and recording requirements for 1/2 inch, 9-track magnetic tape defined in the American National Standards Institute (ANSI) standard X3.40 1981. This standard defines the minimum physical and magnetic requirements for 1/2 inch wide magnetic tape. In addition to meeting ANSI requirements, all Digital recommended tape must conform to Digital's own magnetic tape specification. This specification is used in evaluating and qualifying magnetic tapes for Digital's use and sale to customers.

Digital constantly evaluates tape media to ensure a high quality product. To date, there are no back-coated magnetic tapes that meet Digital's specification. Back-coating causes such problems as tape slippage, auto-load failures, and false EOT (end of tape) and BOT (beginning of tape) sensing. Back coating also requires more frequent drive cleaning, due to the residue left on the tape drive. As a result of these problems, back-coated magnetic tapes are not recommended for the TU77 tape drive.

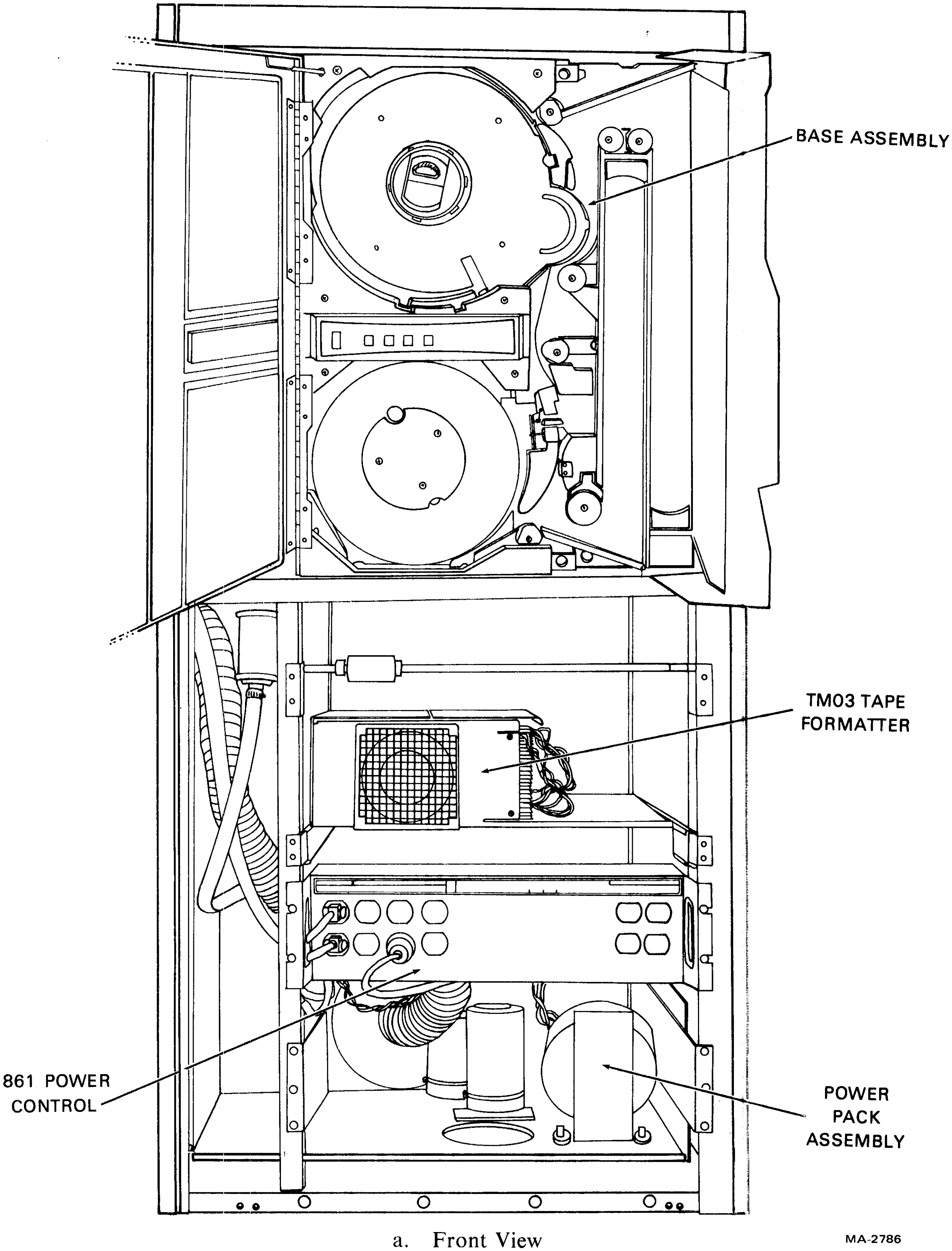
To ensure the best performance and maximum reliability of the TU77 tape drive, you should only use those magnetic tapes that meet both ANSI requirements and Digital's specification.

1.2 PHYSICAL DESCRIPTION

Figure 1-2 shows the locations of the major TU77 subassemblies.

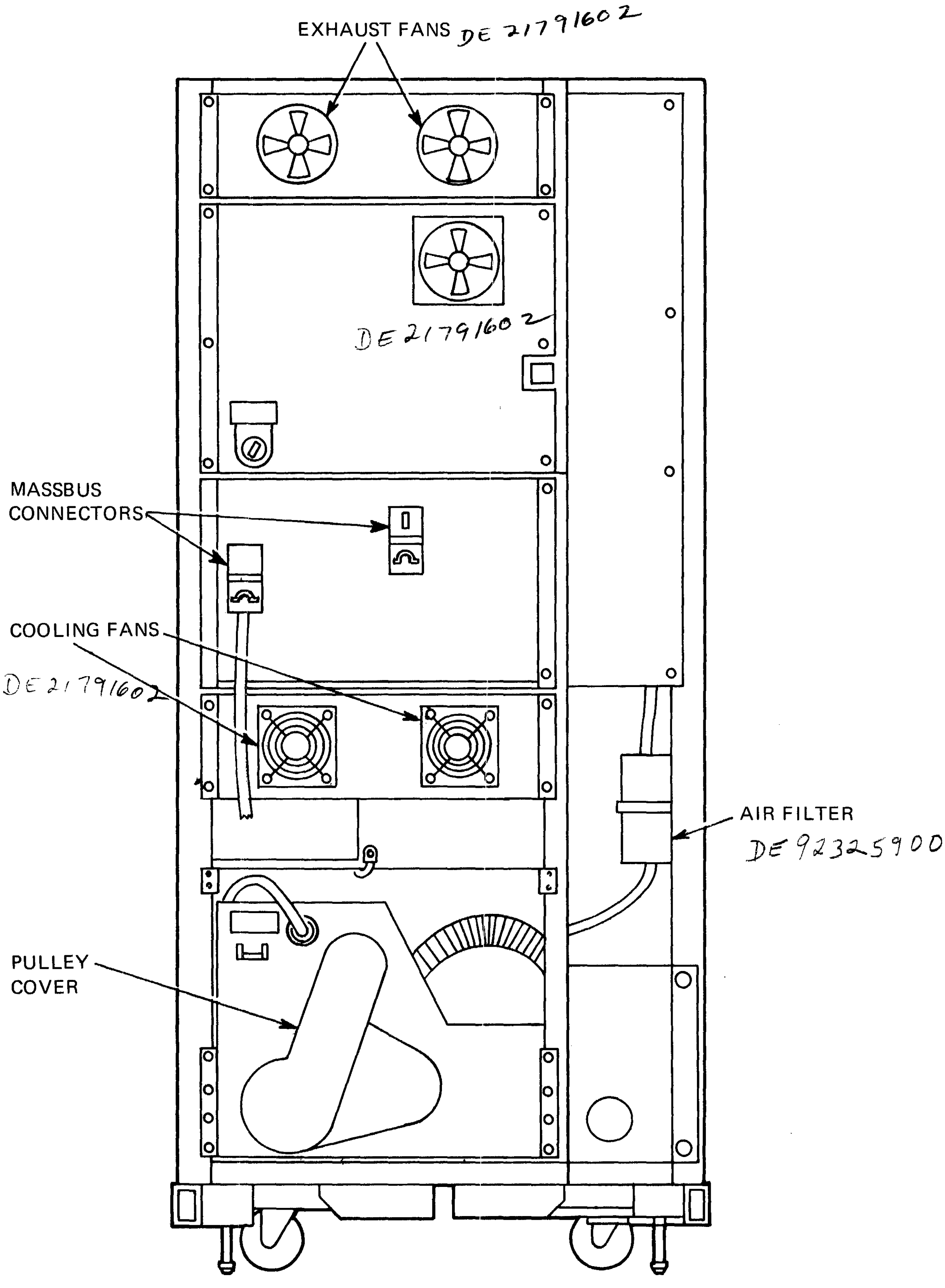
TM03 tape formatter (master TU77 only)
H740-DA power supply (master TU77 only)
861 power control
TU77 transport, consisting of

- Base assembly
- Card cage assembly
- Power pack assembly



a. Front View

Figure 1-2 TU77 Master Tape Transport



b. Rear View

Figure 1-2 TU77 Master Tape Transport

Figure 1-3 is a front and rear view of the base assembly, identifying the following components within the assembly.

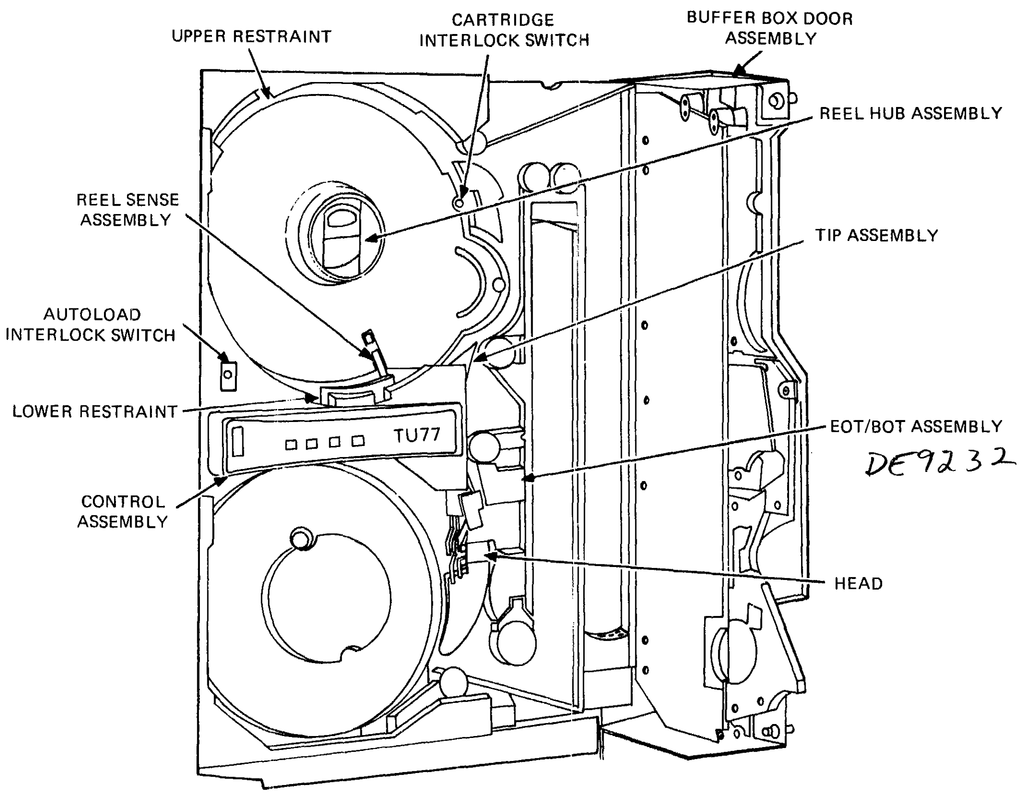
Control assembly (PN 29-23214)
Reel sense assembly (PN 29-23216)
Autoload interlock switch (PN 29-23297)
Reel hub assembly (PN 29-22776)
Buffer box door assembly (PN 29-23215)
Tape in path (TIP) assembly (PN 29-23243)
EOT/BOT assembly (PN 29-23242)
Head (PN 29-23233)
Cartridge interlock switch (PN 29-16280)
Upper restraint (PN 29-23225)
Lower restraint (PN 29-23224)
Cartridge motor (PN 29-23280)
Pressure switch (Pneumatic interlock (PN 29-23240)
Pressure valve assembly (PN 29-23249)
Interconnect F1 printed circuit board (PCB) (PN 29-23213)
Reel motor assemblies (2) (PN 29-23236)
Write protect assembly (PN 29-23235)
Vacuum valve assembly (PN 29-23248) DE0020/8
Pressure switches (vacuum) (2)(PN 29-23238, 29-23239)
Pack sense assembly (PN 29-23217)
Capstan motor assembly (PN 29-23234)
Service lock
Preamp printed circuit board (PCB) (PN 29-23232)
Vacuum transducer assembly (PN 29-23246)
Pressure switch (column limit) (PN 29-23238)

Figure 1-4 shows the following card cage assembly items.

Magtape adapter (MTA) M8940 PCB (PN M8940)
Data L PCB (PN 29-23227)
Write PCB (PN 29-23226)
Control M PCB (PN 29-23229)
Capstan/regulator PCB (PN 29-23230)
Reel servo PCB (PN 29-23231)
Blower motor (PN 70-14569)
Exhaust fans (2) (PN 12-10930)
Interconnect D1 PCB (interconnecting backplane not shown in Figure 1-4) (PN 29-23211)

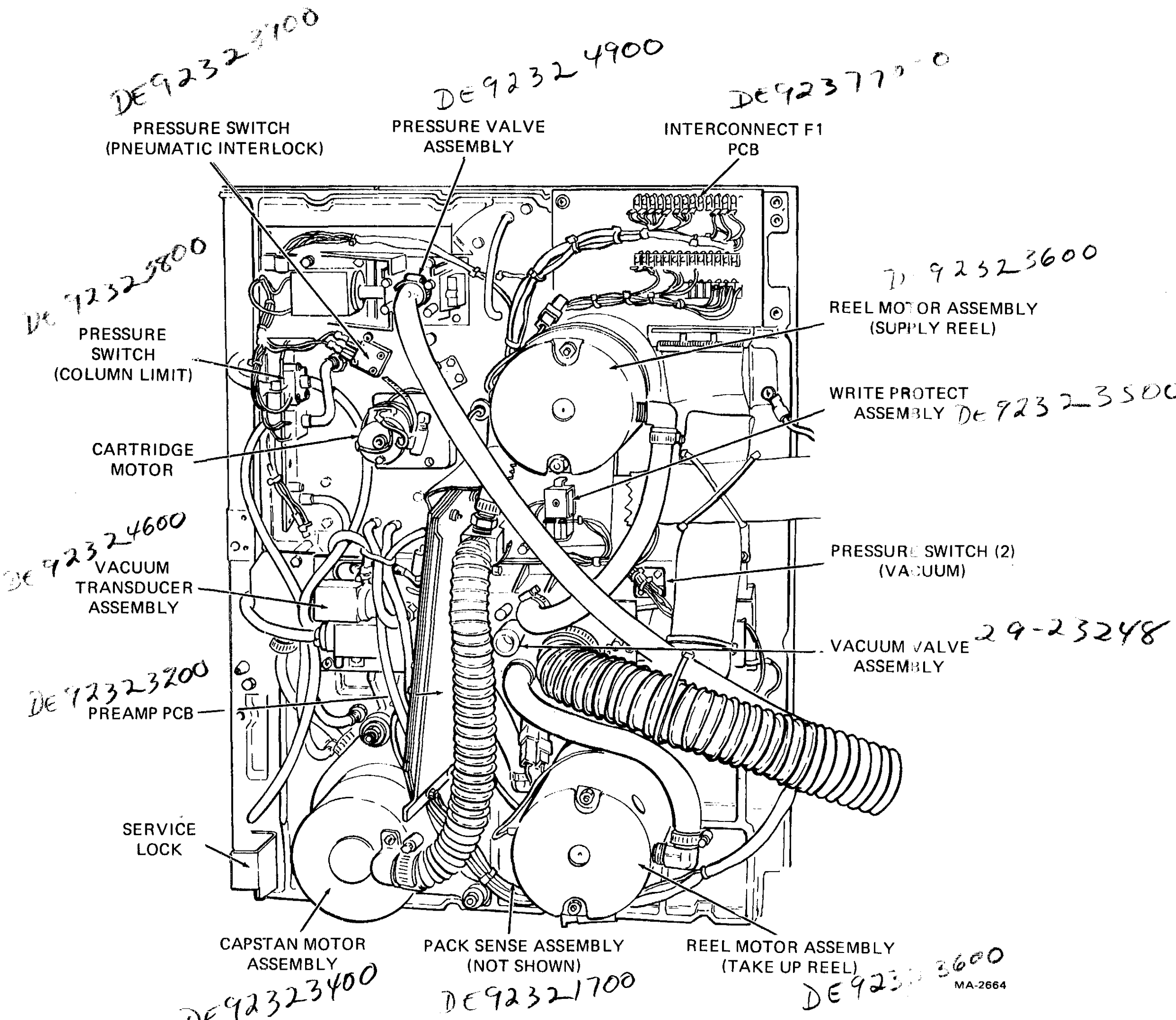
Figure 1-5 shows the following power pack assembly items.

Rectifiers (3) (PN 29-23311, 29-23312) CR3 CR(1+2)
Vacuum hose
Fuse panel
Air filter (PN 29-23259)
Blower (PN 29-23253)
Pulley cover
Power transformer terminal strip
Compressor (PN 29-23257)
Motor (PN 29-23254)
Transformer (PN 29-23258)
SOLID STATE RELAY S3 DE 92230800



a. Front View

Figure 1-3 Base Assembly



b. Rear View

Figure 1-3 Base Assembly

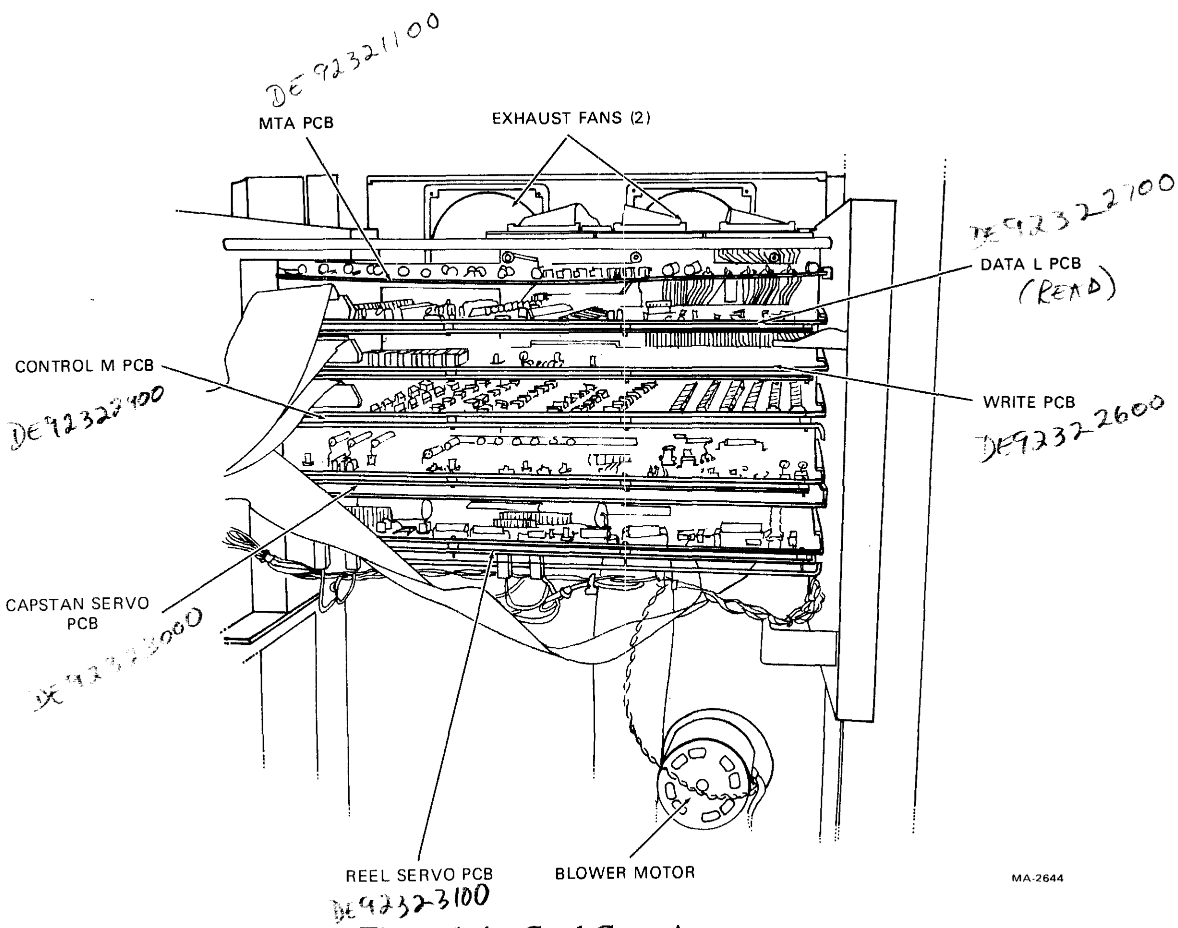


Figure 1-4 Card Cage Area

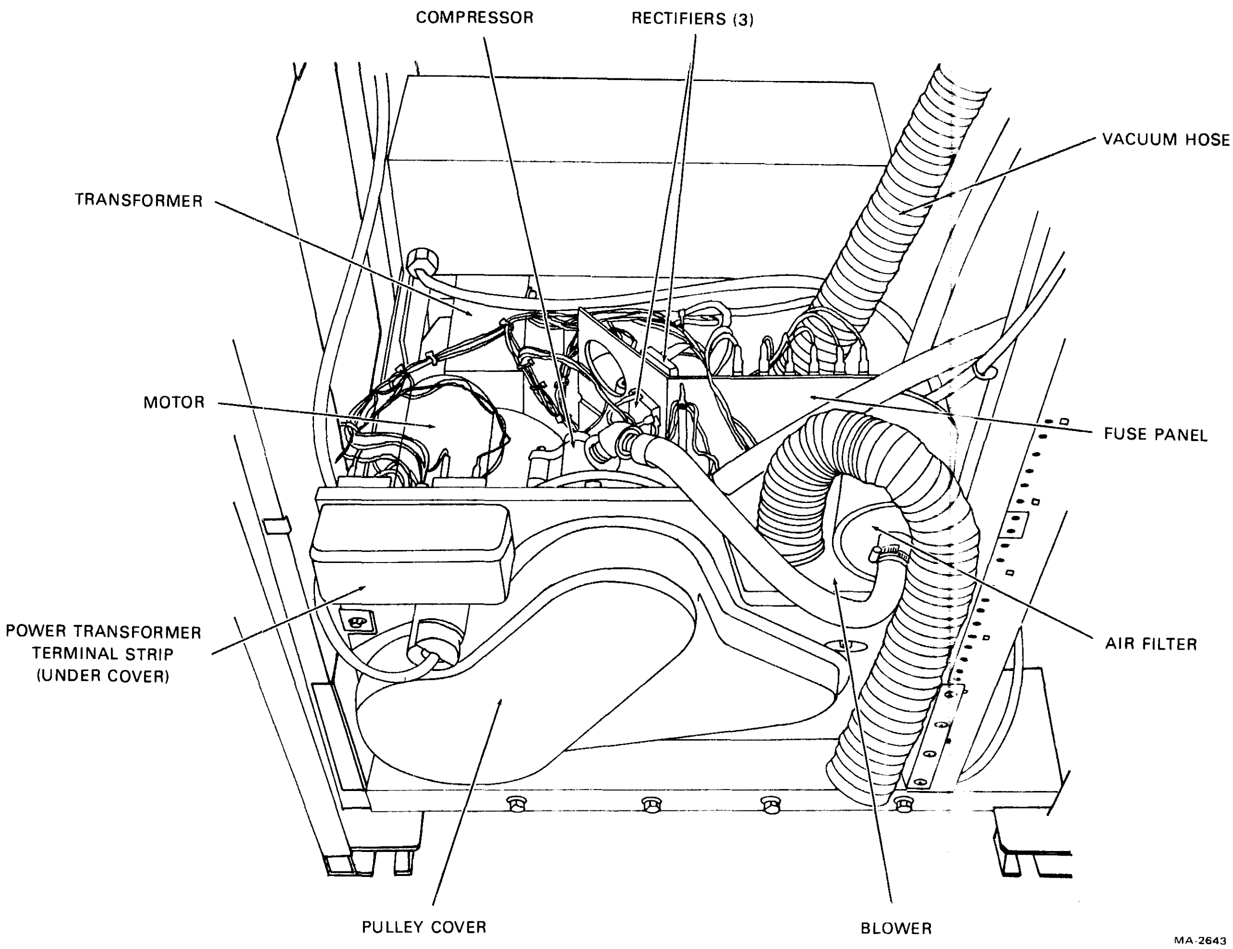


Figure 1-5 Power Pack Assembly; Rear View

1.3 FUNCTIONAL DESCRIPTION

Figure 1-6 shows the TU77 configurations that are possible with the Massbus. The TM03 tape formatter interfaces up to four TU77 transports to the Massbus. You can add up to eight additional TM03s, with each formatter interfacing up to four additional TU77s. Thus the maximum configuration interfacing a Massbus controller consists of 8 TM03 formatters and 32 TU77 transports.

The TM03 tape formatter is housed in the TU77 cabinet. TU77 cabinets containing a TM03 (and its associated H740-DA power supply) are called master transports; TU77 cabinets without the TM03 and H740-DA are slave transports. The basic transport within a TU77 master is identical to a TU77 slave transport.

Figure 1-7 is a functional block diagram of a master TU77 tape transport. During a write operation the TM03 accepts write data from the Massbus and formats it into 8-bit data characters for the TU77 transport. During a read operation 8-bit characters received from the transport are formatted into data words and placed on the Massbus. Massbus data is in PDP-10 compatible, PDP-10 core dump, PDP-11 normal or PDP-15 normal format. During a write operation the TM03 disassembles the Massbus data under control of the CPU, which specifies the format of the data. During a read operation the TM03 reassembles the data characters into the Massbus format specified by the CPU. The TM03 writes and reads the data in either 800 BPI NRZI or 1600 BPI PE formats.

During a write operation the TM03 generates a parity bit for each 8-bit data character written on tape. The parity bit is added to the data character, providing 9-bit tape characters to the transport. Error detection is accomplished by parity checks and, during NRZI operation, cyclic redundancy check (CRC) and longitudinal redundancy check (LRC) checks. Error detection occurs for both read and write operations. During a write operation a read-after-write function is performed; the data just written on tape is read by the TM03 and undergoes error checking. During read operations, the TM03 can perform error correction of single-track errors in both NRZI and PE. PE single-track correction occurs automatically, while NRZI single-track error correction is under software control and must be implemented by the program.

The TM03 accomplishes automatic error correction of single-track errors in both NRZI and PE. PE error correction occurs automatically, while NRZI error correction is under software control and must be implemented by the program. A parity bit is generated for each 8-bit data character written on tape. The parity bit is added to the data character, providing 9-bit tape characters to the transport. During a read operation the TM03 performs parity and CRC checking of the data being read. During a write operation a read-after-write function is performed; the data just written on tape is read by the TM03 and undergoes parity and CRC checking.

The TM03 also controls and monitors tape transport operation. It receives operational commands from the CPU, then selects the desired transport and issues functional and motion commands. The TM03 monitors transport operation and provides error and status information to the CPU.

The H740-DA power supply supplies regulated ±15 V and +5 Vdc operating voltage for the TM03. Power-fail signals AC LO and DC LO are also supplied to the TM03.

The 861 power control provides ac power to the transport cabinet. The 861 provides filtering for the ac input power, which is supplied to switched outlets when the remote power on/off line is enabled from the system processor via the remote switching control bus. There is no power on/off control on the TU77 control panel. Transport power is turned on and off at the system processor. The switched ac is supplied to the H740-DA power supply (master TU77 only), the three cabinet cooling fans and the transport power pack.

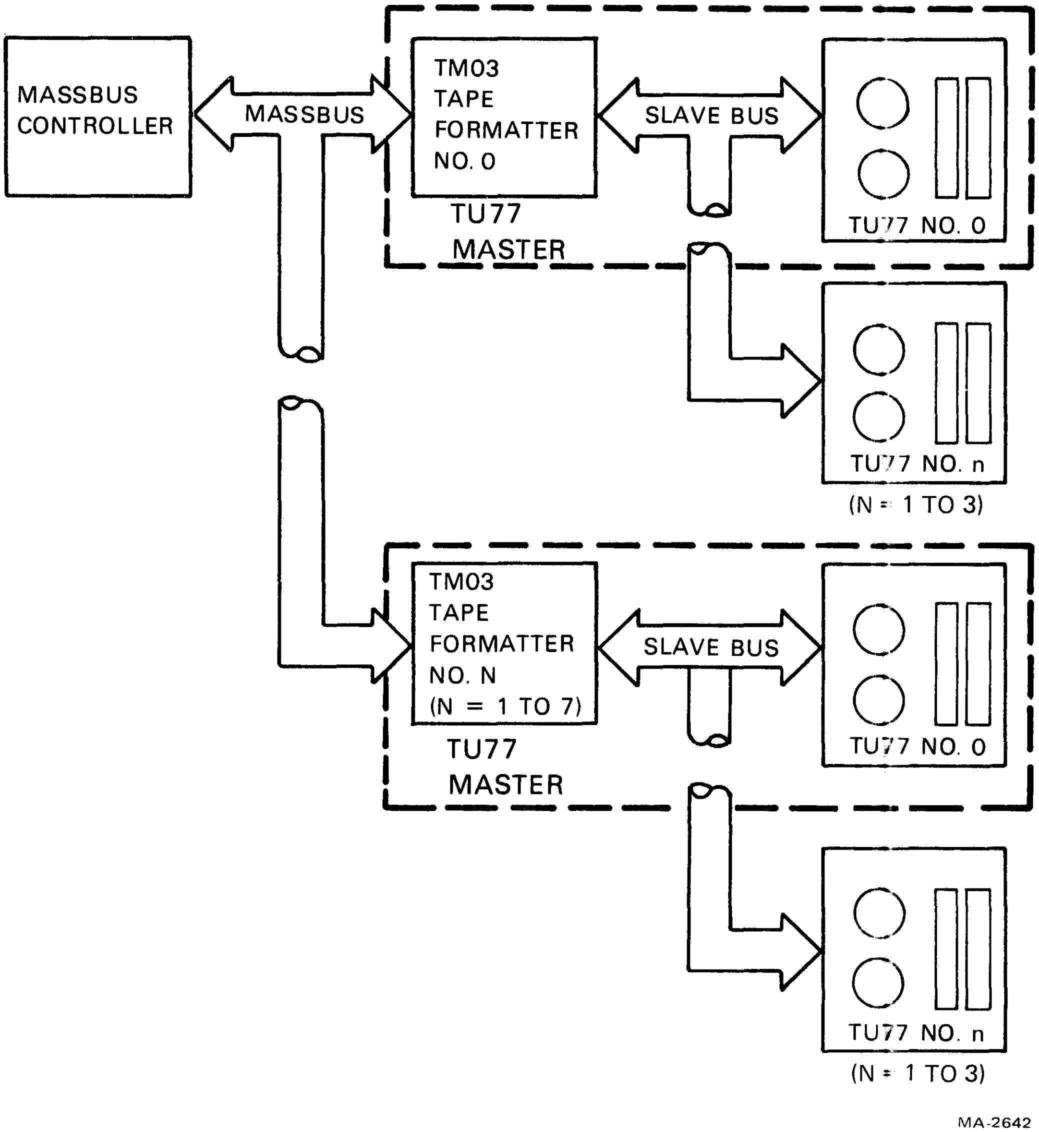


Figure 1-6 Possible TU77 Configurations

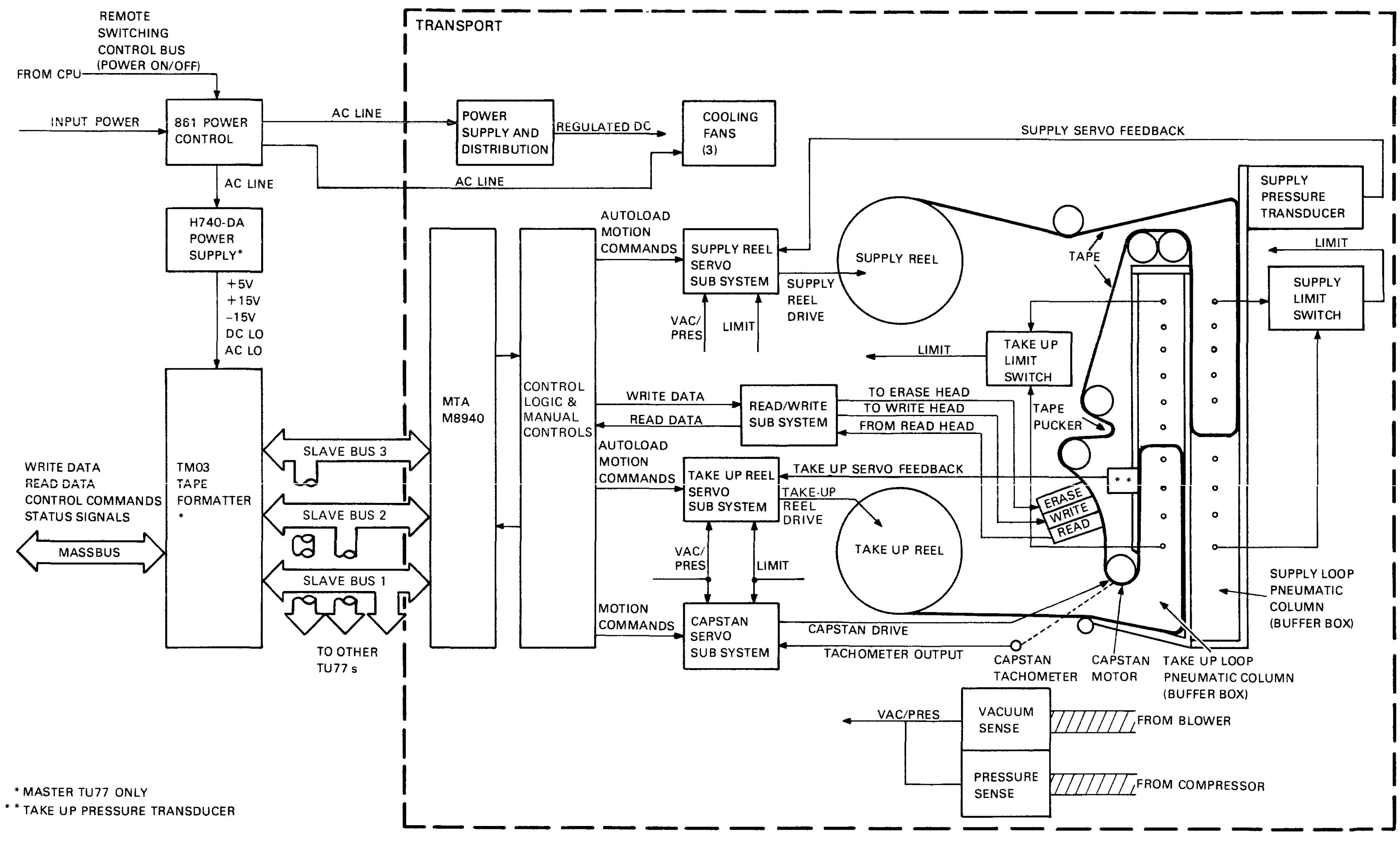


Figure 1-7 Master TU77 Functional Block Diagram

The basic TU77 transport contains the following seven functional areas (Figure 1-7).

Capstan servo subsystem
Reel servo subsystem (2)
Pneumatic subsystem
Read/write subsystem
Control logic and manual controls
MTA interface
Power supply and distribution

The capstan servo subsystem controls the speed and direction of tape movement past the read/write heads. The subsystem is a velocity servo that receives command signals from the control logic specifying forward, reverse, or rewind motion. The capstan motor responds with the appropriate velocity. The capstan tachometer generates a feedback signal proportional to speed. The feedback signal is summed with the basic command signal to maintain the correct capstan velocity at all times.

The reel servo subsystems control the speed of the tape reels as required to maintain optimum tension on the tape between the supply and the take-up reels. The supply reel and take-up reel servos are similar but separate subsystems. The path followed by the tape in either direction between the supply reel and take-up reel contains two tape loops in the buffer box (supply loop and take-up loop). Each loop is separately formed and maintained by a vacuum in conjunction with automatically controlled reel motor speeds. In effect, the reel servos function to feed tape into and remove tape from the buffer box at the rate required to maintain the correct loops.

Servo operation is initiated by sensing that the tape loop position has changed as a result of forward or reverse tape motion. The velocity of the reel motors is controlled by pressure sense feedback from pressure transducers connected to the supply buffer box and the take-up buffer box. Air is drawn from the closed ends of the two buffer boxes, creating a vacuum causing the tape loop to form in each box. The differential between the positive pressure inside the loop and the relatively negative pressure at the closed end of the buffer box (outside the loop) maintains the proper tension on the tape during the tape loaded state.

A separate chamber is located behind each buffer box and is connected to its respective box by a series of holes. These holes are spaced so that if the loop becomes larger, more of the holes are exposed to the positive pressure inside the loop, and fewer are exposed to the lower pressure area outside the loop. This feature causes the pressure in the chamber to rise. Conversely, if the loop becomes smaller, the pressure in the chamber will decrease.

Pressure transducers connect to the supply and take-up chambers. The pressure variations are interpreted by the pressure transducers to provide the supply and take-up servo feedback signals. The pressure sensitive feedback signals are fed back to the reel servos to adjust the velocity of the reel motors for the proper loop in the two buffer boxes. The top and bottom holes in each buffer column are limit ports. The limit ports connect to supply and take-up limit switches, which feed back to both the take-up and supply servos. If the tape crosses a limit port in either the supply or take-up columns, a disabling signal is coupled back to the servos, stopping both reel motors before tape damage occurs.

A pneumatic interlock shuts down the capstan servo and the reel servos if a pneumatic failure is detected. The pneumatic subsystem contains a blower to create the vacuum for the tape columns, and a compressor to generate pressure for the tape path bearings. Vacuum and pressure are monitored by sensing devices. If either is lost, the sensing device sends a VAC/PRES signal to the three servo subsystems, stopping the servo motors and preventing tape damage.

The read/write subsystem processes and transfers data to and from the magnetic tape. The read function processes data picked up from the tape by the read heads and translates the information from the recorded NRZI or PE format to digital data acceptable to the external controlling circuits. The function includes the read after write capability, which allows the formatter to verify the execution of a write command while writing is in progress. The write function prepares incoming data for recording in NRZI or PE format and writes the information on the tape in the selected format.

The control logic and manual control circuit interfaces other TU77 subsystems. The control logic transfers the read/write data to and from the read/write subsystem, and transfers the operational commands to the capstan servo. During the autoload sequence the logic circuits control the steps of the sequence by issuing the appropriate commands to the reel servos. Timing of the autoload sequence steps, and other operational sequences (such as rewind), is controlled and monitored by the control logic. Commands generated by the manual controls are processed by the control logic and applied to the appropriate subsystem. Transport status (such as transport selected, on line, EOT and BOT) is sensed by the control logic, which modifies the signals to the read/write subsystem and to the servo subsystems accordingly. The logic turns on the appropriate control panel indicators to indicate transport status. Transport status is sent to the TM03 tape formatter via the MTA interface module.

The control and read/write signals are coupled from the slave bus to the transport via the magnetic tape adapter (MTA) interface module M8940. The M8940 adapts the signals on the slave bus to the format required by the transport and vice versa. This process includes signal gating, latching and timing. The M8940 also has a test mode capability for troubleshooting and maintenance.

The power supply function includes ac rectification, filtering, dc regulation, and distribution of power as required to the various subsystems.

1.4 RELATED DOCUMENTS

Table 1-1 lists documents related to the TU77 tape transport.

1.5 MECHANICAL AND ELECTRICAL SPECIFICATIONS

Table 1-2 lists the mechanical and electrical specifications of the transport.

Table 1-1 Related Documents

Title	Document Number	Description
TM03 Magnetic Tape Formatter User's Manual	EK-TM03-OP	Description, programming information and installation information of the TM03
TM03 Magnetic Tape Formatter Maintenance Manual	EK-TM03-TM	Theory of operation, programming information, installation and maintenance of the TM03
H740-D Power Supply Maintenance Manual	DEC-11-H740A-A-D	Theory and maintenance of H740-DA power supply
861-A,B,C Power Controller	DEC-00-H861A-A-A	Theory and maintenance of 861 power control
TU77 Magnetic Tape Transport User Guide	EK-TU77-UG	Description, installation, instructions, and operating procedures for the TU77.
TU77 Magnetic Tape Transport Technical Manual, Volume 1	EK-1TU77-TM	Schematics and logic prints of TU77
TU77 Magnetic Tape Transport Technical Manual, Volume 2	EK-2TU77-TM	Description, installation, operation, theory and maintenance of TU77
TU77 Magnetic Tape Transport IPB	EK-TU77-IP	Exploded views and parts lists of TU77

Table 1-2 Mechanical and Electrical Specifications

Item	Specification
Tape (computer grade)	
Width	12.6492 ± 0.0508 mm (0.498 ± 0.002 in)
Thickness	0.0381 mm (1.5 mil)
Tape tension	2.224 ± 0.139 Newtons (8.0 oz nominal)
Reel diameter (autoload)	266.7 mm (10.5 in) maximum (Note 1) and easy load cartridge #1 and #2™
Recording modes	1600 BPI PE 800 BPI NRZI
Magnetic head	Dual stack (with erase head)
Tape speed	3.2 m/s (125 ips)
Instantaneous speed variation	±3 percent
Long term speed variation	±1 percent
Rewind time (731.5 m) (2400 ft)	65 seconds nominal (80 seconds maximum)
Tape cleaner	Dual-blade type connected to vacuum supply
Interchannel displacement	
Read	3.81 μm (150 μin) maximum (Note 2)
Write NRZI	5.72 μm (225 μin) maximum (Note 3)
Write PE	11.43 μm (450 μin) maximum
Start time	3.0 ± 0.3 ms
Stop time	3.0 ± 0.3 ms
Start distance	4.216 ± 0.508 mm (0.166 ± 0.02 in)
Stop distance	4.953 ± 0.508 mm (0.195 ± 0.02 in)
Beginning of tape (BOT) and end of tape (EOT) detectors (Note 4)	Photoelectric
Tape creepage	None
Pneumatic interlock	Tape motion disabled when vacuum is lost in vacuum column
Load time	No greater than 10 seconds without a retry, and 20 seconds with a retry for 10-1/2 inch reels
Unload time	Less than 7 seconds for 10-1/2 inch reels
Write gap to read gap distance	0.381 cm ± 0.013 cm (0.150 in ± 0.005 in)

Table 1-2 Mechanical and Electrical Specifications (Cont)

Item	Specification
Weight	288 kg (640 lbs) (master unit)
Cabinet dimensions	
Height	152.4 cm (60.0 in)
Width	67.3 cm (26.5 in)
Depth (from face of front door to rear of cabinet)	81.9 cm (32.3 in)
Operating temperature	4.44° to 44.0°C (40° to 112°F) (Note 5)
Nonoperating temperature	−45.55° to 71.11°C (−50° to 160°F)
Operating altitude	0 to 2439 m (0 to 8000 ft) (Note 6)
Nonoperating altitude	15,240 m (50,000 ft) maximum
Power	
Volts ac	200, 210, 220, 230, 240, 250 (Note 7)
Frequency	50 ± 1 or 60 ± 1 Hz
Kilovolt Amp (KVA)	
Standby (loaded)	1.3 KVA maximum (Note 8)
Start/stop	2.1 KVA maximum (Note 8)
Electronics	All silicon

™ Easy Load #1 and #2 are trademarks of IBM.

NOTES

1. 177.8 mm (7 in) and 216.0 mm (8.5 in) reels may be used but cannot be autoloaded.
2. This is the maximum displacement between any two bits of a character when reading a master tape using the read section of the read-after-write head.
3. This is the maximum displacement between any two bits of a character on a tape written with all ones using the write section of the read-after-write head.
4. The approximate distance from the detection area to the write head gap is 35.6 mm (1.40 in).
5. For data transfer, the operating temperature depends on the nature of the tape material.
6. Operation above 610 m (2000 ft), in 610 m (2000 ft) increments requires installation of high altitude pulleys and belts in the TU77 power pack.
7. Line variations must be within +10 percent.
8. Slave unit only. Add 625 W for master units.

CHAPTER 2
INSTALLATION

2.1 SITE PLANNING AND CONSIDERATIONS

This section describes space, power, and environmental requirements for the TU77.

2.1.1 Space Requirements

Figure 2-1 shows the space and service clearances required for the TU77 cabinet. You must provide enough space to slide the TM03 out of the cabinet for servicing and to open the front and rear doors on the TU77 tape transport.

2.1.2 Power Requirements

The TU77 tape transport can operate from 200 to 250 Vac, 50/60 Hz with proper connections on the power chassis. Line voltage should be maintained within ±10 percent of the nominal value. The frequency should not vary more than ±1 Hz.

2.1.3 Environmental Requirements

Locate the TU77 transport in an area free of excessive dust and dirt or corrosive fumes and vapors. To ensure proper cooling, the bottom of the cabinet and the air vents in the front panel and rear door of the cabinet must not be obstructed. The operating environment should have cool, well-filtered, humidified air; the correct temperature range is 15° to 27° C (59° to 80°F), with a relative humidity of 40 to 60 percent.

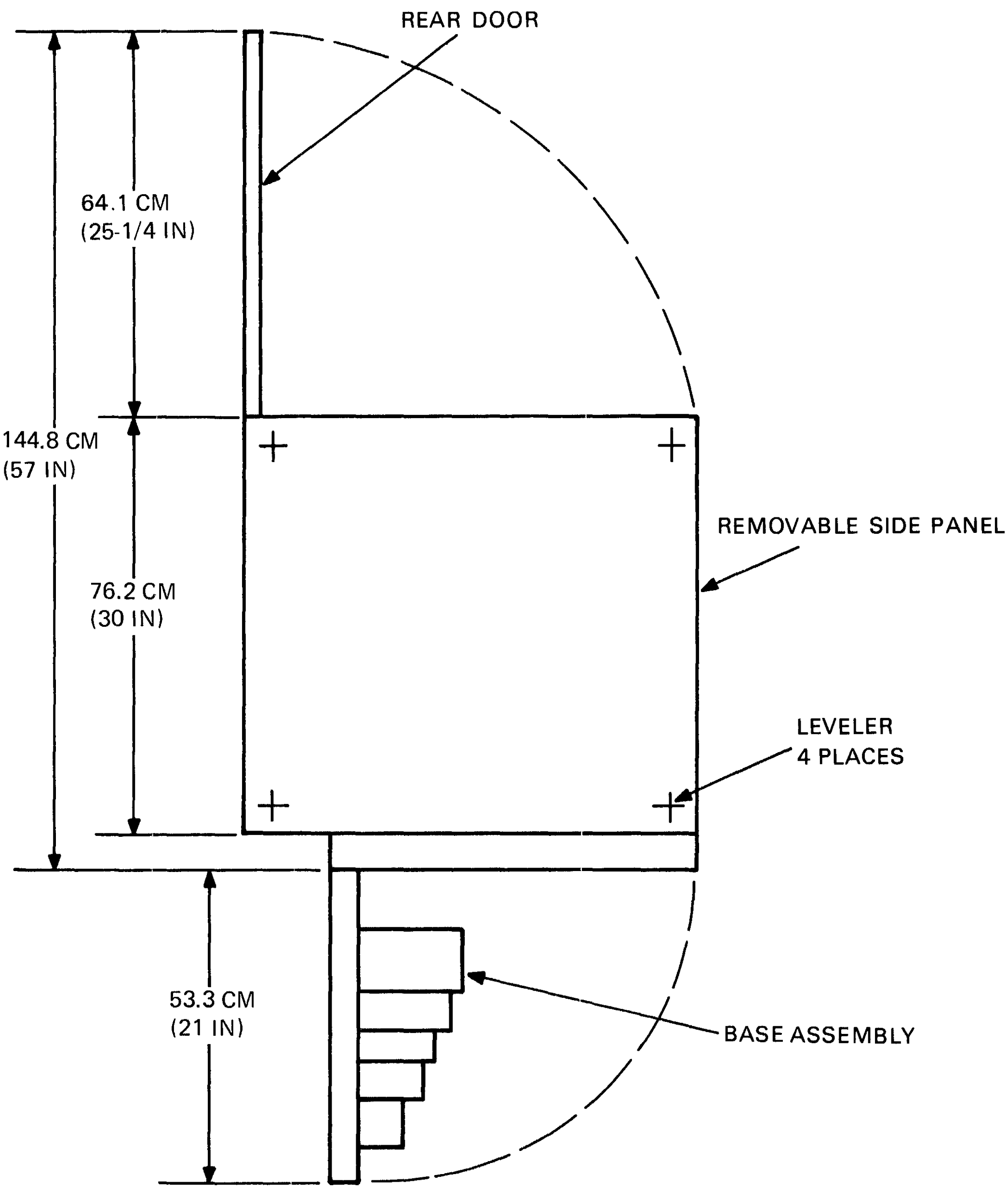


Figure 2-1 Space and Service Clearance, Top View

2.2 UNPACKING AND INSPECTION

This section describes how to unpack and inspect the TU77.

2.2.1 Unpacking

The TU77 cabinet (H9500) comes mounted to a shock absorbing wooden shipping skid that measures approximately 76 cm (30 in) wide, 107 cm (42 in) long, and 15 cm (5.75 in) high. The cabinet comes packed in an extra strong corrugated cardboard container that measures approximately 76 cm (30 in) wide, 89 cm (35 in) long, and 147 cm (58 in) high. (Units shipped outside the continental United States have another wooden container around the cardboard carton. The side panels of the container are bolted together.) Two wooden ramps are also mounted to the shipping skid. You must reposition these ramps during the unpacking procedure before rolling the cabinet off the skid.

Unpack the TU77 and remove the shipping skid as follows. (Refer to Figure 2-2.)

1. Remove the banding, angle boards, shipping carton, and plastic bag from the TU77 as shown and dispose.

2. Remove the four hex bolts and square washers that support the TU77 to the skid. Dispose of the three skid blocks and hardware.

3. Remove four thumbscrews (PN 12-18197-00) and two flat washers (PN 90-09025-00) from the shipping kit. Also remove two 1/4-20 × 3/4 in. hex bolts and secure the orange wheel locks to the cabinet. Make sure the wheels are facing from side to side on the TU77, and not front to back.

4. Remove the two skid ramps (PN 99-06642-00) from the front of the skid; save the two flat washers and dispose of the two hex bolts and external tooth washers. (You must have four flat washers for this deramping procedure.)

5. Attach both skid ramps and secure to the side of skid as shown.

CAUTION

The following step requires two people to roll the TU77 down the wooden ramps. Most of the TU77's weight is in the upper-half of the cabinet, making the unit top-heavy. Do not try to do this procedure with only one person.

6. Have one person stand in front of the TU77 and one person stand at the rear of the TU77. Then guide the unit down the ramps until it is safely on the floor.

7. Dispose of the ramps and hardware.

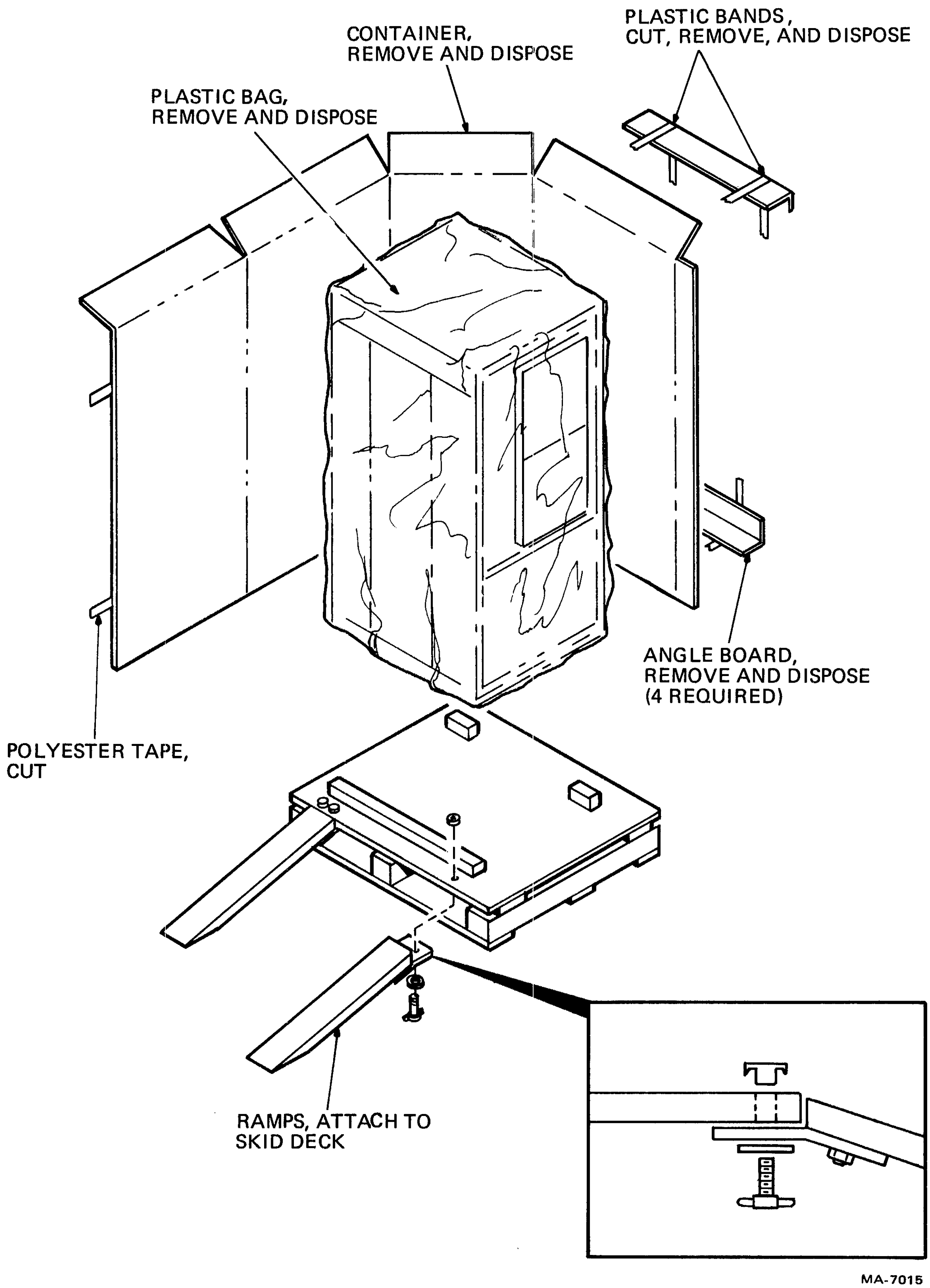


Figure 2-2 Unpacking the TU77

2.2.2 Inspection

After unpacking the TU77 transport, inspect it and report any damage to the responsible shipper and the local Digital sales office. Inspect the TU77 as follows.

1. Inspect all switches, indicators, and panels for damage.

2. Open the TU77 front door. Press the upper and lower release buttons and open the buffer box door. Check that the buffer box door is tightly secured to the cabinet. Inspect for foreign material, loose or damaged components, and glass damage.

3. Check the transport for any foreign material that may have lodged in the take-up reel or other moving parts.

4. Rotate the supply hub and take-up reel. Check for binding and physical damage.

5. Rotate the capstan. Check for binding and physical damage.

CAUTION

The capstan is fragile. Do not touch the capstan rubber surface and do not apply pressure to the capstan which might cause it to deform.

6. Check tape path for any sharp edges.

7. Close the buffer box door by pressing the two release buttons, using moderate pressure. (The buttons will not catch if pressed too hard.)

8. Close the TU77 front door.

2.3 SINGLE TRANSPORT INSTALLATION

This section describes how to install a single TU77 transport.

2.3.1 Mechanical Installation

After you remove and inspect the shipping container, roll the transport cabinet into position and proceed as follows.

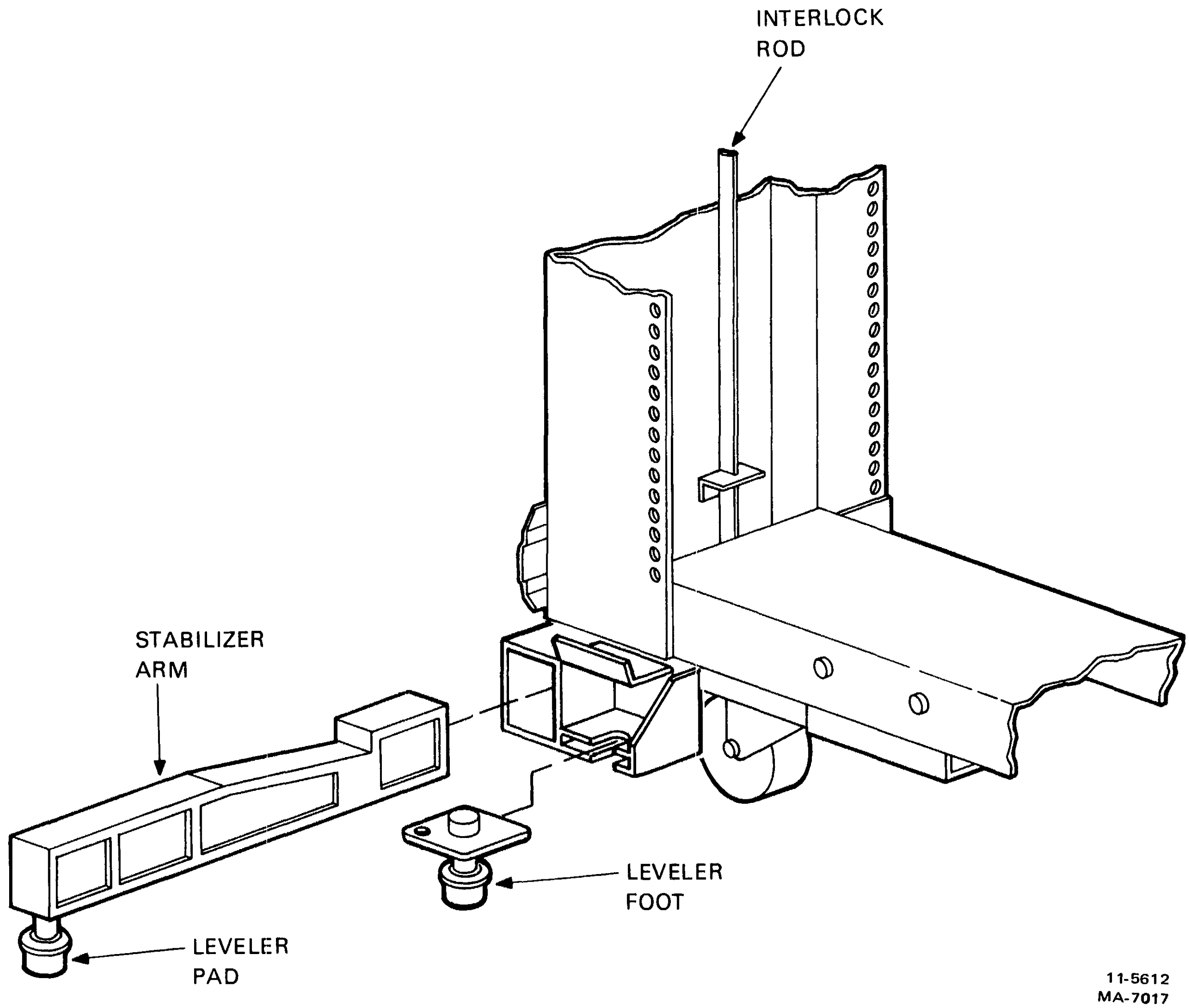


Figure 2-3 Location of Stabilizer Arm and Leveler Feet

1. An array of vertical slots provide venting in the cabinet front cover. A quick-release latch is located approximately 2.54 cm (1 in) behind each end of this array. Insert a thin-bladed tool, such as a small steel rule, into one of the end slots; push on the latch while simultaneously exerting a forward pull to release one corner of the front cover. In the same manner, while continuing to exert a forward pull, release the latch at the other end of the array to free the front panel. Remove the front panel and set it aside. Do not disconnect the ground strap from the front panel.

2. Remove the two leveler pads and four leveler feet that are wrapped in blister wrap and taped to the inside of the front panel.

3. Raise the interlock rods on each side of the cabinet. Remove the two stabilizer arms from the stabilizer sleeve assemblies (Figure 2-3).

4. Screw the leveler pads into the stabilizer arms.

5. Raise the interlock rods and reinsert the stabilizer arms into the stabilizer sleeve assemblies.

6. Install the leveler feet in the lower corners of the cabinet frame (Figure 2-3).

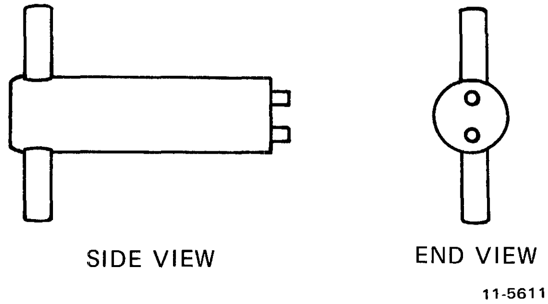


Figure 2-4 Rear Door Opening Tool

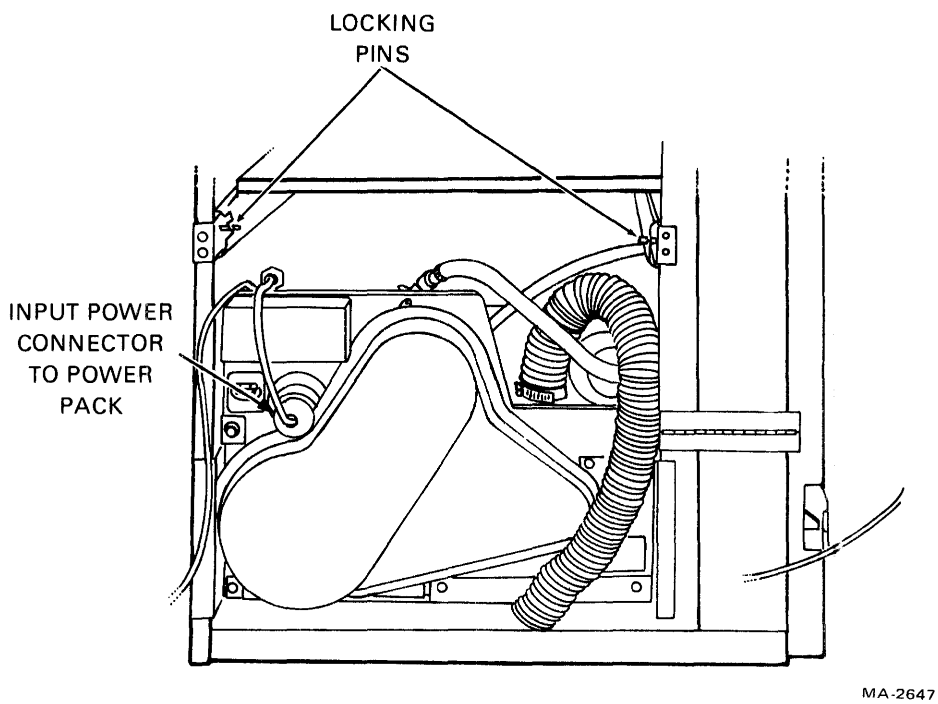


Figure 2-5 Location of TM03 Shelf Locking Pins and Power Pack Connector

7. Use a 1.43 cm (9/16 in) wrench to lower the leveling feet until they make contact with the floor, stabilizing the cabinet.

8. Use a level to adjust the feet until the cabinet is level.

9. Extend the two stabilizer arms and lower the leveler pads until they just touch the floor yet can easily slide along the floor. Do not place any weight on the leveler pads.

10. Insert an opening tool (Figure 2-4) into the rear door. Turn the tool one-quarter turn in a counterclockwise direction and open the door.

11. Remove the locking pins from the rear of the TM03 shelf slide assembly (Figure 2-5).

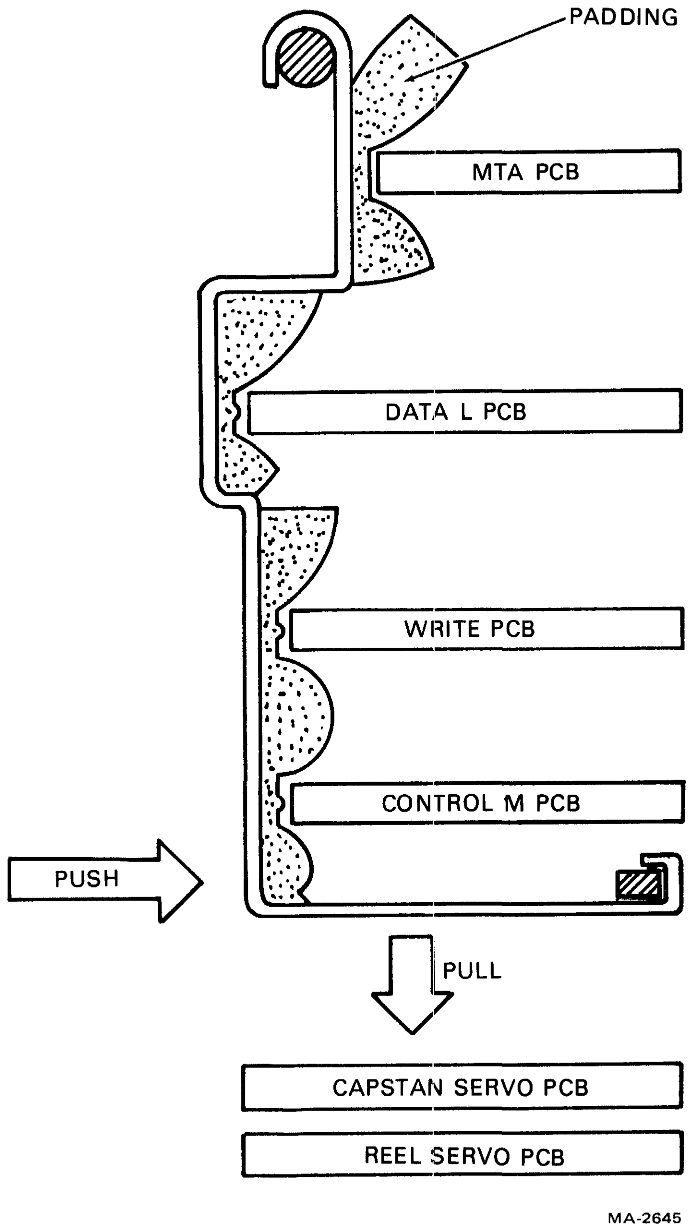


Figure 2-6 PCB Shipping Bracket

12. Open the transport front door. Use a screwdriver to release the service lock located in the lower right corner of the base assembly. Swing the base assembly open.

NOTE
The base assembly will not swing open unless the stabilizer arms are extended (step 9).

13. Remove the PCB shipping bracket by pushing in on the lower front and pulling down from underneath (Figure 2-6).

14. Check the seating of PCBs in their sockets.

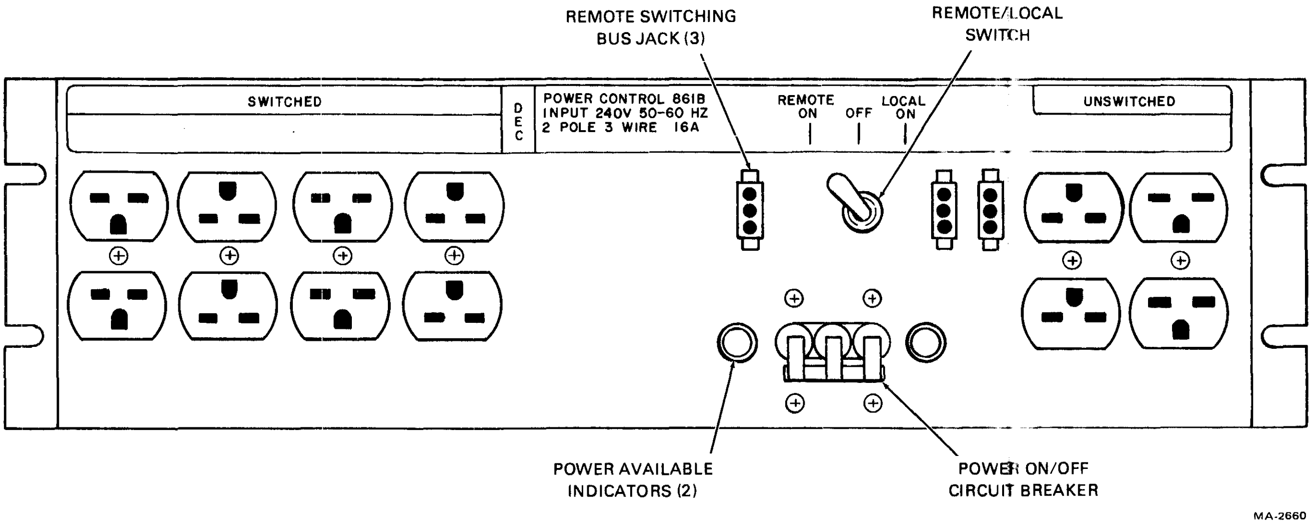


Figure 2-7 861B Power Control Panel

2.3.2 Power and Cabling

Check the TU77 power and cabling as follows.

1. Check TU77 internal cabling in this order.
   a. Power cable from 861 switched outlet to transport power pack (Figure 2-5)
   b. Power cable from 861 switched outlet to cabinet blowers
   c. Power cable from 861 switched outlet to H740-DA power supply
   d. H740-DA power cabling to TM03*
   e. TM03 cabling to Massbus connector panel*
   f. TM03 cabling to the three connectors on the M8940 MTA board.*
2. Check that the power on/off circuit breaker on the 861 is on and the REMOTE/LOCAL switch is set to REMOTE ON. (Figure 2-7).
3. Check the fuses on power pack fuse panel (Figure 1-5). To see the fuses, you must fully extend the TM03 shelf. You can see the fuses from the front of the cabinet. For a closer view, look over the fuse panel at the rear of the cabinet.
4. Remove the cover from the power transformer terminal strip (Figure 2-8). (The ac input plug on power pack must also be removed.) Check that the white/black wire and the two white/red wires are connected to the lower terminals as shown in Table 2-1. The terminals are numbered 1 through 9 from left to right.

---

*See *TM03 User's Manual* or *TM03 Technical Manual* for TM03 cabling. The TM03 manuals are listed in Table 1-1.

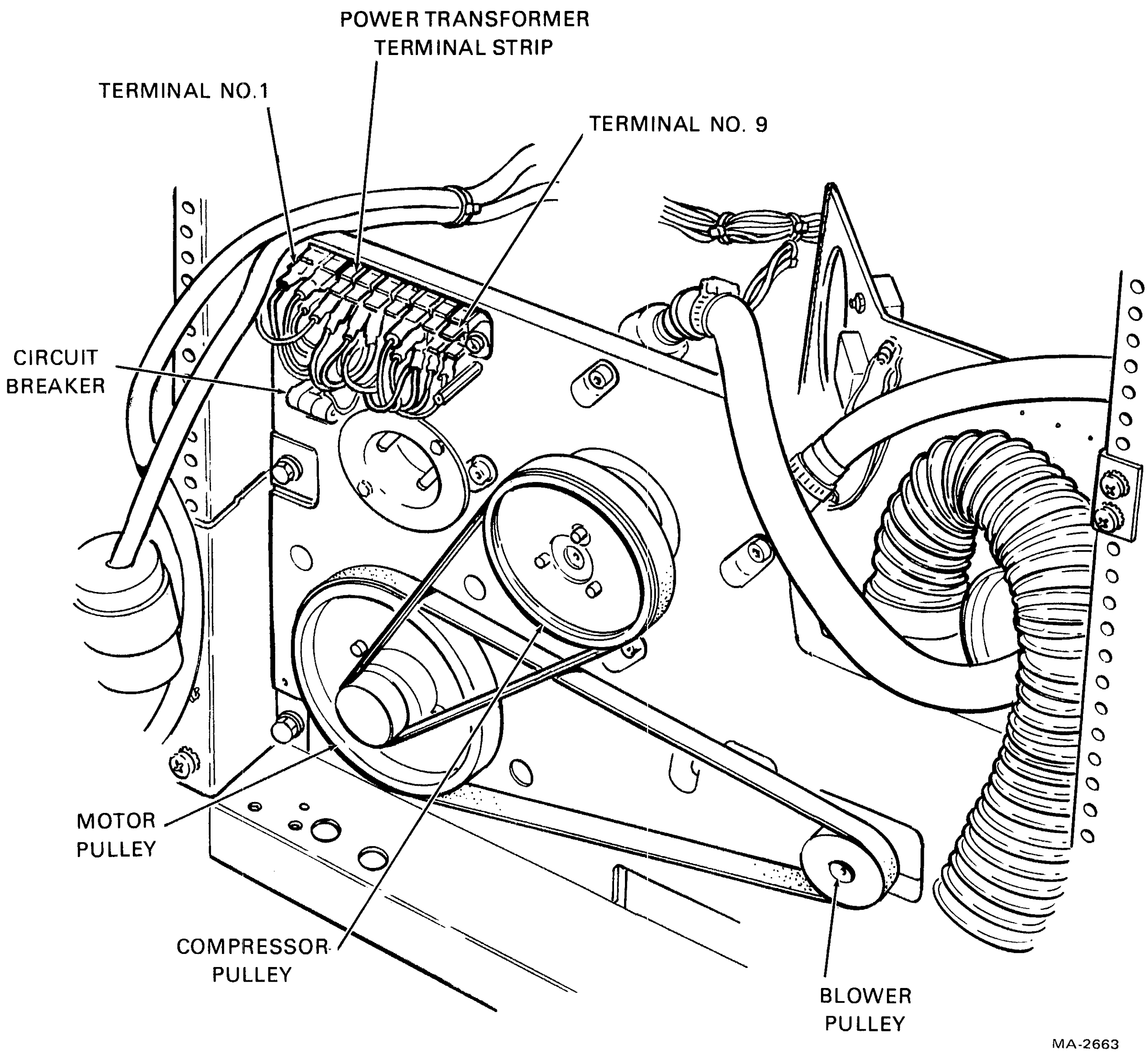


Figure 2-8 Rear of Power Pack with Pulley Cover Removed

Table 2-1 Primary Power Connections

Input Voltage	White/Black Wire	Brown Wire and White/Red Wire
198 – 205	TB1-4	TB1-7
206 – 215	TB1-3	TB1-7
216 – 225	TB1-4	TB1-8
226 – 235	TB1-3	TB1-8
236 – 245	TB1-4	TB1-9
246 – 255	TB1-3	TB1-9

Replace the cover and connect the power pack connector.

5. Check that the circuit breaker on the rear of the power pack is in the on (up) position.

6. Remove the pulley cover from the rear of the transport power pack (Figure 2-8). Spin the ac motor pulley by hand and check that the blower and compressor belts are tight and track properly.

NOTE
All TU77 transports with a serial number of WS009170 or above are manufactured to operate in the 0 to 610 m (0 to 2000 ft) range. If the transport you are installing will operate at higher elevations, you must install one of the optional high-altitude kits listed below. If not, replace the pulley cover and proceed with step 7.

The following optional high-altitude kits are available for installation on TU77 transports with a serial number of WS009170 or greater.

610 to 1220 m (2000 to 4000 ft)	60 Hz (PN A2W-0473-10 or 29-23979) 50 Hz (PN A2W-0473-11 or 29-23976)
1220 to 1830 m (4000 to 6000 ft)	60 Hz (PN A2W-0474-10 or 29-23980) 50 Hz (PN A2W-0474-11 or 29-23977)
1830 to 2439 m (6000 to 8000 ft)	60 Hz (PN A2W-0475-10 or 29-23981) 50 Hz (PN A2W-0475-11 or 29-23978)

Refer to Table 2-2 for a list of parts and associated part numbers for each kit.

Table 2-2 **Pulley and Belt Part Number for Altitude Changes**

Altitude	Freq.	Blower Belt	Compressor Belt	AC Motor Pulley	Compressor Pulley
610 to 1220 m (2000 to 4000 ft)	60 Hz 50 Hz	108479-03 108479-05	108479-08 108479-08	108478-15 108478-03	102635-01 102635-01
1220 to 1830 m (4000 to 6000 ft)	60 Hz 50 Hz	108479-11 108479-12	108479-01 108479-08	108478-14 108478-10	102635-03 102635-03
1830 to 2440 m (6000 to 8000 ft)	60 Hz 50 Hz	108479-11 108479-12	108479-01 108479-01	108478-07 108478-11	102635-05 102635-05

NOTE
Vendor part numbers shown.

Install the high-altitude kit as follows.

a. Turn transport power off at the cabinet power controller.

CAUTION
You must remove the 220 V power cord before performing this or any other removal and replacement procedure within the power pack assembly.

b. Remove the belt guard. Remove both belts by rotating the pulleys clockwise, and slipping the belts off the larger pulleys. It is not necessary to loosen any compressor or blower mounting screws.

c. Remove the pulley set from the ac motor shaft. Save the small pulley (hub) for installation. Replace the larger pulley with the correct pulley from the high-altitude kit. Reinstall the pulleys on the motor shaft.

d. Remove the pulley from the compressor shaft and replace it with the correct high-altitude compressor pulley.

e. Replace the belts with the correct high-altitude belts. Rotate the belts clockwise by placing a belt around the smaller pulley and rotating it onto the larger pulley. If too tight or loose, adjust the position of the blower or compressor.

f. Check that both belts track completely on the pulleys. If not, you may have to shift the motor pulleys.

g. Replace the belt guard and the power cord.

h. Package the old belts and pulleys in a marked container, and leave the container in the base of the transport. The transport may move to a lower altitude in the future.

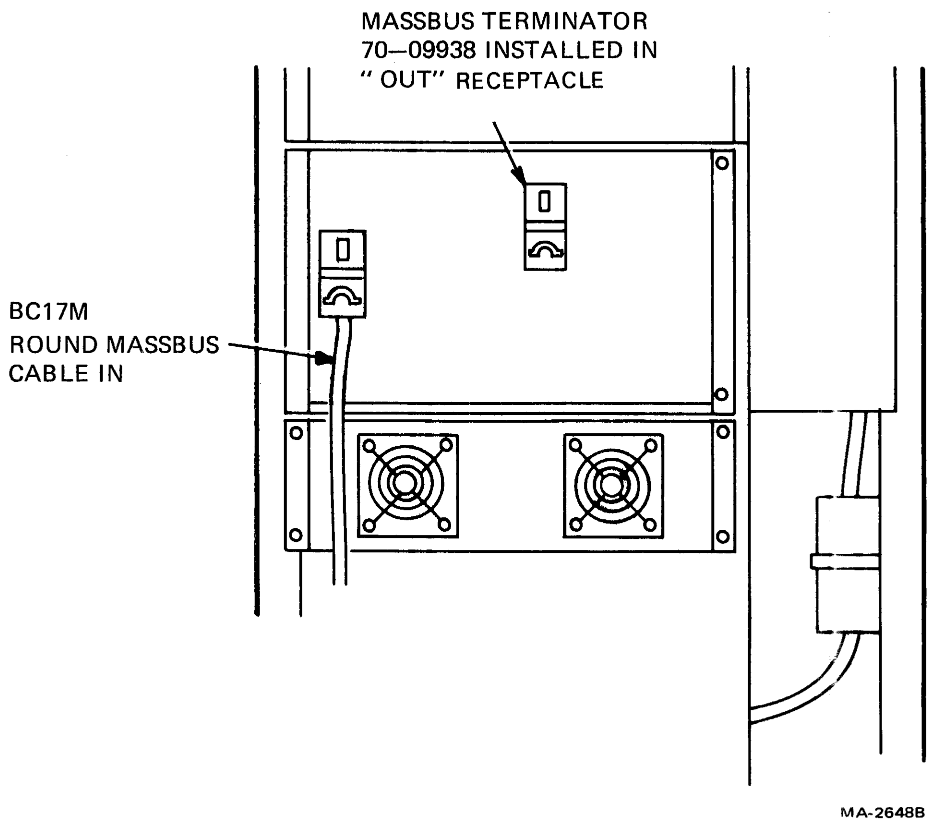


Figure 2-9 Massbus Connection to TU77 Master Transport

NOTE
You must perform vacuum and air pressure checks and adjustments. Refer to the Pneumatic System Checks (Paragraph 2.5.1.9).

7. Connect the BC17M round Massbus cable to the in connector on the rear of the TU77 (Figure 2-9).

8. Connect a Massbus terminator into the out receptacle.

9. Connect the remote switching control bus from the CPU to one of the three jacks on the 861, next to the remote/local switch.

10. Use the green/yellow ground cable provided to ground the TU77 cabinet frame to the CPU cabinet frame. The grounding studs for the TU77 are on the lower side frame members (Figure 2-11).

11. Replace the front panel. Close the rear door.

12. Check that system power is off at the CPU and connect the ac power cable from the 861 to the power source.

13. Perform the acceptance tests (Paragraph 2.5).

2.4 MULTI-TRANSPORT INSTALLATION

This section describes how to install more than one TU77 transport.

2.4.1 Mechanical Installation

When an installation contains more than one transport, only the master transport is shipped with the side panels. During installation, one of the side panels is removed and the master and slave transport(s) are bolted together. The removed side panel is then mounted onto the end slave transport.

After you remove and inspect the shipping containers, roll the transport cabinets into their approximate position. Place the master transport next to the CPU. Proceed as follows for each cabinet unless otherwise specified.

1. An array of vertical slots constitute venting in the cabinet front cover. A quick-release latch is located approximately 2.54 cm (1 in) behind each end of this array. Insert a thin-bladed tool, such as a small steel rule, into one of the end slots; push on the latch while simultaneously exerting a forward pull to release one corner of the front cover. In the same manner, while continuing to exert a forward pull, release the remaining latch at the other end of the array to free the front panel. Remove the front panel and set it aside. Do not disconnect from the front panel.

2. Remove the two leveler pads and four leveler feet that are wrapped in blister wrap and taped to the inside of the front panel.

3. Raise the interlock rods on each side of the cabinet. Remove the two stabilizer arms from the stabilizer sleeve assemblies (Figure 2-3).

4. Screw the leveler pads into the stabilizer arms.

5. Raise the interlock rods and reinsert the stabilizer arms into the stabilizer sleeve assemblies.

6. Install the leveler feet in the lower corners of the cabinet frame (Figure 2-3).

7. Extend the two stabilizer arms from each cabinet and lower the leveler pads until they just touch the floor. Do not place any weight on the leveler pads. (The pads will be readjusted later.)

8. Open the master transport front door. Use a screwdriver to release the service lock in the lower-right corner of the base assembly. Swing the base assembly open.

NOTE

The base assembly will not swing open unless the stabilizer arms are extended (step 7).

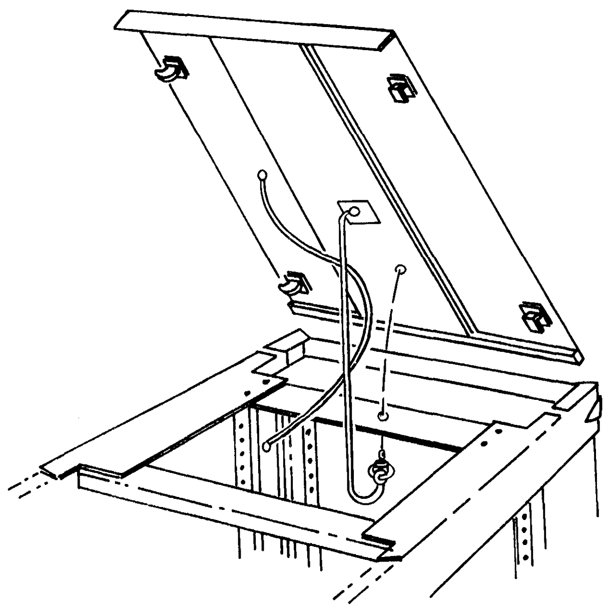


Figure 2-10 Top Cover Fastener

9. Locate the fastener attached to the bottom of the master transport top cover (Figure 2-10). Release the top cover by turning the fastener one-quarter turn in a counterclockwise direction. When the cover is released, the fastener hangs by a wire from the top cover. Pull the top cover forward approximately 1.27 cm (0.5 in) and lift off. Rest the cover on top of the cabinet leaving the ground wire connected.

10. Remove the end panel furthest from the CPU by grasping both sides of the panel and lifting it off the four mounting bolts. If the side panel will not lift off, you may have to loosen the mounting bolts. Remove the front panel trim to gain access to the upper front mounting bolt. To remove the trim, lift up and out (Figure 2-11).

11. Disconnect the side-panel ground strap from the cabinet frame and set the panel aside.

12. Remove the four exposed mounting bolts from the master transport.

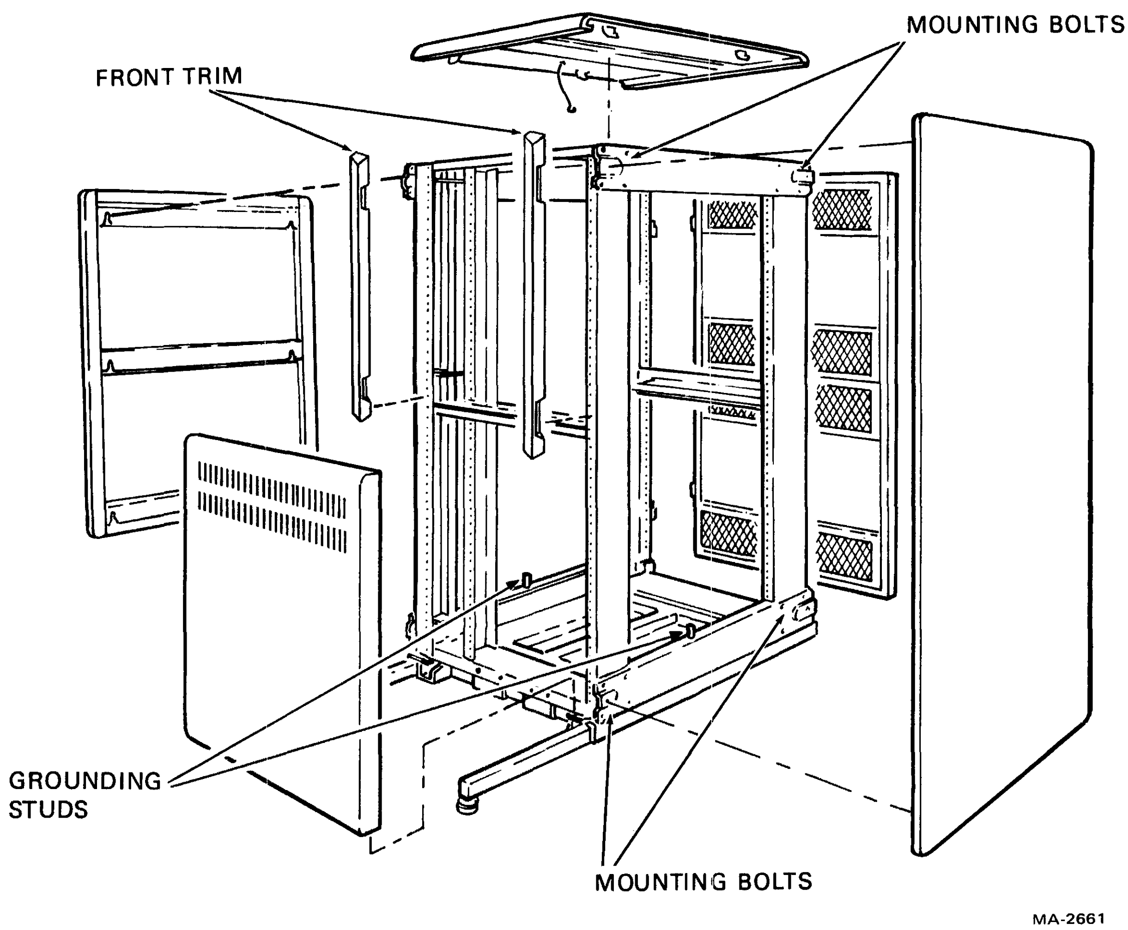


Figure 2-11 Corporate Cabinet with Side Panels and Top Cover Removed

13. Push the cabinets together, with the mounting-bolt plates side by side.

    a. Use the short ground strap provided with the slave transports to ground the master and slave cabinets together. The grounding studs for the TU77 are on the lower side frame members (Figure 2-11).

    b. Use the green/yellow ground cable provided with the master transport to ground the master TU77 cabinet frame to the CPU cabinet frame.

14. Use a 1.43 cm (9/16 in) wrench to lower the leveling feet of the highest cabinet until they make contact with the floor giving the cabinet a firm base.

15. Use a level to adjust the feet until the cabinet is level.

16. Level and adjust the adjoining cabinet(s) so that the bolting (middle) holes on the four corner bolting plates are aligned.

17. After aligning the bolting holes of adjoining cabinets, insert 1/4-20 bolts into the holes and secure them with kep-nuts (bolts and nuts are provided in the hardware installation packet). Bolting the cabinets in this manner provides good horizontal alignment.

18. After all the cabinets are bolted together, readjust the leveler pads on the stabilizer arms until each pad touches, yet easily slides along the floor. Do not place any weight on the leveler pads.

19. Install the four mounting bolts from the master cabinet into the mounting-bolt plates of the end slave transport. Remove front panel trim if necessary.

20. Open the base assembly of the end slave transport. Release the top cover fastener; remove the cover and rest it on top of the cabinet, off to one side. Do not disconnect the cover ground strap.

21. Set the side panel taken from the master transport, next to the slave transport. Connect the panel ground strap to the cabinet frame and mount the panel onto the side of the slave transport.

22. Replace the top cover and secure the cover fastener.

23. Unlock the rear door of the master transport, using the opening tool (Figure 2-4). Insert the tool and turn one-quarter turn in a counterclockwise direction.

24. Remove the locking pins from the rear of the TM03 shelf slide assembly of the master TU77 cabinet (Figure 2-5).

25. Open the base assembly of each transport and remove the PCB shipping bracket by pushing in on the lower front and pulling down from underneath (Figure 2-6). Check the seating of PCBs in their sockets.

2.4.2 Power and Cabling

Perform the following steps for each of the TU77 cabinets unless otherwise specified.

1. Check TU77 internal cabling in this order.

   a. Power cable from 861 switched outlet to transport power pack (Figure 2-5)

   b. Power cable from 861 switched outlet to cabinet blowers

   c. Power cable from 861 switched outlet to H740-DA power supply*

   d. H740-DA power cabling to TM03*

   e. TM03 cabling to Massbus connector panel*

   f. TM03 cabling to the three connectors on the M8940 MTA board*.

2. Check that the power on/off circuit breaker on the 861 is on and the REMOTE/LOCAL switch is set to REMOTE ON (Figure 2-7).

3. Check fuses on power pack fuse panel (Figure 1-5). You can see the fuses from the front of the cabinet. (On the master transport, you must to fully extend the TM03 shelf to see the fuse panel.) You can get a closer view from the rear of the cabinet by looking over and down onto the fuse panel.

---

* Master TU77 only. See *TM03 User's Manual* or *TM03 Technical Manual* for TM03 cabling. The TM03 manuals are listed in Table 1-1.

4. Remove the cover from the power transformer terminal strip (Figure 2-8). (The ac input plug on the power pack must also be removed.) Check that the white/black wire and the two white/red wires are connected to the lower terminals as shown in Table 2-1. The terminals are numbered 1 through 9 from left to right. Replace the cover and connect the power pack connector.

5. Check that the circuit breaker on the rear of the power pack is in the on (up) position.

6. Remove the pulley cover from the rear of the transport power pack (Figure 2-8).

   NOTE
   All TU77 transports with a serial number of WS009170 or above are manufactured to operate in the 0 to 610 m (0 to 2000 ft) range. If the transport you are installing will operate at higher elevations, you must install one of the optional high-altitude belt and pulley kits. Refer to Paragraph 2.3.2, step 6 for instructions.

   Spin the ac motor pulley by hand and check that the blower and compressor belts are tight and track properly. Replace the pulley cover.

   NOTE
   You must perform vacuum and air pressure checks and adjustments. Refer to the Pneumatic System Checks (Paragraph 2.5.1.9).

7. Connect the BC17M round Massbus cable to the in connector on the rear of the master TU77 (Figure 2-9).

8. If the system has only one master TU77, connect a Massbus terminator into the out receptacle of the master unit. If the system contains another master TU77, connect them together in daisy chain fashion by connecting another BC17M Massbus cable from the out receptacle of the first TU77 master to the in receptacle of the second. If there are more master units in the system, connect them onto the daisy chain in a similar manner. Install a Massbus terminator into the out receptacle of the last master unit on the chain.

9. Daisy chain the slave TU77s interfaced to a particular TM03 as follows. Connect three slave bus cables from the M8940 MTA board in the master unit to the M8940 MTA board in the first slave unit; repeat this for up to a maximum of three slave units (four transports to one TM03 tape formatter).

   If the system contains more than three slave units, a second TU77 master unit is required. The slave bus cabling is shown in Figure 2-12. The orientation of the slave bus to the MTA boards is colored stripes on the left with the smooth side up for the in cables, and colored stripes on the left with the ribbed side up for the out cables (Figure 2-13).

10. All M8940 MTA boards have five resistive dual in-line package (DIP) pack terminators (PN 13-11003-01) for terminating the slave bus. Remove the terminators from all except the first M8940 board of each slave bus chain. The location of the terminators are shown in Figure 2-12 and 2-13.

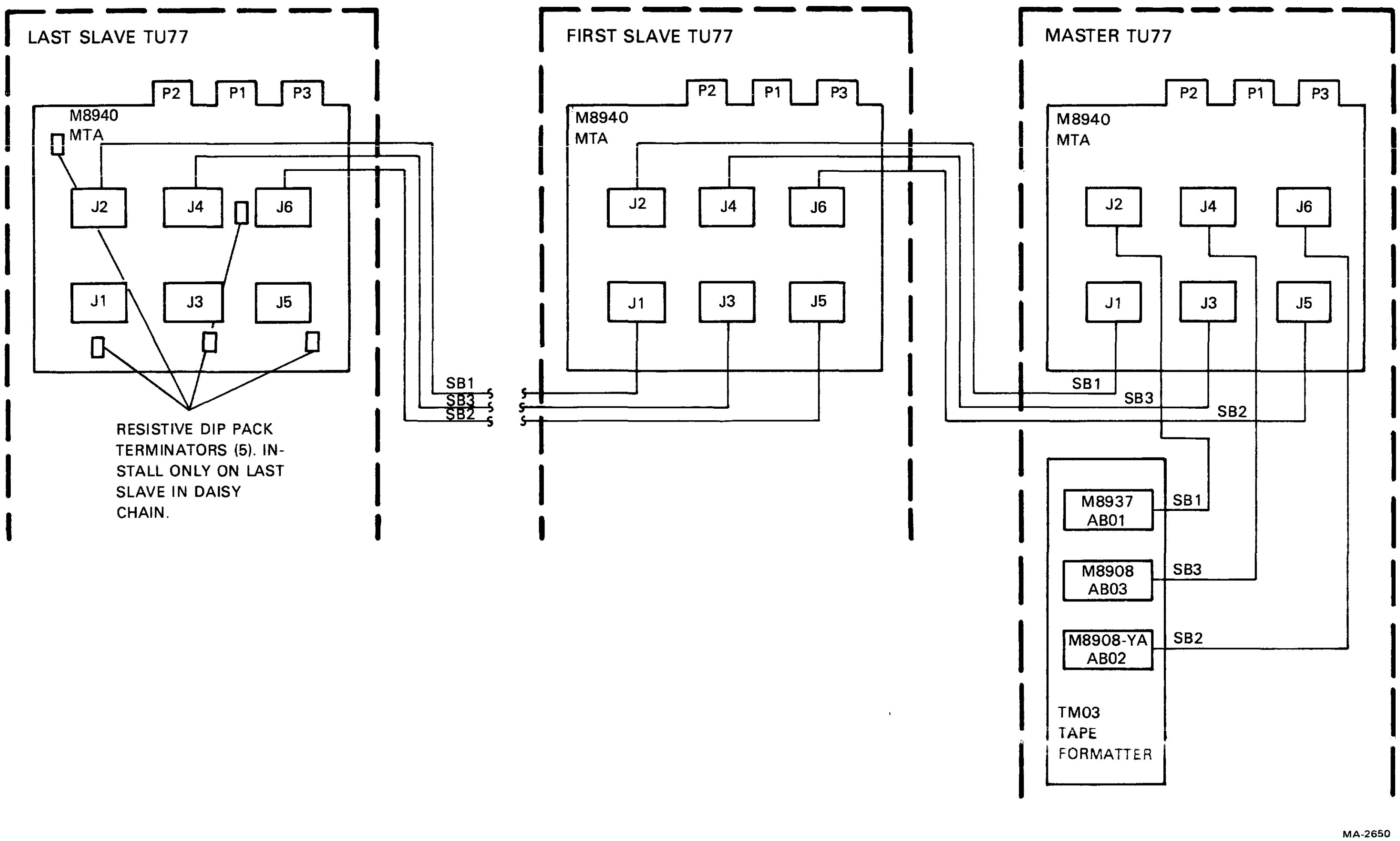


Figure 2-12 Slave Bus Cabling of TU77 Daisy Chain

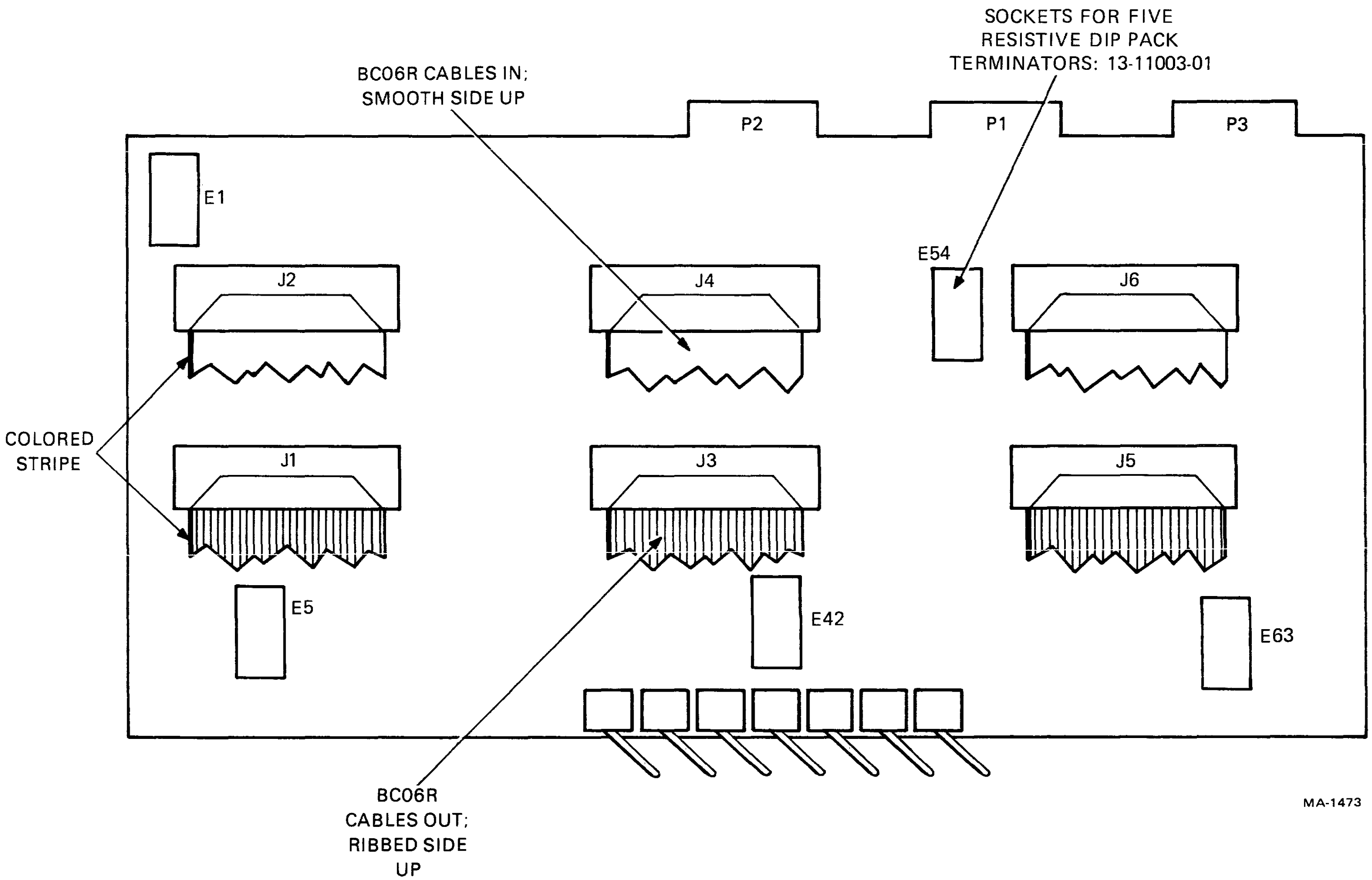


Figure 2-13 Cable Orientation on M8940 MTA Module

11. Daisy chain the remote switching control bus by connecting the bus from the CPU to one of the three jacks next to the REMOTE/LOCAL switch on the 861 in the master TU77. Connect the bus from one of the two remaining jacks to the 861 in the next TU77. Continue the daisy chain until all the TU77s are connected to the remote switching control bus.

12. Check that system power is off at the CPU. Connect the ac power cable from each 861 to a power source.

13. Install cabinet front panels. Close and secure all base assemblies.

14. Perform the acceptance tests (Paragraph 2.5).

2.5 ACCEPTANCE TESTING

This section lists and describes all the tests required for acceptance testing of the TU77 transport and the TM03 tape formatter. If the acceptance tests are performed satisfactorily, then the TM03 and the TU77 are correctly installed and operating.

Acceptance testing is divided into two categories: a turn-on and loading checkout, and the system diagnostics. The turn-on and loading checkout checks basic functions of the transport only. The diagnostics treat the TM03 and the transport as a subsystem. This section provides instructions on how to run these diagnostics and interpret the results.

If you are unfamiliar with interlocks and other conditions affecting autoload/manual load selection, refer to Paragraph 3.2.2.

2.5.1 Turn-On and Loading Checkout

The turn-on and loading checkout consists of loading the transport under various conditions and checking for the proper responses. The checkout uses flowcharts to show the proper sequence of events for each of the loading operations. Actions listed inside a flowchart box occur at about the same time, while actions listed in separate boxes occur in sequence. The flowcharts include minor troubleshooting to aid in locating simple problems caused by bad tape or improper loading procedures. Perform the following operations in order.

2.5.1.1 Power On – Follow the instructions and check for the events specified in Figure 2-14.

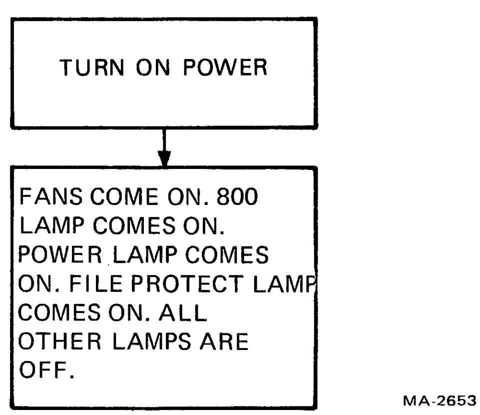


Figure 2-14 Power On

2.5.1.2 Load Sequence Without Tape – With no tape reel mounted on the supply hub, follow the instructions and check for the events specified in Figure 2-15.

2.5.1.3 Inhibited Autoload Sequence – Install a write enable ring on a large 267 mm (10-1/2 in) reel of tape. Tape the leader to prevent magnetic tape from coming off the reel. Mount the reel onto the supply hub. Close the transport front door so the interlock can enable the autoload sequence. If you want to leave the door open, override the interlock by pulling it out. Follow the instructions and check for the events specified in Figure 2-16.

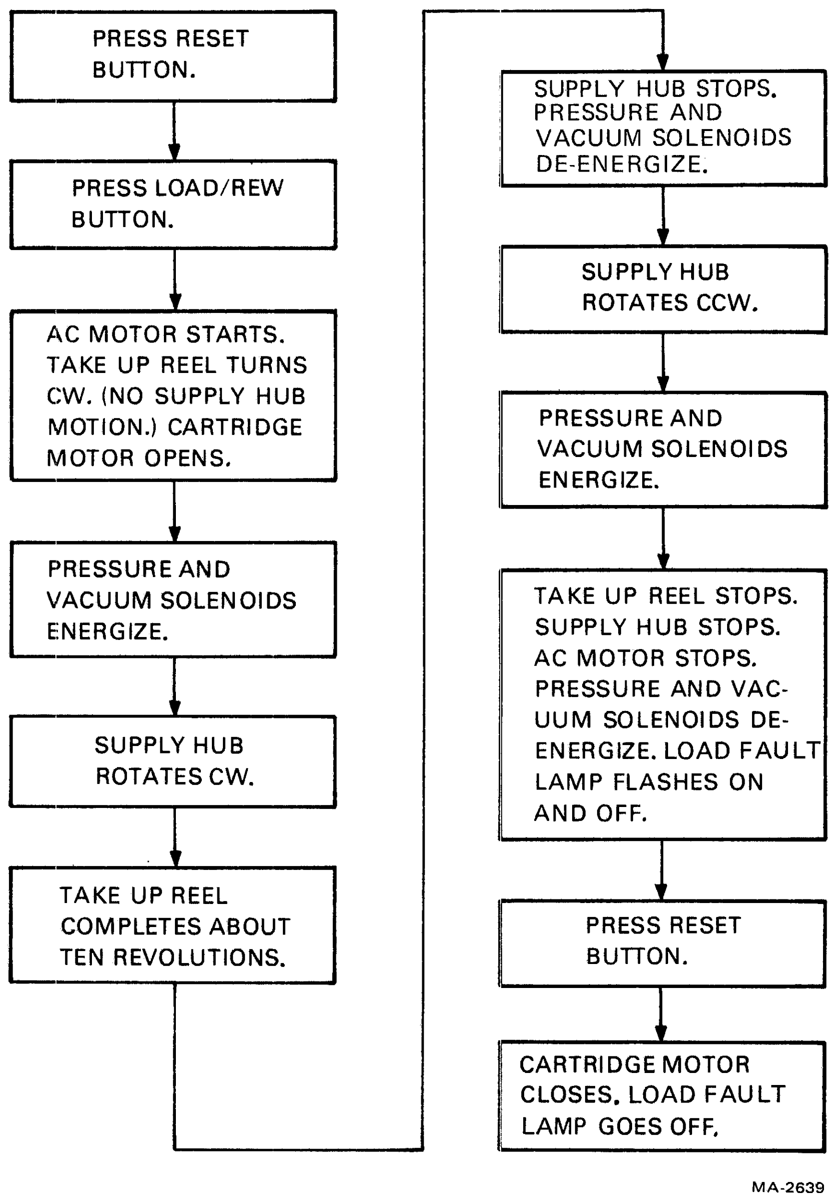


Figure 2-15 Load Sequence Without Tape

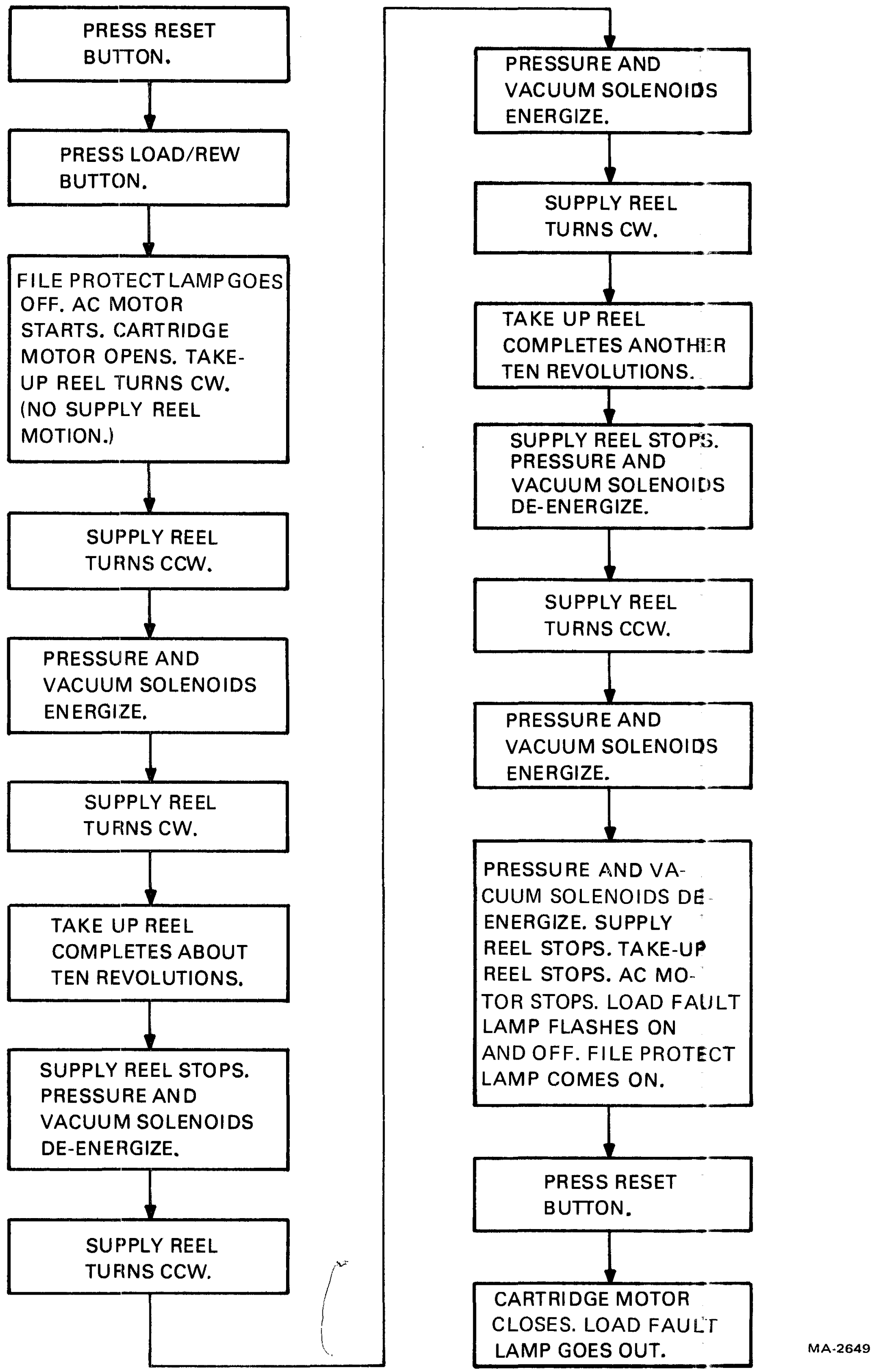


Figure 2-16 Inhibited Autoload Sequence

2.5.1.4 Autoload Sequence – Remove the tape from the leader, allowing the magnetic tape to come off the supply reel. Check that the leader has no creases or rips. If necessary, cut the end of the tape with the tape crimper. Leave the write enable ring installed. Close the transport front door so the interlock can enable the autoload sequence. If you want to leave the door open, override the interlock by pulling it out. Follow the instructions and check for the events specified in Figure 2-17.

2.5.1.5 Manual Load Sequence – Install a write enable ring on a 216 or 178 mm (8-1/2 or 7 in) reel of tape and mount the reel onto the supply hub. Check that the leader has no creases or rips. If necessary, cut the end of the tape with the tape crimper. Insert 8 to 10 cm (3 to 4 in) of tape into the threadblock column. Follow the instructions and check for the events specified in Figure 2-18.

2.5.1.6 Unload Sequence – Follow the instructions and check for the events specified in Figure 2-19.

2.5.1.7 Manual Load Repeatability – Check manual load repeatability as follows.

1. Mount a 216 or 178 mm (8-1/2 or 7 in) reel of tape onto the supply hub.
2. Check that the leader has no creases or rips. If necessary, cut the end of the tape with the tape crimper.
3. Insert 8 to 10 cm (3 to 4 in) of tape into the threadblock column.
4. Initiate a manual load by pressing and releasing the LOAD/REW button.
5. If the tape loaded successfully, press the UNLOAD button to unload the tape.
6. Repeat steps 3, 4, and 5 to attempt eight manual loads. If a failure occurs within the 8 tries, continue manual loading up to 20 tries. There should be no more than 3 failures among the 20 successive tries.
7. After completing the manual load repeatability test, check the tape for damage caused by the tape transport. The tape should not show damage that would cause a load failure or data errors.

2.5.1.8 Autoload Repeatability – Check autoload repeatability as follows.

1. Mount a large 267 mm (10-1/2 in) reel of tape onto the supply hub.
2. Check that the leader has no creases or rips. If necessary, cut the end of the tape with the tape crimper.
3. Close the transport door.
4. Initiate an autoload by pressing and releasing the LOAD/REW button.
5. If the tape loaded successfully, press the UNLOAD button to unload the tape.
6. If the autoload fails, the tape will automatically try to load a second time. If the second attempt fails, the load fault indicator will flash on and off. This is counted as one failure.
7. Repeat steps 3, 4, 5, and 6 to attempt nine autoloads. If a failure occurs within the 9 tries, continue autoloading up to 20 tries. There should be no more than 2 failures among the 20 successive tries.
8. After completing the autoload repeatability test, check the tape for damage caused by the tape transport. The tape should not show damage that would cause a load failure or data errors.

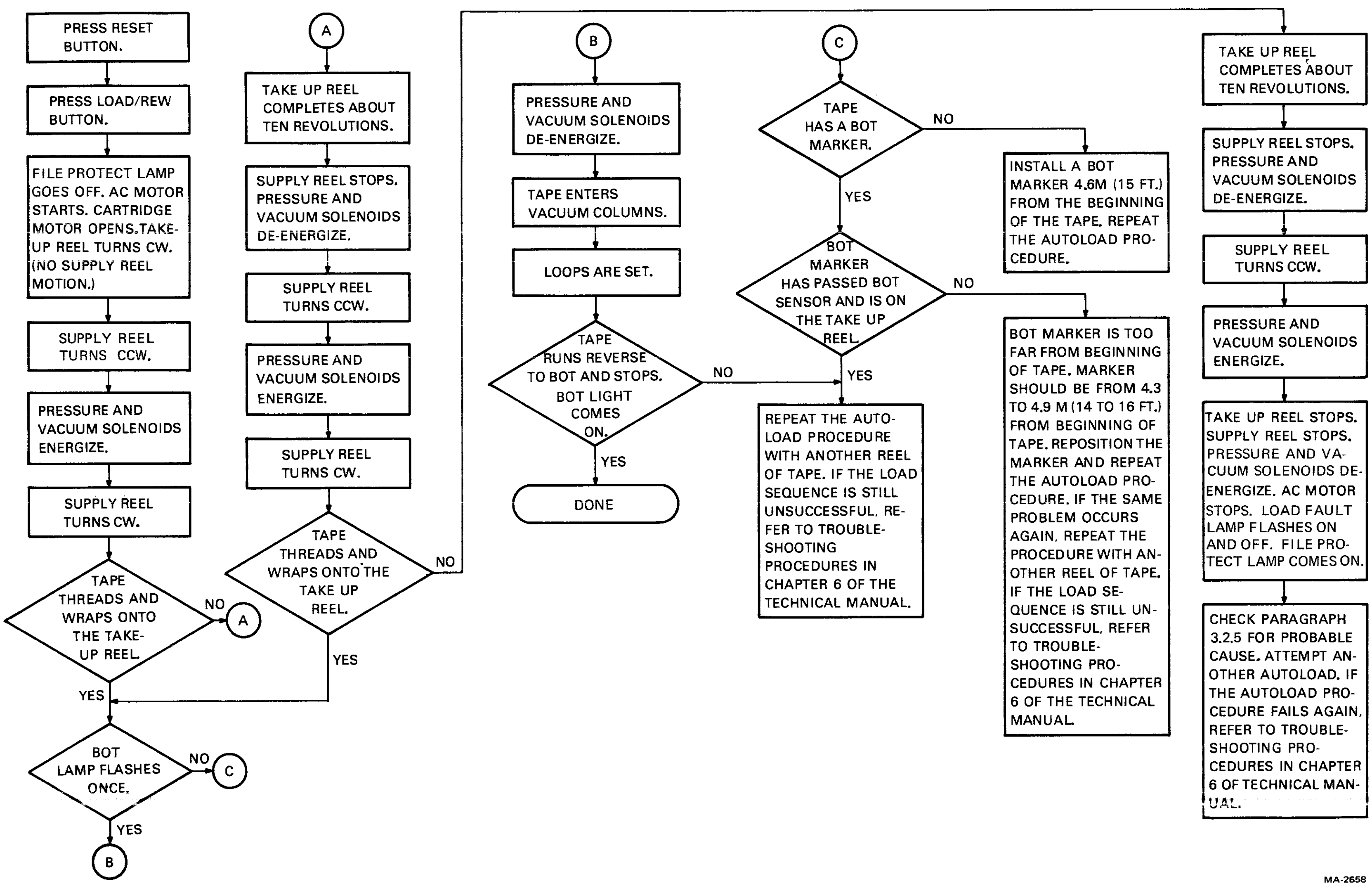


Figure 2-17 Autoload Sequence

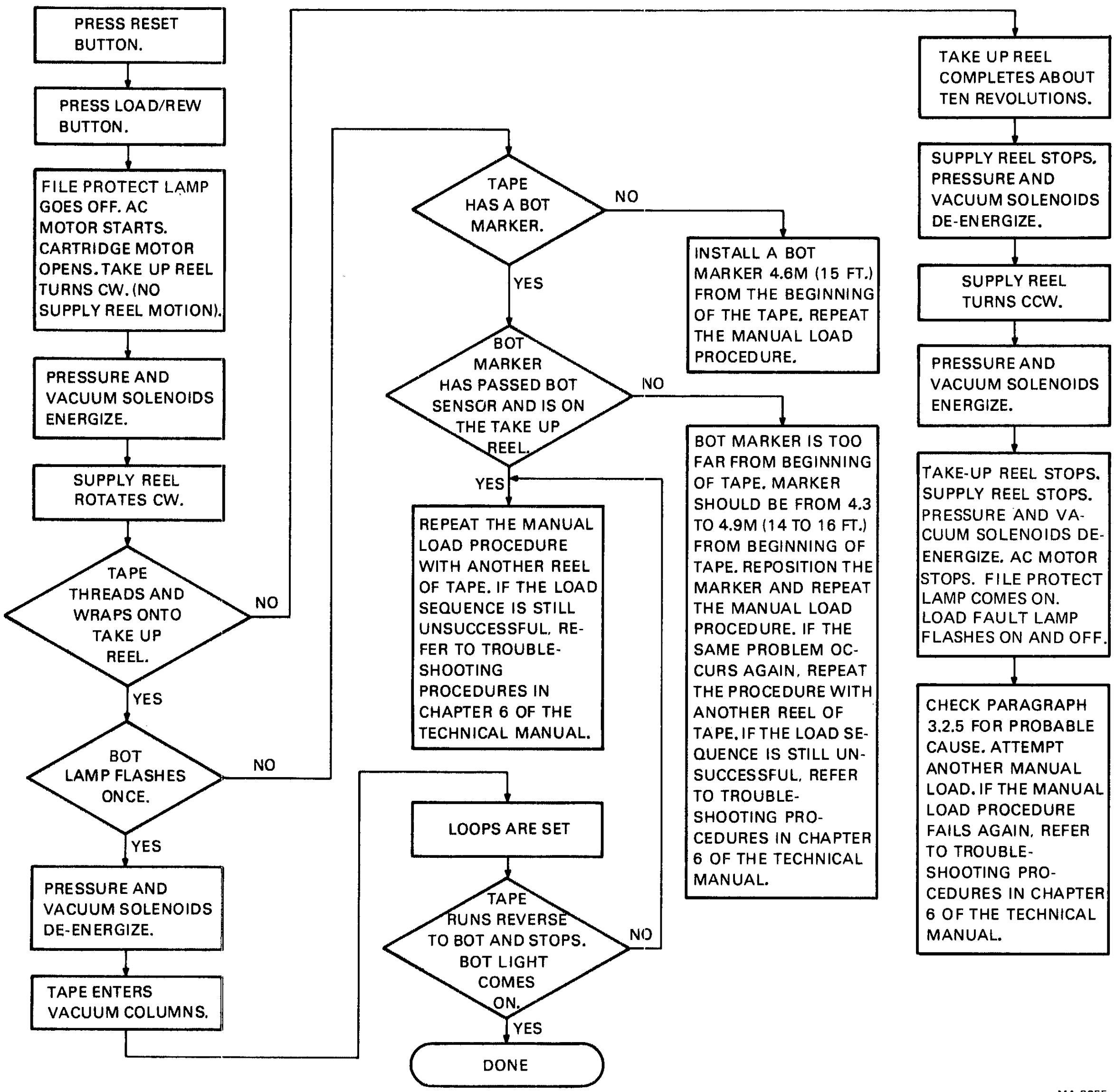


Figure 2-18 Manual Load Sequence

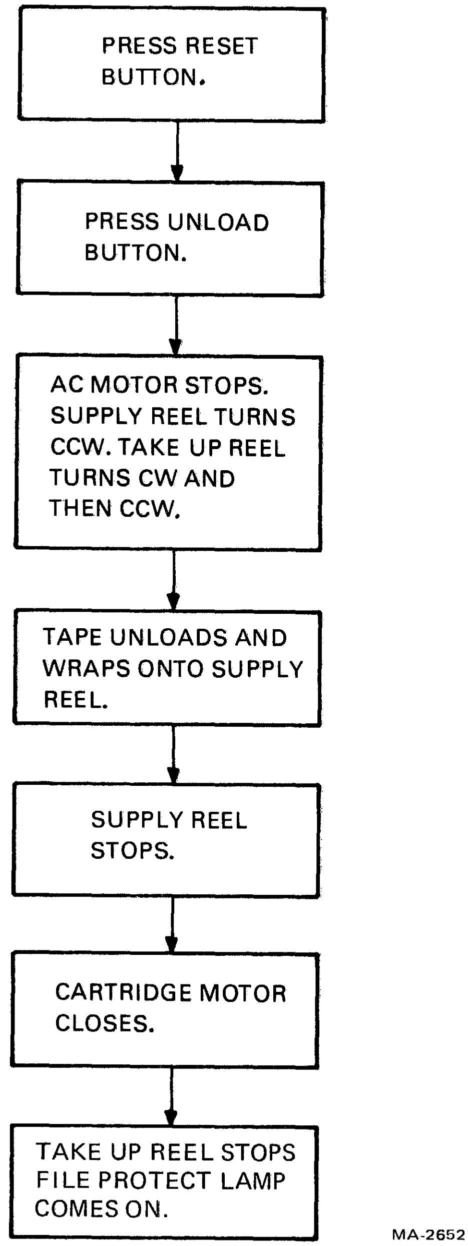


Figure 2-19 Unload Sequence

2.5.1.9 Pneumatic System Checks – Verify each TU77 vacuum and pressure setting by performing the procedures in Paragraph 6.5.6. This is especially important if a high-altitude belt/pulley kit has just been installed. Adjust any setting that is out of tolerance.

2.5.2 TM03/TU77 Diagnostics

Install a write enable ring on a large 267 mm (10-1/2 in) reel of tape. Mount the reel onto the supply hub. Close the transport front door to close the autoload interlock or pull out the interlock switch to override. Press the LOAD/REW button to load the tape. Press the ON LINE button and check that the on-line indicator is on.

Table 2-3 lists the TM03/TU77 diagnostics for PDP-11, DECSYSTEM-20, and PDP-11/780 VAX systems. Run the following diagnostics that apply to the system used. Use the instructions in the diagnostic documentation and check for the specified results.

Table 2-3 TM03/TU77 Diagnostics Used for Acceptance Testing*

Title	PDP-11	Number DECSYSTEM-20	PDP-11/780 VAX	Description
Control Logic Test 1	MAINDEC 11-DZTEA†	–	–	Test TM03 logic. Includes control and data logic in maintenance modes wrap 0 through 3. Indicates probable faulty area.
Control Logic Test 2	MAINDEC 11-DZTEB†	–	–	Tests TM03 logic. Includes control and data logic in maintenance mode wrap 4. Indicates probable faulty area.
Basic Function Test	MAINDEC 11-DZTEC†	MAINDEC 10-DFTUE‡	–	Tests the subsystem command functions (read, write, space, etc.)
Drive Function Timer	MAINDEC 11-DZTEE†	–	ZZ-ESMAB	Tests for proper tape motion timing (speed, acceleration, deceleration) and data transfer rate.
Data Reliability	MAINDEC 11-DZTED†	MAINDEC 10-DFTUK†	ZZ-ESMAA	Tests TM03 and TU77 circuitry by writing and reading user-determined or predetermined data patterns and recording modes. Provides error information to the user via the console.

* Additional TM03/TU77 diagnostics are available for maintenance
† Revision B (Rev 2) or higher
‡ Revision F (Rev 6) or higher

2.5.2.1 Control Logic Test No. 1 – Run control logic test 1 for two passes. No errors are allowed. Run the test again with manual intervention.

2.5.2.2 Control Logic Test No. 2 – Run control logic test 2 for two passes. No errors are allowed.

2.5.2.3 Basic Function Test – Run the PDP-11 basic function test for two passes. No errors are allowed. Run the DECSYSTEM-20 basic function test B1 and B2 for one pass each. No errors are allowed.

2.5.2.4 Drive Function Timer – Run the PDP-11 or VAX-11/780 drive function timer diagnostics for two passes. No out-of-range errors are allowed.

2.5.2.5 Data Reliability

NOTE
In using the data reliability diagnostic on the PDP-11, DECSYSTEM-20, and PDP-11/780 VAX, do not count errors caused by bad tape.

*PDP-11 System Using 11-DZTED**

1. Run the data reliability test for one pass in NRZI mode with the following parameters.

   Density = 3
   Parity = 0
   Format = 14
   Record count = 1
   Character count = 20
   Pattern number = 1
   Tape mark = 1
   Interchange read = 0
   Single pass = 1
   CRC correction = 0
   Stalls
      Read = 1
      Write = 1
      Turnaround = 1

   Before typing the last CR, set the console switches to 000720. Then type CR to run the test. The following errors are allowed.

   0 hard errors (read and write)
   2 soft write errors
   2 soft read errors

* Revision B or higher.

2. Run the data reliability test for one pass in PE mode with the following parameters.

   Density = 4
   Parity = 0
   Format = 14
   Record count = 1
   Character count = 20
   Pattern number = 1
   Tape mark = 1
   Interchange read = 0
   Single pass = 1
   Stalls
      Read = 1
      Write = 1
      Turnaround = 1

   Before typing the last CR, set the console switches to 000720. Then type CR to run the test. The following errors are allowed.

   0 hard errors (read and write)
   4 soft write errors
   2 soft read errors

*DECSYSTEM-20 Using 10-DFTUK**

1. Run NRZI test R8 for one pass. The following errors are allowed.

   0 hard errors (read and write)
   3 soft write errors
   1 soft read errors

2. Run PE test R1 for one pass. The following errors are allowed.

   0 hard errors (read and write)
   3 soft write error
   1 soft read error

3. Set left switches to 400010. Run the NRZI IW test for one pass with the following parameters entered on the terminal.

   Density = 800
   Close skew window = CR
   Data compare mask = CR
   SYSERR recording = N
   Fast mode Y or N = Y
   Verify tapes = N

   The following errors are allowed.

   0 hard write errors
   1 soft write error

---

* Revision B or higher.

Run the NRZI IR test for one pass. The following errors are allowed.

0 read errors (hard or soft)

4. With the left switches still set to 400010, run the PE IW test for one pass with the following parameters entered on the terminal.

   Density = CR or 1600
   Close skew window = CR
   Data compare mask = CR
   SYSERR recording = N
   Fast mode Y or N = Y
   Verify tapes = N

   The following errors are allowed.

   0 hard write errors
   1 soft write error

   Run the PE IR test for one pass. The following errors are allowed.

   0 read errors (hard or soft)

PDP-11/780 VAX System Using ZZ-ESMAA

1. Run the data reliability test for one pass in NRZI mode. Supply the requested information. The following errors are allowed.

   0 hard errors (read and write)
   2 soft write errors
   2 soft read errors

2. Run the data reliability test for one pass in PE mode. Supply the requested information. The following errors are allowed.

   0 hard errors (read and write)
   4 soft write errors
   2 soft read errors

CHAPTER 3
OPERATION

3.1 CONTROLS AND INDICATORS

The TU77 operational controls and indicators are on the transport control panel. The controls and indicators are shown in Figure 3-1 and listed in Tables 3-1 and 3-2.

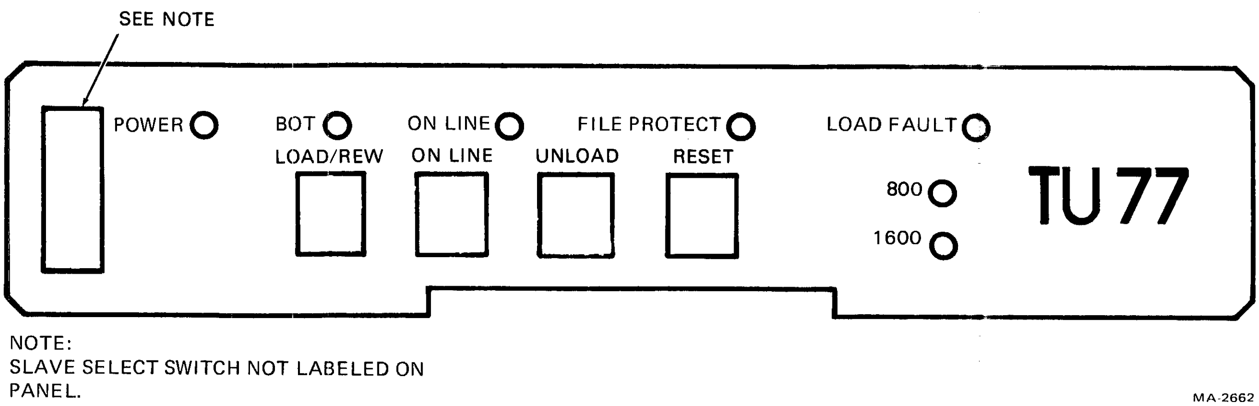


Figure 3-1 TU77 Control Panel

Table 3-1 TU77 Controls

Control	Function
Slave Select switch (unlabeled)	Selects the address (slave number 0 to 3) of the tape transport.
LOAD/REW	Pressing and releasing the LOAD/REW button will initiate one of three sequences. 1. With no tape in path, a load sequence is initiated. 2. With tape in path but not tensioned, a mid-reel load sequence is initiated. In a mid-reel load sequence the tape will load and run in the reverse direction to BOT. 3. With tape in path and tensioned, and the transport off-line, the tape rewinds to BOT. If the tape is already at BOT or if the transport is on-line, no action occurs.

Table 3-1 TU77 Controls (Cont)

Control	Function
ON LINE	Pressing and releasing the ON-LINE button will change the transport from off-line to on-line. Pressing and releasing the button again will change the transport from on-line to off-line.
UNLOAD	If the TU77 is off-line, pressing and releasing the UNLOAD button causes the tape to rewind and unload. If the tape is already at BOT, it will unload. If the TU77 is on-line, the UNLOAD button has no effect.
RESET	Pressing and releasing the RESET button terminates all functions and clears a load fault.

Table 3-2 TU77 Indicators

Indicator	Function
power	Indicates presence of dc and secondary ac power.
bot	Indicates tape is at BOT.
on line	Indicates the TU77 is on-line. The transport will return to off-line if any of the following occur. 1. ON LINE button is pressed. 2. An external rewind unload command is received. 3. Vacuum column interlock is broken. 4. AC power is lost. 5. RESET button is pressed.
file protect	Indicates that a reel of tape without a write-enable ring has been loaded onto the transport.
load fault	Lamp flashes when a load fault has occurred; there are two causes. 1. The autoload sequence has failed to load a tape from a 267 mm (10-1/2 in) reel after two trys. 2. A load sequence has failed to load tape from a 216 or 178 mm (8-1/2 or 7 in) reels.
800	Indicates the tape transport is set to read or write at 800 BPI (NRZI mode).
1600	Indicates the tape transport is set to read or write at 1600 BPI (PE mode).

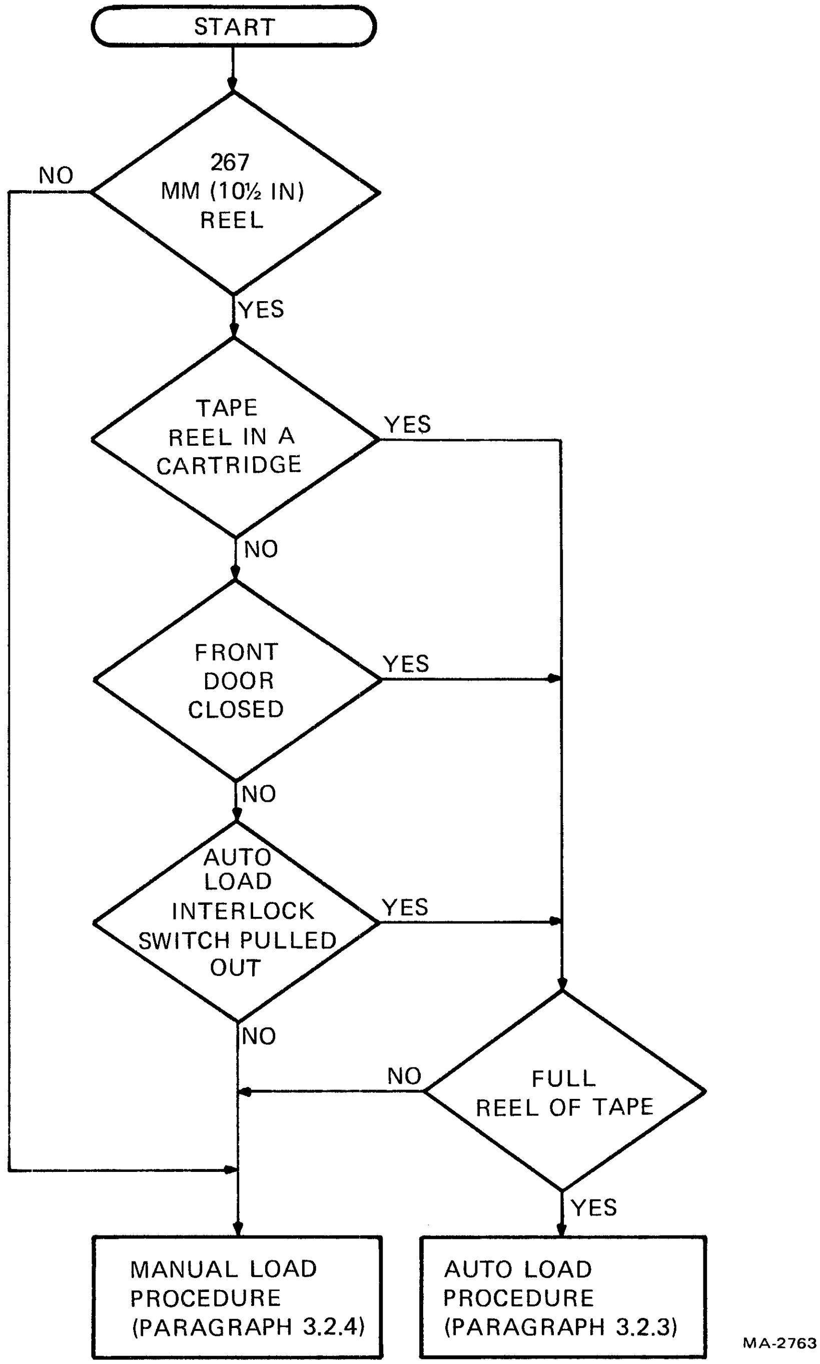


Figure 3-2 Autoload / Manual Load Selection

3.2 OPERATING PROCEDURES

This section describes the TU77 operating procedures.

3.2.1 Power On/Off

Power is applied to the TU77 when the system CPU is turned on. The 861 power control is remotely enabled from the CPU and applies ac power from the power source to the TU77 cabinet.

3.2.2 Autoload/Manual Load Selection

Figure 3-2 shows various conditions and interlock settings that affect the selection of an autoload or manual load procedure.

If you load a 216 or 178 mm (8-1/2 or 7 in) reel, you must use the manual procedure. If you load a 267 mm (10-1/2 in) reel, and the reel is in a cartridge, the cartridge will engage the cartridge interlock; the interlock bypasses the autoload interlock and causes the autoload procedure to be used.

You must use a full reel of tape for an autoload sequence. The minimum quantity of tape to accomplish automatic loading is such that the outer turn of tape is between 1.59 and 0.64 cm (5/8 and 1/4 in) from the outer edge of the reel (Figure 3-3). Large 267 mm (10-1/2 in) reels not containing sufficient tape to accomplish automatic loading must follow the manual load procedure.

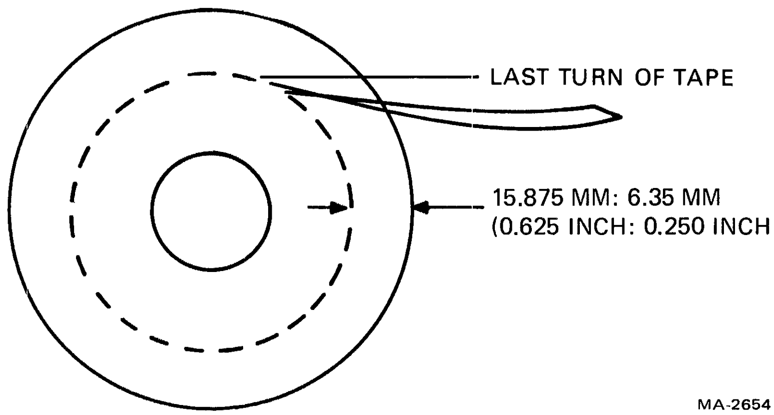


Figure 3-3 Tape Content Limit

If you do not use a tape cartridge, the autoload procedure is followed if the transport front door is closed. When the front door is open, the autoload procedure will still be used if the autoload interlock is pulled out. Otherwise, the manual procedure must be followed.

3.2.3 Autoload

1. Check the tape path for cleanliness. (Refer to Paragraph 4.3.4 for cleaning procedure.)

2. Check that the tape reel is a large 267 mm (10-1/2 in) reel and that it has a full reel of tape.

3. Check that end of tape has a clean edge and is not bent, torn or frayed. If necessary, trim the end with the tape crimper (PN 47-00038).

NOTE
Do not crimp the tape unnecessarily. Each crimping shortens the tape leader and could eventually lead to failures in the autoload sequence.

4. Check that a static charge is not causing the end of tape to stick to the reel. The end of tape must be free of the reel to accomplish autoload.

5. If a write operation will be performed, install a write enable ring onto the rear flange of the tape reel.

6. Place the supply reel in position on the upper hub, rotate until it slips easily into place, and press the reel-retaining actuator. The reel should be positioned so that the tape will unwind if the reel is turned clockwise.

NOTE
The supply reel may be contained in an Easy-Load™ wraparound cartridge. It is not necessary to remove or open the cartridge. The cartridge will open automatically during the autoload sequence.

7. Carefully close the buffer door, making sure the door is closed securely.

8. Close the transport front door.

NOTE
The transport front door must be shut to close the autoload interlock and enable the autoload sequence. If you want to leave the door open, override the interlock by pulling the switch out.

9. Check that power is applied to the tape transport (power indicator on).

10. Follow the instructions and check for the events specified in Figure 3-4. If the tape fails to load properly, the figure contains some operator troubleshooting hints you can try before calling maintenance personnel. Refer to Figure 3-4 to identify tape path components.

3.2.4 Manual Load

1. Check the tape path for cleanliness. (Refer to Paragraph 4.3.4 for cleaning procedure.)

2. If a write operation will be performed, install a write enable ring onto the rear flange of the tape reel.

3. Place the supply reel in position on the upper hub. Rotate the reel until it slips into place, and press the reel-retaining actuator. The reel should be positioned so that the tape will unwind if the reel is turned clockwise.

4. Manually place the tape leader between thread block 1 and air bearing (Figure 3-5).

NOTE
Ensure that there is no tape slack or sag between the supply reel and thread block 1.

5. Carefully close the buffer door, making sure the door is closed securely.

6. If you are loading a 216 or 178 mm (8-1/2 or 7 in) reel, close the transport front door. If you are loading a 267 mm (10-1/2 in) reel, leave the transport door open; this disables the autoload sequence that would normally occur with a 267 mm reel.

7. Check that power is applied to the tape transport. (Power indicator is on.)

8. Follow the instructions and check for the events specified in Figure 3-6. If the tape fails to load properly, the figure contains some operator troubleshooting hints that can be tried before maintenance personnel are called. Refer to Figure 3-5 to identify tape path components.

™ Easy-Load is a trademark of IBM.

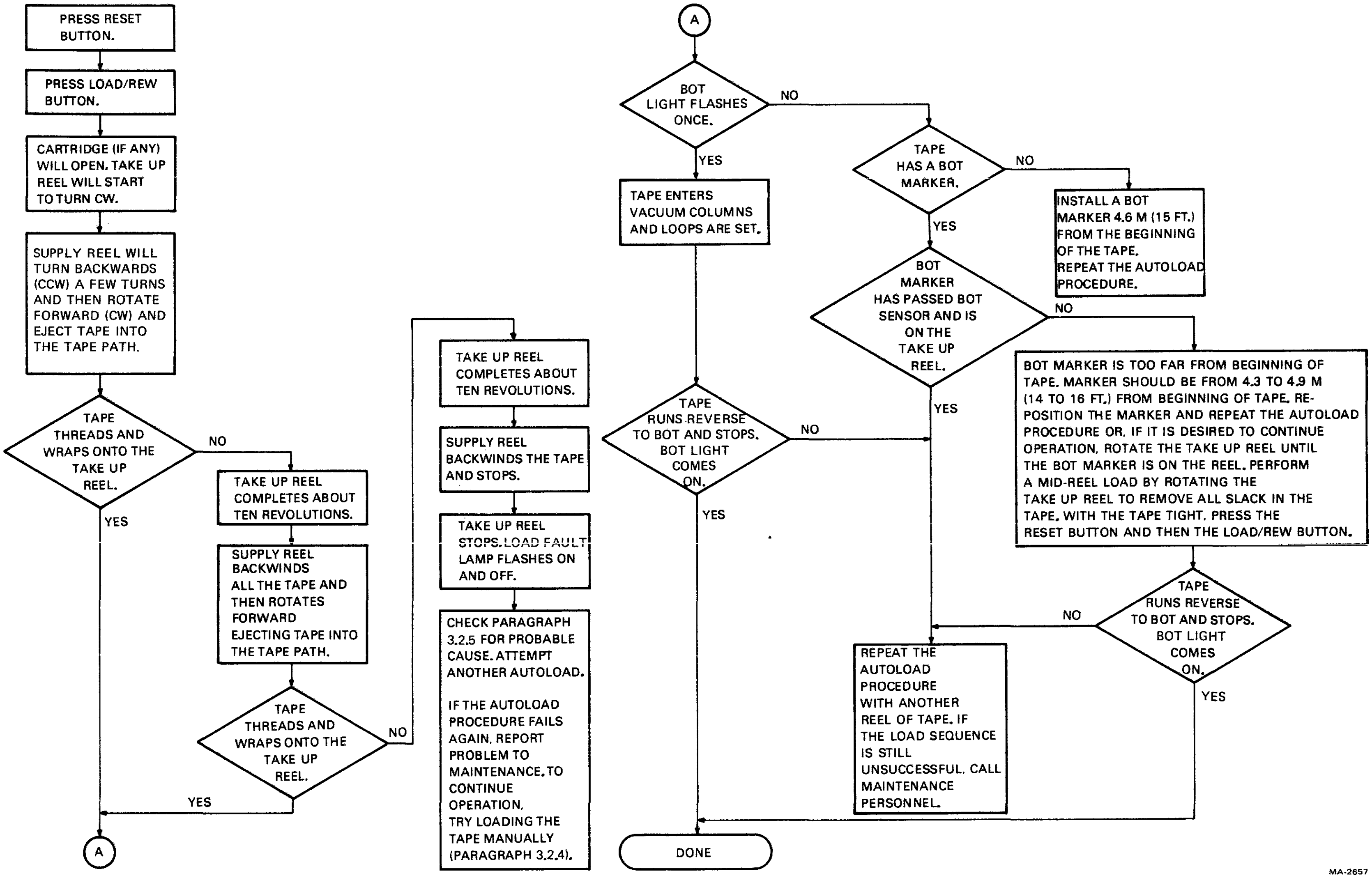


Figure 3-4 Autoload Sequence with Operator Troubleshooting

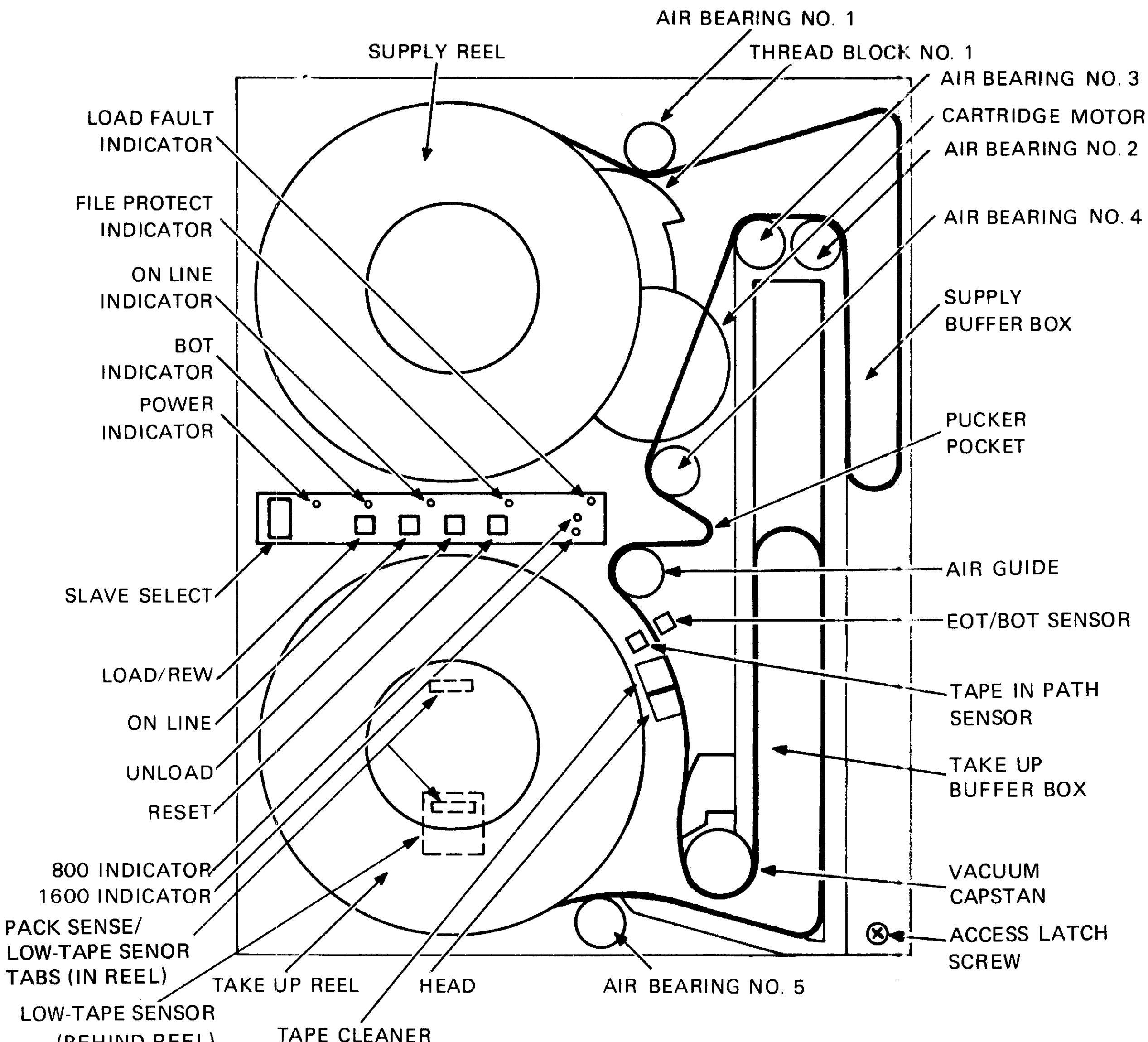


Figure 3-5 Tape Path and Controls

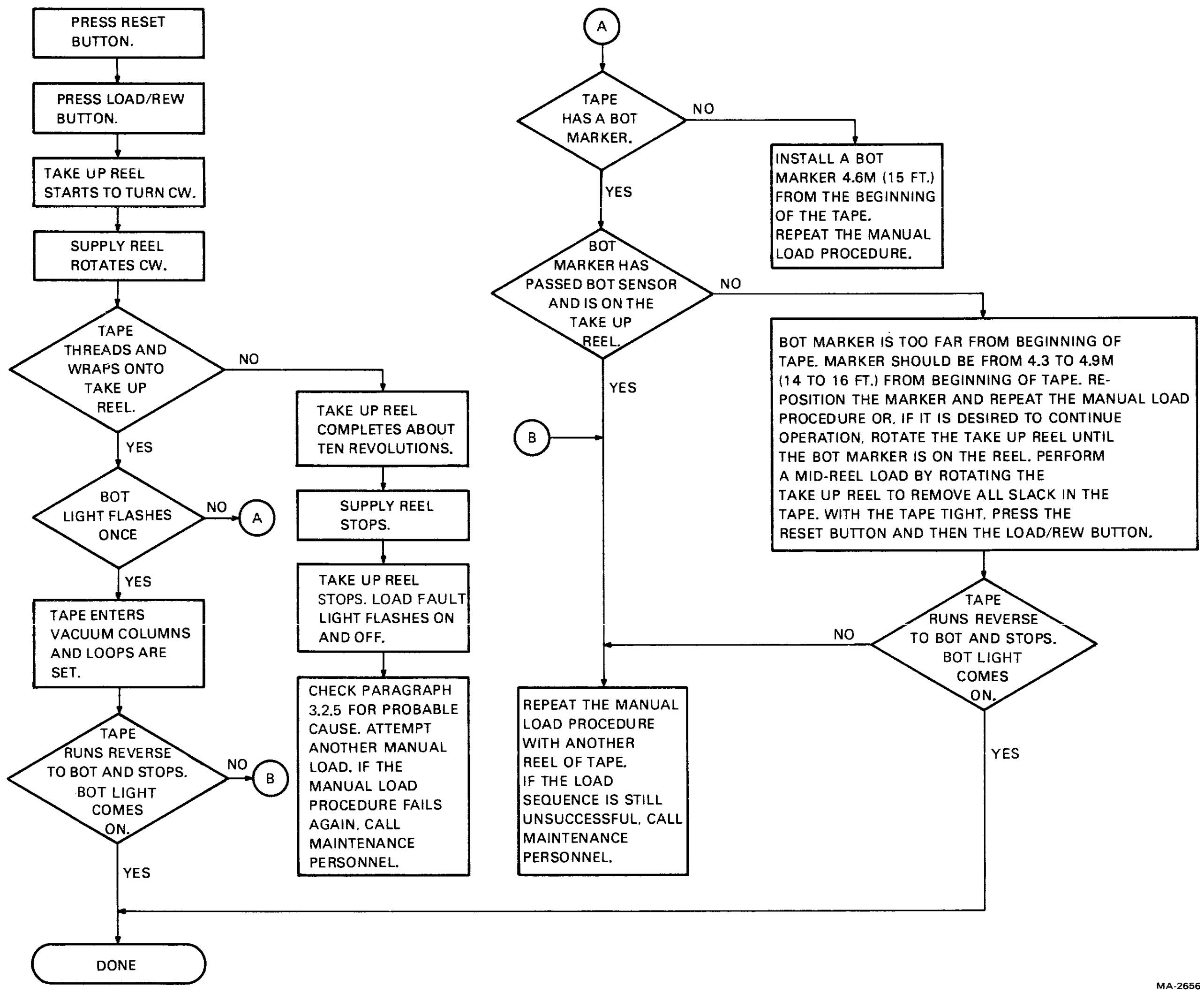


Figure 3-6 Manual Load Sequence with Operator Troubleshooting

3.2.5 Probable Causes of Load Failure

1. Check that the buffer door is closed and sealed properly.

2. Check for ripped, creased, or damaged tape leader. This is especially critical if an autoload failure has occurred. If necessary crimp the end of the tape with a tape crimper.

3. Check that the write-enable ring is inserted in the tape reel if a write operation will be performed. (File protect indicator should be off.)

4. Check that the transport front door is open and the autoload interlock switch is not pulled out if you are doing a manual load with a 267 mm (10-1/2 in) reel of tape.

5. If you are doing an autoload, check these items.

   a. A large 267 mm (10-1/2 in) reel of tape is on the supply hub.

   b. The supply reel has a wraparound cartridge. If not, check that the transport door is closed; or if the door is open, check that the interlock switch is pulled out.

   c. The supply reel has a full reel of tape. The tape must be between 0.64 and 1.59 cm (1/4 and 5/8 in) from the outer edge of the reel.

3.2.6 Mid-Reel Load

A mid-reel load is usually required after a power failure or a lost interlock.

1. Rotate the take-up reel to remove all slack in the tape.

CAUTION

Do not attempt mid-reel load until all slack is manually removed from the tape between the reels.

2. Press the RESET button.

3. Press the LOAD/REW button.

The transport loads tape and starts a reverse operation to BOT. To stop the transport, press the RESET button. Any other command may now be given.

3.2.7 Unload

1. Press the RESET button to terminate any current operation and place the transport off-line.

2. Press the UNLOAD button. If the tape is at BOT, it will backwind onto the supply reel. If the tape is at mid-reel, it will rewind to BOT and then unload (backwind onto the supply reel).

3.2.8 Rewind

If you press the LOAD/REW button, with tape tensioned and the transport off-line, the tape rewinds to BOT. If you press the button with the tape at BOT, no action occurs.

3.2.9 On-Line/Off-Line

Pressing the ON LINE button places the transport on-line and turns on the on-line indicator. While on-line, the transport can accept external commands provided it is selected and ready. If you press the ON LINE button again, the transport will go off-line and the on-line indicator turns off. Also, the transport automatically reverts to off-line if any of the following occur.

- An external REWIND UNLOAD command is received.
- Vacuum column interlock is broken.
- AC power is lost.
- RESET button is pressed.

CHAPTER 4
CUSTOMER CARE AND PREVENTIVE MAINTENANCE

4.1 CUSTOMER RESPONSIBILITIES

The customer is directly responsible for the following items.

1. Obtaining operating supplies, including magnetic tape and cleaning supplies.
2. Supplying accessories, including cabinetry, tables, and chairs.
3. Maintaining the required logs and report files consistently and accurately.
4. Making the necessary documentation available in a location convenient to the system.
5. Keeping the exterior of the system and the surrounding area clean.
6. Ensuring that ac plugs are securely plugged in each time equipment is used.
7. Performing specific equipment care operations described in Paragraph 4.2 and 4.3 at the suggested frequencies, or more often if required by usage and environment.

4.2 MAGNETIC TAPE CARE

Follow these guidelines to care for magnetic tape.

1. Do not expose magnetic tape to excessive heat or dust. Most tape read errors are caused by dust or dirt on the read head. You must keep the tape clean.
2. Always store tape reels inside containers when not in use. Keep the empty containers tightly closed to keep out dust and dirt.
3. Never touch the portion of tape between the BOT and EOT markers. Oil from fingers attracts dust and dirt.
4. Never use a contaminated reel of tape. A contaminated reel spreads dirt to clean tape reels and could have an adverse affect on tape transport reliability.
5. Always handle tape reels by the hub hole. Squeezing the reel flanges could lead to tape edge damage in winding or unwinding tapes.
6. Do not smoke near the tape transport or storage area. Tobacco smoke and ash are especially damaging to tapes.

7. Do not place magnetic tape near any line printer or other device that produces paper dust.

8. Do not place magnetic tape on top of the tape transport, or in any other location where it might be affected by hot air.

9. Do not store magnetic tape in the vicinity of electric motors.

4.3 CUSTOMER PREVENTIVE MAINTENANCE OF TU77

This section describes customer responsibilities for maintaining the TU77.

4.3.1 General

Digital Equipment Corporation tape transports are highly reliable precision instruments that will provide years of trouble-free performance when properly maintained. A planned program of routine inspection and maintenance is essential for optimum performance and reliability. The following information helps customers care for their equipment and ensure the highest level of performance and reliability.

4.3.2 Preventive Maintenance

To ensure trouble-free operation, a preventive maintenance schedule should be kept. Preventive maintenance consists of cleaning only a few items, but the cleanliness of these items is very important to proper tape transport operation. The frequency of performance varies somewhat with the environment and degree of use of the transport. Therefore, a rigid schedule applying to all machines is difficult to define. Daily cleaning is recommended for units in constant operation in ordinary environments. This schedule should be modified if experience shows other periods are more suitable. Paragraph 4.3.4 contains the cleaning instructions.

Before performing any cleaning operation, remove the file reel and store it properly. Clean all items in the tape path on a daily basis. In cleaning, it is important to be thorough yet gentle and to avoid certain dangerous practices. Remember that some tape cleaners are strong cleaning agents and should not come in contact with painted surfaces or plastic.

CAUTION

Do not use acetone or lacquer thinner, rubbing alcohol, or excessive cleaner. Be extremely careful not to allow the cleaner to penetrate ball bearings and motors.

4.3.3 Magnetic Tape Transport Cleaning Kit

A magnetic tape transport cleaning kit (TUC01) has been carefully configured to provide cleaning materials that will not harm tape equipment and will not leave any residue behind to interfere with data reliability. The hints contained in the following paragraphs will ensure the very best results possible from the kit.

The Freon TF113™ cleaning fluid in this kit is one of the safest and best degreasing agents available. It will not adversely affect any part of Digital's tape equipment. To ready the can of fluid for service, unscrew the top and punch a small hole in the metal seal covering the pour spout.

WARNING

TF113 is an unrestricted, nonhazardous substance. However, when using TF113, avoid excessive skin contact; do not allow TF113 to come in contact with the eyes, and do not swallow it. Use TF113 only in a well ventilated area.

™ Freon TF113 is a trademark of Dow Chemical Company.

When cleaning tape equipment, never dip a contaminated cleaning swab or wipe into the can. To transfer fluid onto the swab, pour a little into the screw cap and dip the swab into the cap. Discard the remaining fluid when the cleaning operation is complete.

Always keep the can of fluid tightly closed when not in use, because Freon TF113 evaporates rapidly when exposed to air.

Use the cleaning materials in the kit to clean tape heads, air bearings, tape guide blocks, the tape cleaner, capstan, reel hubs, and any part of the transport where a dirty residue could come in contact with tape. To clean other parts of the transport, such as the exterior surfaces of doors, use any reasonably clean, lint-free material with or without cleaning fluid.

NOTE
For an unusually stubborn dirt deposit that appears to resist TF113, try a mild soap and water solution to dislodge it. After using soap, be sure to wash down the affected area thoroughly with TF113 to remove soapy residues.

4.3.4 Cleaning the TU77 Tape Transport

1. Dismount the tape from the unit.

2. Clean the following components of the transport, using a foam-tipped swab soaked in cleaning fluid (Figure 4-1).

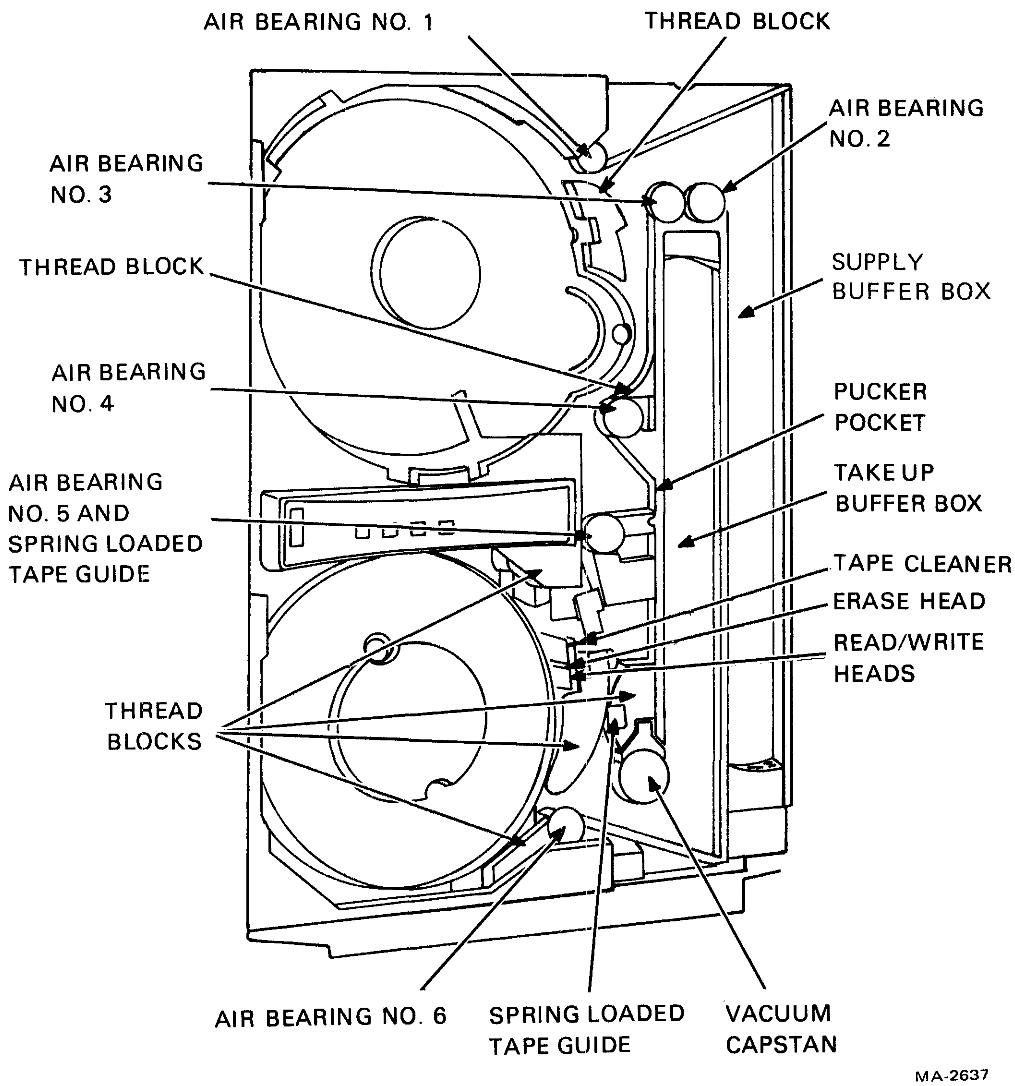
   Read/write head
   Erase head
   Tape cleaner
   Air bearings (6)
   Spring-loaded ceramic tape guides (2)
   Thread blocks (6)
   Capstan
   Buffer boxes (2)
   Pucker pocket
   Buffer box glass, pocket glass, door overlay

   NOTE
   Always use foam-tipped swabs for cleaning. Do not touch any part of the tape path; oil from fingers attracts dust and dirt. Also excessive physical pressure on the capstan could affect capstan alignment.

3. When cleaning the thread blocks, make sure to clean the air guide ports. Every thread block has air guide ports, except the metal block containing the spring-loaded tape guide.

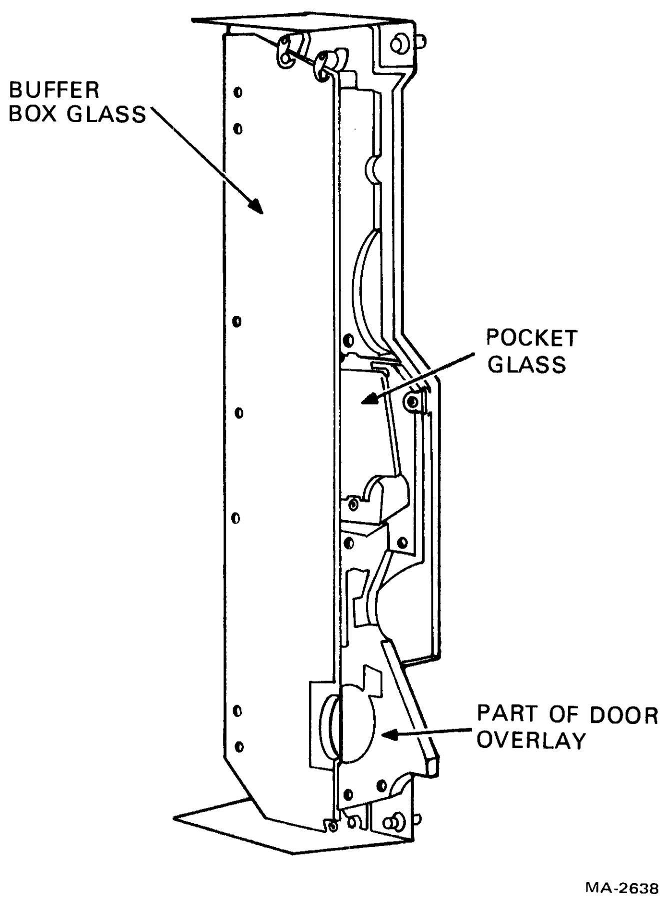
4. When cleaning the spring-loaded ceramic guides, make sure the washer is pressed firmly against the tape guide surface and not hung up on its shaft.

5. When cleaning the inner surface of the vacuum door, use a lint-free wipe and cleaning fluid. Pass another lint-free wipe over the head, using a polishing action to remove any remaining deposits.



a. Tape Path Items

Figure 4-1 Transport Items for Daily Cleaning



b. Buffer Box Door
Figure 4-1 Transport Items for Daily Cleaning

CHAPTER 5
THEORY OF OPERATION

5.1 GENERAL

This chapter describes the basic functioning of the TU77 Transport and the detailed circuit operation of the Printed Circuit Board Assemblies (PCBAs). Chapter 1 contains an overall functional description of the transport. Refer to Chapter 1 for a general description of the TU77. The description in this chapter picks up where the Chapter 1 description leaves off.

The text is supported by applicable schematics, simplified detail diagrams, and other conventional illustrations. In addition, block diagrams for major functions are provided as follows.

1. System functions integrated
2. Power supply and distribution
3. System controls
4. Capstan servo subsystem
5. Air load/control function
6. Reel servo subsystem
7. Write function
8. Read function

Functional block diagrams listed in items two through eight each present one essential function, such as the read function. The subject function of each diagram is covered completely, if required for clarity, from input signals to outputs, regardless of circuit location in the hardware. This distinguishes the functional block diagram from the schematic, which in most cases is confined to a single PCBA or other hardware unit. The schematics provide greater detail and may be identified by hardware references on the functional block diagrams. The eight functional block diagrams are located in Volume 1 along with the TU77 engineering drawings.

The functions of the TU77 Transport are shown in detail in Figure 1 in Volume 1 and divided for discussion into the following major categories.

Power supply and distribution
System control
Air load/control
Reel servos
Capstan servo
Write function
Read function

The figure illustrates the interrelationship between the transport functions and the interface connections to the MTA module (M8940).

Interface inputs and outputs are identified by connector and pin designations and by mnemonic terms for the signals. These terms are defined in the glossary. Signal flow between the six internal functions is also shown. These functions (control, capstan, reel servo, write, read, and power distribution) are separately covered, so connectors are not identified in Figure 1.

5.2 THEORY OF OPERATION SYMBOLOGY

Specific symbols and mnemonic standards are used within the text and drawings of this chapter. An exception is the paragraph on the M8940 interface module. A note under Paragraph 5.4 explains the M8940 symbology. The following explanations refer to other areas of the TU77 transport.

5.2.1 Functional Block Diagram Symbology

Symbols used in the functional block diagrams of Volume 1 are illustrated in Figure 5-1. Parts of signal paths confined to hardware assemblies are placed within boundaries which indicate the subassembly level. Hardware of one level (such as a PCBA) is included within boundaries of the next higher level assembly (such as the card cage).

The block diagrams illustrate the purpose of the modules, cards, assemblies, or components involved in the operation of the overall function. The active components in each block are shown to link the block diagram to the schematic. Interconnecting wires, plugs, jacks, terminal boards, adjustments, controls, meters, and test points are shown. Signal lines are coded by means of special arrowheads and are identified by signal flags. Signal lines illustrate significance of the signal in the discussion by the weight of the line.

Hardware reference designations are printed in the upper left corner of the area representing that hardware. Controls and control nomenclature which are visible when the equipment is mounted and operating under normal conditions (dust covers, doors closed, etc.) are considered front panel controls. Front panel controls appear on the diagram in a line art window in the function and hardware on which they are located.

Signals which are generated in a particular function, and are used in another function, are interfaced by terminating the signal in a shadow box area representing the other function which uses the signal. Since all functions are located in hardware, all pins of plugs and jacks through which the signal passes are shown to provide an easy method of tracing signals from one functional block diagram to another. Signal flags (mnemonic terms) aid the user in more rapidly locating the desired signal. Mnemonic terms, and abbreviations are defined in the glossary.

The text provides a description of the functional block's operation within the overall function. The text is written to establish how a particular portion of the function interplays with the other portions of the function. References to engineering drawings, schematics, etc., include document number and a zone code formed of the document sheet number, vertical coordinate number and horizontal coordinate letter (e.g., zone 2-4 F).

5.2.2 Schematic Diagram Symbology

Interface voltage levels between the MTA and the transport (at interconnect D1) are:

Low (True) = 0 V
High (False) = +3 V

A true signal from the M8940 interface (MTA) will be 0 V (nominal) at the input to the transport's receiver circuits. Similarly, a true signal from the transport to the MTA will be 0 V (nominal) at the output of the transport's driver circuits. At interface, therefore, low = true, and a mnemonic term with a prefix I for interface is always interpreted as low = true, whether the interface signal is an input or output.

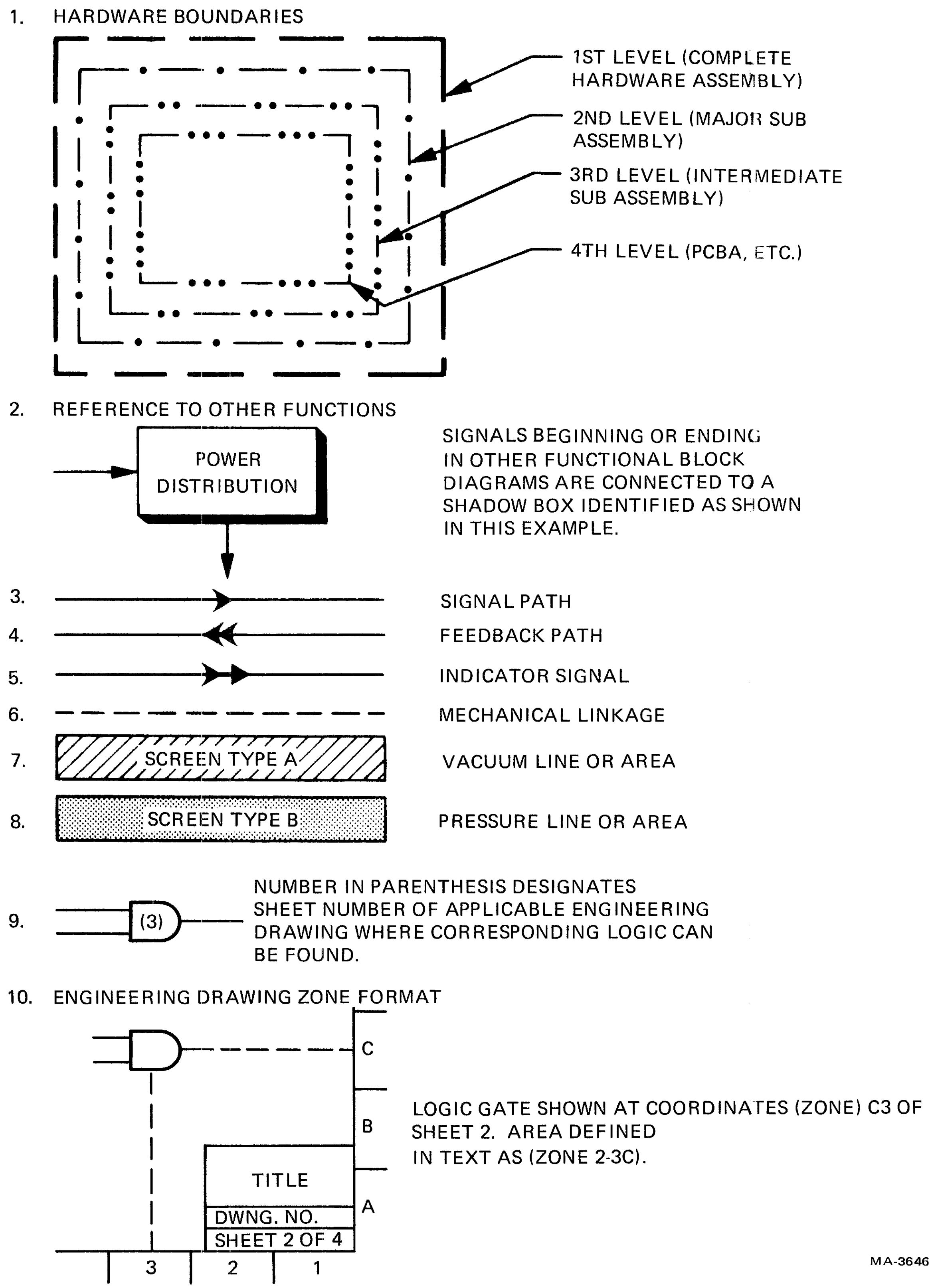


Figure 5-1 Functional Block Diagram Symbology

At other points in a circuit, a true signal may be low; for example, ISIGNAL applied to a NOR gate or inverter produces SIG, which is high = true. If SIG is similarly inverted it produces NSIG, which is low = true. As far as voltage levels are concerned, NSIG is the same as ISIG; ISIG is known to be low = true without the N because the I indicates an interface signal, which are standardized as low = true.

An interface signal that may appear to be irregular in regard to voltage level is the high/low density select signal. This is because the signal is essentially true in either high or low state, depending on whether high or low density is selected. To simplify understanding the logic, this is considered a high-density select signal. It is true (high density mode is selected) when the voltage level is low. If the voltage level is high, the high density signal is false and the system operates in low density mode.

Standard symbology is used in all schematics, logic drawings, etc. Mnemonic terms are defined in Appendix A. The alphabetic character I is used as the first letter of a mnemonic term to indicate an interface signal. When necessary for clarification, a D (driver) or an R (receiver) is added at the end of an expression to indicate output and input signals, respectively.

An N is used in the beginning of a mnemonic term to indicate a NOT (low voltage level) state, which in some documentation is expressed by the overline or bar symbology (e.g., NSIGNAL A = NOT SIGNAL A = $\overline{\text{SIGNAL A}}$). The N pertains only to the voltage level; it does not imply that the signal is logically false.

Other symbology used on the schematic drawings is explained in Figure 5-2.

5.3 TU77 CABLING/INTERCONNECTIONS

5.3.1 Input/Output Cabling and Connectors

All input/output signals between the TM03 tape formatter and the TU77 transport are via the M8940 interface module (Figure 5-3). The module receives the slave bus from the TM03 and plugs into J1, J2, and J3 on the interconnect D1 PCBA. The transport interface signals are also coupled to two other sets of connectors on interconnect D1. These are J101, J102, J103 located on the top edge of the interconnect D1 PCBA, and J201, J202, J203, J204 located on the rear of the interconnect D1 PCBA (Figure 5-4). The two sets of connectors are not used but can serve as test points for the transport interface signals. The functional block diagrams contained in Volume 1 show these connectors and identify the signals on each pin.

5.3.2 Interconnect D and D1 PCBAs

The interconnect D1 PCBA is the vertical board which provides the interconnections between the various logic boards in the card cage. The interconnect D1 PCBA is illustrated in Figure 5-4 and connections provided by the PCBA are listed in Appendix D. This chapter refers only to the interconnect D1 PCBA, however some earlier models of the TU77 used an interconnect D PCBA. The D board is identical to the D1 board except for the cable connection to the F1 PCBA. The D board has a permanent junction connecting the cable while the D1 board has a jack (J24) (Figures 5-4 and 5-5).

5.3.3 Interconnect F and F1 PCBAs

The interconnect F1 PCBA, mounted at the rear of the transport base assembly, provides interconnections between the card cage logic circuits and the controls, sensors, and indicators on the base assembly. Circuits for the interconnect F1 PCBA are shown on Schematic No. 107307.* Connections are made from interconnect D1 PCBA via ribbon cable to terminal connectors one through four on the interconnect F1 PCBA. Interconnect D1 provides J24 for connection/disconnection of the ribbon cable at the interconnect D1 end of the cable.

*F1 only. Drawing No. 107189 for interconnect F PCBA

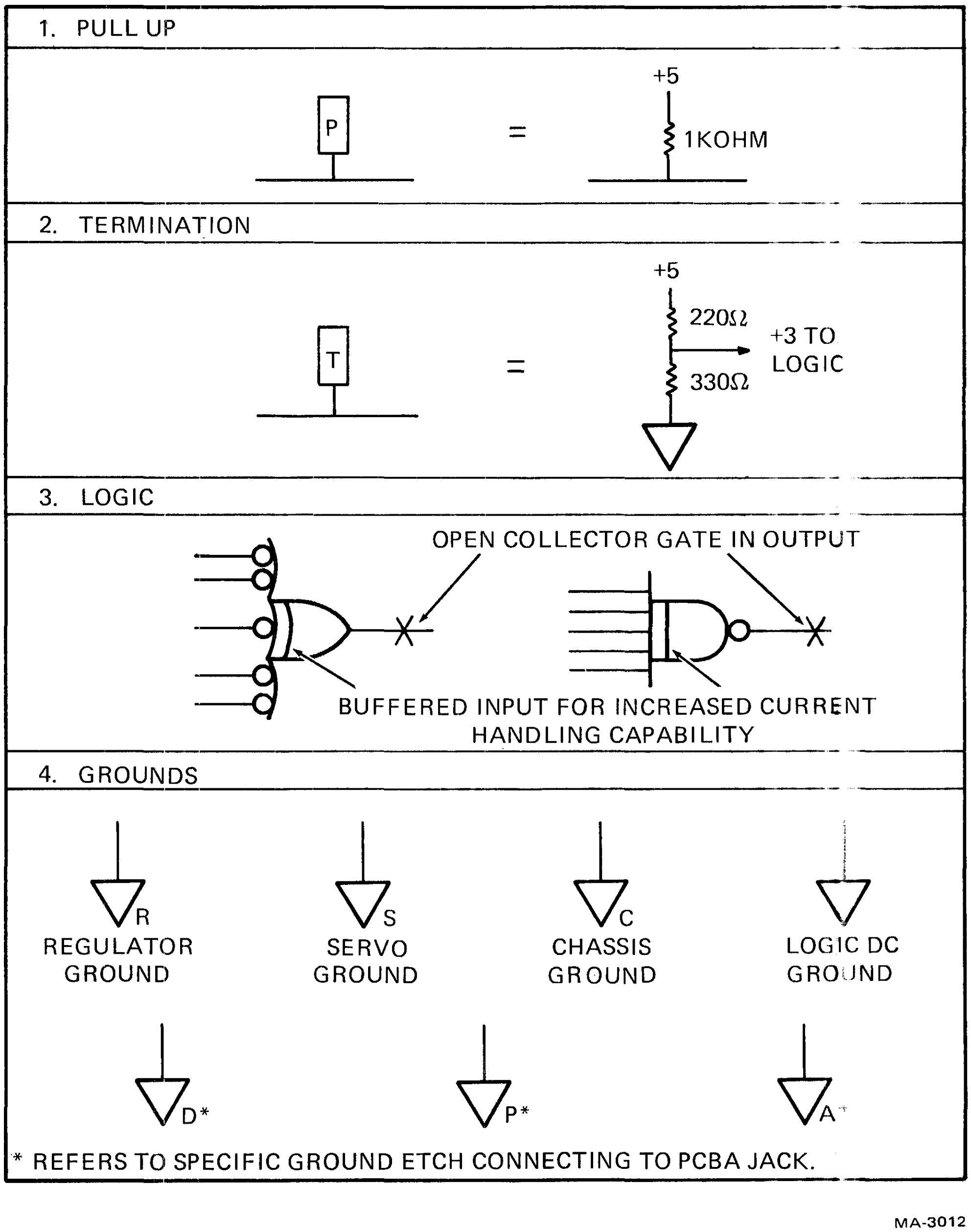


Figure 5-2 Schematic Diagram Symbology

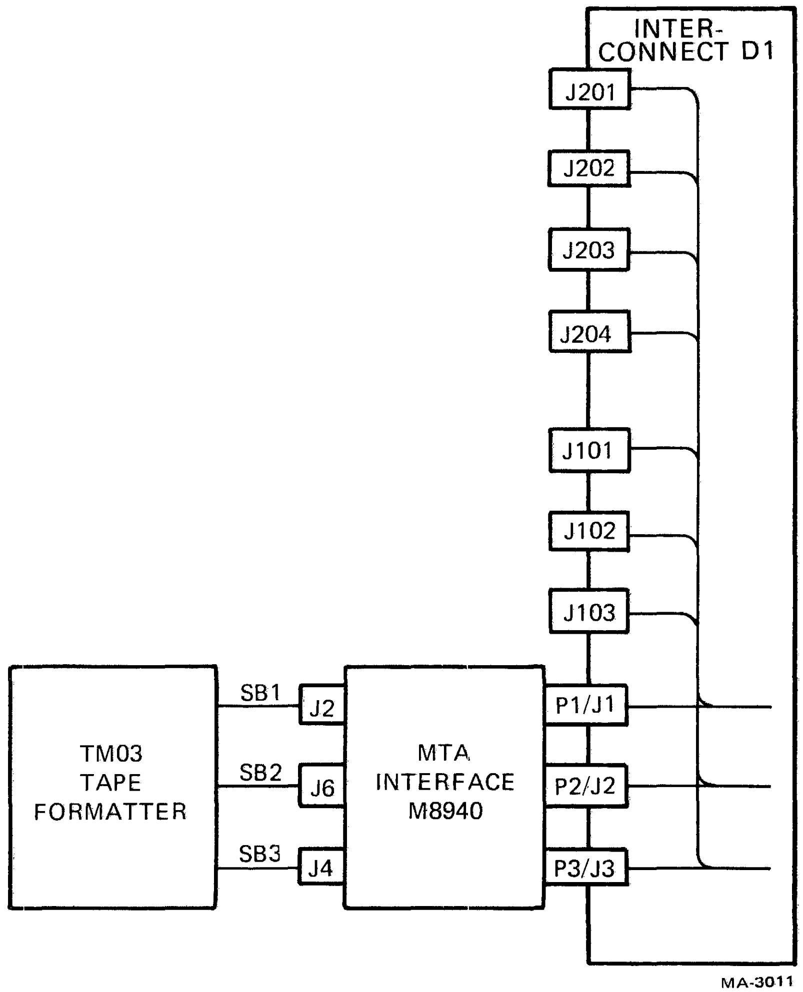


Figure 5-3 TU77 Interface Connections

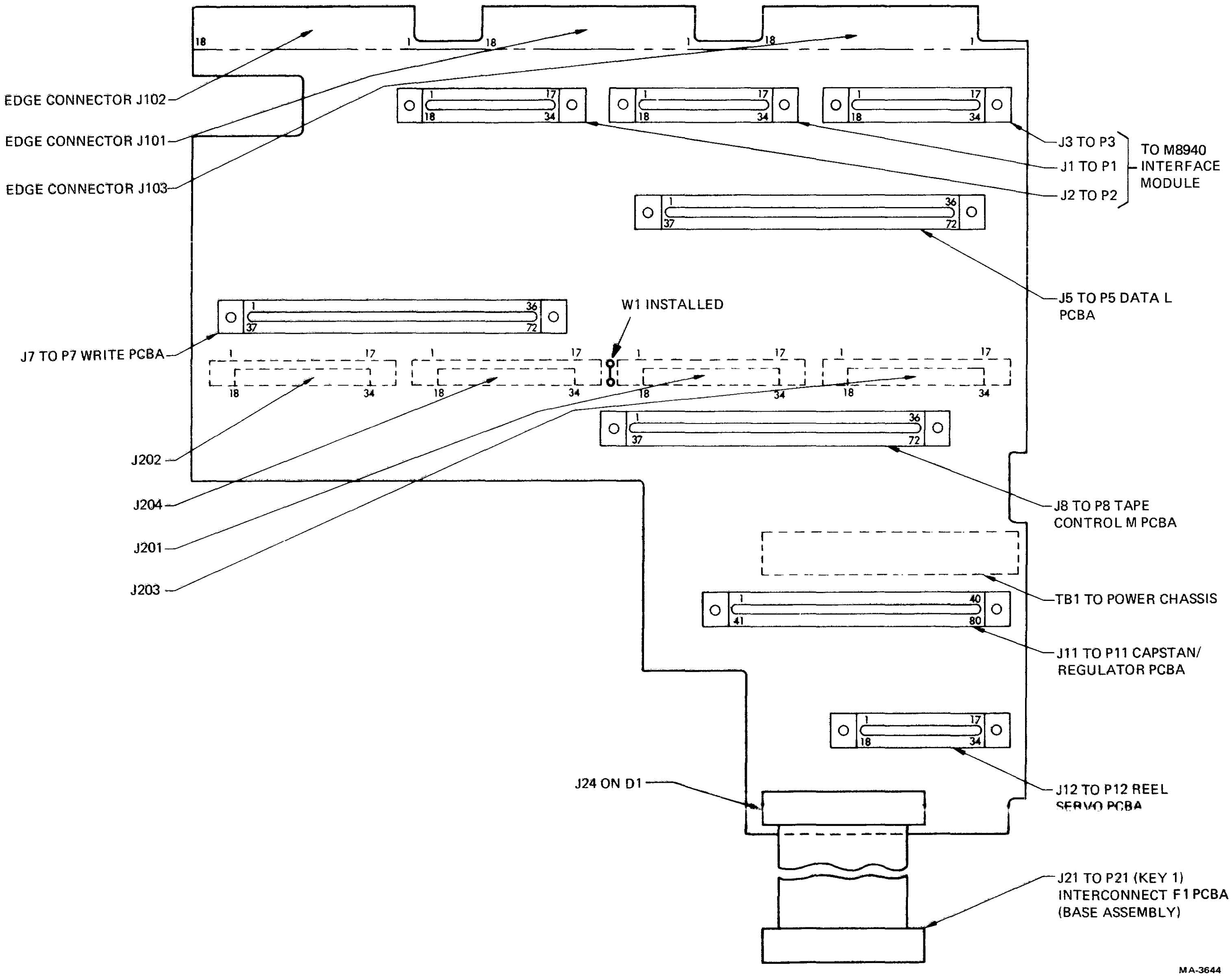


Figure 5-4 Interconnect D1 PCBA; Front View

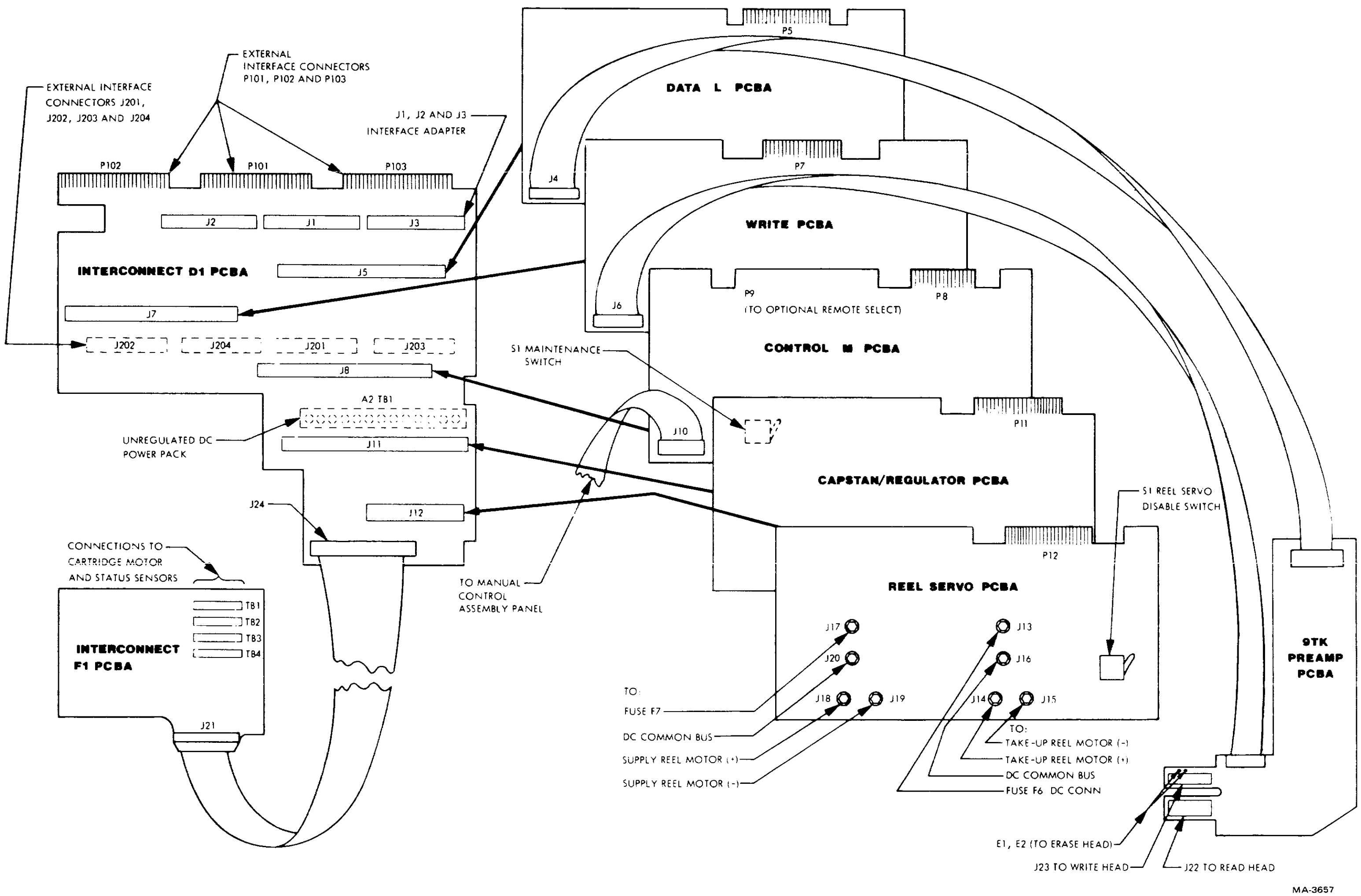


Figure 5-5 Circuit Card Interconnections

The theory of operation chapter refers only to the interconnect F1 PCBA, however some earlier models of the TU77 used an interconnect F PCBA. Although not electrically identical, the two PCBAs are interchangeable and perform the same basic functions. The differences between the two PCBAs are listed below.

1. Interconnect F has a piggyback board which has been eliminated on the F1 PCBA
2. The tape in path (TIP) adjustment (R15) on the F PCBA has been eliminated on the F1 board
3. Position adjustment test points for the takeup reel (TP2) and the supply reel (TP1) have been added to the interconnect F1 PCBA
4. The new layout of the F1 board has resulted in new designations for the PCBA adjustments and test points. The old and new designations are shown below.

Item	**Old Designation (F Board)**	**New Designation (F1 Board)**
EOT/BOT Adjustment	R6	R22
EOT/BOT Test Points	TP1 TP2	TP5 TP6
Low Tape Adjustment	R13	R17
Takeup Reel Position Adjustment	R103	R9
Supply Reel Position Adjustment	R203	R1
Ground Test Point	TP5	TP7

5.3.4 Internal Interconnections

Interconnections between various functional PCBAs (Control M, Write, etc.) are provided by the interconnect D1 PCBA, into which the other boards are plugged (Figure 5-4). The conductors on the interconnect D1 PCBA interconnect the logic signals, distribute power, and route commands. Conductor connections on the interconnect D1 PCBA are listed in Appendix D. The few logic interconnections made by cable are illustrated in Figure 5-5. Primary and secondary power circuit cables are covered in Paragraph 5.5.

5.4 MTA INTERFACE M8940

The MTA module interfaces all signals between the TM03 and the transport. Figure 5-6 divides the MTA into functional areas and shows the major signals associated with those areas. Paragraphs 5.4.1 through 5.4.9 discuss these areas in more detail. Another important function of the MTA module is maintenance testing of the transport. Each functional area discussed in Paragraphs 5.4.1 through 5.4.9 are treated both in normal operation and in test mode.

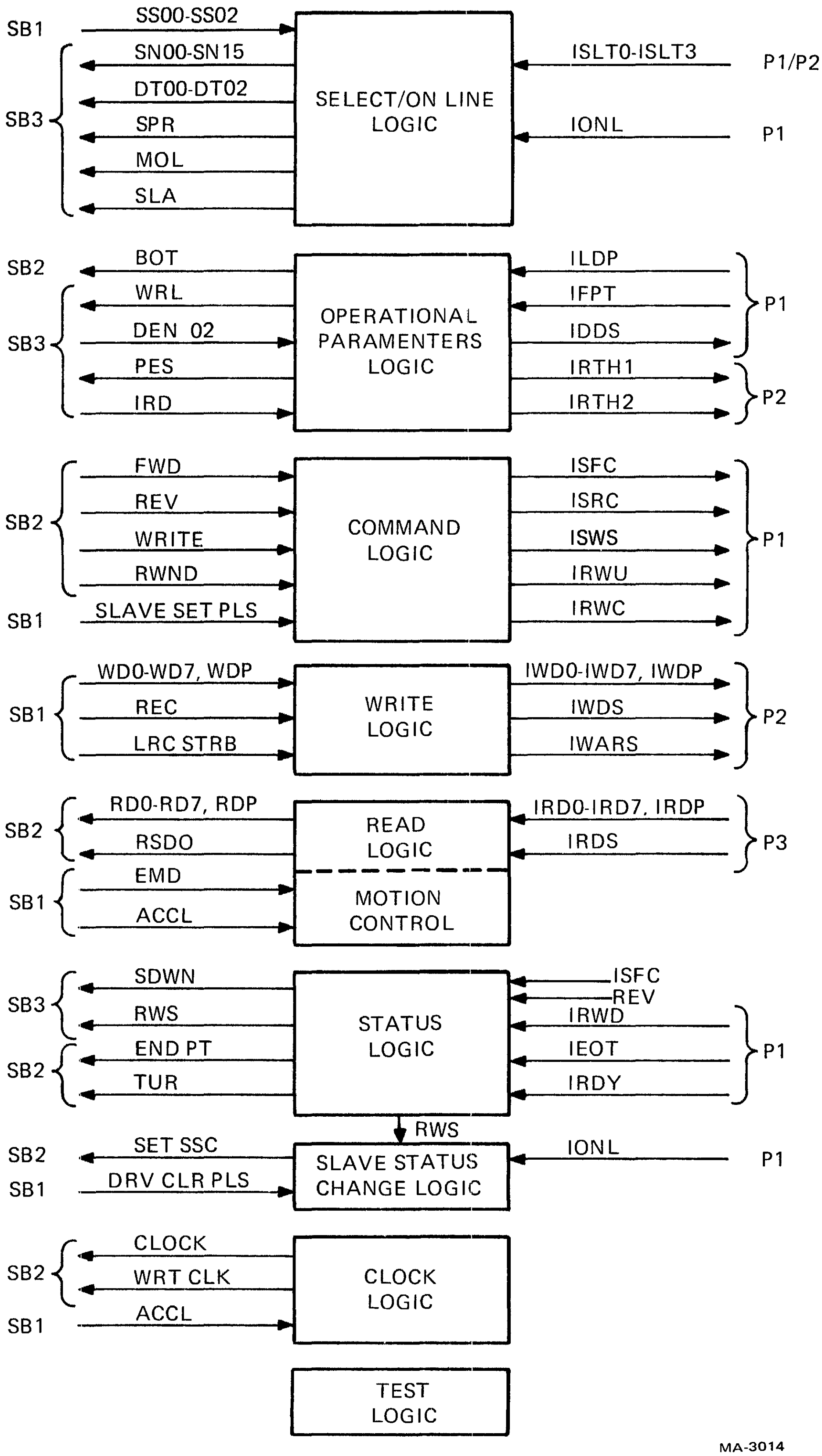


Figure 5-6 MTA Block Diagram

Referring to Figure 5-6, the select/on-line logic receives a select code from the TM03 and a transport code from the slave transport. If the two codes match, the transport is selected. With the transport selected, some or all of the following signals are sent to the TM03, depending on the on-line state (IONL) of the transport.

Transport serial number
Drive type
Slave present (SPR)
Medium on-line (MOL)
Slave attention (SLA)

Load point and file protect signals from the transport are received by the operational parameters logic and sent to the TM03 as BOT and WRL respectively. DEN02 from the TM03 specifies PE or NRZI mode. IDDS to the transport and PES to the TM03 indicate the transport mode of operation. Interchange read (IRD) alters the read circuit parameters in the transport via signals IRTH1 and IRTH2. IRTH1 widens the read skew window in NRZI operation. It is used only in the maintenance mode for testing purposes. IRTH2 lowers the read threshold in PE mode after the PE preamble has been detected.

The command logic accepts input commands from the TM03 and outputs commands to the transport when SLAVE SET PLS asserts. Four basic commands are involved: forward motion, reverse motion, write and rewind. Two rewind commands may be issued to the transport: a simple rewind (IRWC) and rewind and unload (IRWU).

The write logic accepts write data and record pulses (REC) from the TM03 and outputs them to the transport as write data and write strobes (IWDS). When the LRC character is being written, LRC STRB asserts and issues a write amplifier reset pulse (IWARS) to the transport instead of an IWDS pulse.

The read logic accepts read data and read strobes (IRDS) from the transport and outputs read data and read strobes (RSDO) to the TM03. Read data is transferred only when acceleration (ACCL) is false (transport is up to speed).

Whenever transport motion is initiated, an enable motion delay (EMD) pulse asserts and gates a start-up motion delay code onto the read lines for the TM03. The status logic generates a 14 ms settledown (SDWN) pulse whenever a motion command (forward, reverse, or rewind) is negated. Signals indicating a rewind operation, end of tape and transport ready, are received from the transport and output to the TM03 as RWS, END PT and TUR respectively. The slave status change logic asserts SET SSC to the TM03 when the transport comes on-line, goes off-line, or terminates a rewind operation. DRV CLR PLS pulses clear the SET SSC signal.

The clock logic generates CLOCK and WRT CLK for the TM03. CLOCK is present at all times while WRT CLK is present only when ACCL is false (transport up to speed). The test logic includes seven test switches used for maintenance testing of the transport. These switches place the transport off-line, provide test write data in NRZI and PE modes, and provide test motion commands to the transport.

NOTE

The block diagrams that follow use logical AND and OR symbols. It does not necessarily follow that a corresponding gate exists on the M8940 logic prints. The assertion of inputs A and B causing the assertion of output C may be represented on a block diagram

by a single AND gate, yet the engineering drawing may show that several circuit stages are involved in the ANDing operation.

In Paragraph 5.4 the diagrams are block diagrams, not simplified logic diagrams, therefore no L or H designations are used with the signals. All signals are shown to be asserted when the signal function is true.

Inverters are used to represent a NOT function; that is, a given signal must be false to cause an action to occur.

The signal names used on the functional block diagrams are the names used on the engineering circuit schematics (CS prints). Where other signal names or notes are used they are enclosed in parentheses.

5.4.1 Select/On-Line (Figure 5-7)

The slave select code SS00 SB1-SS02 SB1 from the TM03 is compared to the transport number ISLT0-ISLT3. If a match is obtained the UNIT SEL light on the M8940 illuminates. Also, the following signals are returned to the TM03:

Slave serial number	SN00 SB3-SN15 SB3
Drive type code	DT00 SB3-DT02 SB3
Slave present	SPR SB3

If the slave is on-line, IONL is true and asserts ON LINE which sets the edge-triggered slave attention flip-flop. IONL by itself does not cause any signals to assert to the TM03. If the slave is selected and IONL is true, ONL and ONLA assert and the following additional signals are returned to the TM03:

Medium on-line	MOL SB3
Slave attention	SLA SB3

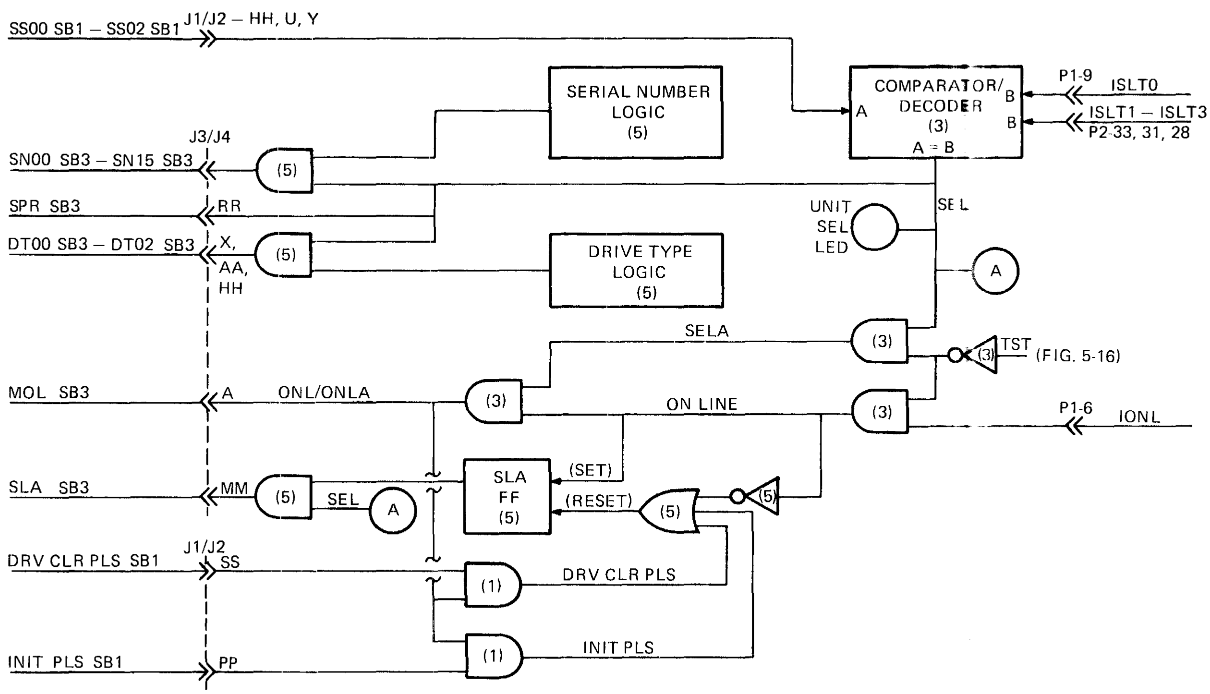
NOTE

ONL and ONLA fan out from different points on the circuit board but are functionally identical. For simplicity ONL is used throughout the following discussions and will be referenced in places where the signal is actually ONLA.

Slave attention SLA SB3 is negated by:

DRV CLR PLS
INIT PLS
Slave going off-line

In test mode TST asserts and negates SELA which in turn causes ONL to go false. With SELA and ONL false, all I/O signals to the slave bus discussed in this paragraph are blocked except the slave select code from the TM03; and the slave serial number, drive type code, and SPR SB3 to the TM03. The UNIT SEL lamp functions normally in test mode.



NOTE:
DESIGNATIONS IN PARENTHESIS REFER TO SHEET NUMBER OF ENGINEERING DRAWING CONTAINING CORRESPONDING LOGIC.

MA-3003

Figure 5-7 Select/On-Line Block Diagram

5.4.2 Operational Parameters (Figure 5-8)

If tape is loaded and under tension in the vacuum column and the supply reel has the write enable ring removed, then IFPT is true. With ONL true, WRL SB3 will be asserted to the TM03. If the tape is at the load point, ILDP is true and asserts BOT SB2 to the TM03. ILDP also sets the load point flip-flop. The output of the load point flip-flop gates clock F2 to the density flip-flop. DEN02 is applied to the D input of the flip-flop from the slave bus. DEN02 is true for PE operations and false for NRZI operations. With DEN02 true, the density flip-flop is set and asserts DENSITY. This in turn asserts IDDS to the transport and returns phase encoded status (PES) to the TM03 on SB3.

The state of the density flip-flop can be changed so long as the load point flip-flop remains set and gates in clock F2. The load point flip-flop is reset by EMD which asserts during transport start up and transport slow down. Due to the first start up being from BOT, the flip-flop is not reset by the first EMD pulse and remains set for the first record. It is reset by EMD when the transport starts into the slow down period following the first record. When the load point flip-flop resets, the transport is locked into the existing density mode and cannot be changed until the tape is returned to BOT.

An interchange read signal (IRD) is received from the TM03 to alter read parameters in the transport. IRD is gated to one of two transport signal lines depending on the mode of operation. In NRZI mode, DENSITY is false and gates IRD to IRTH1. When IRTH1 is true, the read data skew window in the transport is widened. IRTH1 is not used during normal operation. It is used only in the maintenance mode for testing purposes. In PE mode DENSITY is true and gates IRD to IRTH2. When IRTH2 is true the read data threshold in the transport is lowered. This occurs when the TM03 detects the PE preamble.

In test mode TST is true and ONL is false (Paragraph 5.4.1). All I/O signals to the slave bus discussed in this paragraph are blocked, and in addition, the following actions occur.

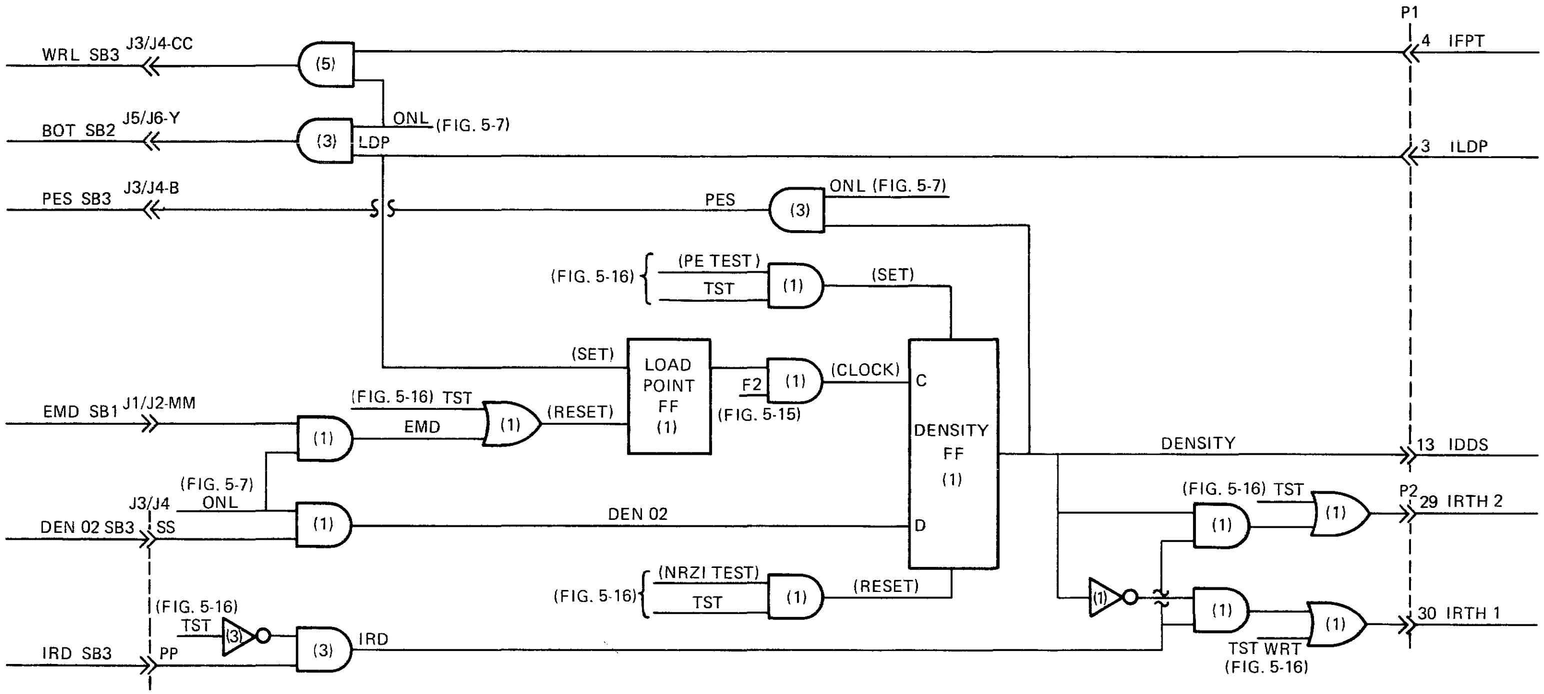
1. The load point flip-flop is reset inhibiting the clock input to the density flip-flop
2. The state of the density flip-flop is determined by the PE/NRZI test switch which now sets the operational mode
3. IRTH2 is asserted lowering the read threshold in the transport
4. If the READ/WRITE test switch is set to WRITE, TST WRT is true which asserts IRTH1 and widens the read data skew window in the transport.

5.4.3 Commands (Figure 5-9)

With ONL true, the following command signals are obtained from the slave bus:

FWD SB2 – true for forward motion,
REV SB2 – true for reverse motion,
WRITE SB2 – true for a write operation, false for a read operation,
RWND SB2 – true for a rewind operation,
SLAVE SET PLS SB1 – asserts to initiate the command function.

SLAVE SET PLS SB1 asserts DRV SET PLS which latches up FWD SB2, REV SB2 and WRITE SB2 in the command latch flip-flops. The flip-flop's outputs are routed to the transport via a test/normal mux as ISFC (forward motion command), ISRC (reverse motion command), and ISWS (write command). The outputs remain available to the transport until STOP SB1 from the TM03 resets the latch flip-flops. DRV SET PLS also gates RWND SB2 out to the transport as IRWU and/or IRWC. IRWC is a rewind command and IRWU is a rewind and unload command. A rewind and unload command is specified by the simultaneous assertion of RWND SB2 and WRITE SB2. Note that the two rewind commands to the transport are not latched up on the M8940.



NOTE:
DESIGNATIONS IN PARENTHESIS REFER TO SHEET NUMBER OF ENGINEERING DRAWING CONTAINING CORRESPONDING LOGIC.

Figure 5-8 Operational Parameters Block Diagram

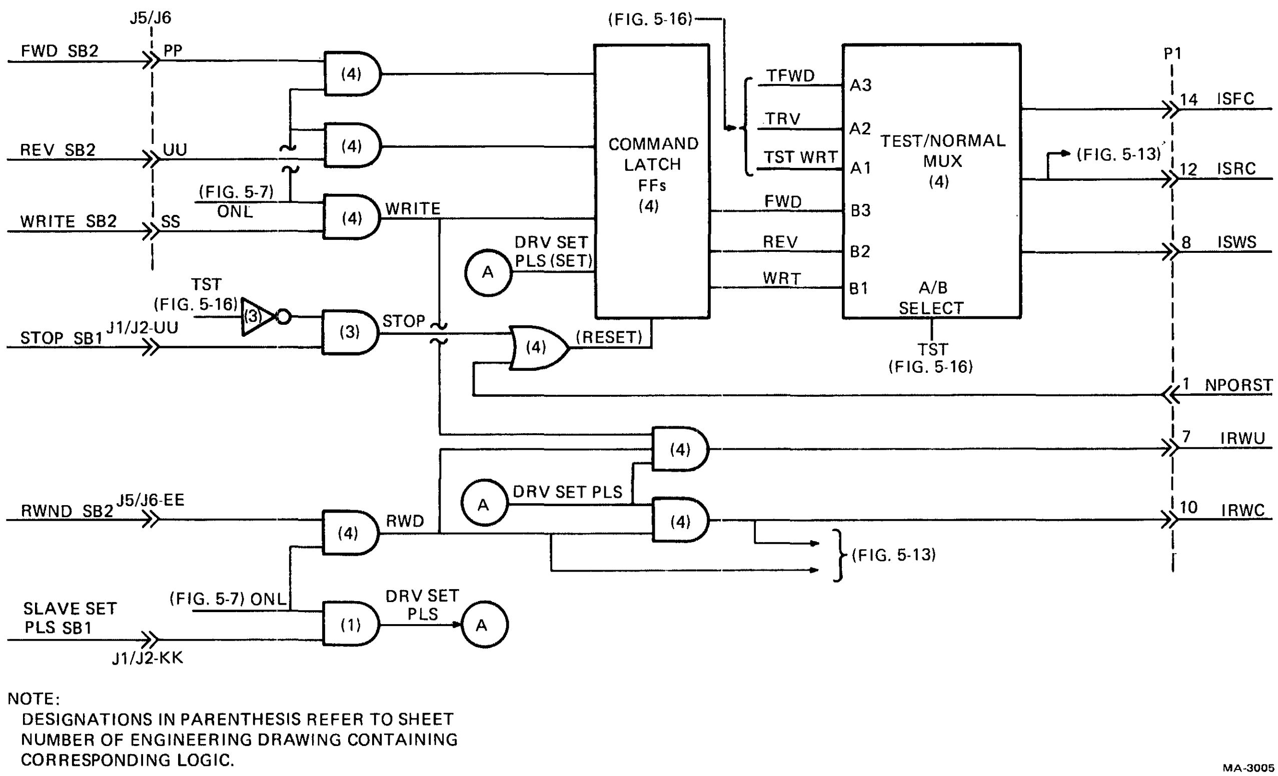


Figure 5-9 Commands Block Diagram

In test mode TST is true and ONL is false (Paragraph 5.4.1). All I/O signals to the slave bus discussed in this paragraph are blocked. The assertion of TST causes the test/normal mux to select commands from the test logic instead of the command latch flip-flops. The test logic supplies a forward command (TFWD), a reverse command (TRV) and a write command (TST WRT) which are routed to ISFC, ISRC and ISWS respectively. The test logic does not supply a rewind command.

5.4.4 Write (Figure 5-10)

With ONL true, write data from the TM03 (WD7 SB1-WD0 SB1, WDP SB1) is received and gated to the transport as IWD0-IWD7, IWDP. Record pulses (REC SB1) are applied to the test/normal mux and output as WDS EN. The reset state of the LRC flip-flop gates WDS EN to the transport as write data strobes (IWDS). When LRC STRB asserts (at the end of a NRZI record) the LRC flip-flop is set inhibiting the IWDS output path but enabling the IWARS output path. The next WDS EN pulse asserts IWARS to write the LRC character on tape. At the end of the record ACCL SB1 comes true and resets the LRC flip-flop thereby enabling the IWDS output path for the next record.

In test mode TST is true and ONL is false (Paragraph 5.4.1). All inputs from the TM03 discussed in this paragraph are blocked. The IWD0-IWD7, IWDP write data to the transport is now provided by the test logic. Also the true state of TST causes the test/normal mux to select WRT CLK from the clock logic as the write strobe. TST holds the LRC flip-flop reset thereby outputting all test mode write strobes as IWDS.

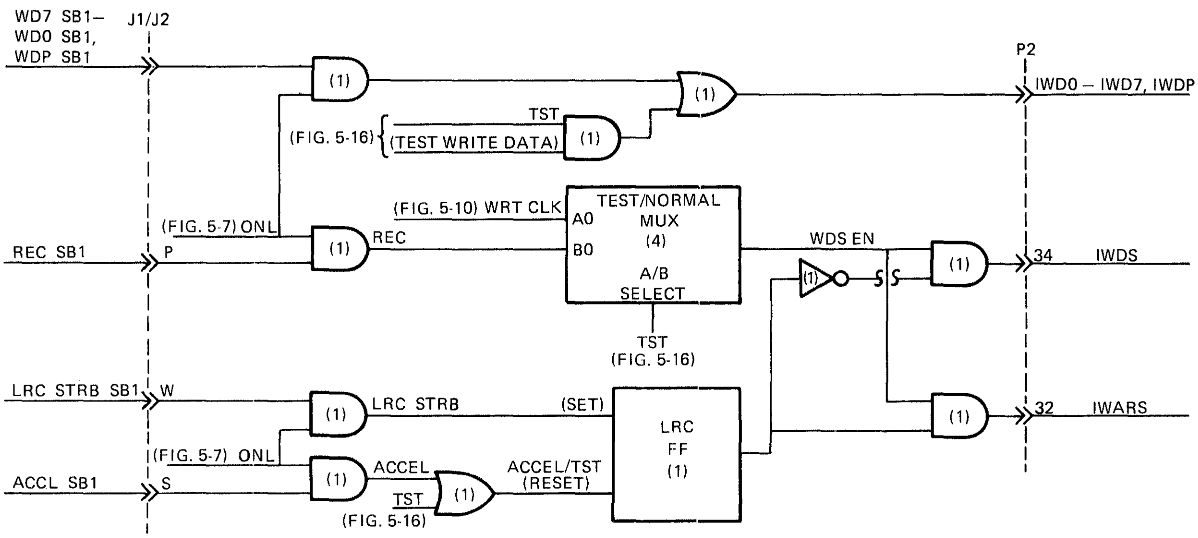
5.4.5 Read (Figure 5-11)

With ONL true, read data and read strobes are transferred from the transport to the TM03 in both NRZI and PE modes. IRD0-IRD7, IRDP is received from the transport and applied to a read data transparent latch. The read data output from the transparent latch follows the input so long as enable is true. When enable negates, the output is latched at its existing state. In NRZI operation (DENSITY false) IRDS pulses enable the transparent latch. Read data bits 0 – 6, P from the latch are applied to the B inputs of a read data/motion delay multiplexer. RD0 – RD6, RDP are strobed from the multiplexer to the TM03 slave bus by read output gate. Read output gate also couples RD7 directly from the read data transparent latch to the slave bus.

Read output gate is asserted by READ ENABLE, which is generated by the read strobe sync logic. The purpose of the read strobe sync logic is to synchronize the read strobes (RSDO SB2) with the read data (RD0 SB2-RD7 SB2, RDP SB2) sent to the TM03. The IRDS pulses and a 1.6 MHz clock (F4) are applied to the sync logic which generates RSDO pulses centered on READ ENABLE. Figure 5-12 illustrates the timing of the read strobe sync logic.

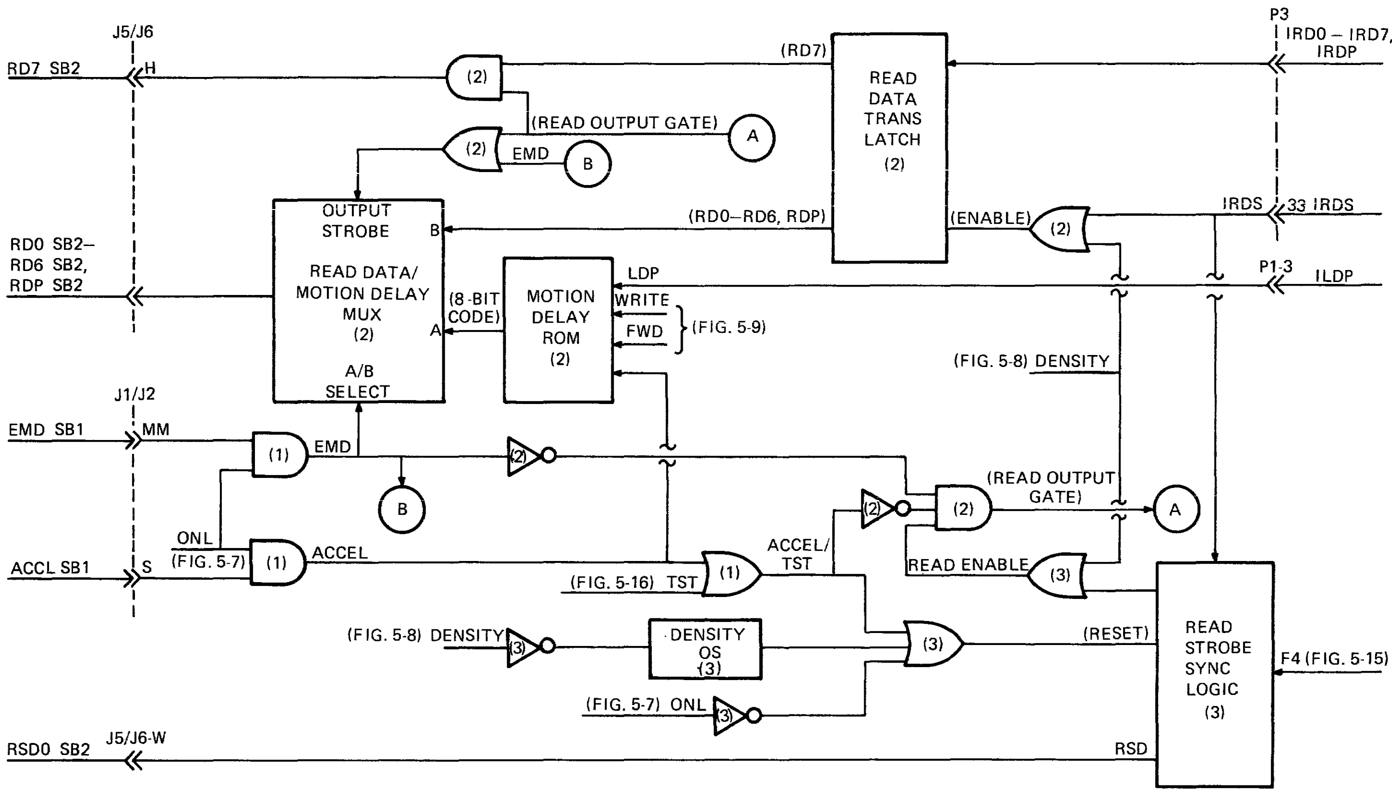
ACCL SB1 and EMD SB1 from the TM03 must be false for read data gate to be true and couple RD0-RD7, RDP to the slave bus. ACCL SB1 goes false when the transport is up to speed and data transfers are allowed. EMD SB1 is a pulse that asserts at transport start up and slow down. The EMD pulse switches the read data/motion delay multiplexer to the A input which is an 8-bit delay code obtained from a motion delay ROM.

The code specifies the start up and slow down delay periods for the TM03. The true state of EMD negates read output gate, but holds the multiplexer output strobe true. Thus, during the EMD pulse, the delay code is multiplexed onto eight of the nine read data lines and coupled to the TM03 slave bus. The delay code is a function of direction of motion (FWD), type of data transfer (WRITE), whether the transport is starting or stopping (ACCEL) and whether the transport is starting from BOT (LDP).



NOTE:
DESIGNATIONS IN PARENTHESIS REFER TO SHEET NUMBER OF ENGINEERING DRAWING CONTAINING CORRESPONDING LOGIC.

Figure 5-10 Write Block Diagram



NOTE:
DESIGNATIONS IN PARENTHESIS REFER TO
SHEET NUMBER OF ENGINEERING DRAWING
CONTAINING CORRESPONDING LOGIC.

MA-3002

Figure 5-11 Read Block Diagram

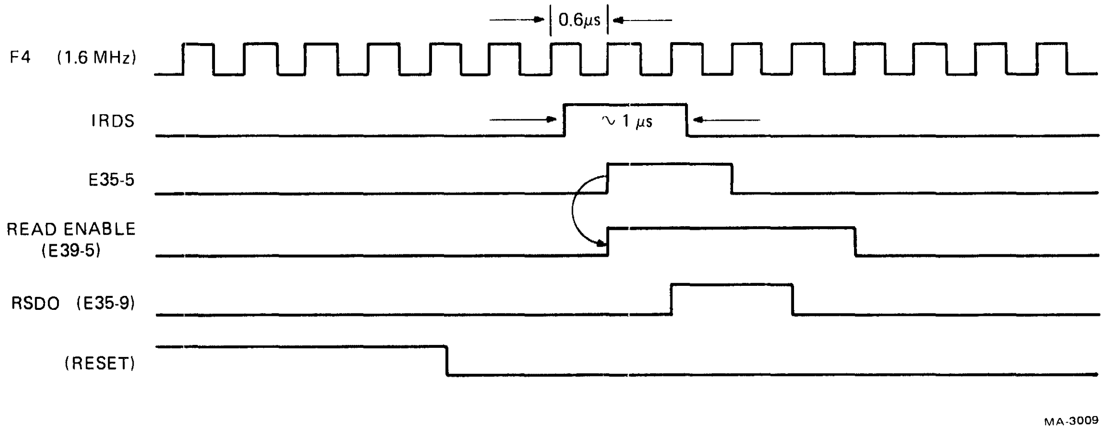


Figure 5-12 Timing of Read Strobe Sync Logic

In PE mode, the read data from the transport is routed to the read data transparent latch as in NRZI operation, however, now the true state of DENSITY continuously enables the latch. This causes the latch output to follow the input at all times. With DENSITY true, READ ENABLE is asserted, thereby passing the read data from the transport to the TM03, subject only to the negation of ACCL SB1 and EMD as discussed for NRZI operation.

ACCEL/TST holds the read strobe sync logic reset, inhibiting the generation of RSDO SB2 pulses and NRZI READ ENABLE gates. When ACCEL/TST negates and data transfers commence, the sync logic sequence will be enabled as shown in Figure 5-12. The sync logic is also held reset when the transport goes off-line. A reset pulse is generated each time DENSITY goes from a true state to a false state.*

In test mode, TST is true and ONL is false (Paragraph 5.4.1). While in test mode, all the I/O signals to the slave bus discussed in this paragraph are blocked. EMD is false and negates read output gate. With EMD and read output gate false, no data is output to the slave bus over the read data lines. TST asserts ACCEL/TST which holds the read strobe sync logic reset. No RSDO SB2 pulses are generated by the sync logic while in the reset state.

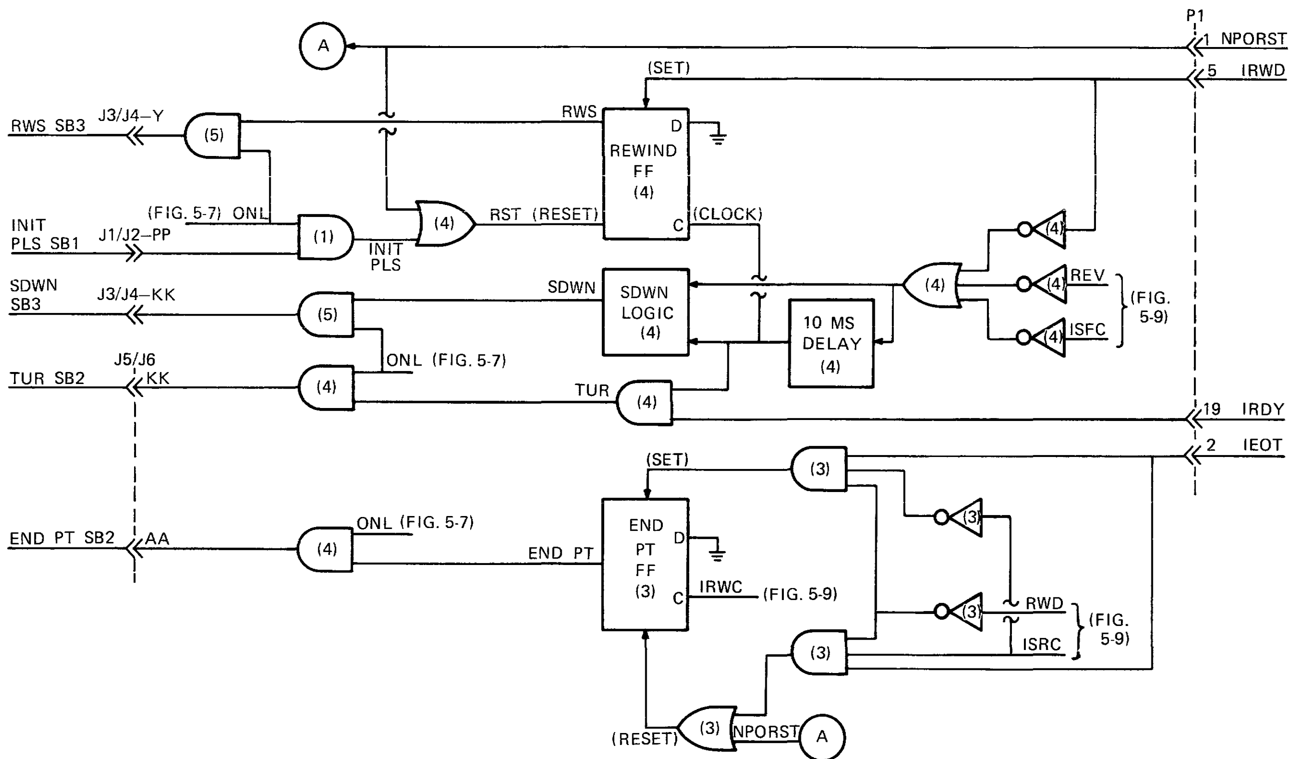
5.4.6 Status (Figure 5-13)

Settledown (SDWN) and tape unit ready (TUR) are generated on the MTA module and sent to the TM03 if ONL is true. The three motion commands IRWD, REV and ISFC are monitored by the SDWN logic. When a motion command terminates, the SDWN logic asserts SDWN. Fourteen ms later a second input to the logic negates SDWN. At this time TUR asserts if the transport is ready to accept a new command (IRDY true).

When a rewind operation occurs, IRWD comes true, setting a RWS flip-flop and, if ONL is true, asserts RWS SB3 on the slave bus. The flip-flop is clocked reset after the settledown period (following the termination of the rewind operation) by the output of the 10 ms delay circuit.

When the transport reaches EOT, IEOT comes true, and if a rewind is not in progress, either sets or resets the end-point flip-flop depending on whether the transport is going forward or reverse. The flip-flop is set and asserts END PT SB2 on the slave bus if EOT is reached while going forward (ISRC and RWD false) and reset if it is reached while going in reverse (ISRC true). In addition, the flip-flop is clocked reset whenever an IRWC rewind command is asserted.

*Occurs during start up from BOT when TM03 automatic density select function places transport in PE to look for ID burst, but finds none.



NOTE:
DESIGNATIONS IN PARENTHESIS REFER TO SHEET NUMBER OF ENGINEERING DRAWING CONTAINING CORRESPONDING LOGIC.

Figure 5-13 Status Block Diagram

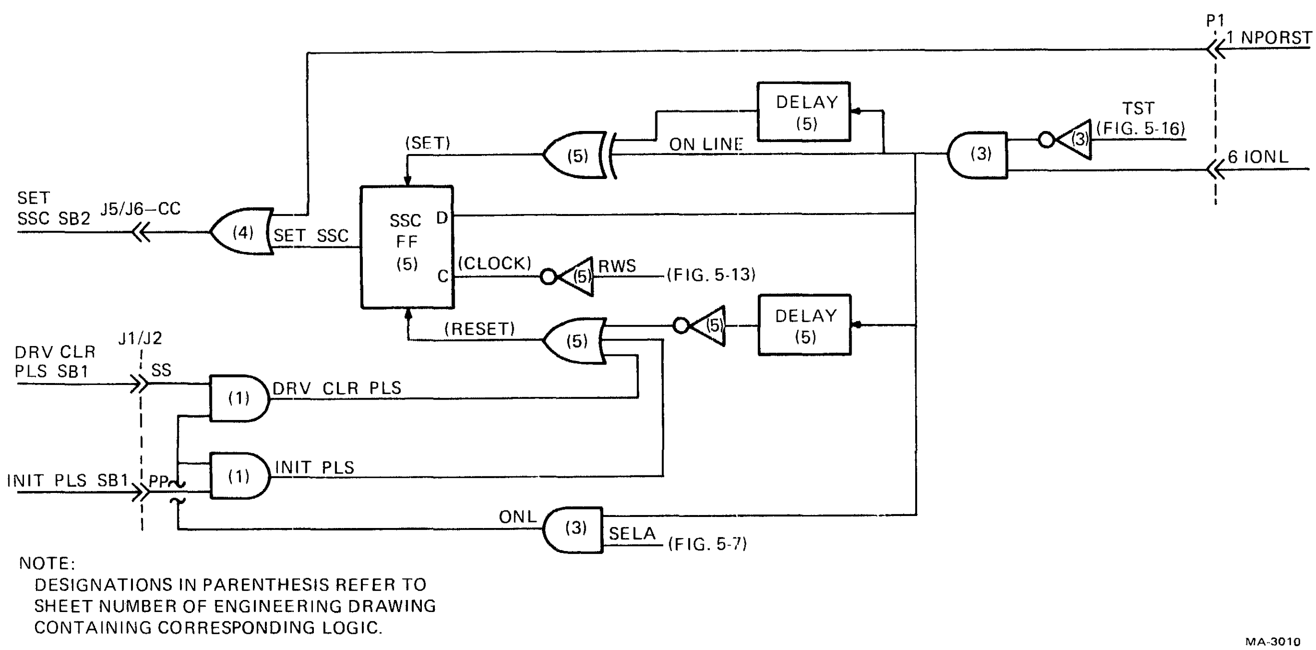


Figure 5-14 Slave Status Change Block Diagram

In test mode, ONL is false (Paragraph 5.4.1) and all I/O signals to the slave bus discussed in this paragraph are blocked. Otherwise the functioning of the status logic remains the same.

5.4.7 Slave Status Change (Figure 5-14)

When not in test mode, a slave status change signal (SET SSC SB2) is sent to the TM03 when:

1. Transport comes on-line,
2. Transport goes off-line,
3. A rewind is completed on an on-line transport.

It is not necessary for the transport to be selected to operate the slave status change function. An SSC flip-flop is set whenever the transport comes on-line or goes off-line. The flip-flop is pulsed to the set state by the action of an exclusive OR and delay circuit. Also, the flip-flop is clocked set at the end of a rewind if the transport is on-line. The software clears the flip-flop by asserting DRV CLR PLS SB1 on the slave bus. When going off-line, ON LINE negates setting the flip-flop via the exclusive OR, however, ONL also negates inhibiting DRV CLR PLS. In this case the flip-flop is reset by the negation of ON LINE via a delay network resulting in the negation of the SET SSC pulse.

In test mode, TST is true and inhibits the setting of the SSC flip-flop. The only condition that can now assert SET SSC SB2 on the slave bus is the assertion of NPORST from the transport.

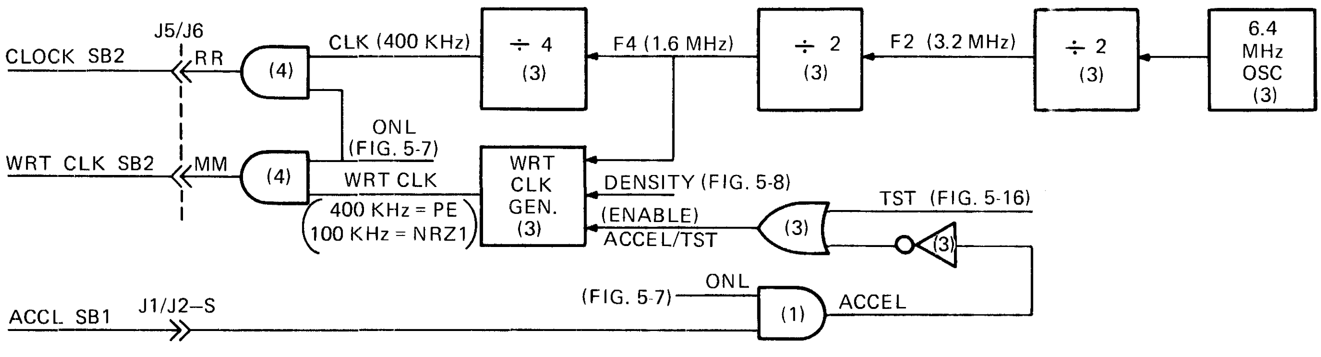


Figure 5-15 Timing Clocks Block Diagram

5.4.8 Timing Clocks (Figure 5-15)
With ONL true, two clock signals generated on the M8940 module are sent to the TM03 as CLOCK SB2 and WRT CLK SB2. The output of a 6.4 MHz oscillator is divided down in steps to a 400 KHz signal (CLK) and is output to the slave bus as CLOCK SB2. The 400 KHz CLK signal is present at all times. WRT CLK is generated from F4, and is 400 KHz in PE (DENSITY true) or 100 KHz in NRZI (DENSITY false). WRT CLK is present only when the write clock generator is enabled. The generator is enabled by the negation of ACCEL which occurs when the transport is up to speed and data transfers may occur.

In test mode, TST is true and ONL is false (Paragraph 5.4.1). All I/O signals to the slave bus discussed in this paragraph are blocked. The assertion of TST continuously enables the write clock generator, otherwise the clock logic functions as in normal operation.

5.4.9 Test Logic (Figure 5-16)
Seven test switches on the M8940 module are utilized for maintenance and testing of the transport. Placing the transport in the test mode will take it off-line providing the transport is presently on-line. If the transport is placed off-line by the ON LINE switch on the control panel, the MTA test switches will have no effect. The effect of the test mode on each of the functional areas has already been discussed. The following is a description of the test switches and their associated logic.

5.4.9.1 Normal/Test Switch (S4) – This switch illuminates the test indicator and places the transport in test mode by asserting TST to the M8940 functional areas. With TST true, ONL negates (Paragraph 5.4.1) thereby isolating the transport from the slave bus effectively placing it off-line. The only interface to the slave bus in test mode is the slave select code from the TM03, drive type code, slave present (SPR), transport serial number and SET SSC SB2 due to a transport power clear.

5.4.9.2 Read/Write Switch (S7) – This switch selects a read or write command for the ISWS signal to the transport via the test/normal mux (Figure 5-9), and asserts IRTH1 to the transport in NRZI operation to widen the read skew window (Figure 5-8).

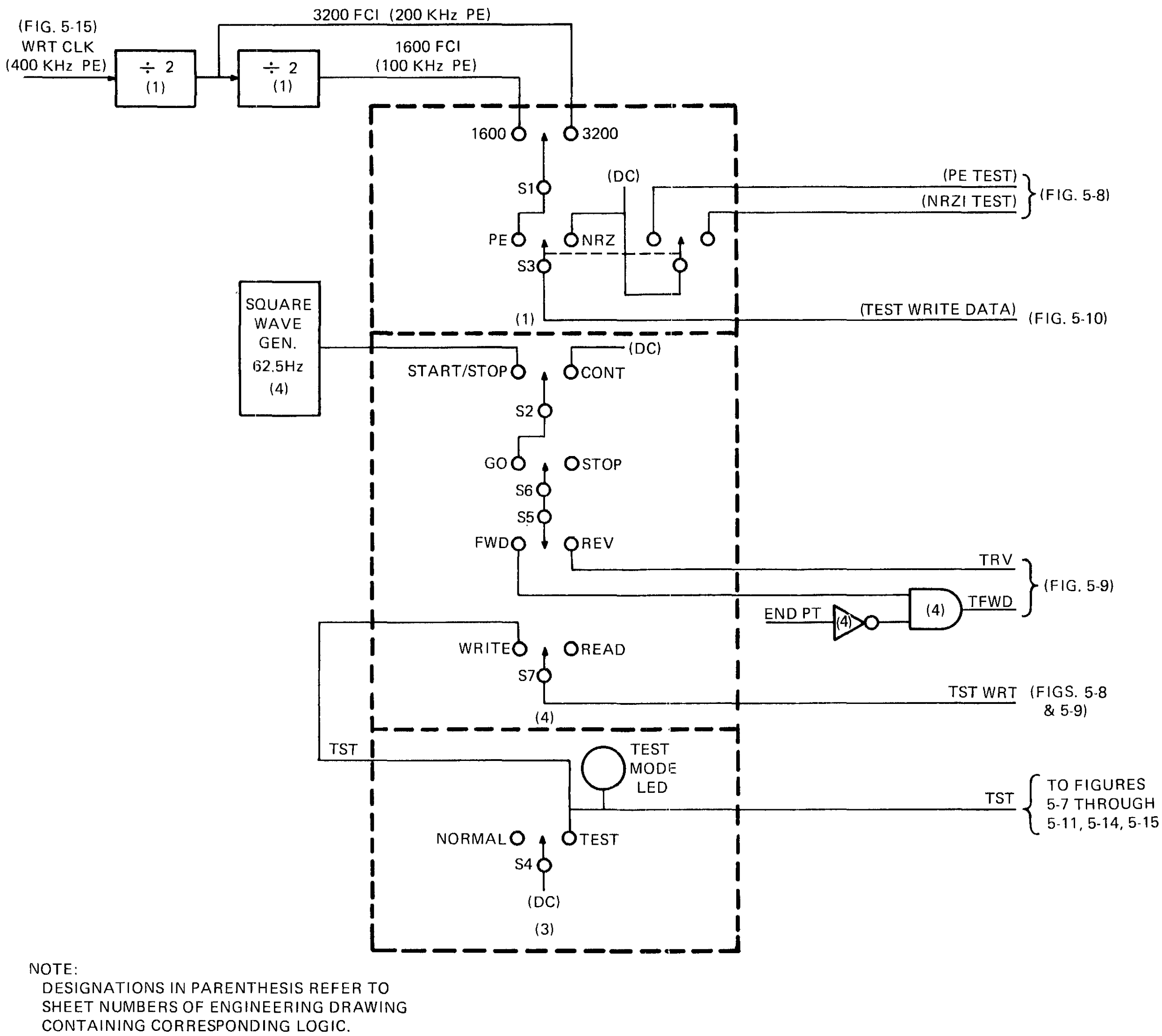


Figure 5-16 Test Logic Block Diagram

5.4.9.3 Start-Stop/Cont Switch (S2) – This switch selects start/stop or continuous motion test signal for stop/go switch S6.

5.4.9.4 Stop/Go Switch (S6) – This switch selects stop or go motion for transport test. If the switch is in the GO position it receives the type of test motion selected by S2.

5.4.9.5 Forward/Reverse Switch (S5) – This switch selects forward or reverse direction for motion signal (if any) from S6. It outputs TFWD or TRV as ISFC or ISRC respectively (Figure 5-9). Forward motion (TFWD) is inhibited if END PT is true.

5.4.9.6 1600/3200 Switch (S1) – This switch selects either 1600 FCI* (100 KHz) or 3200 FCI (200 KHz) for test write data in PE test mode. The 1600 FCI and 3200 FCI clocks are derived from WRT CLK.

5.4.9.7 PE/NRZI Switch (S3) – In NRZI position this switch resets density flip-flop (Figure 5-8) placing transport in NRZI mode, and supplies an asserted steady state level as test write data to the M8940 write channel (Figure 5-10). In PE position it sets density flip-flop placing transport in PE mode, and supplies the clock selected by S1 as test write data to the M8940 write channel.

5.5 POWER SUPPLY AND DISTRIBUTION (Figure 2 in Volume 1)

The transport derives all power from a single ac input as shown in simplified form in Figure 5-17. Primary ac power is used for the motor which drives the blower and compressor. A secondary winding output of transformer T1 provides 8.5 Vac to the power reset (NPORST) circuits. Other secondary winding outputs are rectified and delivered to the capstan/regulator PCBA, where they are regulated. Reel servo unregulated ±36 Vdc power is supplied to the reel servo PCBA. Power used for the read, write and erase heads is regulated on the 9-track (9TK) preamplifier PCBA.

The following paragraphs describe in detail the power supply and distribution circuits for a TU77 transport operating on 210 V 60 Hz power. For equipment using voltages and frequencies other than 210 V 60 Hz, it must be determined that the input receptacle is properly connected to the primary winding taps. Various connections are listed in Table 2-1 and detailed further in the following paragraphs. For clarification, the subject matter is divided into the following topics.

Primary Power Connection and Controls
Blower/Compressor Motor Power
Unregulated DC Power Supplies
DC Power Regulation and Distribution

5.5.1 Primary Power Connections and Controls

The transport derives all required power from a single ac input. The input voltage is optional between 190 and 250 Vac, in 10 V increments, but the input must correspond to the connections between power circuit breaker CB1 and the primary winding taps of the transformer. These taps are available at power supply terminal board A1TB1 (Figure 5-18). The transport may also be prepared for either 50 or 60 Hz power. This requires a different ac motor pulley and different drive belts. Figure 5-18 shows that the ac power input is available to the transport when circuit breaker CB1 is closed.

5.5.2 Blower/Compressor Motor Power

The blower/compressor ac motor operates directly on the ac input as shown in Figure 5-19. It is turned on automatically when solid-state switch S3 closes the circuit between A1TB1-1 and -2. Switch S3 is controlled by +12 Vdc at S3-3 and a low (0 Vdc) pneumatic return PNU RET at S3-4. The +12 Vdc is supplied by rectifier CR2 when the secondary winding of transformer T1 is energized. S3-4 goes low during load operation and stays low unless interlock is lost or air or vacuum pressure is inadequate. The motor has an internal thermal switch, which interrupts power to the motor windings during periods of over-temperature conditions. The switch contacts close whenever motor temperature returns to normal.

*FCI = flux changes per inch

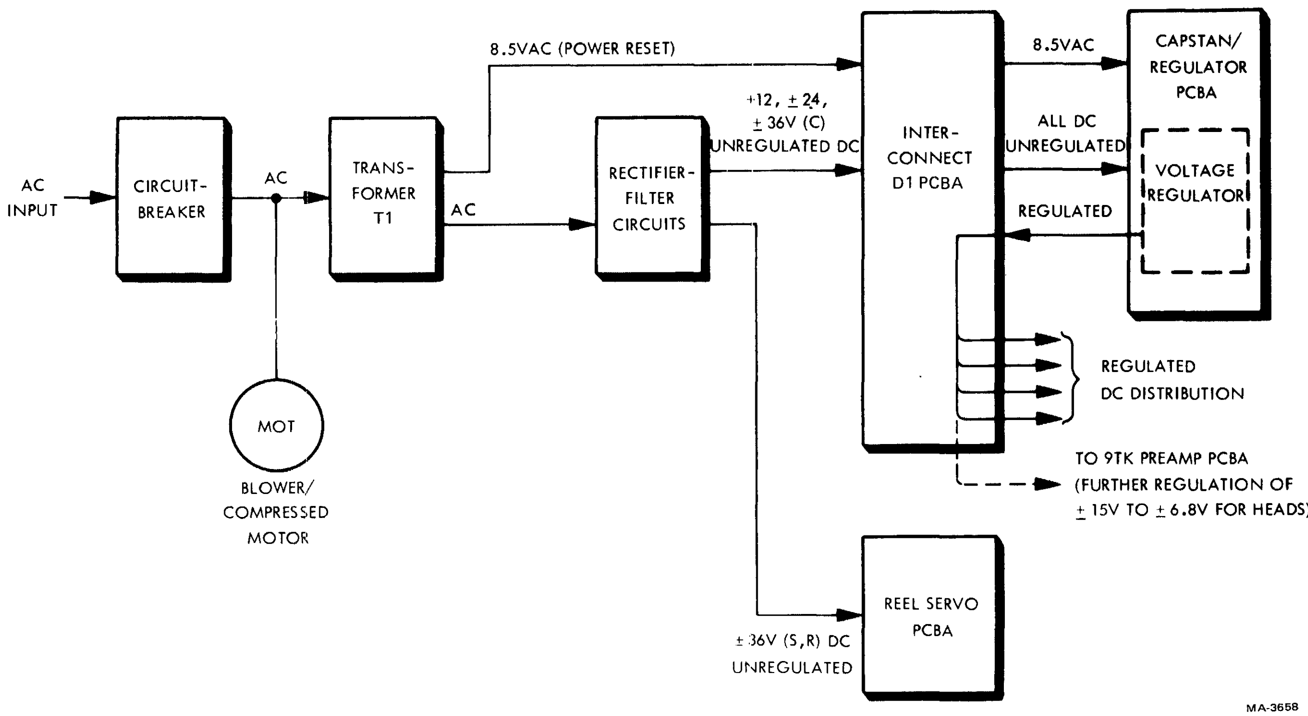
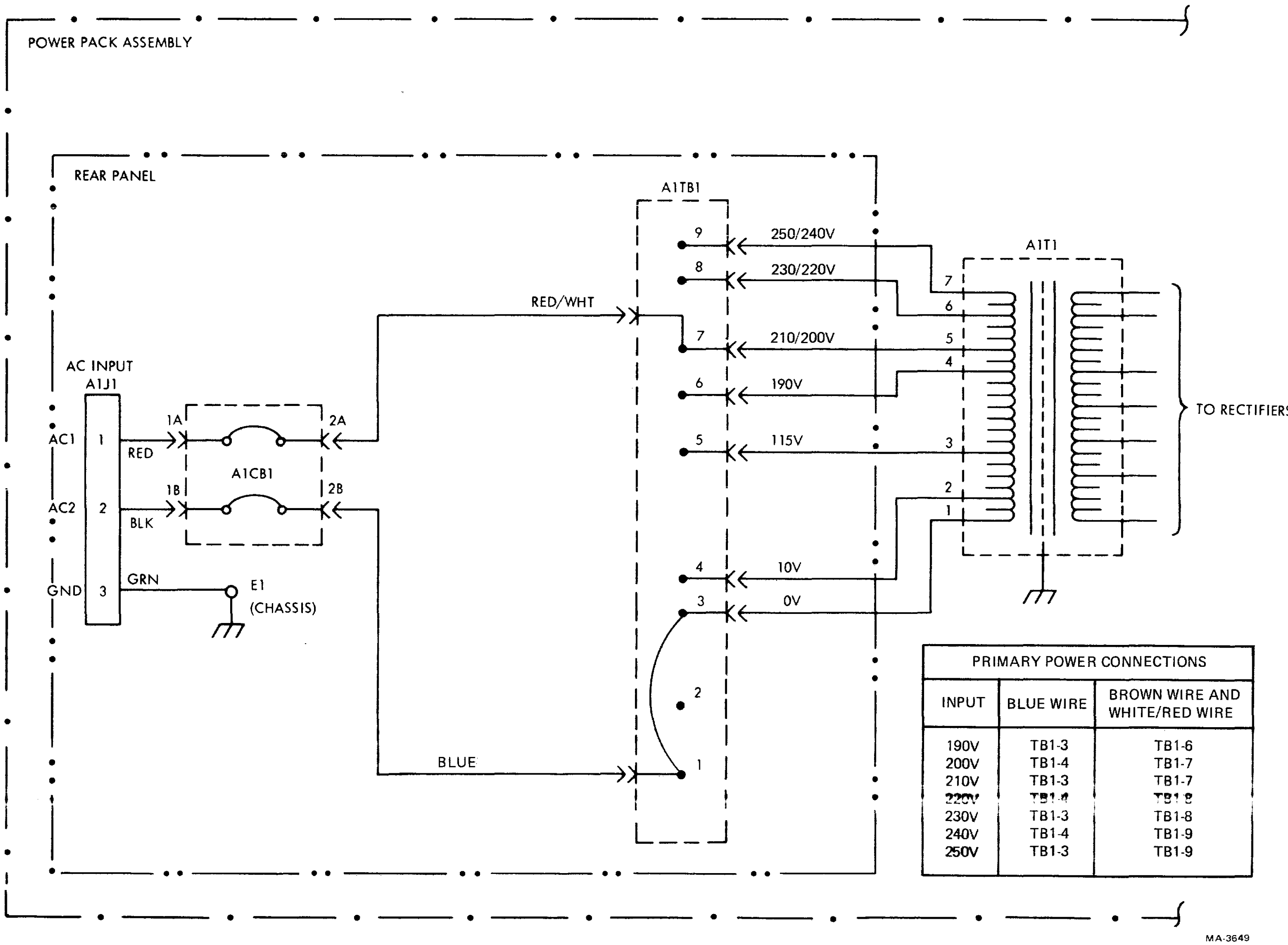


Figure 5-17 Power Supply Simplified Block Diagram



PRIMARY POWER CONNECTIONS		
INPUT	BLUE WIRE	BROWN WIRE AND WHITE/RED WIRE
190V	TB1-3	TB1-6
200V	TB1-4	TB1-7
210V	TB1-3	TB1-7
~~220V~~	~~TB1-4~~	~~TB1-8~~
230V	TB1-3	TB1-8
240V	TB1-4	TB1-9
250V	TB1-3	TB1-9

Figure 5-18 Primary Power Hookup and Control

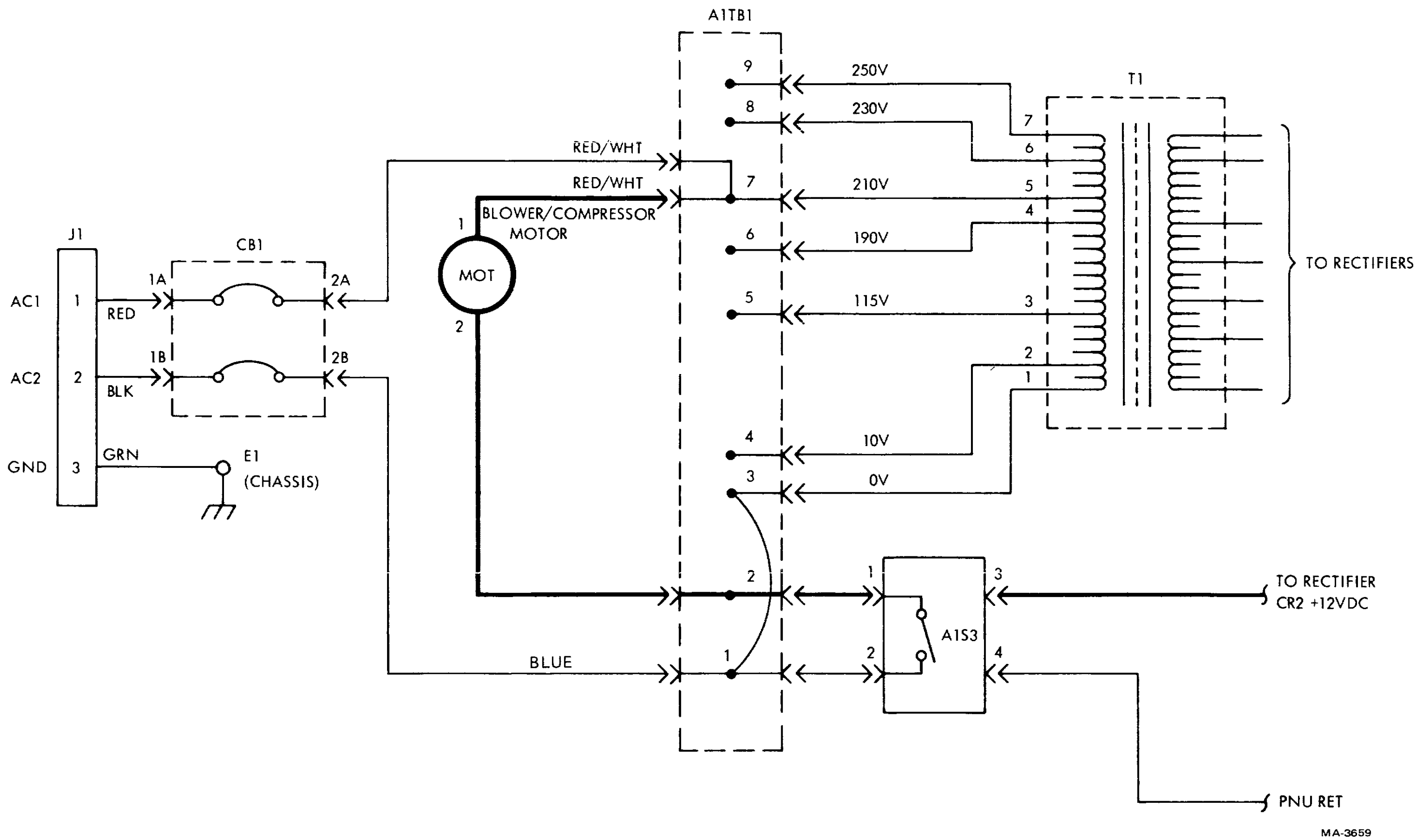


Figure 5-19 Blower/Compressor Motor Power and Control

5.5.3 AC Power

AC power is used in the transport to operate the blower/compressor drive motor and to initiate the power-on reset process (NPORST) via the power supply rectifiers and the power-on reset logic (Paragraph 5.5.7). The voltage applied to the motor is 210 V, so long as the input taps on the transformer match the applied voltage.

The power-on reset requirement is 8.5 Vac derived directly from the secondary winding of transformer T1. The connection to the secondary tap is made physically at the input to rectifier CR2, which is connected to A2TB1-10. A2TB1 is located at the rear of the card cage and provides direct inputs to vertically mounted interconnect D1 PCBA, to which it is attached. The 8.5 Vac is delivered to pin 40 of J11 for use in the capstan/regulator PCBA for generating the power-on reset signal (NPORST).

5.5.4 Unregulated DC Power Supplies

Power for the dc circuits is derived from various taps of the secondary winding of transformer T1, as shown in Figure 5-20. These ac voltages are rectified by CR1, CR2, and CR3 to produce nominal +12 Vdc, ±24 Vdc, and ±36 Vdc unregulated voltage.

Actual rectifier outputs are as follows:

Nominal	Rectifier Output
+12	9.0 to 11.0 Vdc at 10 A, 2 V peak-to-peak maximum ripple at 10 A
+24	21.5 to 24.5 Vdc at 5 A, 2 V peak-to-peak maximum ripple at 5 A
-24	-21.5 to -24.5 Vdc at 5 A, 2 V peak-to-peak maximum ripple at 5 A
+36	33.0 to 37.0 Vdc at 15 A, 43 Vdc maximum at no load, 2 V peak-to-peak maximum ripple at 15 A
-36	-33.0 to - 37.0 Vdc at 15 A, -43 Vdc maximum at no load, 2 V peak-to-peak maximum ripple at 15 A

Rectifier outputs are routed through the respective fuses to terminal A2TB1, attached to the rear of interconnect D1 PCBA, as shown in Figure 5-20. They are connected through interconnect D1 PCBA conductors to the capstan/regulator PCBA for regulation and further distribution, except that the PNU RET line is routed to the control M PCBA.

Supply reel and takeup reel +36 Vdc unregulated power is routed directly from the respective fuse to the reel servo PCBA, without going through the interconnect D1 PCBA. Similarly, - 36 Vdc unregulated power is also routed to the reel servo PCBA.

All dc return lines terminate at the dc common bus, mounted on the top of the capacitors. The bus is connected to the center tap of the T1 secondary winding.

5.5.5 DC Power Regulation

The +12 and ±24 Vdc unregulated power outputs are later regulated to provide the required +5, ± 15, and ±6.8 Vdc power (Figure 5-21) as follows.

5.5.5.1 +5 Vdc Regulator - The +12 Vdc unregulated voltage is received by the +5 V regulator on the capstan/regulator PCBA. The +5 V regulator uses a type LM305-IC to control the series power transistor and has a full load capacity of 8 A. TP11 (on capstan/regulator PCBA) is used to monitor the regulated +5 Vdc output.

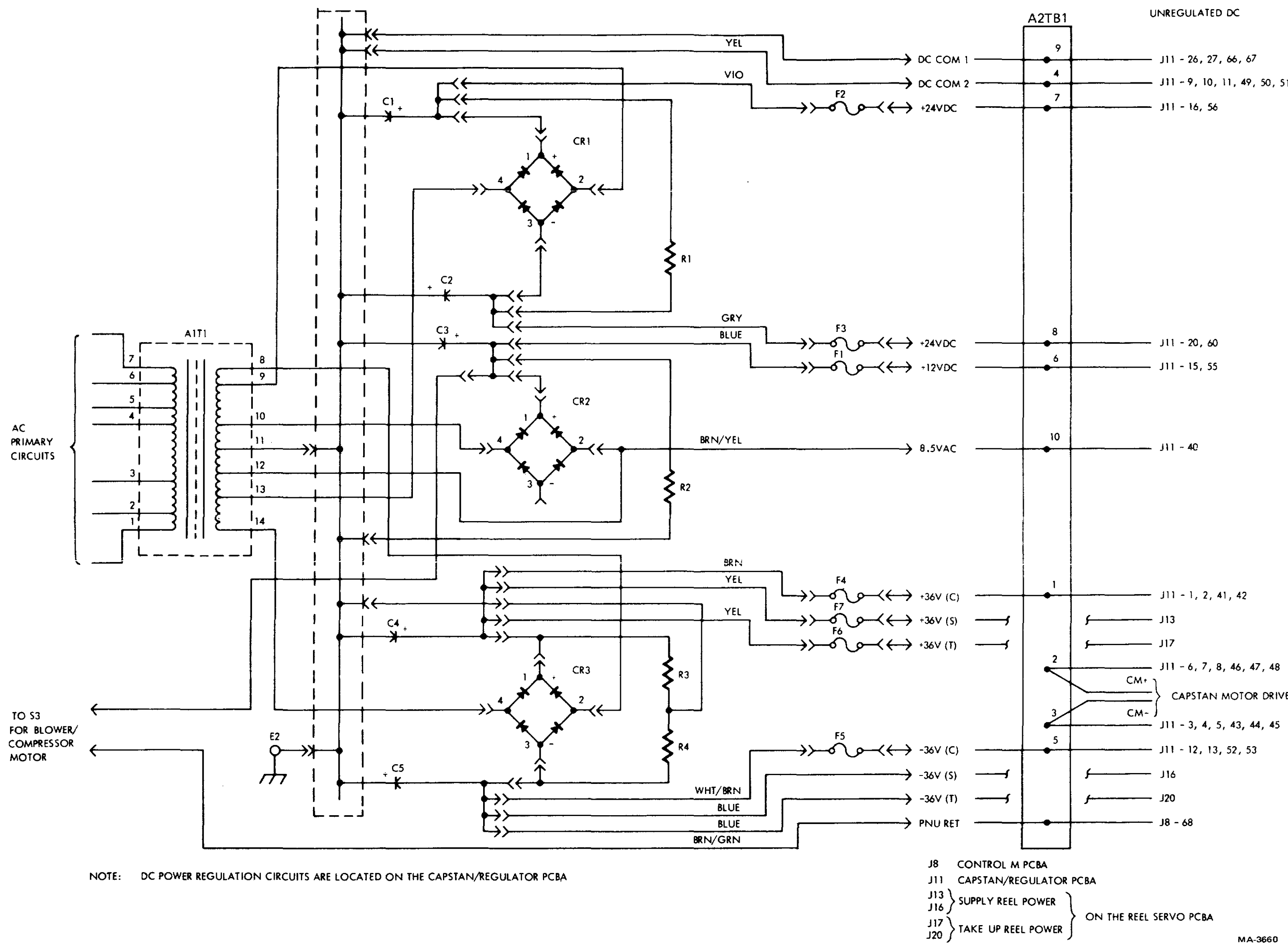


Figure 5-20 Unregulated Power Distribution Circuits

The +5 V is used primarily in the logic and lamp drive circuitry. Current is limited in the +5 V supply by means of current foldback techniques, thus providing over-current protection.

Over-voltage protection is provided on the +5 V lines. A voltage over 6.2 V fires an SCR and crowbars the output voltage to zero. Primary power must be removed for a short period of time in order to reset the crowbar circuitry.

Separate +5 V regulation is provided on the reel servo PCBA for its internal logic, +5 Vdc (L), and amplifier, +5 Vdc (A), circuits.

The M8940 interface logic uses +5 V (L) from the transport via P3-11, 12, 13, 28, 29, 30; and P1-18. The write, data L, and control M modules are made compatible with the M8940 logic by obtaining their terminator voltage [+5 V (T)] from the +5 V (L) source via jumper W1 on the interconnect D1 PCBA. W1 is used to connect the +5 V (L) at J11-22, 23, 62, 63 to J5-7, 43; J7-21, 57; and J8-37 as +5 V (T).

5.5.5.2 ±15 Vdc – The ±24 Vdc unregulated voltage is received by the ±15 V regulator on the capstan/regulator PCBA and converted into ±15 Vdc. The ±15 V regulator uses a type LM325 IC to control the series power transistors and has a full load capacity of 2.5 A. TP15 is used to monitor regulated +15 Vdc output and TP18 to monitor regulated -15 Vdc.

5.5.5.3 ±6.8 Vdc – The +6.8 V and -6.8 Vdc used in the preamp circuitry are derived from the +15 V and -15 Vdc by voltage regulators VR1 and VR2 on the 9TK preamplifier PCBA, which is mounted on the rear of the transport drive base assembly behind the read/write head area. Regulated outputs are monitored at TP4 and TP1, respectively. The regulated ±15 Vdc used for this purpose is supplied through the data L PCBA.

5.5.5.4 ±36 Vdc (**C**) – Unregulated +36 Vdc (C) for the capstan motor is connected from fuse F4 to A2TB1, on the interconnect D1 PCBA, through the PCBA conductors to J11 and the capstan/regulator PCBA. Unregulated -36 Vdc (C) is routed similarly from fuse F5.

NOTE

A2TB1-2 and -3 serve as connecting points for controlled capstan motor drive power (– and +, respectively). These are part of the capstan circuits and not part of the power distribution system.

5.5.5.5 ±36 Vdc (**S**) – Unregulated +36 Vdc (S) for the supply reel motor is connected from fuse F7 directly to J13 on the reel servo PCBA, without using interconnect D1 PCBA circuits. Unregulated -36 Vdc (S) is connected from rectifier CR3-3, without fusing, to J16 on the reel servo PCBA.

5.5.5.6 ±36 Vdc (**T**) – Unregulated +36 Vdc (T) for the takeup reel motor is connected directly from fuse F6 to J17 on the reel servo PCBA. Unregulated -36 Vdc (T) is connected from CR3-3, without fusing, directly to J20 on the reel servo PCBA.

5.5.6 Regulated Power Distribution

All 5 Vdc and 15 Vdc power is regulated on the capstan/regulator PCBA and is distributed to other boards via J11 and conductors on the interconnect D1 PCBA, the internal connections of which are listed in Appendix D. Regulated power distribution is illustrated in Figure 5-21.

The reel servo PCBA contains voltage regulators for +5 Vdc (L) and +5 Vdc (A) used in the logic and amplifier circuits, respectively, on the same board. Similarly, the 6.8 Vdc used by the read, write, and erase heads is regulated internally on the 9TK preamplifier PCBA.

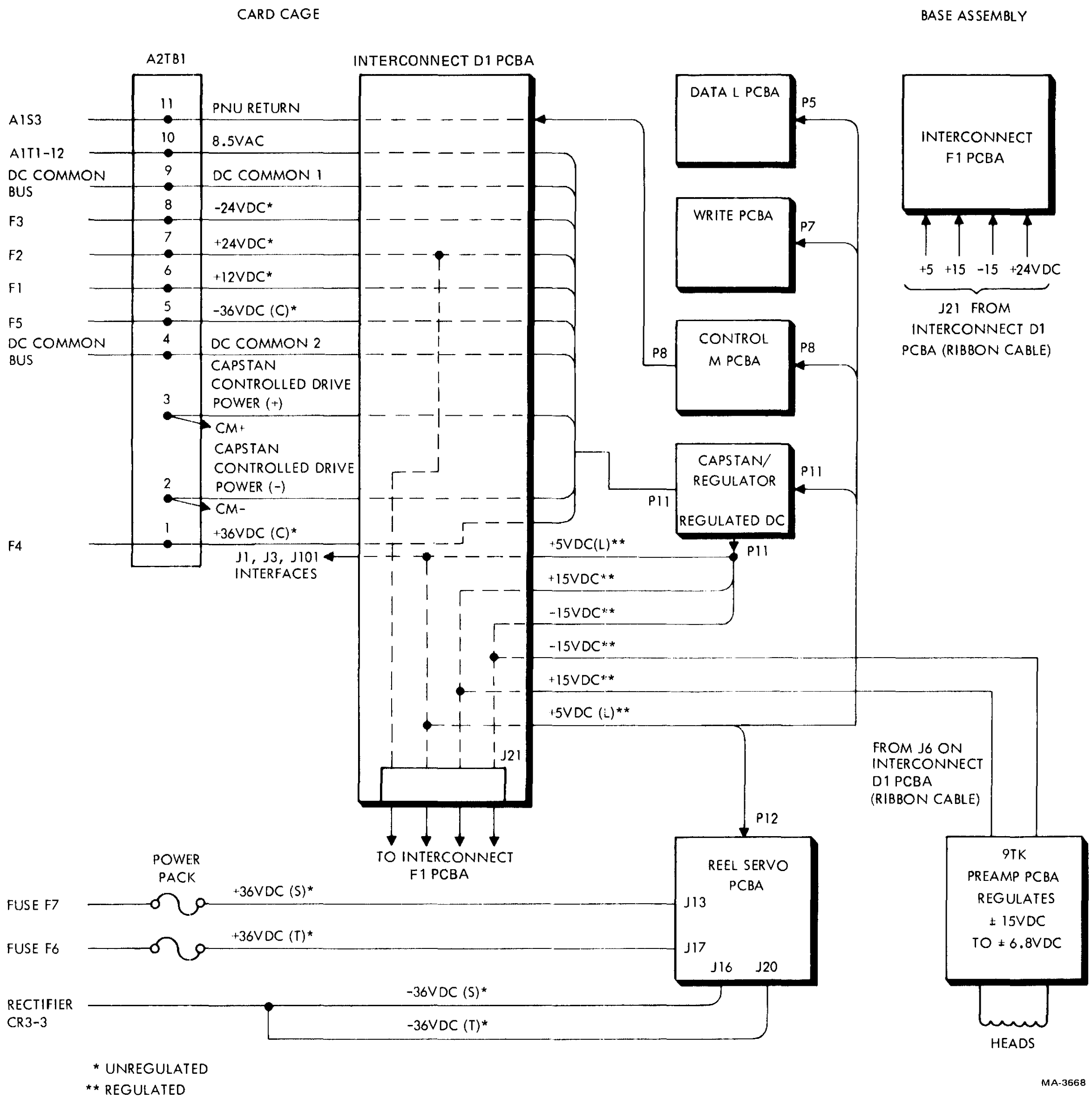


Figure 5-21 DC Power Regulation and Distribution

5.5.7 Power Reset (NPORST), Enable (ENBL, NENBLE), and Master Reset Pulse (NMRSTP) Generation

Restoring power after an interruption initiates pulses that reset or preset various flip-flops, etc., preparatory to starting operation. The following unregulated power at inputs to the capstan/regulator PCBA are involved.

+24 Vdc input at P11-16, 56
-24 Vdc input at P11-20, 60
+12 Vdc input at P11-15, 55
8.5 Vac input at P11-40

Figure 5-21 shows the source of the power, and Schematic No. 104757 shows the circuits on the capstan/regulator PCBA that develop the resetting pulses and enabling conditions. The +24 Vdc and -24 Vdc inputs are regulated to +15 Vdc and -15 Vdc, respectively, by LM235N (U1) and transistors Q32 and Q35 (zones 3-8E,F).

Resistors R114 and R121 (zones 3-7E,F) provide for dividing the difference between +15 Vdc and -15 Vdc at approximately the -5 Vdc level. However this point is regulated by VR4 (zone 3-6E), inverted to one diode drop below ground at U11-11 (zone 3-5H), and applied to adjacent U11-4. Resistors R115 and R122 (zones 3-7E,F) provide a +5 Vdc level, which is connected directly at U11-5 (zone 3-5H). When +15 Vdc and -15 Vdc supplies are functioning, U11-6 is high, turning on Q29 (zone 3-4G) and delivering a high through diode CR7 and the 3.9 V voltage regulator VR2 to Q31 (zone 3-3G). Q31 conducts, dropping Q30 base input to 0 V. This turns Q30 off, applying a high to Q55 and a low to Q56. Q56 is turned off and Q55 conducts sending a high = false NPORST through P11-37, 77 and to the base of Q51. Q51 conducts turning on Q50 and Q52 making the enable (ENBL) signal low = false.

The preceding conditions are valid, when power is applied, after a brief delay. The delay provides the low = true NPORST and high = true ENBL pulses. After the duration of the pulses, the previously described false conditions will be sustained as long as the 8.5 Vac, entering at P11-40 (zone 3-10E), maintains a charge in the C20 network (zone 3-5G, 3-4G) between diodes CR8 and CR9. When power is disconnected, the 8.5 Vac is disconnected, allowing the input to VR2 (zone 3-4G) to bleed through CR9 and R110, disabling the above circuits. The 8.5 Vac feature protects the circuits from damage by rapid discharge of the power pack capacitors whenever power is switched off or disconnected.

Since Q29, CR6, and R99 (zone 3-4G), are connected to the +12 Vdc supply (after regulation to +5 V by LM305 [U2] in zone 3-8G) all of the outputs of the power pack except ±36 Vdc contribute to the reset/enable (NPORST/ENBL) network. These supplies must be in operating order to provide the appropriate reset/enable signals, which effectively checks the supplies before operation of the transport. ENBL is used on the capstan/regulator PCBA to enable the cartridge motor drive circuits (zone 3-8C).

NPORST, gated with NINTLK (zone 2-8H) to produce CAPSTAN ENABLE, is delivered through J11-37 and J11-77, via the interconnect D1 PCBA to the write PCBA (J7-11), control M PCBA (J8-61), reel servo PCBA (J12-9, 26), and as IPCLR to the M8940 interface module. NPORST is used to reset and enable various circuits as required after a power interruption. The master reset pulse (NMRSTP) is initiated by either NPORST or the manual RESET switch output, as applied to J8-61 or J10-25 respectively, on the control M PCBA (Schematic No. 104745, zone 2-7C).

5.5.8 Power Indicator

The power indicator is lighted when power is on by lamp driver U5. This is one of the indicator drivers on the control M PCBA which are enabled and, in this case, switched on by NPORST from the capstan/regulator PCBA.

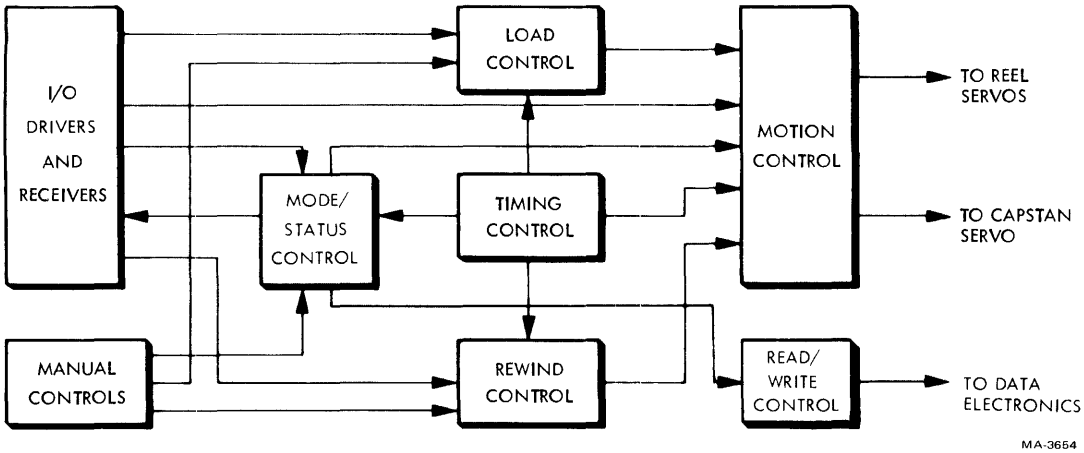


Figure 5-22 Control Logic Block Diagram

5.6 SYSTEM CONTROL (Figure 3 in Volume 1)

5.6.1 Control System Overview

The control logic circuitry manages the operation of the transport on the basis of commands received from the host system and/or manual commands entered by means of switches provided on the transport. Figure 5-22 is a simplified block diagram of the control logic.

Most of the control circuits are mounted on the control M PCBA, which is plugged into connector J8 on the vertical interconnect D1 PCBA. The control M PCBA circuits are covered in detail in Paragraph 5.6.6. The following text covers the control system in general.

Inputs and outputs from the host system are connected via the MTA M8940 interface module which plugs into J1, J2, and J3 on the interconnect D1 PCBA.

Figure 5-23 illustrates the general routing of control signals throughout the transport assembly.

5.6.2 Manual Controls

Manual controls (Table 3-1) include the system unit code select thumbwheel switch, LOAD/REW switch, ON LINE switch, UNLOAD switch and the RESET switch. Manual switching is illustrated in Figure 5-24. The power circuit breaker switch, mounted on the rear panel, is discussed in the power supply and distribution text.

In addition to the operational switches mentioned, a tape motion switch (on the control M PCBA) and a reel servo disabling switch (on the reel servo PCBA) are provided for maintenance purposes.

The decade thumbwheel switch (S8) located next to the power indicator is for setting the transport circuits so they will respond when properly addressed by the host system. Positions 0, 1, 2, and 3 are used. Contacts 0, 1, 2, and 3 are connected to the MTA module via the control M module. SLT COM on P10-4 is connected to ground. The switch grounds one of the four select lines which connect to the MTA module via the control M module. Which select line is grounded depends on the transport number selected by the switch. SLT COM is grounded by jumper W17 on the control M module (Schematic No. 104745 zone 2-13C). Jumper W17 also asserts SLT and SLTA which enables the various transport circuits involved in host system operation.

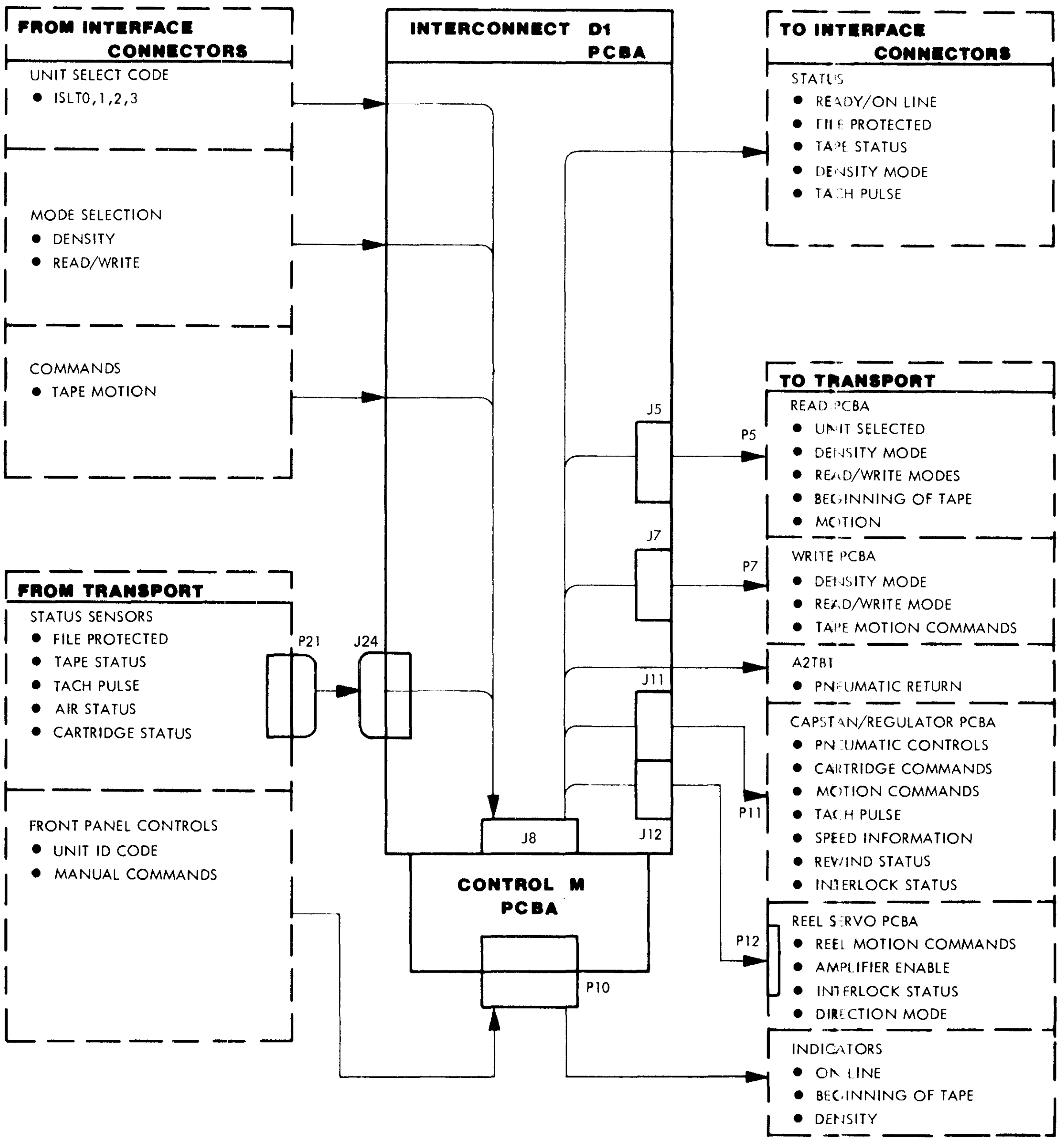


Figure 5-23 Control Signal General Routing

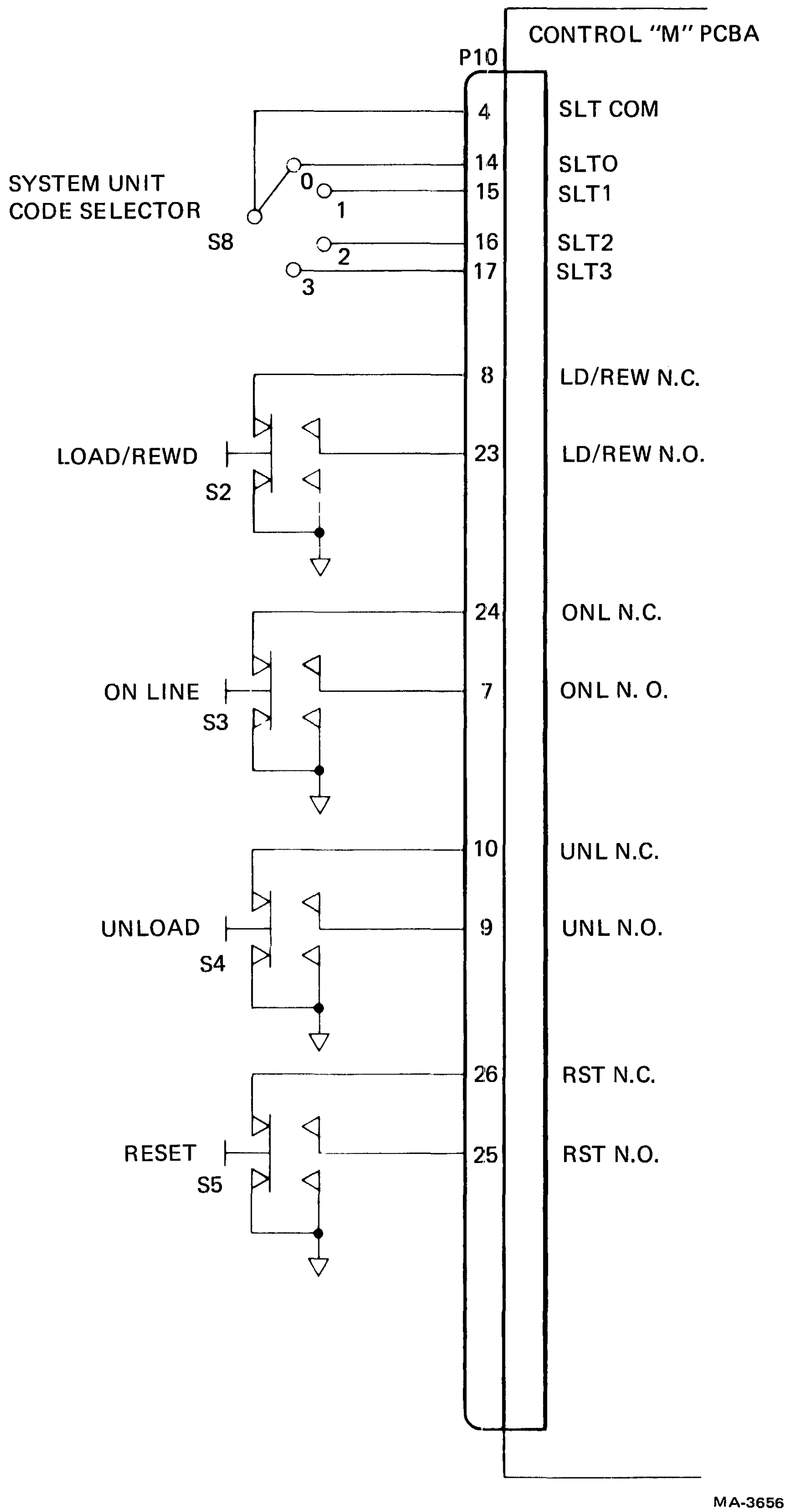


Figure 5-24 Manual Control Switching

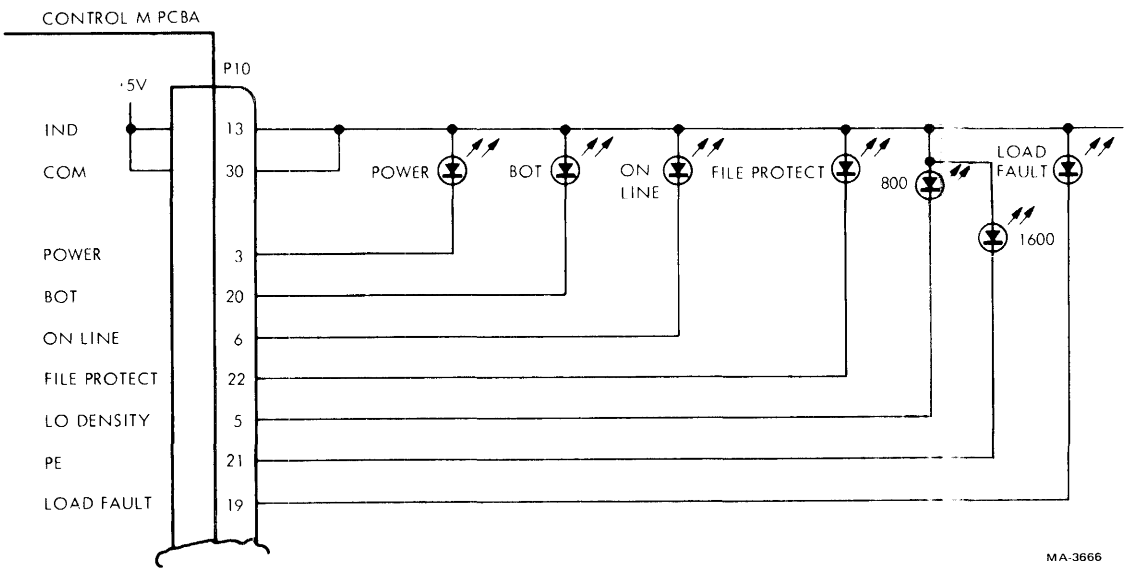


Figure 5-25 Front Panel Indicator Connections

LOAD/REW, ON LINE, UNLOAD, and RESET switches S2 through S5 (Figure 5-24) are momentary, push button devices which normally hold one of their two contacts at low (nominal 0 V) level. When depressed they remove signal ground from the contact and momentarily connect ground to the other contact. Circuits operated by these switch commands are located on the control M PCBA, discussed in Paragraph 5.6.6. The autoload interlock switch on the front of the base assembly inhibits the autoload sequence* and allows only a manual load sequence if the transport front door is open and a reel cartridge is not used. If a reel cartridge is used, the load sequence is always automatic regardless of whether the door is open or closed. (See Chapter 3 for manual and automatic loading instructions.)

5.6.3 LED Status Indicators

Panel LED indicators include POWER, BOT, ON-LINE, FILE PROTECT, LOAD FAULT, 800, and 1600. All indicators are connected to system circuitry through connector P10, which is mounted on the control M PCBA (Figure 5-25). BOT becomes illuminated to indicate that the BOT marker has been sensed and that the tape is in the beginning-of-tape position. ON-LINE indicates that the transport has been switched to the host system. (It is not an active part of the host system, however, until selected by the system and the transport is in ready status.) FILE PROTECT (FPT) is illuminated to indicate that the write enable ring is not in place and that the file is protected against writing. When illuminated, the LOAD FAULT (LDF) indicator cautions the operator that the tape failed to load. The 800 indicator is illuminated when the system is set for low density (NRZI) operation; the 1600 indicator becomes illuminated when the system is set for high density (PE) operation.

The indicator common (IND COM) makes +5 V available to the indicators whenever transport power is on. Any of the LEDs will conduct and emit light when the controlling input to the LED is low = true.

*Pulling out the switch overrides the interlock function allowing the autoload sequence with the front door open.

5.6.4 Control System Inputs/Outputs

Inputs and outputs to the control system are generalized in Figure 5-23. Interface connectors are mounted directly on the interconnect D1 PCBA, which routes command/status signals between the MTA interface module and the control M PCBA edge connector P8.

Manual control switches and associated LED indicators are connected directly to J10 on the control M PCBA. Status sensor information is connected through interconnect F1 PCBA and J24 to a fixed connection on interconnect D1 PCBA, which routes them to the control M PCBA. Outputs from the control M PCBA to the various other card cage PCBAs (read, write, capstan, reel, servo, etc.) are all routed via the interconnect D1 PCBA, as shown in Figure 3 in Volume 1.

5.6.5 General Modes of Operation

Transport operational modes may be divided into two categories: off-line modes and on-line modes.

Off-line operation includes tape loading, unloading, and some maintenance/test procedures. Front panel control switches are used to select and run off-line operations. In addition to these controls, maintenance test procedures involve use of a manual switch (located on the control M PCBA) to control tape motion and a similar switch (located on the reel servo PCBA) to disable reel motion. Additional manual switches are located on the MTA interface board.

On-line operation essentially includes read/write and motion procedures under control of the host system. Initiation of on-line operation requires that the transport (in a multitransport system) has been selected by the host controller, tape has been loaded, all interlocks have been made, and the transport has provided the selected, ready, and on-line (SRO) signal.

When system power is turned on, an ac voltage (8.5 Vac) is applied to the capstan/regulator PCBA which generates a power-on reset pulse (NPORST) to the control logic. NPORST in turn develops a master reset pulse (NMRST) which clears the control M logic prior to receiving the manual load command (LD/REW N.O.) Until the tape is loaded and the necessary interlocks are made, the logic will ignore all other commands with the exception of reset. Reset will stop the load operation and prepare for another load command, in addition to its normal clearing and resetting functions.

Upon completion of a successful load operation, the control logic will accept all other commands except a load command. In order to execute another load operaton, one of the vacuum interlocks must be open.

When the tape is loaded and positioned between the BOT and EOT, a REWIND command may be initiated via the interface or manual operator control.

NOTE

If more than one transport is used in the system, the unit select thumbwheel switch must be set to correspond with the controller's unit address code in order to operate on interface signals.

Receipt of the rewind command by the rewind control logic causes the following:

1. Rewind command is initiated,
2. A high speed reverse signal is sent to the capstan servo,
3. Tape is wound onto the supply reel at high speed until low tape is sensed,

4. The tape slows to synchronous reverse speed,

5. Tape continues to wind onto the supply reel until it reaches BOT tab, where it stops.

An unload command may be initiated from the control panel (off-line) or the interface (on-line). If the tape is not at the BOT, a rewind will be executed, then the unload operation. If the tape is at the BOT, only the unload operation will be executed.

Jumper W17 on the control M module asserts SLT and provides SLTA to the output logic. The output logic provides NSLTA to the read function via J8-23. Jumper W17 also grounds SLT COM on J10-4. SLT COM routes to the select switch on the front panel control unit. The select switch connects ground to one of the ISLT lines which routes to the MTA module via J10 and P9 of the control M module and the interconnect D1 PCBA. Select logic on the MTA module senses the grounded ISLT line and the transport select code from the TM03. If the transport numbers represented by the two inputs match, the MTA module connects the transport to the TM03 formatter.

After power is on, the reset signal (NPORST), the input and output logic, and the front panel switches are enabled and provide control of the transport provided system power is on (NPORST false). If system power is interrupted, NPORST goes low (true) causing the logic to provide the master reset signal (NMRSTP) to the rewind generator and the air load/control function. Pressing and releasing the RESET button also generates the master reset pulse (NMRSTP). NMRSTP clears the rewind generator and the logic in the air load/control function. When NPORST goes high it initiates enabling of the front panel indicators.

Refer to Figure 3 in Volume 1. The +5 V and logic return lines are connected to the EOT/BOT assembly via TB2 on the interconnect F1 PCBA. The EOT/BOT assembly provides the off-tab voltage and either the EOT or BOT voltage depending on which tab is detected. These voltages are supplied to the EOT/BOT amplifier. The EOT/BOT amplifier provides the NBOT or NEOT signals, via P24, to the input logic. R22 on interconnect F1 PCBA adjusts NBOT and NEOT voltages.

After power has been applied to the transport (NPORST false), IDDS on J8-19 of the control M PCBA generates a low density signal (NPE high) on P8-25, and a data density signal (DDI) to the PCBA's output logic. The output logic provides either a low LO DENSITY or a low PE to light the 800 or 1600 indicator respectively depending on the interface signal, IDDS. The input logic also provides the density signal (NPE) to the read and write function. The NPE density signal becomes NHID to the read function on J5-10 and to the write function on J7-61. At the same time, the write function provides a file protect signal (FPT) to the output logic via J8-60. The output logic provides a low FILE PROTECT to light the file protect indicator if the write enable ring is not installed.

When the air load/control function detects a load command, it provides a low load status signal (NLDS) to the ready generator (control M PCBA). The low NLDS disables the ready generator during a load sequence.

After the loops are set in the buffer boxes, the air load/control function initiates an interlock signal (INTLK1), not more than one second after interlock has been detected, to the rewind generator. Approximately one second after INTLK1, the delayed interlock signals (DINTLK and NDINTLK) and the interlock pulse (INTLKP1) are generated (control M PCBA), DINTLK is applied to the rewind generator, the ready generator and the input logic. At the same time, NDINTLK and INTLKP1 are coupled to the input logic. If interlock is lost, the function provides a loss of interlock pulse (NINTLKP2) to the rewind generator. NINTLKP2 disables the rewind generator.

The high DINTLK from the air load/control function to the rewind generator causes the generator to produce the rewind signals REV, RWS and NRWS. REV is applied to the capstan servo function and causes the transport to rewind to BOT. At the same time, the low NRWS disables the ready signal (RDY). If either NMRSTP from the input logic or NINTLKP2 from the air load/control function are low, the rewind generator provides a reset signal (NRST1) to the input logic.

When the BOT tab is detected, NBOT is sent from the EOT/BOT amplifier to the input logic (J8-52). The input logic applies NBOT to the rewind generator and the motion control. NBOT resets the rewind generator and provides a low REV which removes the drive from the capstan servo function. The high NRWS enables the ready generator. The input logic also provides BOT and NBOT to the output logic and BOT to the air load/control function. The output logic provides the drive signal, BOT, which lights the BOT indicator on the front panel. The output logic also provides the BOT INT signal to the read function via J8-48.

When DINTLK, NLDS and the unload signal (NUNL1) are high from the air load/control function and NRWS is high from the rewind generator, the ready generator provides the ready signal (RDY) for the motion control and the input logic. TP24 (control M PCBA) is used to monitor the ready signal.

The ONL N.O. and ONL N.C. are provided to the input logic from S3, the front panel ON LINE switch. When ONL N.O. is low, a flip-flop is set which then provides three on-line signals (an output from U25-5, NONL, and a delayed signal, DONL). The high output from U25-5 provides ON LINE which lights the front panel ON LINE indicator. At the same time, NONL is sent to the motion control and air load/control function. The delayed on-line signal, DONL, is sent to the output logic. If the transport is selected, ready and on-line, the input logic provides the SRO signal to the output logic.

The status lines reflect the state of the transport. The SRO signal (from the control M PCBA output logic) enables three of the status interface lines which function as follows. If the transport is:

1. At BOT, ILDP is low
2. At EOT, IEOT is low
3. Not having power reset, IRDY is low.

When the transport is selected, ready, and on-line, the remaining interface lines (IFPT, IONL, ITACH, IRWD, and IDDI) become active. When the input logic detects a forward command (ISFC low) or a reverse command (ISRC low), the input logic provides a low NSFC or a low NSRC to the motion control.

The motion commands are enabled by a high NONL from the input logic and a high RDY from the ready generator. If the transport is at BOT (NBOT low), NSRC is inhibited. When a valid NSFC or NSRC is detected by the motion control, it provides the motion signals (NGOP, NMOT, and MOTION) and the direction signal, REV (REV high = reverse, REV low = forward) depending on the state of NSRC and NSFC. MOTION is supplied to the read and write functions via J8-28. The output from U42-11 is coupled to the stop pulse generator. NGOP is provided to the input logic. NMOT is applied to the capstan servo function via J8-51. REV is also sent to the capstan servo function and the reel servo function via J8-66.

When NONL is high, the maintenance switch (S1 on control M PCBA) is enabled. This switch allows for off-line testing of the transport. S1 moves tape in a forward and reverse direction. TP21 is used to monitor motion. TP 22 is used to monitor reverse and TP23 is used to monitor forward. TP30 and TP31 are for applying a clock (CLKE or CLKG) to test the manual FWD/REV circuits.

When the motion control output (TP21 control M PCBA) goes high, it initiates the output of a high stop pulse on the NDRV line at P8-65. This causes NMOT and the stop pulse to apply dynamic braking to the transport mechanism for a specified time determined by the duration of the pulse.

5.6.6 Control M PCBA

The control M printed circuit board assembly (PCBA) integrates, develops, and applies the commands received from the host system, the manual control switches, or the M8940 test switches.*

External commands, including transport selection codes, are delivered from the interface to the control M PCBA via the interconnect D1 PCBA, connector J8. Manual commands from the control panel are connected via J10 on the control M PCBA.

Internal signals used in the control process include feedbacks and status signals. These arrive at the control M PCBA via the interconnect F1 PCBA (J24) and J10 on the interconnect D1 PCBA. Timing is provided by a 1-MHz oscillator and a battery of frequency dividers, which are part of the control M PCBA.

Inputs and outputs are detailed in Figure 5-26. The following text describes the control M PCBA circuits that develop the input signals into control outputs for the other transport circuits and the host system. Refer to Chapter 1 for the theory of operation of the entire control subsystem external to the control M PCBA. Refer to Figure 4 in Volume 1 for source of sensor feedbacks.

5.6.6.1 Control System Timing – Control M PCBA clocks are derived from the 1-MHz oscillator circuits associated with crystal Y1 (Schematic No. 104745, zone 1-17F.) The 1-MHz prime frequency is referred to as clock A (CLKA) which may be monitored at TP20.

The oscillator output is cascaded through a series of decade dividers and one final flip-flop to provide the required additional frequencies. The available frequencies, including the oscillator output, are listed in Table 5-1. Load/unload sequence counter outputs are discussed in Paragraph 5.9.2.

5.6.6.2 Transport Selection (NSLTA) – In host systems which use more than one transport, each unit is assigned a selection code number. The designated number (0, 1, 2, or 3) is set on the front-panel thumbwheel switch. The common contact of the switch is grounded by jumper W17 on the control M module (Schematic No. 104745, zone 2-17C). One of the select lines (J10-14, 15, 16, 17) is grounded by the thumbwheel switch and routed to the MTA module via P8-15, 39, 40, 41 and the interconnect D1 PCBA. Jumper W17 also supplies a low input to U44-5 (zone 2-13C), producing SLT and SLTA signals. SLT is applied to the motion command circuits (zone 2-16D) as one of the enabling inputs. SLTA is routed to U102-1 (zone 2-3F) to produce the NSALTA control signal at P8-23. NSLTA is applied to other transport circuits through interconnect D1 PCBA.

*Transport must be on-line in order to use M8940 test switches.

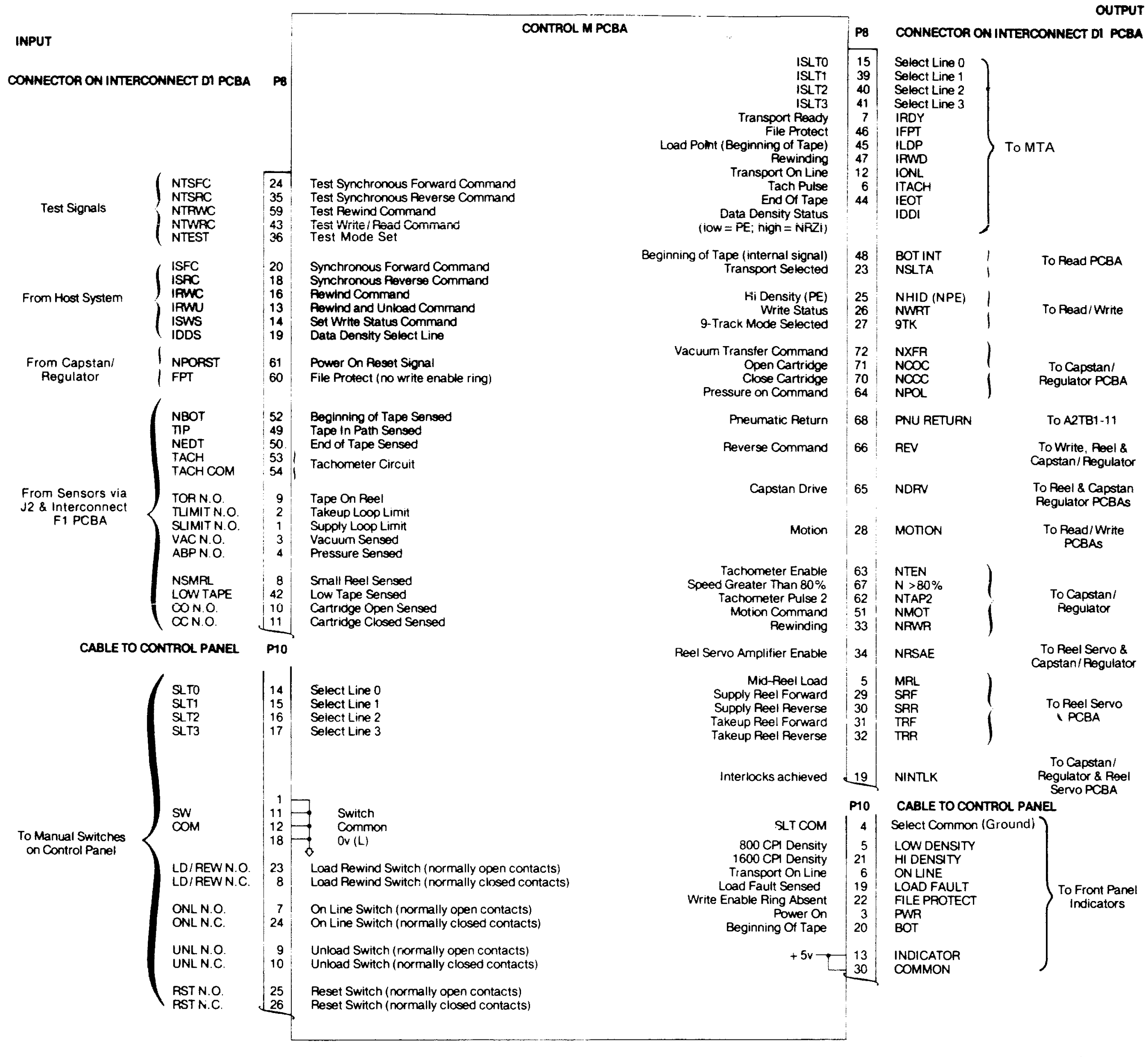


Figure 5-26 Control M PCBA Inputs and Outputs

Table 5-1 Basic Timing Frequencies
(Schematic No. 104745)

Name	Frequency	Test Point	Distribution	Sheet and Zone	Primary Use	Associated Signals
CLKA	1 MHz	TP20	U113-3, 11	3-14A	Tachometer pulse generation	TAPEN, TACHP, NTAP2, NTEN, NRWR, N > 80%
			U115-5	3-12A	GO pulse generation	NGOP
CLKB	100 KHz	TP15	U35-11, U25-11	2-8C	Master reset pulse generation	NMRSTP
			U35-3 U34-3, 11	2-8F	Load reset pulse, load pulse and rewind pulse generation	NLRSTP, NLDP NREWP
CLKC	10 KHz	TP39	U214-11, U215-11	3-6F	Stop pulse generation	NDRV
	1 KHz				Not used	
	100 Hz	TP17			Not used	
CLKE	10 Hz	TP19	U65-9	2-4C	Load fault indicator control	LOAD FAULT (LDFS)
			U54-13	3-15F	GO pulse, stop pulse generation	NGOP, NDRU, NMOT
			U114-11	4-11B	Load fault signal	LDFS
					Vacuum control	NXFR
					Reel motion	SRF, SRR, TRF, TRR
			U163-5	4-11E	Thread signal	THDS
			U196-11, U205-3	4-12D	Set tape loops command	STL
			U101-14	4-7D	Load fault	LDFO, LDFS
CLKF	1 Hz		U164-11,3	4-14G	Interlock circuits	INTLK1, DINTLK, NDINTLK, INTLKPI
CLKG	0.5 Hz		U64-13, U74-1	3-15G	Forward/reverse motion	NGOP (NTSFC, NTSRC mode check)

5.6.6.3 Modes of Operation – The control M PCBA processes internal and external commands to establish the required modes of operation. The major modes, as determined by the purposes for which the transport is to be used are:

- Read Only, Forward
- Read Only, Reverse
- Write and Read Forward
- High Recording Density (PE)
- Low Recording Density (NRZI)
- Load Tape
- Rewind Tape
- Unload Tape
- Test.

Some of these modes are effective simultaneously with each other and with certain transport states that define the conditions required to enable the major modes of operation. The transport states are:

Reset/Preset
Interlock
9-Track
PE/NRZI
Beginning of tape Interlock
Unit Selected.

These states are discussed in the following paragraphs.

Control M PCBA circuits which process the various commands and the operational task operations (Load, etc.) are discussed later in this chapter.

5.6.6.4 Reset/Preset State – The reset/preset state clears and resets the transport's circuits for a new operation. It is initiated automatically when power is applied after an interruption. It may be initiated by the operator at other times by momentarily pressing the RESET pushbutton.

The circuits that check the conditions (adequate power, etc.) and develop the reset/preset signals (NPORST, and ENBL) are located on the capstan/regulator PCBA and are discussed on a system basis in Paragraph 5.5.7. The control M PCBA uses RST N.O., RST N.C. and the NPORST signals which are described in the text.

NPORST is a low = true pulse produced when power is applied. The pulse input is at P8-61 (Schematic No. 104745, zone 2-9B.) NPORST is used to enable the front panel indicators (zone 2-3C). It is also applied to NOR gate U45 (zone 2-6C) as one of two inputs, either of which will produce NMRSTP at the output of NAND gate (U55-8). NMRSTP is the low = true master reset pulse used in various circuits on the control M PCBA as listed in zone 2-5C.

RST N.C. (J10-26) and RST N.O. (J10-25) inputs establish the state of flip-flop output U36-9. As the mnemonics imply, the RESET pushbutton switch contacts normally close the U36-13 clear (CL) inverted input circuit to signal ground (0 V) and Q output (U36-9) is low. The preset (PR) input (U36-10) is kept high by U16-13.

When the RESET switch is depressed, RST N.O. contacts are closed to ground and RST N.C. contacts are opened. The preset input U36-10 is pulled down momentarily, and the Q output (U36-9) applies a high to flip-flop U35-12. At clock B time, applied at U35-11, the Q output (U35-9) applies a high to NAND gate U24-13 and to flip-flop input U25-12. The $\overline{Q}$ output of the flip-flop goes high, and U25-8 sends a high to NAND gate input U24-12. NAND gate output U24-11 goes low and initiates an NMRSTP low = true pulse from U55-8. The pulse continues approximately 10 μs after the pushbutton is released.

The low = true master reset pulse (NMRSTP), whether generated manually or automatically when power is applied, is used in the following networks on the control M PCBA:

Used in Producing	Schematic No. 104745, Sheet and Zone
NRST1	3-14E
PNU RETURN, UNL1	4-6F
NLDFS, NPOL, NXFR	4-7B
NLRST	4-12H
RST, NRST	4-14D

NRSTI goes to U81-4, to preset the flip-flop (zone 3-14E) that controls rewind status, and to U25-1, to clear the flip-flop that initiates the on-line signals (DONL, NONL).

The PNU RETURN signal (4-1G) is used to turn on the compressor/blower motor. It is enabled by the application of NMRSTP to U146-1 and 13 (zones 4-4F, 5F, 6F).

Load fault status (NLDFS) flip-flop (zone 4-7B) is cleared by the application of NMRSTP to U192-1. This enables motion and other physical command outputs through P8 as shown in zones 4-2A through 4-2G. The PNU RETURN signal goes to A2TB1-11 for blower control; NXFR, NCOC, NCCC, and NPOL are connected to the capstan/regulator PCBA; NRSAE, MRL, SRF, SRR, TRF, and TRR are connected to the reel servo PCBA.

NLRST (zone 4-11H) is produced either by NMRSTP at U174-9 or by the interlock (NINTLK) signal at U174-10, 11. NLRST resets the tape loading procedure flip-flop (zones 4-11F, G through 4-7G). RST and NRST (zone 4-12D) are initiated by NMRSTP at OR gate U154-9 or by other inputs to the same gate (zone 4-14D). RST resets the try counter (zone 4-16B) which issues a load command from U175-11, and the load sequence counter which produces the load counts (NC1,2; C1, etc.). Refer to zones 4-14A through D from where the count signals fan out to other areas of sheet 4.

The preceding paragraphs describe the distribution of the master reset pulse NMRSTP and, in general, the circuits on the control M PCBA where used. The complete functions of the various circuits are described separately in appropriately titled paragraphs.

5.6.6.5 Interlock State (NINTLK, INTLK, INTLK1, DINTLK, NDINTLK, NINTLKP1, NINTLKP2) – The interlock state circuits are designed to inhibit and/or enable various modes on the basis of monitored air and tape conditions. The basic interlock signal is the low = true NINTLK level found at TP62 and P8-69 (Schematic No. 104745, zone 4-2H), and at the NAND gate output (U154-6) where the signal originates. The NAND gate (zone 4-15G) requires a high level at inputs U154-1,2,4, and 5 to produce a low = true NINTLK output level at U154-6. The inputs are controlled by the pressure switches that sense the supply and takeup reel loop limits (SLIMIT N.O. and TLIMIT N.O.), vacuum pressure (VAC N.O.) and positive pressure (ABP N.O.).

The switches are each connected (via interconnect F1 PCBA; J24, interconnect D1 PCBA, and J8) to their respective pins (J8-1,2,3, and 4) as shown in zones 4-17F and G.A satisfactory condition causes the corresponding switch to close its circuit to signal ground. This pulls down the level at the respective input to J8. Zones 4-17F,G through 4-14F,G show how these inputs are ANDed at gate output U154-6 to produce NINTLK.

5.6.6.6 9-Track State – The 9-track signal is hardware-selected by means of jumper W4 (Schematic No. 104745, zone 2-6H). The jumper pulls down the inverted input to U181-5, causing U181-6 to produce a high = true 9TK signal at P8-27. This is connected via conductors on the interconnect D1 PCBA to J5-11 (data L PCBA) for data reading circuits. Jumper W4 is always in.

5.6.6.7 PE/NRZI State – Control M PCBA output NPE (low = true) at P8-25 selects high density phase encoded (PE) operation. When NPE is high = false, the low density NRZI mode is effective (Schematic No. 104745, zone 2-2G).

Density selection is normally accomplished by the host system software through the formatter (write operation) or the formatter alone (read or spacing operation). If the formatter applies a low = true IDDS at the interface, P8-19 (zone 2-17D) will be low. This will apply a low at U54-2 (zone 2-5G), causing the OR gate to place the transport in PE mode (NPE low = true).

The other input to OR gate U54-1 is normally held high since jumper W2 (zone 2-8G) is removed, thus disabling NAND gate U111-12 (zone 2-7G). This circuit also initiates the DDI signal (zone 2-3G and 2-12D) which produces the interface IDDI signal through P8-17 (zone 2-11D). The interface driver (U151) is enabled by transport selection (SLTA) from U65-6 (zone 2-12C) which is always asserted by jumper W17. (The IDDI output on P8-17 is not used.)

5.6.6.8 Beginning of Tape Interlock (BOT INT) State - The BOT INT output at P8-48 (Schematic No. 104745, zone 2-2G) of the control M PCBA is a high = true level initiated when the beginning marker on the tape is in register with the BOT optical sensor. At this time a low = true level (NBOT) appears at P8-52 (zone 2-9B) via interconnect D1 and F1 PCBAs. The NBOT signal is also applied to various circuits on the control M PCBA as shown or referenced on the schematic (zones 2-8B through 2-2B).

5.6.6.9 Unit Selected State (NSLTA) - The NSLTA output at P8-23 of the control M PCBA (Schematic No. 104745, zone 2-2F) is always at a low = true level. This circuit is discussed in Paragraph 5.6.2.

5.7 AIR LOAD/CONTROL

The air load/control subsystem includes the air and electronic provisions which control and monitor the path travelled by the tape between the reels (Figures 4 in Volume 1 and 5-27).

The speed at which the tape passes the read and write heads is controlled by the capstan servo subsystem. The speed of the supply and takeup reels must vary according to the quantity of tape on the reels. For example, when the supply reel is full and the takeup reel nearly empty, the takeup reel must rotate much faster than the supply reel in order to transfer the tape past the read/write head assembly at a constant 3.2 m/s (125 in/s) rate. Each of the reels is driven by a separate motor, controlled by a servo system that adjusts the speed as required to maintain proper tape transfer. The subject air load/control subsystem provides tape loop status signals to the reel servo circuits, which use the information to regulate the power applied to the reel motors.

The input port of the blower is used as the source of vacuum (minus atmosphere) pressure that forms the tape loops. Vacuum is applied to the buffer boxes, loop pocket, corner pockets, and the capstan. Energizing solenoid K3, on the vacuum valve, switches vacuum to the hub of the takeup reel to facilitate threading. A typical tape loop formation is illustrated in Figure 5-28. The complete tape path is illustrated in Figure 3-5.

5.8 REEL SERVOS (Figure 5 in Volume 1)

5.8.1 Reel Servo Overview

The reel servo subsystem controls the speed of the tape reels as required to maintain optimum tension on the tape between the supply and takeup reels, the tension being interpreted from the positions of the tape loops.

Figure 5-29 illustrates the basic signal flow as applied to each of the reel servos. The servo loop monitors the power interlock signal and disables the reel servos if the interlock is broken. While loading and unloading tape, the reel motors are controlled by forward and reverse signals from the control logic. When tape is loaded, control of the servo loop is assumed by the loop position signal from the position transducer. During normal run operations, a loop offset generator generates a signal which offsets the tape loops. The direction of the offset is determined by the direction and type of motion (forward, reverse, or rewind). During rewind a larger offset is used to allow for the higher tape speed.

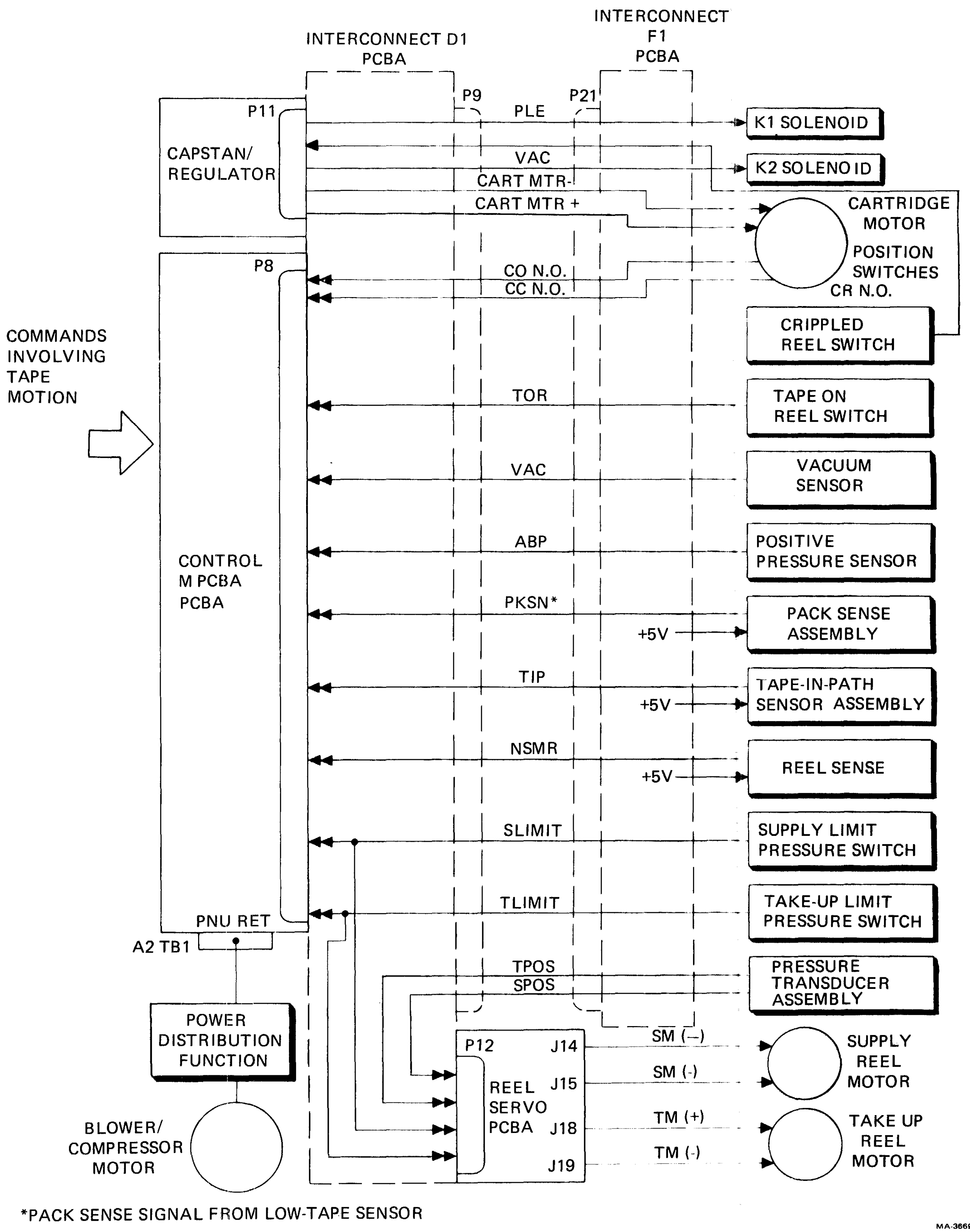


Figure 5-27 Air Load/Control Function

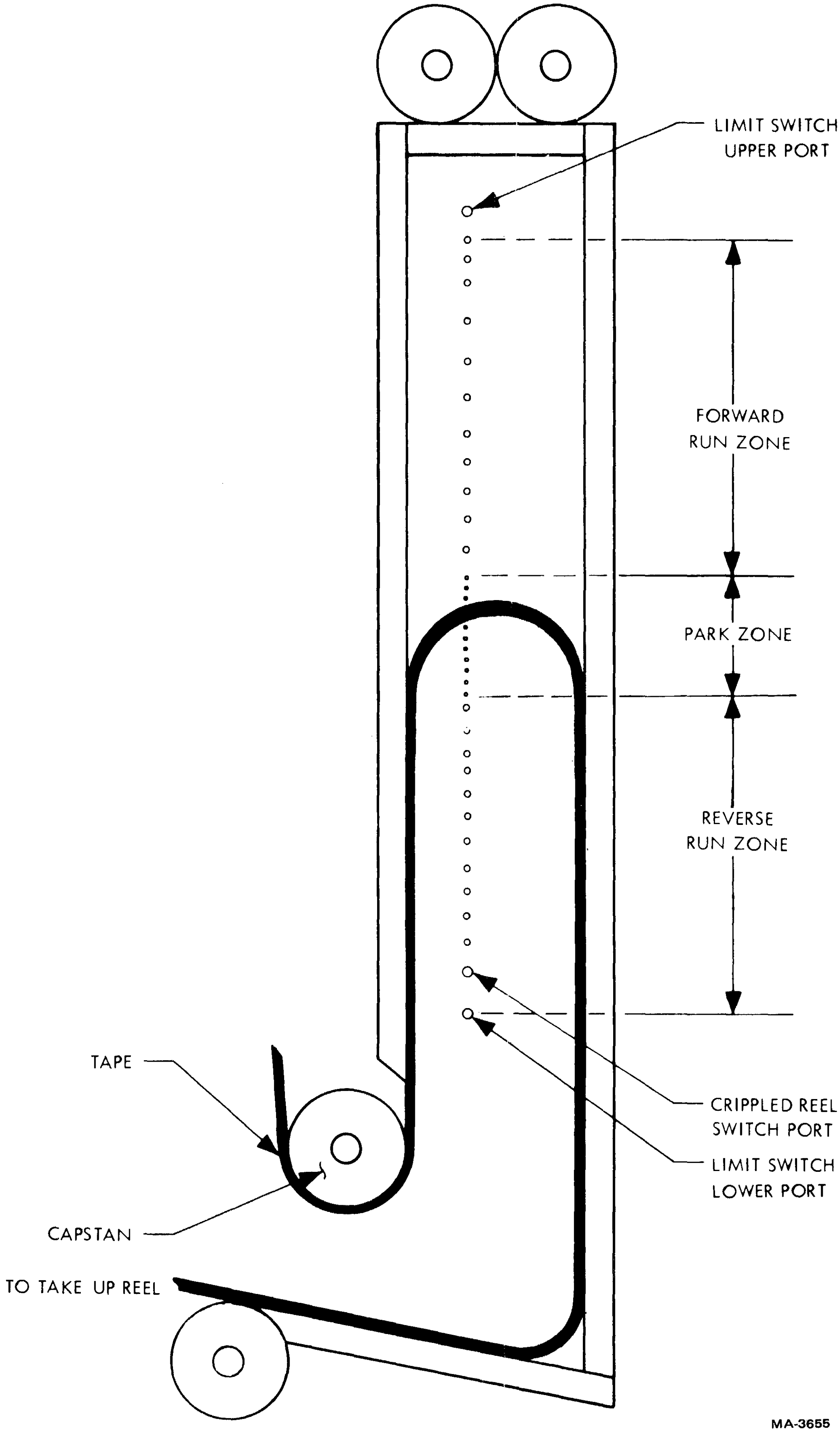


Figure 5-28 Tape Loop In Takeup Buffer Box

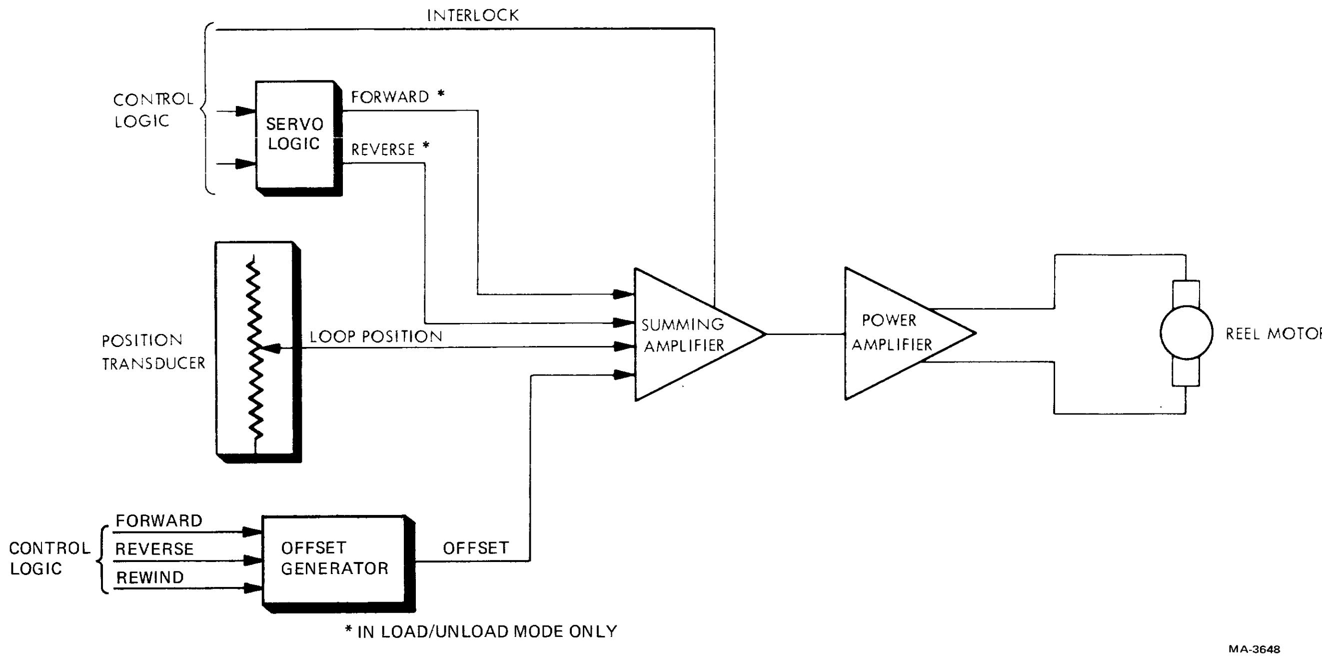


Figure 5-29 Reel Servo Block Diagram

If the supply reel with tape is properly loaded, the air system in operation and interlock circuit status is acceptable, reel motion will begin. The speed of the reel rotation will be subject to feedback information from the air load/control subsystem. This information includes the tape loop position transducer output for the appropriate servo (supply or takeup) and an offset input. The offset input pertains to adjusting the reel motion to achieve a different loop configuration for different tape motion directions.

The supply and takeup reel servo networks are identical except for the polarity of the position transducer outputs and the inclusion of the crippled reel signal in the takeup reel servo circuits.

During load and unload operations, at which times the tape path has not stabilized, the speed of the reels is totally a function of voltage specified by the control electronics. Load and unload sequences are described in Paragraph 5.9.

5.8.2 Reel Servo PCBA

The reel servo PCBA, plugged into J12 on the interconnect D1 PCBA, contains the supply reel and takeup reel power amplifiers which control the speed and direction of reel motion (Schematic No. 106925).

While the speed and direction of the capstan drive motor determines the motion of tape across the heads, reel motion is a critical factor in tape transport management. Reel motion is determined by tape loop position. Reel speed is adjusted to maintain the proper tape loop thereby maintaining the proper tape tension. In so doing the reel speeds will change according to the quantity of tape on the reel. A tape loop offset is placed into the reel servo loops. The direction of the offset is determined by the direction and type of tape motion (forward, reverse, or rewind). Reel servo PCBA inputs and outputs are detailed in Tables 5-2 and 5-3. Power amplifiers and outputs to the reel motors are shown on sheet 4 of Schematic No. 106925.

Table 5-2 Reel Servo PCBA Inputs

Input	Connector	From	Purpose
+36 V(S)	J13	F7	Supply reel motor power
-36 V(S)	J16	C5(-)	Supply reel motor power return
+36 V(T)	J17	F6	Takeup reel motor power
-36 V(T)	J20	C5(-)	Takeup reel motor power return
REWR	J12-13	J11-78	Rewind ramp signal from capstan/regulator ramp generator
REV	J12-33	J8-66	Reverse command from control M PCBA
NRSAE	J12-11	J8-34	Reel servo enable signal
NPORST	J12-9,26	J11-37,77	Power-on reset signal
NTINTLK	J12-31	J2-10	Takeup loop interlock (TLIMIT signal)
NSINTLK	J12-30	J21-6	Supply loop interlock (SLIMIT signal)
TRF	J12-15	J8-31	Takeup reel forward command
TRR	J12-14	J8-32	Takeup reel reverse command
SRF	J12-17	J8-29	Supply reel forward command
SRR	J12-16	J8-30	Supply reel reverse command
MRL	J12-28	J8-5	Midreel load signal
SPOS	J12-20	J21-37	Supply loop position signal
TPOS	J12-3	J21-21	Takeup loop position signal
NDRV	J12-27	J8-66	Drive reel command
+15 V(L)	J12-6,23	J11-21,61	Regulated dc from capstan/regulator PCBA
0 V(L)	J12-4,5,21,22	J11-26,27,66,77	DC ground
-15 V(L)	J12-7,24	J11-14,54	Regulated dc from capstan/regulator PCBA
+15 V(R)	J12-32 }	Interconnect	Power for position transducer
0 V(R)	J12-34 }	F1 PCBA	

Table 5-3 Reel Servo PCBA Outputs

Output	Connector	To	Purpose
SM(+) SM(-)	J14 J15	Supply reel motor	Drive Power
TM(+) TM(-)	J18 J19	Takeup reel motor	Drive Power

Drive power unregulated ± 36 V inputs to the reel servo PCBA are through J13, J16 (supply reel + and -) and J17, J20 (takeup reel + and -,) respectively (zones 4-1G, 4-1A).

Outputs to the reel motors are, respectively: supply reel motor +, SM(+), J14; supply reel motor -, SM(-), J15; takeup reel motor +, TM(+), J18; takeup reel motor -, TM(-), J19.

Input signals to the reel servo PCBA are through interconnect D1 PCBA and J12, shown at the lefthand side of sheets 2 and 3 of Schematic No. 106925.

Both supply and takeup reel amplifiers are enabled by low = true reel servo amplifier enable (NRSAE) at J12-11 and high = false power-on reset (NPORST) at J12-9,26 (after reset pulse) (zones 2-8F and 2-8E). Gate U10-6 (zone 2-6E) produces amplifier enable (NAE) when low and, when high, initiates the dynamic brake outputs for both reels in both directions (SFBRK, SRBRK, TFBRK, and TRBRK) (zones 2-1D and 2-1E).

The brake signals are sent to the amplifiers (zones 4-8F,E,B, and A, respectively). The NAE signal is routed as shown at zone 3-4E as one of the conditions for development of the drive signals, NSDA, NSDB, NTDA, and NTDB (zones 3-1G,F,C, and B, respectively). These are routed to the amplifier circuits as shown in zones 4-8F and G, for supply reel signals NSDA and NSDB, and 4-8C for corresponding takeup reel signals.

Mode control circuits (zones 2-8E through 2-6C) interpret the supply reel (SR) and takeup reel (TR) forward or reverse motion commands (SRF, SRR, TRF, TRR) with respect to whether the tape interlocks (NSINTLK and NTINTLK) are set and whether a midreel load (MRL) operation is in progress. The outputs of the mode control network are applied to the corresponding mode switches shown in zones 3-5B,6B,5F, and 5G.

Reel load speed adjustment circuits are shown in zones 3-5H,6H and 3-5C,6C. The supply loop position feedback signal (SPOS) is applied to the summing amplifier network through J12-20 (zone 3-8G). Takeup loop position signal feedback is applied to the corresponding takeup reel summing network through J12-3 (zone 3-8B). The offset factor is introduced into the summing networks (zones 3-8F and 3-8A) to reproportion the supply and takeup loops during a rewind operation.

The offset signal is developed on the basis of reverse motion signal (REV), J33, and rewind ramp signal (REWR), J13, shown in zones 2-8F and 2-8H, respectively. REWR is developed on the capstan/regulator PCBA and REV is provided by the control M PCBA. Normal offset adjustment circuits are shown in zone 3-5D, where resistance of potentiometer R76 contributes to the T-wave generator circuits controlled by the park loop gain switch shown near the NDRV input J12-27 (zone 3-8E).

The reel servo inhibit switch (zone 2-6F) provides for disabling reel servo circuits for maintenance purposes.

The 5 V regulator network produces the +5 V (A) (zone 2-3C) for the amplifier circuits and the +5 V (S) (zone 2-3D) for all reel servo logic requirements. Zones 2-8B through 2-6A show the +15 V and -15 V inputs to the reel servo PCBA circuits.

5.9 TAPE LOAD, UNLOAD, AND REWIND OPERATION

5.9.1 Load/Unload Sequences

5.9.1.1 Tape Load – During a load operation, the following series of events occur (Figure 5-30).

1. When the LOAD/REW button is depressed, the blower (vacuum) and compressor will activate and the reel servos are enabled.

2. If there is tape in path at this time, a midreel load situation is assumed and the unit will set loops and start towards BOT.

3. If tape was not in the tape path, the cartridge motor will open the cartridge, the takeup reel will turn clockwise (CW) and a normal load will be initiated.

4. With the transport front door closed, the supply reel will backwrap for approximately two turns before starting the threading process.

   NOTE

   If the diameter of the outside turn of tape is too small, it will be necessary for the operator to manually place the tape in the tape path and to load with the transport front door open. The outer turn of tape must be between 1.59 and 0.64 cm (5/8 and 1/4 in) from the outer edge of the reel to accomplish autoload (Figure 3-2). Also, 216 and 178 mm (8-1/2 and 7 in) reels require the operator to place the leader over thread block 1.

5. After backwrapping, the supply reel will start forward and tape will thread through the tape path.

6. When beginning of tape (BOT) is detected, vacuum is applied to the buffer boxes and the reel motors will turn such that tape loops are set in the buffer boxes and interlock is made.

7. The transport is then ready for controller commands and data run operation.

When the tape is satisfactorily loaded, the transport is ready to make data runs, etc., as commanded by the controller. When a motion command arrives at the interface, the system control subsystem sends a drive (NDRV) and direction (REV, true or false) signal to the capstan servo subsystem which initiates tape movement across the read/write head assembly. Pressure transducers in the air load/control subsystem sense tape loop position and feed signals to the summing logic in the reel servo subsystem. The output of the summing logic is applied to the power amplifiers that drive the reel motors.

5.9.1.2 Tape Unload – The same auxiliary circuits employed to load tape into the vacuum chambers (load operation) are used during an unload operation (Figure 5-31). When the UNLOAD button is depressed while the unit is at midtape, the following sequence is initiated:

1. Tape rewinds to BOT
2. Blower (vacuum) motor is turned off causing the pneumatic interlock to be broken
3. Tape is wound onto the supply reel
4. Reel motors are stopped
5. Cartridge is closed

Unload procedure with tape at BOT is identical to the above but without rewind operation.

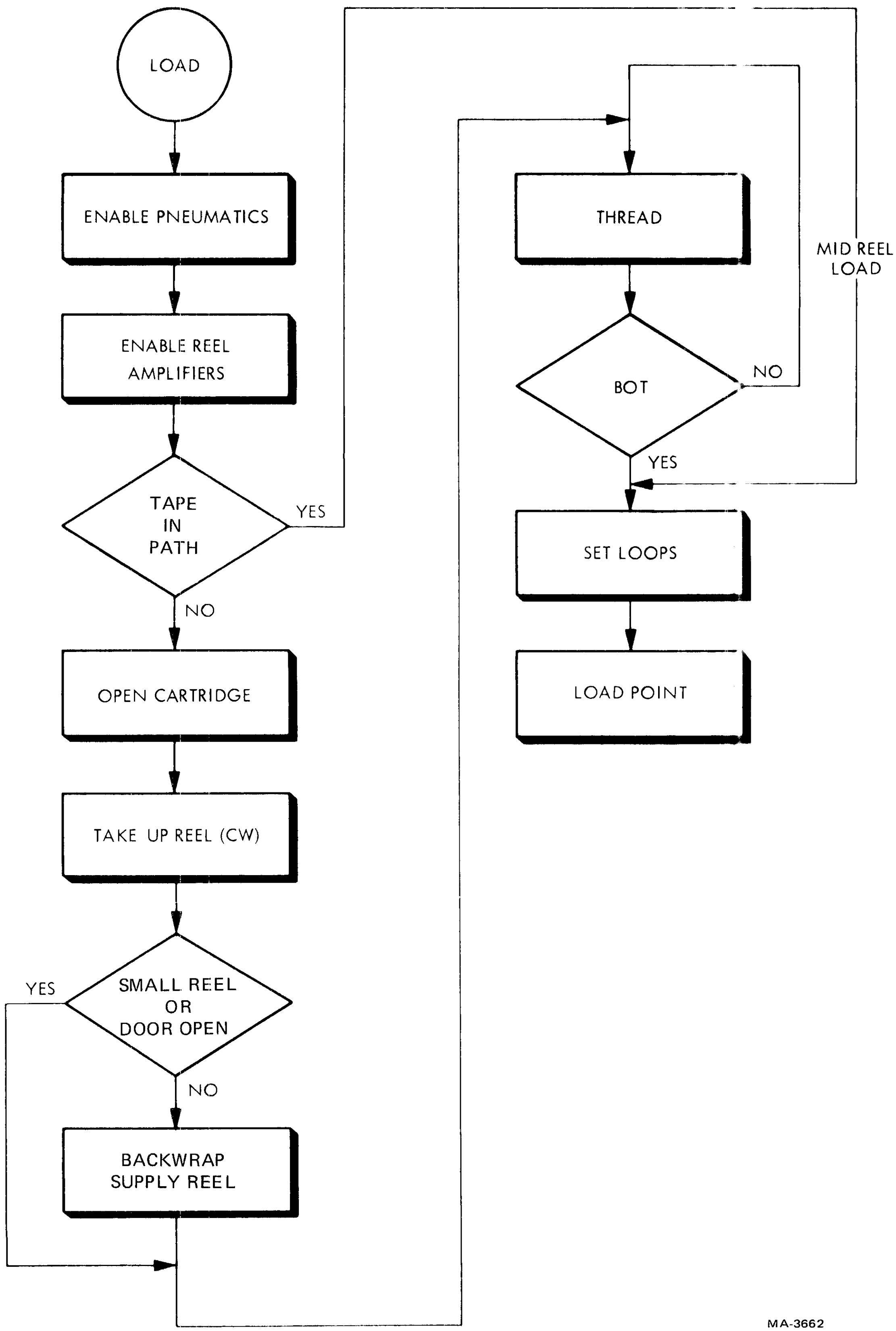


Figure 5-30 Load Sequence

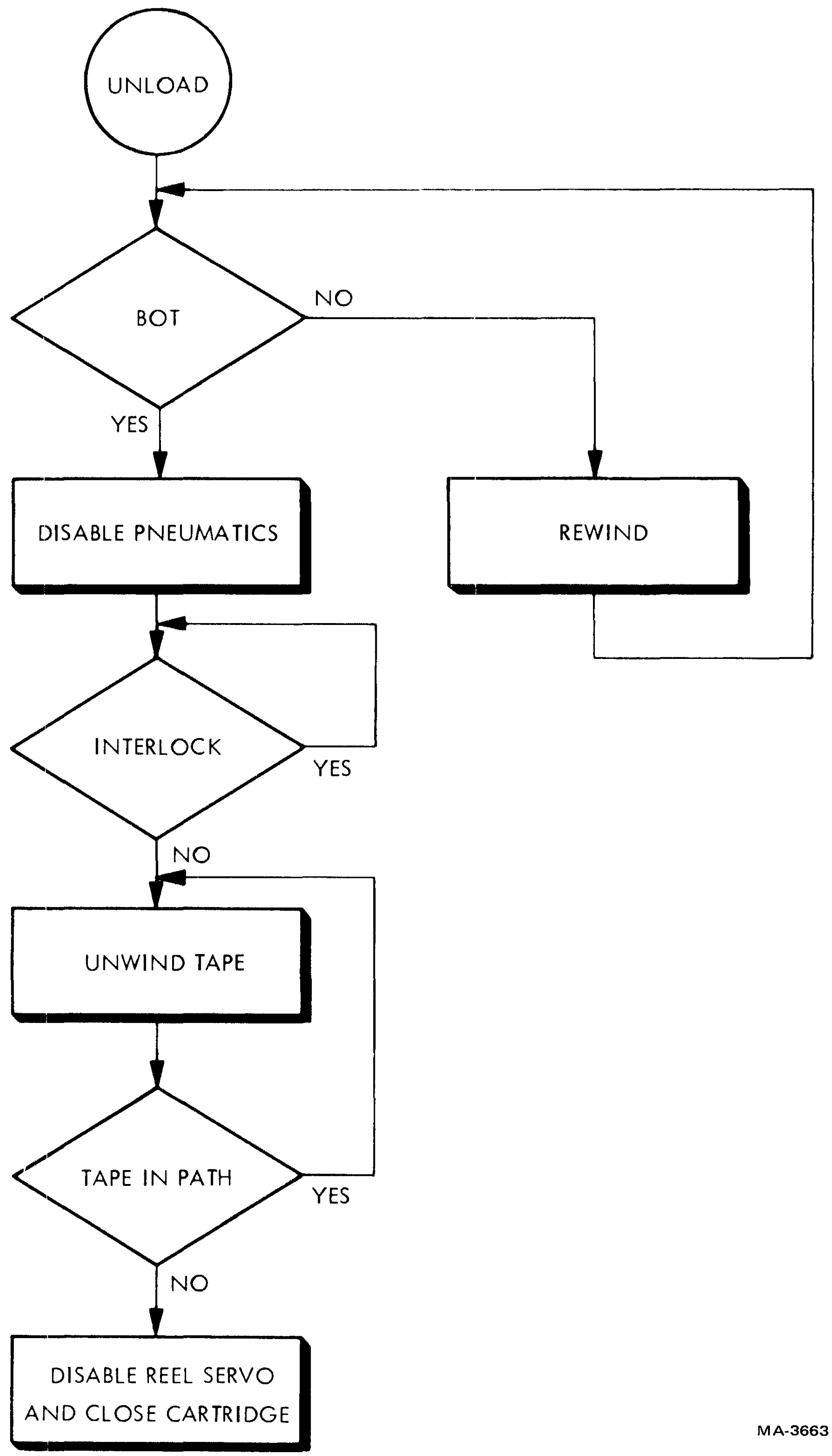


Figure 5-31 Unload Sequence

5.9.2 Load/Unload/Rewind Circuit Operation

The tape loading procedure involves all of those steps which result in the tape being installed and brought to the beginning-of-tape (BOT) position. The steps include motion in either or both directions and may include cartridge and pneumatic system control. If a reel of tape has been installed on the supply reel spindle but the sensors determine that the tape has not been threaded through the guides to the takeup reel, normal load conditions exist. Pressing the LOAD/REW button will initiate the automatic threading process, which connects the tape to the takeup reel, forms the loops and stops at BOT. The tape is then ready for a read or write operation.

If tape is sensed between the supply and takeup reels when the LOAD/REWIND button is pressed, a situation called a midreel load condition exists, and rewind mode is initiated. Rewind mode also terminates at BOT. Tape sensor feedbacks are shown in Figure 4 in Volume 1.

Note that when the UNLOAD switch is depressed, rewind mode is also initiated if the tape is not at BOT. The unload mode causes the tape to be completely wound on the supply reel. Unload mode then causes the supply reel cartridge to close.

Schematic No. 104745, sheet 5, contains a flowchart for reel-motion logic by manual control, including motions commanded by means of the LOAD/REW and UNLOAD switches. In the following text the preliminary power-on sequence and the load sequence are discussed with reference to the flowchart (sheet 5) and various referenced zones of other sheets of the same drawing. The power-on sequence is included here because it prepares the subject circuits for the tape procedures.

5.9.2.1 Tape Control Presetting by Power-On Sequence – When power is applied (zone 5-16H), the power-on reset signal (NPORST) is produced (Paragraph 5.6.6.4). NPORST is applied to control M PCBA J8-61 (zone 2-9B). This is distributed as shown at zone 2-8B and is gated with the manual reset circuits (zones 2-9 through 2-5C) to produce the master reset pulse (NMRSTP) at NAND gate output U55-8.

If the tape sensors find tape in the tape path, a high = true TIP signal is received at J8-49 (zone 2-9B) informing the circuits that a load command, when received, will be under midreel load conditions. TIP and NTIP initiate midreel load signals MRL (zones 4-10F and 4-2E) and NMRL (zone 4-9G). NTIP, from zone 2-8B, is applied to NAND gate U182-4 to inhibit a close cartridge command (NCCC). MRL goes to P12-28 of the reel servo PCBA, where, when high = true, it asserts NSRF2 which is applied to U18-10 (zone 3-5H) to supply additional torque to the supply reel servo. NMRL is applied to U111-10 (zone 4-14F) to turn pressure on (PSOL) and U122-10 to preset the air control flip-flop (zone 4-17F).

MRL (zone 4-10F) is also applied to NAND gate U174-1 as one of the conditions that preset the first delay flip-flop (U196-4, zone 4-12E). After a delay, U205-5 clocks the flip-flop that produces the set tape loops (STL) command.

When no tape is found in the path, a normal load condition exists. NTIP is high = false, NAND gate U182-4 (zone 4-3B) is enabled for a high output at U126-9 (zone 4-4B) of the cartridge control flip-flop. The other condition for issuing a close cartridge command is the input CC N.O. at U182-5 from the cartridge open sensor. The NCCC output at P8-70 sets the cartridge mechanism in closed position for installing or removing a reel on the supply hub.

The tape in path signal (NTIP) is also applied to OR gate input U174-3 (zone 4-3E) as one of the conditions for sending the supply reel reverse (SRR) command to the reel servo PCBA. Other conditions are sequence counts (NC0, NC1), a false load fault status signal (LDFS) and/or backwrap (BKW), cartridge open (CO N.O.), unload number 1 (UNL1) depending on the mode of operation. SRR will also be inhibited by the suppression of BKW when the set tape loops (STL) process is initiated. These signals are shown at the right-hand side of sheet 4, zones 4-6G and 4-4E through 4-2C.

5.9.2.2 Circuits Involved in Tape Load/Rewind/Unload Procedures – Circuits involved in load, rewind, and unload control are shown in Schematic No. 104745 and are described as follows.

1. **Clocks.** Basic system clocks (zones 1-16E,F,G through 1-10E,F,G) are based on a crystal oscillator (Paragraph 5.6.6.1).

2. **Load/Rewind Command Pulsing.** Load/rewind command and pulsing circuits (zones 2-9F through 2-5F) are initiated by LOAD/REW momentary switch outputs:

Load reset pulse (NLRSTP)	U24-6, zone 2-6F
Load pulse (NLDP)	U46-6, zone 2-5G
Rewind pulse (NREWP)	U46-12, zone 2-5F

3. **Unload Commands.** Unload command circuits (zones 2-9C,D through 2-5C,D) process either a manual command from the control panel UNLOAD switch or a logic command (IRWU at interface, zone 2-17E, NULC at U45-12, zone 2-6C) and produce unload command number 2 NUNLC2 at U54-8, zone 2-5D.

4. **Reset Commands.** Reset command circuits are located in zones 2-9C through 2-5C. This is the only command that will interrupt a load procedure. The circuit output is master reset pulse NMRSTP.

5. **Load Status.** The load status flip-flop provides the load-in-progress condition for the system. The load status (LDS) level (U136-9, zone 4-11G) participates in setting the backwrap flip-flop (zone 4-8G), sets the thread-mode flip-flop (zones 4-7G,8G), and the set-tape-loops flip-flop (zone 4-7G). These flip-flops then wait for their respective clock inputs. LDS also enables tape and reel motion command gates, etc. (zones 4-3A–G) via U133-8, U121-8, and U192-6 provided no load fault exists as decided at gate output U213-3 (zone 4-6C).

6. **Load/Unload Counts.** Load/unload step sequence count control circuits are located in zones 4-15A through 4-15E, and 4-16B. Counter outputs (U195-12,1,9,8,11) are decoded and produce counts NC0,1, 2, 3, 4, 7, 8, 9 at outputs U185-1, 2, 3, 4, 5, 9, 10, 11, respectively. The counter is incremented at input U195-14 by the output of U175-11 (zone 4-16B), which reflects the low tape sensor input pulses (P8-42, zone 4-17B) divided by 5. The divided count is provided by U165-11 (zone 4-16B). Sensor pulse inputs at U165-1 are inhibited if a load fault exists (NLDFS at U125-5). The divider output (U165-11) is not applied to the load counter (U195-14, zone 4-15D) unless the transport is in load status (NLDS at U175-9, zone 4-16B) or tape-in-path signal (NTIP) is high = false at U175-2 and unload command UNL1 is high = true at U175-1.

7. **Load Fault Recovery.** Load fault flip-flop (zone 4-7B) issues a high load fault status (LDFS) level at Q output U192-5 and a low load fault status level at $\overline{Q}$ output U195-6 whenever conditions warrant aborting the procedure. The flip-flop is cleared by master reset pulse NMRSTP at U192-1. In load status (LDS at U192-2) it will be set to produce fault status by the input at U192-3 from fault NOR gate output U121-8. Low inputs to the NOR gate which clock U192-3 are as follows.

U121-1 (TP41)	Load status is terminated by end of count output to U166-11 (zone 4-13E).
U121-3 (TP42)	Try counter outputs U123-12, 1, 9 are high indicating that two attempts have already been made to load tape. These outputs cause NAND gate output U133-11 to produce a low.

U121-6,11 (TP28)	The system is at the set-tape-loop mode and the tape loop timer outputs U124-9, 8, 11 are all high, indicating that time for setting the loops has run out.
U121-5 (TP32)	Failure of cartridge to open by count C3 as determined by NAND inputs U131-4 and 5 (zone 4-12B).
U121-4 (TP35)	Failure to get proper air pressure and vacuum condition by count C3 as determined by NAND inputs U131-12 and 13 (zone 4-12B). NAOK input at U131-13 is provided by the output of U133-3 (zone 4-16F) on the basis of VAC N.O. and ABP N.O. sensor inputs to P8-3 and P8-4.
U121-12,2 (TP27)	Cartridge problem as determined by NAND output U133-6 when load pulse (NLDP) is received at U132-5. These signals are inverted and applied to U131-1, 2 (zone 4-11B).

8. **Tachometer Circuits.** Capstan tachometer signal processing and application circuits, which provide tape speed information feedbacks for optimum speed control, are shown in the lower half of sheet 3. TACH signals generated by capstan rotation arrive via interconnect F1 PCBA, interconnect D1 PCBA, and P8-53. Signals are shaped to form the tachometer pulse (TACHP) at U104-2 (zone 3-12C) and are sent to the interface ITACH driver (zone 2-12E), provided the tachometer pulse circuits are enabled (TAPEN at U115-12, zone 3-13C). The tachometer pulses are also obtained from U55-6 (zone 3-13B) and applied to flip-flop clock inputs U95-11 and U93-11 and preset input U92-10 (zone 3-7D,C). They are also squared and applied to the velocity decoder and time constant circuits at U85-14 (zone 3-12B).

   After a 20 μs delay, the output U115-8 (zone 3-11A) clears the tachometer pulse No. 2 flip-flop (zone 3-7B), providing a squared pulse 20 μs long (NTAP2) at P8-62. After a 64 μs delay, the output at U104-10 (zone 3-9B) clears the rewind enabling flip-flop and produces a high at U93-6 (zone 3-6C) and U83-5 (zone 3-12D). The inputs that produce U105-8 output (zone 3-9C) are all connected to pull-up resistors U96 which produce high inputs to U105 except those input lines with jumpers installed. The TU77 has jumpers W6 and W7 installed. Thus when time constant counter U86 has a high output on pins 8 and 9, all the U105 inputs will be high and the U105-8 output will go low.

   The low output at U105-8 changes the state of outputs at U95-9 (zone 3-7D) and U92-5 (zone 3-6D). When the latter output is low, the rewind ramp is terminated (NRWR, zone 3-1E). When the N>80% signal is high = false, indicating a tape speed greater than 80 percent has not been achieved, the tachometer enabling signal NTEN is high = false. When 80 percent speed is achieved, these states are reversed. These signals are used in both states (true or false) in the application of acceleration and deceleration (start and stop) ramps and steady synchronous motion.

   Note that conversion of the tachometer frequency pulses (NTAP2) to analog voltage signals used in the capstan servo summing amplifier is accomplished by circuits on the capstan/regulator PCBA (Schematic No. 104757, zones 2-12C,D through 2-9C,D).

9. **Unload Control.** Unload procedure control circuits are shown in zones 4-6G through 4-2B. NUNLC2 (no. 3 above, Unload Commands) presets first stage (rewind) unload command flip-flop (zone 4-6G). Output U146-5 (UNL1) is applied as a condition to various NAND gates as shown in the schematic and to enable the load counter (4-17C). $\overline{Q}$ output U146-6 (NUNL1) provides the reel servo amplifier enable output at P8-34 by presetting flip-flop output U205-9.

NUNL1 is also used in the mode circuits (zone 2-15C) and to initiate the rewind pulse circuits (2-8E). NULRW from U134-12 (zone 4-4E) is applied to U71-11 (zone 3-15E) to establish the state of the rewind status circuits. The output of U82-6 (zone 3-11D) is applied to the motion control circuits at U83-9 (zone 3-13F) to start tape motion.

When BOT is sensed (BOT at U132-13, zone 4-5E), the rewind part of the process ends, but unload rewinding motion continues until interlock is broken (INTLK low = false at U134-1, zone 4-4E). BOT also is applied to the PNU RETURN flip-flop at its presetting input NAND gate (U156-10), and clock input U146-11 (zone 4-4G). At C4 count, flip-flop input U146-13 (zone 4-4G) clears the flip-flop disconnecting the PNU RETURN line, which turns off the blower/compressor motor. When interlock is broken (NINTLK high = false at U204-5, zone 4-3E), U205-9 changes state, disabling the reel servo amplifiers (NRSAE high = false).

5.9.2.3 Tape Load/Unload Procedure Counters – The tape loading procedure employs two counters: a try counter and a sequencing counter.

The try counter provides for automatically making a second attempt to start the loading sequence if the first attempt falls, but it inhibits repetitious recycling. The try counter is cleared and reset by an input at U123-2 and 3 (zone 4-10C) from NOR gate output U154-8 (zone 4-13C). Inputs to the NOR gate are the master reset pulse (NMRSTP), load reset pulse (NLRSTP), unload signal (NUNLC2) and delayed interlock (NDINTLK).

The try counter is incremented by a low input at U123-14 which primarily would reflect the output of NAND gate U116-6 (zone 4-12B). At sequence count one output (C1), the inputs to the NAND gate are C1, try counter zero (NT2), and the inverted NSMRL input. This increments the counter to T1. At NC3 time from the sequencing counter, NOR gate input U186-13 is low, U186-11 is high, U176-10 is low and the try counter is incremented to T2. When the counter outputs are high (at T3) at U123-1 and 9, the output at NAND gate U133-11 is low and reports a load fault at load fault NOR gate U121-3, preventing a third try. The NSMRL input at P8-8 inhibits a second try when a small reel is loaded.

The sequencing counter is reset by the reset (RST) input to the counter at U195-2,3 (zone 4-15D). It is incremented by pulses from the low tape sensor P8-42 (zone 4-17D) after these pulse counts have been divided by five at divider output U165-11 (zone 4-16B). Application of the pulses are on the condition that no load fault has occurred, i.e., the load fault status signal NLDFS at U125-5 (zone 4-17B) is high = false.

The pack sense assembly A4 located on the base assembly (drawing No. 107189) contains an optical detector that senses a low tape condition on the takeup reel. The pack sense assembly output are pulses (PKSN) coupled via TB2 and J21-30 to the control M module J8-42 where they become LOW TAPE SENSOR. The optical detector senses two reflective tabs placed on the inside of the takeup reel flange. The detector looks at these tabs through two slots in the side of the reel opposite the tabs. Each time the reel turns, the two tabs are sensed. This produces two low tape sensor counts per revolution of the reel, provided there is not enough tape on the reel to block the path between the detector and the tabs.

In rewind mode, when the tape on the takeup reel is down to about 9.525 mm (0.375 in), the low tape sensor begins issuing pulses, the first one of which is used to slow tape motion so the reels can stop at BOT. In forward motion, the pulses are sent to the logic until the tape on the takeup reel is sufficient to intercept the sensor path. These pulses, at the rate of two pulses per turn, are sent through P8-42 to U125-4 (zone 4-17B).

During the load process, if no load fault exists, NLDFS will be high = false at U125-5 and U125-6 will apply the inverted pulses to U165-1. The output of U165-11 of the divider will be one pulse per five inputs, or one per 2-1/2 turns of the reel, at NAND gate input U175-12. If the transport is in load status (NLDS at NOR gate U175-9) then U175-11 will issue low load count pulses. These are applied to the sequencing counter incrementing input U195-14.

The outputs of the sequencing counter are applied to decoder inputs U185-12, 13, 14, 15. Decoder outputs are low at times which correspond to the count which is the chip pin number minus 1 (e.g., U185-1 is low at the zero count, U185-2 is low at the first count, etc.). These counts are low = true NC1, NC2, etc. When inverted they are C1, C2, etc. The counts are used to cue the various loading process steps [backwrap (BKW), thread (THD), set tape loops (STL), etc.] (Tables 5-4 and 5-5).

Table 5-4 Load/Unload Sequence Control Count Applications (Schematic No. 104745)

Decoder Pin (Zone 4-15, 16D)	Count* (N = Low)	Distribution/ Zone	Mode	Effect
U185-1	NC0	U202-11/4-4B	Load	Opens cartridge if not open and no fault exists.
		U174-4/4-4E	Unload	Commands supply reel reverse if interlocks are not made (after BOT is reached).
U185-2	NC1	U202-10/4-4B	Load/ Unload	Opens cartridge if not open, tape is in path, and no fault exists.
		U122-11/4-17F	Load	If air pressure is correct, issues PSOL command.
		U174-5/4-4E	Unload	Starts supply reel reverse if interlocks are not made (after BOT is reached).
	C1	U116-4/4-12C	Load	Increments try counter if a small reel has been sensed and if one try has not already been made.
		U135-3/4-9F	Load	Starts backwrap if in load status, small reel has not been detected, and there is no tape in path (not a midreel load).
U185-3	NC2	U202-9/4-4B	Load/ Unload	Opens cartridge if not open and no fault exists.
		U145-11/4-8G	Load	Trailing edge starts threading process if in load status.
U185-4	NC3	U132-9/4-12B	Load	Initiates load fault status if carriage is not open or if air is not correct.

Table 5-4 Load/Unload Sequence Control Count Applications (Cont)
(Schematic No. 104745)

Decoder Pin (Zone 4-15, 16D)	Count* (N=Low)	Distribution/ Zone	Mode	Effect
		U144-12/4-9E	Load	Clears backwrap flip-flop.
		U186-13/4-12D	Load	Increments try counter.
	C3	U183-1/4-5B	Unload	Closes cartridge if unload is complete, there is no tape in path, and cartridge is open.
U185-5	NC4	U125-1,2/4-14D	Unload	Inverts to C4 and goes to U156-13/4-6F to terminate process if in unload status.

*Counts are produced only under the following conditions (zones 4-16B, 17B):

Mode	NLDFS (U125-5)	NLDS (U175-9)	NTIP (U175-2)	UNLI (U175-1)
Load	High = False	Low = True	N/A	N/A
Unload	High = False	N/A	High = False	High = True

Table 5-5 Try Counter Outputs
(Schematic No. 104745, zone 4-10D)

Try No.	U123-12, 1	U123-9	U133-11	Effect
T0 (reset)	Low	Low	High	Enable
T1 (first)	High	Low	High	Permits try
T2 (second)	Low	High	High	Permits try
T3 (third)	High	High	Low	Inhibits try

Counter output U195-11 is inverted and applied to clock flip-flop U166-11, (zone 4-13E). Flip-flop output U166-9 is applied to NAND gate input U133-10 (zone 4-11D). If BOT is reached, load status ends (LDS low), so U133-8 cannot issue a low fault output. If counts stop before BOT is reached, U133-9 will go low, producing a load fault. Also, counter outputs to the decoder are binary; A = 1, B = 2, C = 4, D = 8. D clocks the flip-flop such that output U166-9 goes high at count 16 (the next binary order). This allows for about 92 m (30 ft) of tape to pass, while searching for BOT, without signalling a time-out load fault.

5.9.2.4 Automatic Tape Loading Sequence – When the load command is issued by pressing the LOAD/REW switch, the logic goes through a series of steps based on feedbacks from status sensors and cued by the sequencing counter. The hardware circuits which make the decisions are shown in Schematic No. 104745, sheets 1 through 4. The logic flowchart for the procedure is in the same drawing, sheet 5. Sensor feedbacks are shown in Figure 4 in Volume 1.

If tape is in the path and air status is satisfactory for operation after the LOAD/REW button is depressed, interlocks will have been made (Paragraph 5.6.6.5). NDINTLK will be applied (zone 2-6G) and rewind mode will be commanded by the resulting low = true rewind pulse (NREWP). The tape will stop at BOT, and the load will be completed.

If interlocks are not made when the LOAD/REW command is processed, the automatic load sequence will be initiated by the low = true load pulse (NLDP).

Pulsing is developed by the series of flip-flops (zones 2-8G,F to 7G,F) activated by the LOAD/REW switch. While the momentary switch is depressed, J10-23 is connected to ground, which presets the first flip-flop in the series. The resulting Q output (U36-5) sets the next flip-flop at clock B (CLKB) time. (Refer to Paragraph 5.6.6.1 for system timing details.) When the switch is released, J10-23 is disconnected from ground, U36-4 goes high and U36-1 goes low. This clears the first flip-flop while the second stays in the set state until cleared by an unload (NUNL1) or load status (NLDS) signal at NOR gate U183 inputs 12 or 13 respectively.

The Q output at U35-5 applies a high at NAND gate input U24-4 while the $\overline{Q}$ output at U34-6 applies a high to NAND gate U24-5 producing a load reset low = true output (NLRSTP) at U24-6. This is sent to EXCLUSIVE NOR gate input U154-10 (zone 4-14 D) to reset the load sequence counters and control circuits. At clock B time, the output of U35-5 (zone 2-7F) causes the next flip-flop to change state terminating the NLRSTP pulse (U24-6) and applying its high Q output to NAND gate U33-10 which, while $\overline{Q}$ output at U34-8 is high, causes NAND output U33-8 to initiate a low load pulse (NLDP) at U46-6 (TP18). This pulse is terminated when the $\overline{Q}$ output at U34-8 changes state at the next clock B time. NLDP is sent to U136-10 (zone 4-11G) to preset the load status (LDS) flip-flop and U135-10 (zone 4-9G) to preset the thread status (THDS) flip-flop. It is also inverted and used as a condition for output of NAND gate U131-3 (zone 4-11A).

If no cartridge is in place or if the cartridge is sensed as neither open nor closed, U131-3 (zone 4-11A) is low, causing a load fault signal at U121-8 (zone 4-8B) and a load fault status level (NLDFS) at the $\overline{Q}$ output (U192-6) of the load fault flip-flop. NLDFS is applied to U125-5 (zone 4-17B) as one of the conditions in the network that issues the load count signal to U195-14 to increment the sequence counter U195, and decoder U185 (zone 4-15D,4-14D). If NLDFS is true=low at U125-5, the reel turning pulses from the low tape sensor are prevented from entering the divide-by-five chip at U165-1 (zone 4-16B).

If the cartridge is in place, U185-2 (zone 4-15D) issues count C1, which clocks backwrap (BKW) flip-flop U135-3 (zone 4-8F), and NC1, which clocks the air control flip-flop (U122-11) at zone 4-17F. Since, during normal load sequence, interlock is not made (NINTLK at U154-6, zone 4-15G, high = false), U111-8 (zone 4-14F) issues pressure solenoid command (PSOL).

If no load fault exists, U192-6 (zone 4-7B) will be high and U123-3 (zone 4-6B) will be low, clearing the cartridge command flip-flop (zone 4-4A). This causes $\overline{Q}$ output U126-8 to initiate the NCOC command to open the cartridge.

At NC1, the backwrap flip-flop is enabled to be set (by the output of U155-6, zone 4-9G), provided the inputs (U134-9, 10, 11) are high. This indicates that load status (LDS) mode is set (U134-11), a midreel load condition does not exist (U134-10) and the try counter output (U123-9, zone 4-10C) indicates no more than one previous try has been made (U123-9 high).

Load sequence count NC2 is applied to thread command flip-flop U145-11 (zone 4-7G). The NTHD output (U145-8) is sent to U213-10 (zone 4-5D) to initiate the supply reel forward (SRF) command and continue takeup reel forward (TRF) command.

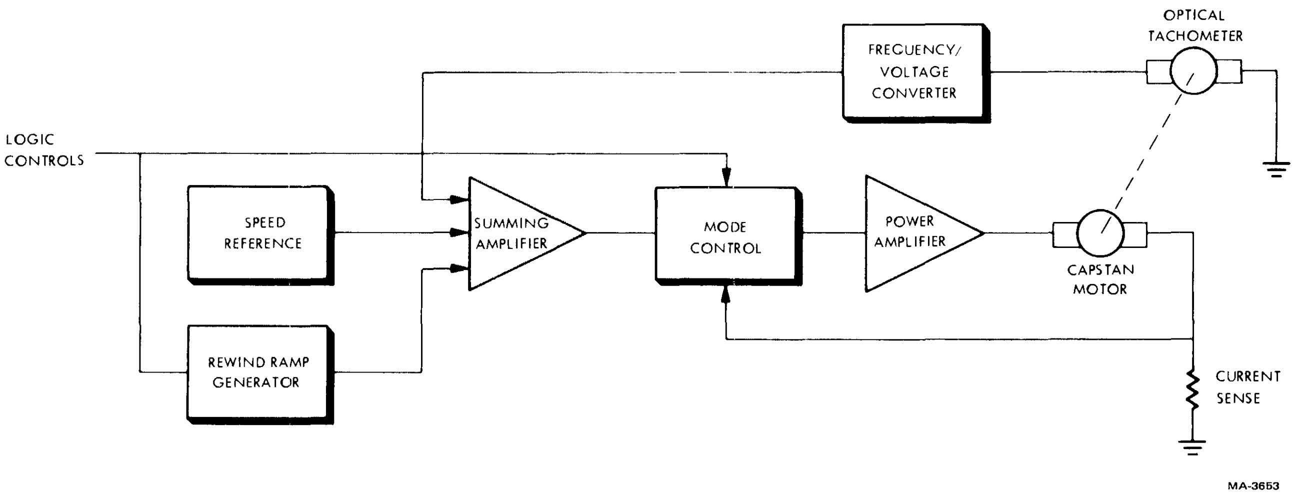


Figure 5-32 Capstan Servo Block Diagram

Load sequence count NC3 (zone 4-14D) applied to OR gate U144-12 (zone 4-9E) initiates clearing of the backwrap flip-flop (zone 4-8F). NC3 at U132-9 (zone 4-13B) is inverted to C3 and applied to NAND gate U131-4, which checks the cartridge open signal CO N.O. for a possible load fault. U131-11 (zone 4-12B) similarly checks for air system faults.

When tape appears in the path (BOT or NAOK), U176-12 (zone 4-7E) presets flip-flop U196-4 (zone 4-12E). The succeeding two flip-flops, clocked by CLKE, provide a delayed output at U205-5, which sets the tape loop command (STL) flip-flop. This delivers STL (zone 4-7G) to the reel servo motion commands at zone 4-4C. The takeup reel reverse (TRR) and supply reel forward (SRF) commands provide slack tape to form the loops.

When loops are set and interlock is made (NINTLK at U213-13, zone 4-6E), takeup reel reverse (TRR) and supply reel reverse (SRR) are commanded (zone 4-1C,D). When BOT is sensed, U146-11 (zone 4-4G) is high and output U146-8 terminates motion.

5.10 CAPSTAN SERVO (Figure 6 in Volume 1)

5.10.1 Capstan Servo Overview

The capstan servo is a velocity management system which acts as the tape mover that pulls tape across the magnetic head assembly for data recording or reproduction. The capstan servo consists of the functional blocks shown in Figure 5-32.

The heart of the servo is the summing amplifier which receives current signals from three sources, sums them, and forces the power amplifier to the proper voltage. The power amplifier applies this voltage to the capstan motor, which responds with the appropriate speed. The capstan tachometer is shaft-coupled to the capstan motor and produces a frequency output proportional to the speed of the capstan motor. This frequency is converted to voltage, which is the tachometer feedback required for constant velocity operation.

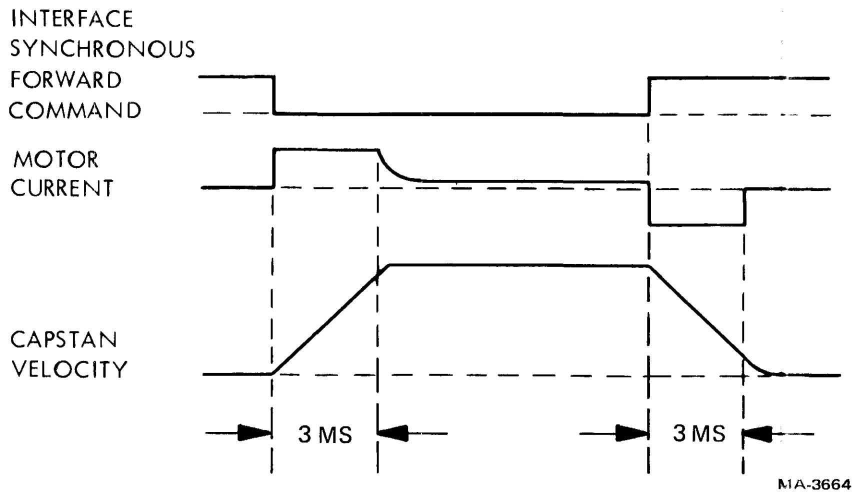


Figure 5-33 Capstan Servo Waveform for Forward Start and Stop

The primary inputs to the capstan servo are the logic control signals. These signals initiate either a positive or negative ramp for forward and reverse operation, or a long rewind ramp used to accelerate the capstan motor to rewind speed. The ramp slopes and final velocities for forward and reverse are adjusted to achieve the desired start/stop characteristics.

Figure 5-33 illustrates typical capstan servo waveforms. The following sequence of events describes the normal operation of the capstan servo.

1. With power applied and tape loaded interlock made, the capstan power amplifier is enabled.

2. Upon receipt of an ISFC command, capstan drive current is applied in the forward direction. The magnitude of the current is constant and determines the constant rate of acceleration.

3. As the capstan approaches synchronous speed, the difference between the commanded speed and the actual speed decreases as does the capstan drive speed.

4. A small error signal determined by the loop gain is required to overcome running losses.

5. When ISFC is terminated, tha polarity of the drive current is reversed. This reverse current is maintained at a constant level for a fixed time.

6. At the end of the reverse current pulse the capstan motor drive voltage is brought to and held at ground level to produce a dynamic braking effect.

NOTE

The synchronous reverse mode (ISRC) procedure is identical except for reversals of direction and drive current.

Each time power is applied to the unit, the power distribution block generates a reset signal (NPORST) to the velocity decoder on the control M PCBA and the capstan control logic on the capstan/regulator PCBA. After tape is loaded into the vacuum column, the interlock signal (NINTLK) from the air load/control function goes low and enables the capstan amplifier.

The system control function, upon receipt of a motion command, supplies the following signals to the capstan mode control logic: drive (NDRV), direction (REV), motion (NMOT), and speed greater than 80 percent (N>80%) (N indicates low = true).

The power amplifier provides drive to the capstan motor via J11 and TB1-3 on the interconnect D1 PCBA.

Tachometer pulses, from the optical sensor mounted on the capstan shaft, are amplified on interconnect F1 PCBA. The signal is routed through interconnect D1 PCBA to control M PCBA where it is squared and sent to the velocity decoder and the interface (TACHP). The velocity decoder generates a 20 μs pulse for each tachometer pulse input. This is called NTAP2 and is sent to the capstan/regulator PCBA where it is converted by the tachometer frequency/voltage converter to the feedback analog (ANALOG TACH) signal for the capstan summing amplifier.

5.10.2 Capstan Servo PCBA

The capstan/regulator PCBA develops the capstan drive motor power inputs CM(–) and CM(+), provides primary regulation of dc voltages, develops the rewind power ramps for the reel servo system, converts capstan tachometer frequency output to proportionate voltages, controls cartridge motor power, and processes vacuum, pressure, and write protect solenoid signals. Capstan/regulator PCBA circuits are shown on Schematic No. 104757.

The capstan motor drive power is developed from the ±36 V unregulated input by the power amplifiers (zone 2-3B) on the basis of inputs through capstan/regulator edge connector P11, as shown at the lefthand side of sheet 2. The amplifiers are enabled by the interlock signal (NINTLK) from the control M PCBA and power-on reset (NPORST) from the regulator circuits (zone 3-1G to 2-8H).

Application of the start ramp, forward stop ramp, or reverse stop ramp (zone 2-7B,C) is controlled by the output of the mode control circuits (zone 2-7E through 2-7F). Direction of application of the start ramp is determined by the output of the forward-reverse switch (zone 2-7D) on the basis of the reverse (REV) signal input (zone 2-12E) as inverted at U7-8 (zone 2-9E). The start ramp is terminated when the capstan speed reaches 80 percent of nominal tape speed. (N>80% input at P11-25 will be low = true.)

Capstan drive speed is determined by summing amplifier output U9-6 (zone 2-7D) on the basis of tachometer feedback pulse (NTAP2) through P11-57 (zone 2-12D) when the tachometer circuits are enabled (NTEN input at P11-17).

In rewind mode, the rewind ramp (NRWR) command at P11-38 (zone 2-12B) initiates the rewind ramp generator (zone 2-8B,9B), the output of which is also integrated in the summing amplifier output.

Circuits which execute the cartridge open command (NCOC) and cartridge closed command (NCCC) are shown on sheet 3, starting with the command inputs at zone 3-10D. The active command is applied to the cartridge motor driver amplifier (zone 3-8D). When the driver is enabled (ENBL at Q53, zone 3-8C), the amplifier output is applied to the bases of Q37 and Q38. If the output is high, Q38 is turned off and Q37 turned on. This pulls down the base of Q36, causing it to connect +24 V to the CART MTR (+) output at P11-30 and 70 (zone 3-1D) and while Q36 is switched on, Q43 is off.

If the amplifier output is low, the states of Q36 and Q43 are reversed, in which case the –24 V source is connected to CART MTR (+) output. The + sign at the output in this case means *more negative* than the return line designated as CART MTR (–). It may be convenient to think of the CART MTR (+) line as the output line (its electrical polarity indicating the direction of motion with + for forward) and the CART MTR (–) as the return line.

Vacuum transfer command (NXFR) input at J11-39 (zone 3-10B) is a command to redirect the application of the vacuum source by controlling the vacuum valve solenoid. When NXFR is low = true, Q44 (zone 3-4C) is switched off, causing Q45 base to be pulled down. This turns Q45 on, which connects the vacuum solenoid return (VAC SOL RET) to ground.

Reel servo amplifier enable (NRSAE) command provides a low at J11-58, which is inverted and cuts off Q54 (zone 3-6C). This low output of Q54 then turns on Q46. This applies a high to NOR gate inputs U11-1 and 2. The inverted output at U11-3 is a low = false file protect (FPT) status signal. The high output of Q46 also turns on Q47, connecting the write protect solenoid return (WP SOL RET) line to ground. If the write enable ring is in place, WP1 N.O. input at J11-69 (zone 3-10B) is high. The high input is regulated in VR7 (zone 3-7B) and applied to the base of Q46. This turns Q46 off causing a low at NOR gate inputs U11-1,2 and a high = true FPT output at J11-19 (zone 3-1B). The Q46 low output also turns Q47 off, which disconnects the write protect solenoid return line from ground, causing the WP1 N.O. input at P11-69 to continue until the circuits are reset. P11-79 input is not used.

The upper half of sheet 3 contains the regulation circuits, which are covered in Paragraph 5.5.

5.11 WRITE FUNCTION (Figure 7 in Volume 1)

NOTE

With the exception of the input/output signals on J7, no mnemonics appear on the write schematic (Drawing No. 104810). Input/output signals on J6 and internal signals on the write PCBA have been assigned mnemonics for use in the following text and block diagrams. The mnemonics are related to the schematic by chip and pin numbers but the mnemonics themselves do not appear on the engineering drawing.

5.11.1 Write Function Overview

The write function records digital information on tape. The recording density is ANSI and IBM compatible, 9-track NRZI or PE Figure 5-34 is a simplified block diagram of the write function.

Assume power is applied and a reel with a write enable ring is installed on the supply reel. Switch S8, on the base assembly, closes and supplies write power (WP1 N.O.) via P21-29 and 32 to the capstan/regulator PCBA (J11-69) and to the write PCBA (J7-24 and 60) where it is designated as WRT PWR. If the write enable ring is not installed on the reel, WP1 N.O. is not applied to the circuitry.

The high density signal (NPE on control M PCBA; NHID on write and data L PCBAs) from the control M PCBA (J8-25) is coupled to the write control logic on the write PCBA. The density command is received from the tape formatter via the M8940 interface module. NHID (or NPE) is used to select either PE or NRZI format (high = NRZI, low = PE).

When a load command is detected, the air load/control function provides a low reel servo enable signal (NRSAE) to the capstan/regulator PCBA via J8-34. The WP1 N.O. signal from S8 (P21-29 and 32) and NRSAE from the air load/control function (J8-34) are applied to the write driver on the capstan/regulator PCBA. The write driver provides a low file protect signal (FPT) to the system control function via J11-19, and a low holding path feedback write lockout signal (W.P. SOL RET) to the WLO solenoid, K2 via J11-33 and 73.

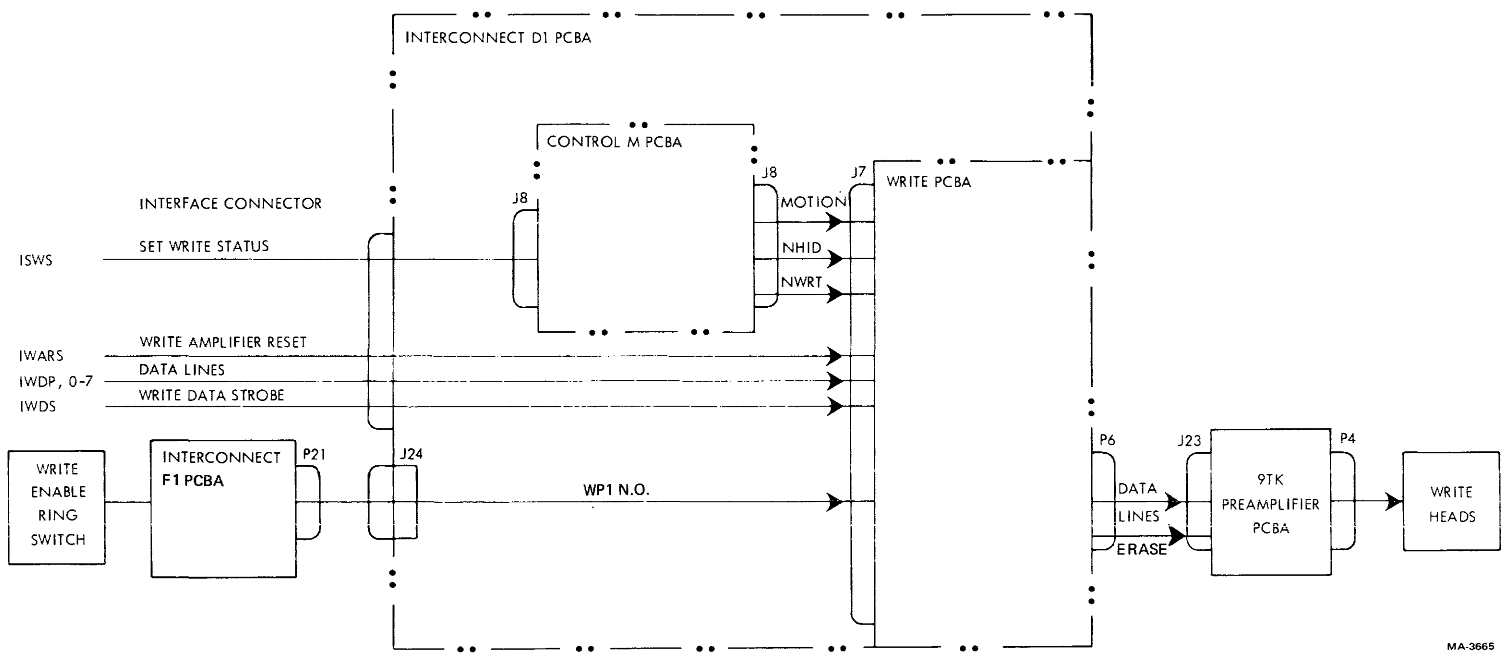


Figure 5-34 Write Function Block Diagram

W.P. SOL RET is coupled through the interconnect F1 PCBA (P21-27 and 28) and energizes the WLO solenoid K2 which holds S8 closed and maintains WP1 N.O. If WP1 N.O. is not present, the write driver provides a high FPT signal to the system control function (J11-19) and a high W.P. SOL RET to the WLO solenoid (J11-33 and 73). The high W.P. SOL RET does not energize the WLO solenoid and no WP1 N.O. is available. TP51 (capstan/regulator PCBA) is used to monitor the file protect signal and TP58 (capstan/regulator PCBA) is used to monitor the write lockout feedback signal.

If the transport is selected, ready, and on-line and the system control function detects both interface write and interface motion commands, the system control function provides a high motion signal (MOTION) via J8-28 and a low write signal (NWRT) via J8-26 to J7-26 and J7-25, respectively of the write control logic.

The interface input data lines (IWDP, IWD0–IWD7) are routed to the write data buffers via J2 of the M8940 interface module. M8940 also provides the write amplifier reset strobe (IWARS) to the write control logic via J7-46, and the write data strobe (IWDS) to the write strobe logic via J7-47.

5.11.2 Write/Deskew PCBA

The write/deskew PCBA (write PCBA) accepts data in binary form from the host system, prepares it for recording in either PE or NRZI format, as directed, and controls the write and erase heads. The write PCBA is plugged into J7 on the interconnect D1 PCBA.

Inputs to the write PCBA are listed in Table 5-6. Outputs are via the data and erase lines through J6 to the 9TK preamplifier PCBA, which routes them directly to the respective heads. Reference is made in the following discussion to the write PCBA Schematic No. 104810 and Figure 7 in Volume 1.

The following paragraphs describe the two modes of operation of the write/deskew PCBA: PE and NRZI.

5.11.2.1 PE Mode (Figure 5-35) – In a PE write operation, after write power (WP1 N.O.) is applied (J7-24 and 60) and NPE (NHID) is low, the selected, ready, and on-line transport is conditioned to write when MOTION (J8-28) and NWRT (J8-26) are received from the control M PCBA.

NWRT supplies a high (WRT) signal (U27-2, zone 2-14G) and clocks the initial PE write step flip-flop (U26-3, zone 2-12E) set. It also enables the write current control ramp generator (Q1, Q2, Q3, U38, zone 2-10 through 12G). The write current control ramp (WCCR) from the collector of Q3 (zone 2-10G) supplies the write logic drivers (Q1, Q2, Q3 of circuits 100 through 900) and the erase driver (Q4, zone 2-9G). NWRT together with MOTION removes the direct clear inputs from flip-flops in the PE/NRZI write logic. U37-10 (zone 2-14G) enables the write amplifier control flip-flops UC and U26 (zone 2-5A through F), and U37-8 (zone 2-13F) enables the write data flip-flops UA and U30 (zone 2-7A through F).

As WCCR ramps up from the write current control ramp generator, the erase driver Q4 (zone 2-9G) conducts and supplies erase drive current (EDC). The EDC signal (P6-17) is coupled through the 9TK preamplifier PCBA and energizes the erase head.

WRT from the write control logic is coupled to the write strobe logic. When WRT goes high it toggles U26-3 (zone 2-12E) set and produces the write current control gain signal (WCCG) from U37-6. WCCR together with WCCG is applied to the write logic drivers. These signals polarize and set the PE current level of the write current signals (WCP, WC0-WC7), applied to the write head windings through J6, to the same polarity as the EDC current. This causes the write head poles to energize and erase the tape to form a portion of the interrecord gap.

Table 5-6 Write PCBA Inputs

Input	Connection	From	Purpose
WP1	J7-60,24	P21-29,32	Write power
NHID (NPE)	J7-61	J8-25	High Density (low = true) signal selecting PE format, from control M PCBA
NWRT	J7-25	J8-26	Write command (low = true) from control M PCBA
MOTION	J7-26	J8-28	Signal from control M PCBA specifying that tape is moving
IWARS	J7-46	J2-32	Write amplifier reset from M8940 interface module
IWDS	J7-47	J2-34	Write data strobe from M8940 interface module
IWDP	J7-45	J2-25	Data parity bit
IWD0	J7-44	J2-24	Data bit of 8-bit byte
IWD1	J7-43	J2-23	Data bit of 8-bit byte
IWD2	J7-42	J2-22	Data bit of 8-bit byte
IWD3	J7-41	J2-21	Data bit of 8-bit byte
IWD4	J7-40	J2-20	Data bit of 8-bit byte
IWD5	J7-39	J2-19	Data bit of 8-bit byte
IWD6	J7-38	J2-18	Data bit of 8-bit byte
IWD7	J7-37	J2-1	Data bit of 8-bit byte
+5 V (T)	J7-21,57	J11-22,23,62,63 via W1 on interconnect D1	Termination voltage
0 V (I)	J7-1- 10		
+5 V (L)	J7-18,19,54,55	J11-22,23,62,63	Logic power from capstan/regulator PCBA
0 V (L)	J7-15,16,17,51,52, 53	J11-26,27,66,77	
+15 V	J7-22,58	J11-21,61	Power for write and erase head
-15 V	J7-23,59	J11-14,54	Power for write and erase head

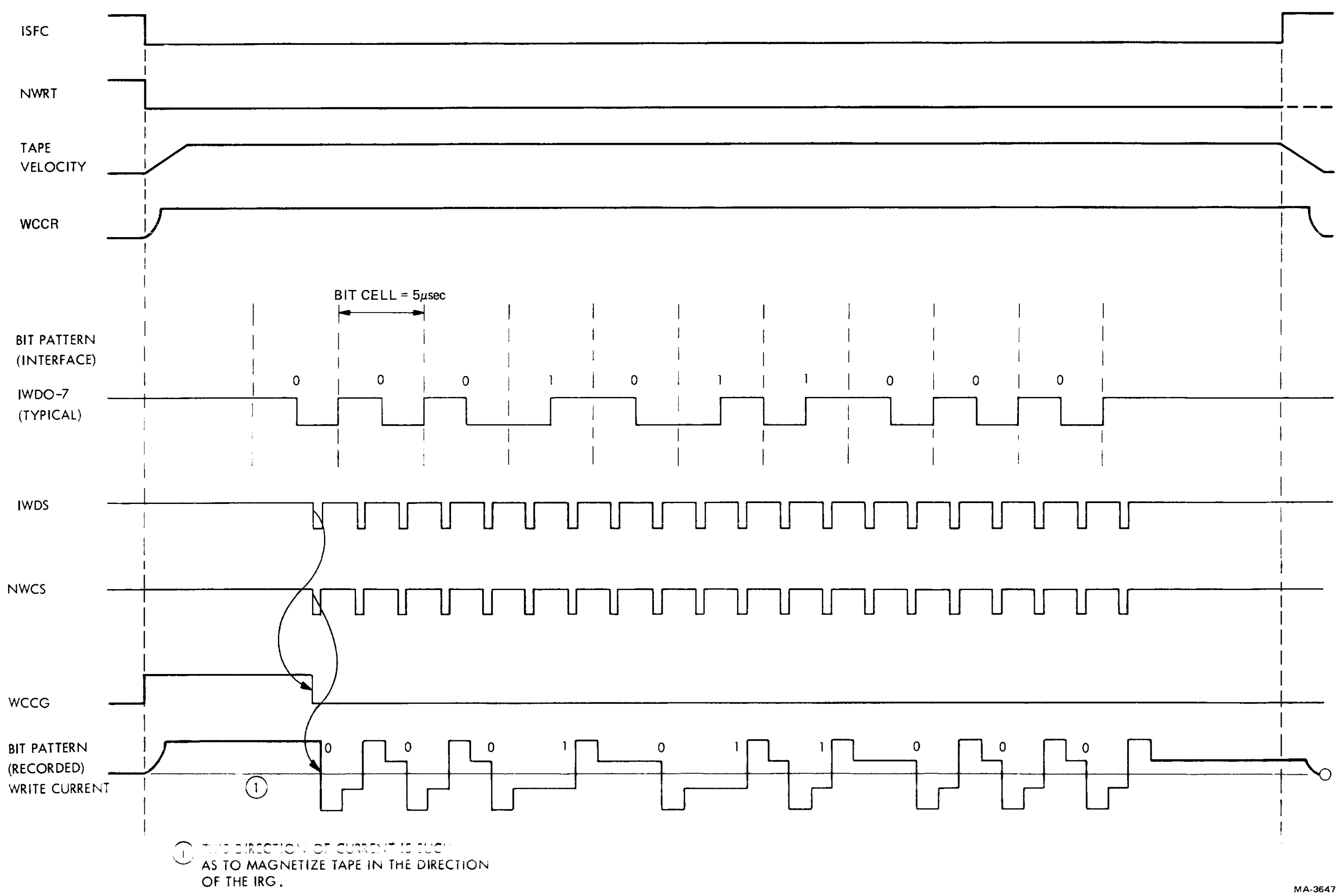


Figure 5-35 PE Data Recording Waveforms

Digital write data from the MTA (J2) enters the write PCBA through J7 as IWDP, IWD0-IWD7 and is buffered and inverted through U21, U24 and U28 (zone 2-14A through D). Inverted data (W/TDP, W/TD0-W/TD7) is presented to the write data flip-flops in the PE/NRZI write logic (UA, U30). After the digital information is present, the write data strobe (IWDS) is sent from the MTA (J2) to the write strobe logic. The write strobe logic provides the two write/test data strobes, W/TDS (U36-8, zone 2-14E) and NW/TDS (U27-10, zone 2-13E).

The W/TDS signal is coupled to the PE/NRZI write logic and strobes data from the interface buffers into the write data flip-flops. It also disables the PE write deskew defeat one shot U35-9 (zone 2-13D) which times out and produces the NWSPE signal from U36-6 (zone 2-13D). NWSPE is coupled to the PE/NRZI write logic where it resets the NRZI write deskew one shots UB, U23 (zone 2-6A through F). The NW/TDS signal is coupled to the write control logic and provides the write control strobe (WCS) at U36-3 (zone 2-12G) and NWCS at U36-11 (zone 2-11G).

The first IWDS applied to the write strobe logic disables the WCCG signal by resetting the initial PE write step flip-flop U26-1 (zone 2-12E). All subsequent PE write compensation steps, for the record written on tape, are provided by the write step one shots (UE, U23, zone 2-4 through F), in the PE/NRZI write logic, which produce the WCCSP-> pulses.

Digital information from the write data flip-flops is presented to the write amplifier control flip-flops UC, U26 (zone 2-5A through F). The control flip-flops produce the write current toggle pulses (WCTP, WCT0-WCT7 and NWCTP, NWCT0-NWCT7). This turns on the write current switches Q2 and Q3 in circuits 100 through 900 to produce the signals WCP, WC0-WC7 through J6 and via the 9TK preamplifier. Q2 and Q3 alternately provide a current path from the center tap of each head winding (–15 V from WP1 N.O.) through the current source transistor Q1 of circuits 100 through 900.

The low NHID1 signal (U37-2, zone 2-14F) from the write control logic is applied to the write logic drivers (Q5 of circuits 100-900) and biases them off thus disabling the NRZI gain.

5.11.2.2 NRZI Mode (Figure 5-36) – In a NRZI write operation, after write power (WP1 N.O.) is applied (J7-24 and 60) and NPE (NHID) is high, the selected, ready and on-line transport is conditioned to write when MOTION (J8-28) and NWRT (J8-26) are received from the control M PCBA.

NWRT supplies a high (WRT) signal (U27-2, zone 2-14G) and enables the write current control ramp generator (Q1, Q2, Q3, U38, zone 2-10 through 12G). The write current control ramp (WCCR) from the collector of Q3 (zone 2-10G) supplies the write logic drivers (Q1, Q2, Q3 of circuits 100 through 900) and the erase driver (Q4, zone 2-9G). NWRT together with MOTION removes the direct clear inputs from flip-flops in the PE/NRZI write logic. U37-10 (zone 2-14G) enables the write amplifier control flip-flops UC and U26 (zone 2-5A through F), and U37-8 (zone 2-13F) enables the write data flip-flops UA and U30 (zone 2-7A through F).

As WCCR ramps up from the write current control ramp generator, the erase driver Q4 (zone 2-9G) conducts and supplies erase drive current (EDC). The EDC signal (P6-17) is coupled through the 9TK preamplifier PCBA and energizes the erase head.

NPE (NHID) produces the signal NHID1 (U37-2, zone 2-14F). NHID1 together with WCCR is applied to the write logic drivers. WCCR supplies current to the current source transistors Q1 (zone 2-3B through G) and NHID1 biases on the NRZI current gain transistors Q5 (zone 2-3B through F). These signals polarize and set the NRZI current level of the write current signals (WCP, WC0-WC7), applied to the write head windings through J6, to the same polarity as the EDC current. This causes the write head poles to energize and erase the tape to form a portion of the interrecord gap.

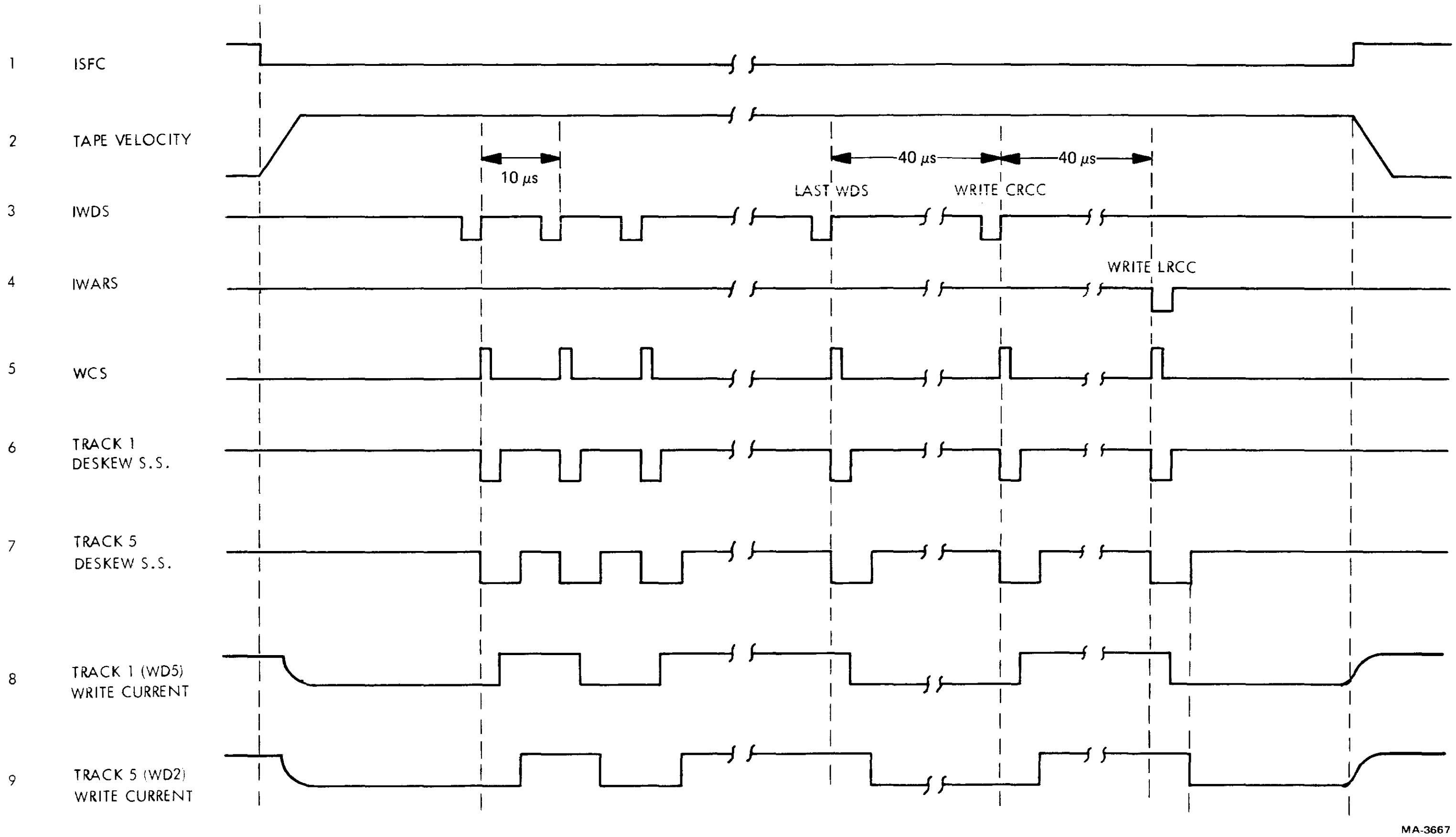


Figure 5-36 NRZI Data Recording Waveforms

Digital write data from the MTA (J2) enters the write PCBA through J7 as IWDP, IWD0-IWD7 and is buffered and inverted through U21, U24 and U28 (zone 2-14A through D). Inverted data is presented to the write data flip-flops in the PE/NRZI write logic (UA, U30, zone 2-7A through F) at point A (zone 2-8B through F). After the digital information is present, the write data strobe (IWDS) is sent from the MTA (J2) to the write strobe logic. The write strobe logic provides the two write/test data strobes, W/TDS (U36-8, zone 2-14E) and NW/TDS (U27-10, zone 2-13E). The W/TDS signal is coupled to the PE/NRZI write logic and strobes data from the interface buffers into the write data flip-flops. The NW/TDS signal is coupled to the write control logic and provides the write control strobe (WCS) at U36-3 (zone 2-12G) and NWCS at U36-11 (zone 2-11G).

Digital information from the write data flip-flops is presented to the write amplifier control flip-flops UC, U26 (zone 2-5A through F). When IWDS occurs, the NWCS signal is produced which is coupled to the NRZI write deskew one shot inputs (UB, U23, zone 2-6A through F). Each of the nine one shots times out at a different rate depending on how it was adjusted (R1) to compensate for write head pole gap scatter. As the one shots time out, their $\overline{Q}$ output clocks the write amp control flip-flops, which assume the data held in the write data flip-flops.

The control flip-flops produce the write current toggle pulses (WCTP, WCT0-WCT7 and NWCTP, NWCT0-NWCT7) which turn on the write current switches Q2 and Q3 in circuits 100 through 900 to produce the signals WCP, WC0-WC7 through J6 and via the 9TK preamplifier. Q2 and Q3 alternately provide a current path from the center tap of each head winding (-15 V from WP1 N.O.) through the current source transistor Q1 of circuits 100 through 900.

One IWDS pulse is provided for each frame of data to be recorded on tape plus one additional pulse to record the CRCC character. The IWARS (write amplifier reset) pulse (J7-46) resets the PE/NRZI write logic to the erase polarity and creates the LRCC character on tape. IWARS enables U32-11 (zone 2-13F) and causes U37-8 (zone 2-13F) to output a low level thus resetting the write data flip-flops. IWARS also enables the IWARS stretcher one shot (U35, zone 2-13H) which when timed out produces a final NWCS pulse thus triggering the write deskew one shots and clocking all write amplifier control flip-flops to a zero state. As each write amplifier control flip-flop changes state, (if it was set initially) the LRCC character is created on tape.

5.12 READ FUNCTION (Figure 8 in Volume 1)

5.12.1 Read Function Overview

The read function recovers the digital information from magnetic tape in either the forward or reverse direction. The format is ANSI and IBM compatible, 9-track, NRZI or PE. Figure 5-37 is a simplified block diagram of the read function.

The high density signal (NHID or NPE) from the control M PCBA (J8-25) is applied to the read control logic on the data L PCBA. The density command is received from the TM03 tape formatter via the M8940 interface module. NHID (NPE) is used to select either PE or NRZI format (high = NRZI, low = PE).

When the system control function detects a read command and an interface motion command, the control M PCBA provides a high motion signal (MOTION) via J8-28 and a high write signal (NWRT) via J8-26 to the data L PCBA. NWRT is used to select either a read or write operation (high = read, low = write).

Because of the read-after-write feature, the transport reads in both read and write modes, and selection of the read-only function is essentially a suppression of the write mode.

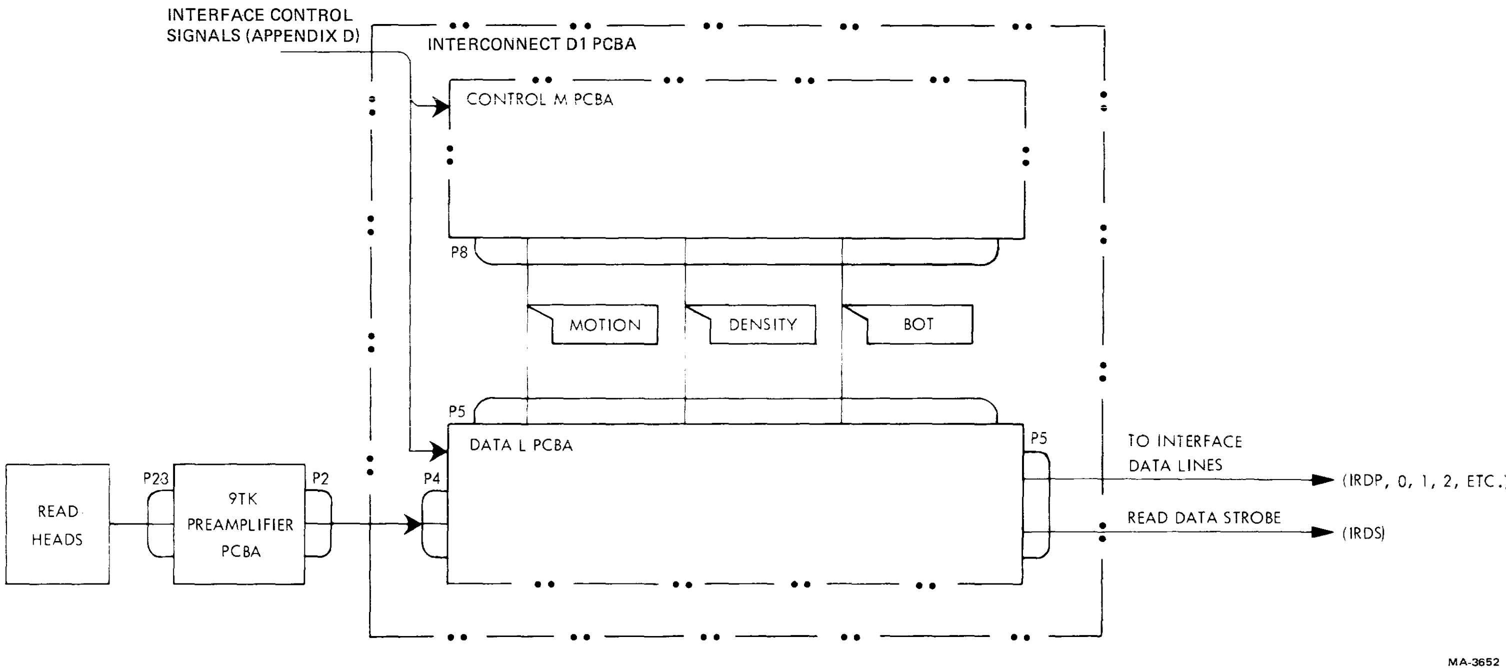


Figure 5-37 Read Function Block Diagram

Data retrieved by the read heads are preamplified on the 9TK preamplifier PCBA and routed directly to J4 on the data L PCBA, where they are processed and presented to the interface in binary form as required by the TM03 tape formatter.

As the tape passes over the read head during a read operation, any flux pattern recorded on the tape (one or zero) generates a waveform in its appropriate data track. It is important to note that during a read reverse operation, the read signal is inverted, i.e., a PE one bit is a negative transition and a PE zero bit is a positive transition.

Solid-state switching is employed to accomplish format selection in the transport. All formats require a minimum signal level for accurate data reproduction. For NRZI tapes this level is approximately 20 percent of the peak voltage output at the read amplifier; on PE tapes this level is approximately 5 percent. These threshold levels prevent tape noise and sporadic signals from appearing as data since these unwanted signals are usually lower than the 20 and 5 percent levels established.

The PE read threshold is initially at 10 percent. After the PE preamble is detected, the TM03 automatically selects a lower threshold level of 5 percent.

The NRZI threshold level cannot be changed. It remains at 20 percent regardless of signal level.

The data electronics do not include provisions for deskewing PE data. PE data is deskewed in the TM03 tape formatter.

There are two types of skew associated with reproducing NRZI data: static and dynamic. Static skew is caused by misalignment of the head azimuth and gap scatter. Azimuth misalignment is normally corrected by adjusting the read head relative to the tape path. Gap scatter is compensated electronically via the read channel window.

Dynamic skew is normally caused by imperfections in tape tracking and is compensated for by use of the transport character gate. The character gate is an electronic window which opens upon receipt of the first data one bit from any track. The window stays open for nominally 47 percent of the bit-cell time. All other ones arriving during the time of this window are considered valid data for that byte.

The dual-stack head enables simultaneous read and write operations to take place, thus allowing writing and checking of data on a single pass. Gap scatter and the azimuth angles of both the read and write heads are either corrected or compensated for.

The read head azimuth adjustment is provided by mechanically positioning the head plate so that the tape tracks at 90 degrees to the read head gap. Since the write and read heads are constructed in the same block, an independent method of azimuth adjustment is required for the write head. This is achieved electronically by triggering the write waveform generator for different channels sequentially, and at such times that the azimuth error in the write head with respect to the read head is minimized.

5.12.2 Data L (Read) PCBA

The data L PCBA processes data picked up by the read head and preamplified on the 9TK preamplifier PCBA. Data is reformatted from PE or NRZI to binary format as required by the host system. The data L PCBA is plugged into J5 on the interconnect D1 PCBA. Data L PCBA inputs are listed in Table 5-7 and outputs in Table 5-8.

The 9TK preamplifier PCBA regulates the 6.8 Vdc power for head circuits, using 15 Vdc regulated inputs from the capstan/regulator PCBA. The 9TK preamplifier circuits are shown on Schematic No. 104815. Circuits on the data L PCBA are shown on Schematic No. 104805. The following text refers to the schematic and to the Read Functional Block Diagram (Figure 8 in Volume 1).

Table 5-7 Data L PCBA Inputs

Input	Connection	From	Purpose
NHID	P5-10	J8-25	Selects PE (low = true) or NRZI (high = false) mode
NWRT	P5-47	J8-26	Selects read only mode (low = true) or read-after-write mode (high = false)
9TK	P5-11	J8-27	Selects 9TK mode
MOTION	P5-48	J8-28	Notifies circuits to strobe data out (tape rolling)
IRTH1	P5-2	Interface	Selects normal threshold
IRTH2	P5-1	Interface	Selects lower-than-normal threshold
NTEST	P5-60	J103-6	Test threshold and read character gate control
DCHP	P5-15		Not used
DCH0	P5-16		Not used
DCH1	P5-17		Not used
DCH2	P5-18		Not used
DCH3	P5-19		Not used
DCH4	P5-20		Not used
DCH5	P5-21		Not used
DCH6	P5-22		Not used
DCH7	P5-23		Not used
R0A	J4-12	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R0B	J4-29	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R1A	J4-11	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R1B	J4-28	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R2A	J4-10	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R2B	J4-27	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R3A	J4-9	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R3B	J4-26	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R4A	J4-8	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R4B	J4-25	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R5A	J4-7	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R5B	J4-24	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R6A	J4-6	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R6B	J4-23	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R7A	J4-5	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA
R7B	J4-22	J2 Preamp PCBA	Read data from 9TK preamplifier PCBA

Table 5-7 Data L PCBA Inputs (Cont)

Input	Connection	From	Purpose
+15 V	P5-5,41	J11-21,61	Power input
-15 V	P5-6,42	J11-14,54	Power input
+5 V(L)	P5-8,9,44,45	J11-22,23,62,63	Logic Power
+5 V(T)	P5-7,43	J11-22,23,62,63 via W1 on interconnect D1	Termination voltage
0 V(L)	P5-4,39,40,3	J11-26,27,66,67	Logic 0 voltage

Table 5-8 Data L PCBA Outputs

Input	Connection	To	Purpose
NRZ	J4-14	9TK Preamp PCBA	Mode control
9TK	J4-15	9TK preamp PCBA	Mode control
NTSKEW	P5-37	J103-5	Test skew
ISGL	P5-64	–	Not used
ISPEED	P5-63	–	Not used
IRDS	P5-71	MTA interface PCBA	Read data strobe
INRZ	P5-66	MTA interface PCBA	NRZI mode operation
I7TR	P5-65	MTA interface PCBA	Low = 7 track; high = 9 track operation
IRDP	P5-72	MTA interface PCBA	Read data parity
IRD0	P5-70	MTA interface PCBA	Read data character
IRD1	P5-69	MTA interface PCBA	Read data character
IRD2	P5-68	MTA interface PCBA	Read data character
IRD3	P5-67	MTA interface PCBA	Read data character
IRD4	P5-62	MTA interface PCBA	Read data character
IRD5	P5-61	MTA interface PCBA	Read data character
IRD6	P6-59	MTA interface PCBA	Read data character
IRD7	P5-58	MTA interface PCBA	Read data character
+5 V(L)	J4-16	9TK preamp PCBA	Logic power

Table 5-8 Data L PCBA Outputs (Cont)

Input	Connection	To	Purpose
0 V(L)	J4-1,2,3,4, 18,19,34	9TK preamp PCBA	Logic power
- 15 V(F3)	J4-17,32,33	9TK preamp PCBA	Power supply to head voltage regulator
+15 V(F3)	J4-20,21,31	9TK preamp PCBA	Power supply to head voltage regulator

On the control M PCBA, jumper W4 is grounded and the inverter provides a high 9-track signal via J8-27 to the read control logic.

The read control logic supplies a high NRZ signal to the NRZI read character gate generator and to the 9TK preamplifier PCBA. At the same time, the read control logic couples PE (U17-10, zone 2-6B) to the read logic decoders and the bandwidth control signal (BWC) to the read channel detectors. The read control logic also provides either the PE threshold enable (PET) or the NRZI threshold enable (NRZIT).

In NRZI, the NRZIT and NRZEN signals enable the NRZI threshold generator and the PET signal disables the PE threshold generator. The NRZIT and NRZEN signals determine the desired threshold depending on the state of IRTH2. TP56 monitors the BWC signal, TP68 monitors the PET signal, and TP72 monitors the NRZIT signal. TP59, TP60, and TP61 monitor the interface signals, ISGL, I7TR, and INRZ, respectively.

The NRZI threshold generator provides the NRZI threshold level signals (NRZP and NRZN) to the read channel detectors. R11 (zone 2-16F) adjusts the level of the NRZP and NRZN signals and TP69 and TP70 monitor the NRZP and NRZN signals, respectively.

As the magnetic tape moves across the head, the read signals (RHP, RH0–RH7) are coupled to the preamplifier via P22. The signals are amplified and coupled to the NRZI/PE dual gain amplifier (RHPA, RH0A–RH7A). The high NRZI signal from the read control logic (J4-14) conditions the NRZI/PE dual gain amplifier to the NRZI mode. The RPA, R0A–R7A signals are amplified and coupled to the read channel detectors via P4. R107, R118, R128, R207, R218, R228, R307, R318, and R328 are used to adjust the NRZI gain. TP101–TP103, TP201–TP203, and TP301–TP303 are used to monitor the output of the 9TK preamplifier PCBA.

The read channel detectors digitally convert the analog input signals (RPA, R0A–R7A) to digital signals. In NRZI mode, the BWC signal from the read control logic sets the proper bandwidth for the NRZI input and the NRZP and NRZN signals from the NRZI threshold generator sets the level of detection. The read channel detectors provide the positive and negative digital read signals (RPDP, R0DP–R7DP and RPDN, R0DN–R7DN) to the read logic decoders.

The low PE signal from the read control logic disables the PE circuitry in the read logic decoders. The U17-2 output from the read control logic is used in NRZI only. Jumpers at J1 and J2 are used to provide a direct read output. The read logic decoders decode the NRZI information and provide the output signals (IRDP, IRD0–IRD7) for use by the TM03 tape formatter. The IRDP, IRD0–IRD7 signals are coupled through edge connector J2. TP67, TP65, TP64, TP63, TP62, TP58, TP57, TP55, and TP54 are used to monitor the output read signals (IRDP, IRD0–IRD7), respectively.

The read channel detectors digitally convert the analog input signals (RPA, R0A–R7A) to digital signals. The BWC signal from the read control logic sets the proper bandwidth for the PE input and the PETL signal from the PE threshold generator sets the level of detection. The read channel detectors provide the positive and negative digital read signals (RPDP, R0DP–R7DP, and RPDN, R0DN–R7DN) to the read logic decoders.

The high PE signal from the read control logic enables the PE circuitry in the read logic decoders. The read interface enable (U17-12, zone 2-6B) from the read control logic is used in NRZI only. Jumpers J1 and J2 are used to provide a direct read output. The read logic decoders decode the PE information and provide the output signals (IRDP, IRD0–IRD7) for use by the TM03 tape formatter. The IRDP, IRD0–IRD7 signals are coupled through edge connector J2. TP67, TP65, TP64, TP63, TP62, TP58, TP57, TP55, and TP54 are used to monitor the output read signals (IRDP, IRD0–IRD7), respectively.

The low NRZ signal from the read control logic disables the NRZI read character gate generator in PE operation (Figure 5-38).

In a NRZI read operation, after NHID is high and MOTION and NWRT are high from the system control function (J8), the transport is conditioned to a NRZI read operation. These signals are routed to the data L PCBA.

When the transport is selected, ready, and on-line, the system control function provides the selected, ready, and on-line signal (NSLTA) to the read control logic via J8-23. Interface signals ISGL, ISPEED, INRZ, and I7TR connecting to J/P5 are not used.

When the interface signal, read low threshold (IRTH2) is coupled to the read control logic via P5-1, it provides a low threshold. The IRTH2 signal is used in PE operation only. In NRZI operation the read threshold is held constant. IRTH2 is discussed for PE operation.

In a PE read operation, after NHID is low and MOTION and NWRT are high from the system control function (J8), the transport is conditioned to a PE read operation. These signals are coupled to the data L PCBA.

The read control logic supplies a low NRZ signal to the NRZI read character gate generator and to the 9TK preamplifier PCBA. At the same time, the read control logic couples PE to the read logic decoders and the bandwidth control signal (BWC) to the read channel detectors. The read control logic also provides either the PE threshold enable (PET) or the NRZI threshold enable (NRZIT). In PE, the NRZIT signal disables the NRZI threshold generator and the PET signal enables the PE threshold generator. The PET signal determines the desired threshold depending on the state of IRTH2. TP56 monitors the BWC signal and TP68 monitors the PET signal. TP72 monitors the NRZIT signal. TP59, TP60, and TP61 monitor the interface signals, ISGL, I7TR, and INRZ, respectively.

The PE threshold generator provides the PE threshold level signal (PETL) to the read channel detectors. R29 is used to adjust the level of the PETL signal and TP71 monitors the PETL signal.

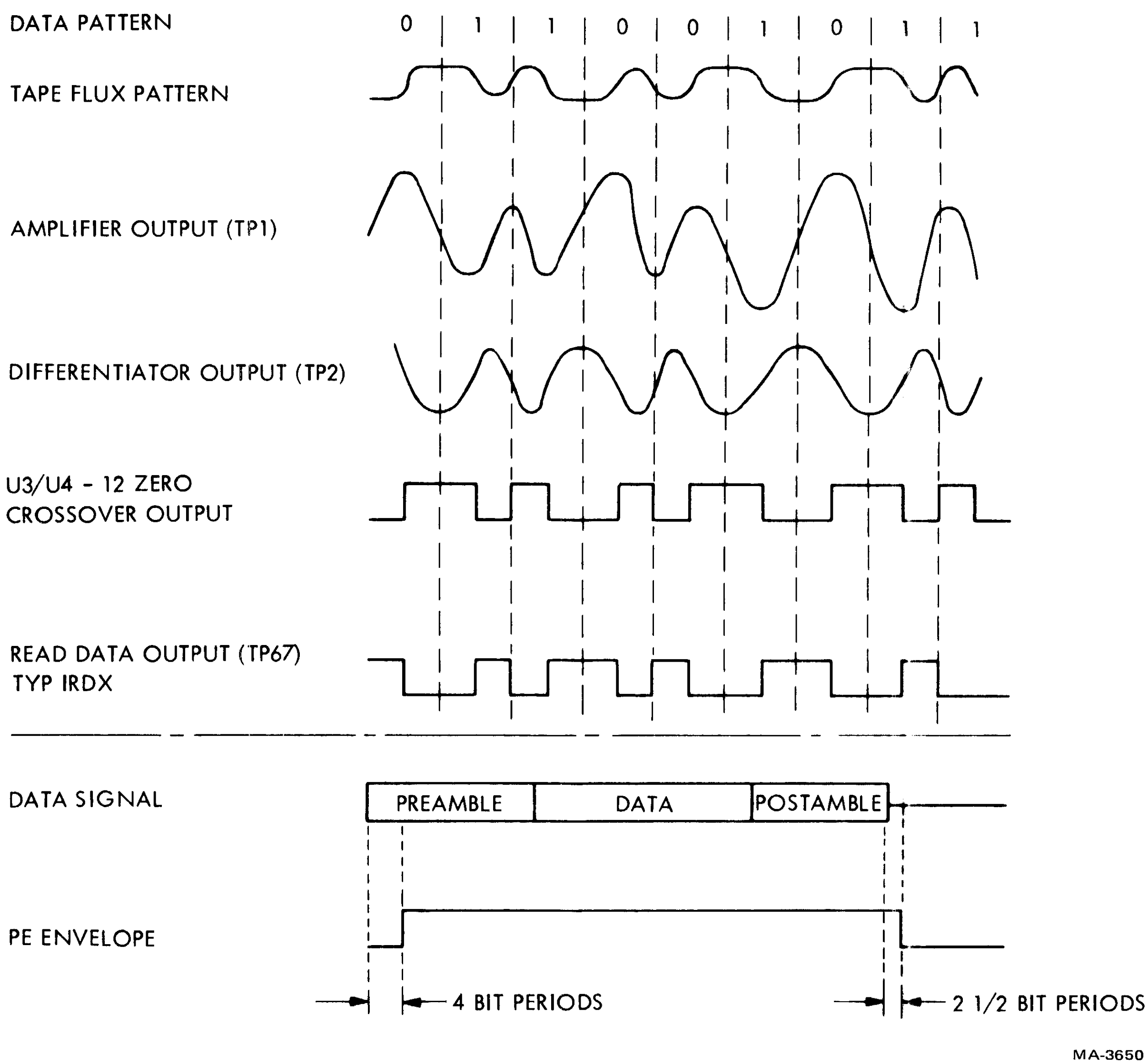


Figure 5-38 PE Data Reproduction Waveforms

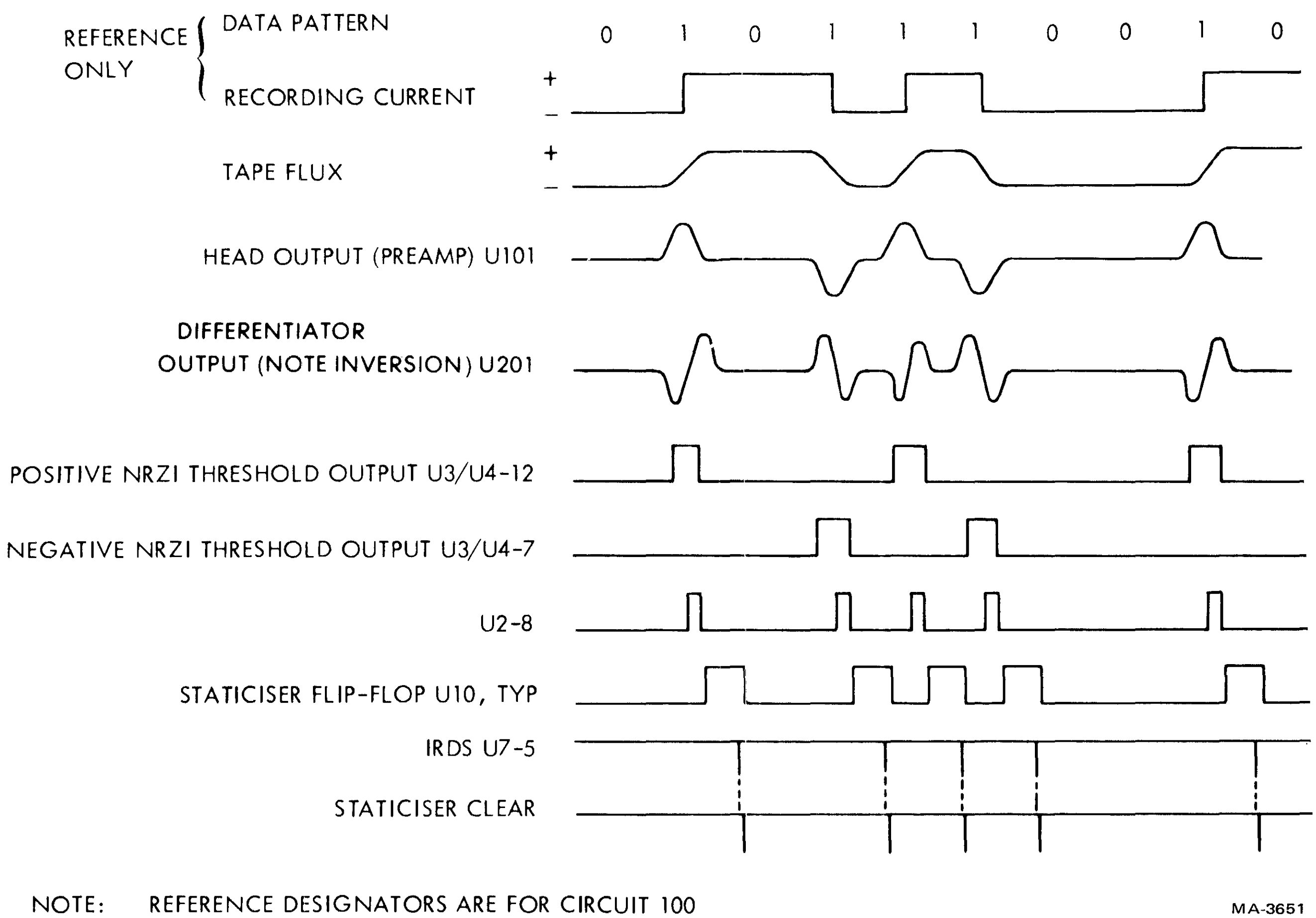


Figure 5-39 NRZI Data Reproduction Waveforms

As the magnetic tape moves across the head, the read signals (RHP, RH0–RH7) are coupled to the preamplifier via P22. The signals are amplified and coupled to the NRZI/PE dual gain amplifier (RHPA, RH0A–RH7A). The low NRZ signal from the read control logic (J4-14) conditions the NRZI/PE dual gain amplifier to the PE mode. The RPA, R0A–R7A signals are amplified and coupled to the read channel detectors via P4. R106, R117, R128, R206, R217, R228, R306, R317, and R328 adjust the PE gain. TP101–TP103, TP201–TP203, and TP301–TP303 monitor the output of the 9TK preamplifier PCBA.

The high NRZ signal from the read control logic enables the NRZI read character gate generator in NRZI operation. The feedback signals (RDP, RD0–RD7) from the read logic decoders are coupled to the NRZI read character gate generator. The RDP, RD0–RD7 signals are processed and provide the test skew signal (NTSKEW) via J5-37. At the same time the RDP, RD0–RD7 signals produce the read data strobe (RDS) which is coupled to the read logic decoder (Figure 5-39). Interface signal IRTH1 is used only in the maintenance mode and is evoked with the interchange read maintenance command through the TM03 formatter. IRTH1 widens the NRZI character gate to a 60 percent window.

R37 is used to adjust the read character gate pulsewidth. TP53 is used to monitor the TSKEW signal. TP51 is used to monitor the read character gate pulse and TP78 is used to monitor the reset pulse.

The RDS signal is coupled to the read logic decoder and inverted to provide the interface signal IRDS. The IRDS signal is coupled to the interface via J5-71.

CHAPTER 6
MAINTENANCE AND TROUBLESHOOTING

6.1 SCOPE
This chapter provides procedures necessary to perform functional alignments, parts replacement, adjustments, and troubleshooting for the TU77 Magnetic Tape Transport assembly. Although TM03 testing is included in some diagnostics, actual maintenance pertaining specifically to the TM03 is contained in the TM03 Technical Manual. The major TU77 assemblies referenced in this chapter are shown in Figures 1-3 and 1-4. The methods for gaining access to these assemblies are outlined in Chapter 2.

6.2 TU77 MAINTENANCE PHILOSOPHY
The TU77 Tape Transport is a reliable, high-performance unit which will provide years of trouble-free operation when properly maintained. A program of routine inspection and maintenance is required for optimum performance and reliability.

A Preventive Maintenance (PM) Program for the TU77 transport is outlined in Paragraph 6.4. A program of daily customer care should include head and tape path cleanings. Adjustments should only be made when problems are encountered in transport operation or during a regular PM cycle. For PM on the TM03 Tape Formatter, see the TM03 Technical Manual.

Corrective maintenance involves troubleshooting at the system level using system diagnostics and visual methods to localize the failure. The system diagnostics direct service personnel to the faulty functional area, not necessarily to the faulty module. When this area is identified, the service representative will use test switches located on the MTA board to isolate the fault to a field replaceable part or required adjustment. Unit level troubleshooting can be performed utilizing functional block diagrams, flow diagrams, timing diagrams and engineering logic drawings, together with proubleshooting aids given in Paragraph 6.6. (Refer to the diagrams in Volume 1 and Chapter 5 of this volume.)

6.3 TEST EQUIPMENT
All tools and test equipment needed to facilitate transport operation and maintenance, according to procedures described in this manual, are listed in Tables 6-1 and 6-2.

Table 6-1 Standard Tools and Test Equipment Required

Equipment	DIGITAL Part Number	Manufacturer's Number
1. Field Service Tool Kit		
Domestic	29-23269	–
European/GIA	29-23271	–
2. Oscilloscope 100 MHz/Dual Trace	–	Tektronix 465 or Equivalent
3. Digital Multimeter	–	Fluke 8020A or Equivalent

Table 6-2 Special Tools and Test Equipment Required

Equipment	DIGITAL Part Number	Manufacturer's Number
Reel motor centering tool	29-23206	—
Reel flange locating bar	29-23207	—
PCBA extender	29-23218	—
Lower restraint tube fitting	29-23228	—
Differential pressure gauge (0–40 inch H_2O)	29-11650	Dwyer #2040
Differential pressure gauge (0–5 PSI)	29-11636	Dwyer #2205
Portable accessory package for gauges (2 required)	29-11647	Dwyer #A-432
Tachometer (decimal readout)	29-11635	—
Tape crimper	47-00038	—
Xcelite handle	29-10562	Xcelite #99-1
7 inch extension	29-11625	Xcelite #99-X10
5/32 inch × 4 inch ballpoint hex driver	29-11630	Xcelite #99-25BP
No. 1 Phillips screwdriver shaft	29-11001	Xcelite #99-821
Master skew tape (1200 ft)	29-19224	—
Magna-See tape developer	29-16871	—
50X microscope with graticule	29-20273	—
Heat sink compound	90-08268	—
Inspection mirror (dental type)	29-19663	—
Cleaning kit	TUC01	—
Standard output tape	29-11691	—

6.4 PREVENTIVE MAINTENANCE

The recommended frequency for performing the PM tasks in this procedure are based upon moderate usage of the equipment. If usage exceeds 2500 vacuum-on hours in a six month time frame, the PM frequency should be increased proportionally. Refer to Table 6-3 for preventive maintenance schedule.

Table 6-3 Preventive Maintenance Schedule

Frequency	Procedure	Reference Paragraph
Daily	Clean read/write head, erase head, tape cleaner blades, ceramic guides, air guide, air bearings, guide block, buffer box (floor and sides), buffer box glass, loop pocket, pocket glass, capstan. **CAUTION** **Observe warnings and notes in Paragraph 4.3.**	4.3.4
Semiannually or 2500 vacuum on hours	Remove and clean foam cabinet filters; one on inside front dress panel and four on inside rear door. Perform general cleaning of cabinet area.	—
	Remove and clean air bearings, air guide, and circular ceramic guide.	6.7.3, 6.7.4

Table 6-3 Preventive Maintenance Schedule (Cont)

Frequency	Procedure	Reference Paragraph
Semiannually or 2500 vacuum on hours (cont)	Remove tape cleaner and clean blades.	6.7.2
	Clean reel sense lenses and EOT/BOT cavities.	--
	Clean cartridge restraints.	--
	Check for head wear and if necessary, replace head.	6.7.1
	Check all hoses and tubing for cracks and tighten all connection clamps if necessary.	--
	Remove pneumatic belt guard and check belts for wear and proper tracking.	Fig. 6-39
	Replace compressor intake muffler/filter element.	--
	Replace compressor in-line exhaust filter.	--
	NOTE **If any of the following checks are out of tolerance, perform the associated adjustment.**	
	Check vacuums and pressures.	6.5.6
	Check supply reel load speed.	6.5.7.2
	Check takeup reel load speed.	6.5.7.3
	Check loop positions.	6.5.7.4
	Check cartridge limit switches.	6.7.9 (Steps 8, 9, 10)
	Check NRZI amplitudes.	6.5.8.2
	Check PE amplitudes.	6.5.8.6
	Check NRZI read skew (azimuth).	6.5.8.3
	Check write deskew.	6.5.9

6.4.1 Daily Preventive Maintenance

Preventive Maintenance for the TU77 transport includes a daily cleaning of all tape path surfaces. This cleaning is required to prevent possible data errors that can be caused by contamination within the tape path. For cleaning procedures refer to Paragraph 4.3.4.

6.4.2 Semiannual Preventive Maintenance

The semiannual PM tasks are to be performed by trained, qualified service personnel only. Table 6-3 outlines the individual tasks and references the appropriate paragraph for individual procedures. Perform the tasks in the order listed in the table. It is not necessary to alter any adjustment on the TU77 if it is performing in a satisfactory manner and the check being performed is within the allowable tolerance. While conducting the semiannual PM, perform a visual inspection of the equipment for loose electrical connections, dirt, cracks, binding, excessive wear, and loose hardware.

6.5 ADJUSTMENT PROCEDURES

Provided in this section are adjustments and alignments relative to the TU77 transport. The adjustments and alignments are functionally grouped. Supporting illustrations are referenced where relative to the procedure.

Some adjustments may require prerequisite (performed before) and/or corequisite (performed with) adjustment of other parameters (Table 6-4). Ensure the adjustments are made as specified in the individual procedures.

Table 6-4 Required Prerequisite/Corequisite Adjustments

Paragraph	Adjustment	Prerequisites Paragraph No.	Corequisites Paragraph No.
6.5.1	Power Distribution	—	—
6.5.2	EOT/BOT Adjustment	6.5.1	—
6.5.3	Tip Sensor Adjustment	6.5.1	—
6.5.4	Pack Sense Adjustment	6.5.1	—
6.5.5	Capstan Servo Adjustments	6.5.1	6.5.8.2, 6.5.8.6
6.5.6	Vacuum and Air Pressure Adjustments	—	—
6.5.6.1	System Vacuum Adjustment	—	6.5.6.2
6.5.6.2	Takeup Reel Vacuum Adjustment	6.5.6.1	—
6.5.6.3	Air Bearing Pressure Adjustment	—	—
6.5.6.4	Thread Block and Cartridge Pressure Adjustment	—	—
6.5.7	Reel Servo Adjustments	6.5.1	—
6.5.7.1	Reel Servo Offset	—	—
6.5.7.2	Supply Reel Load Speed Adjustment	—	—
6.5.7.3	Takeup Reel Load Speed Adjustment	—	—
6.5.7.4	Tape Loop Position Adjustment	6.5.6	—
6.5.8	Read Adjustments	4.3.4, 6.5.1, 6.5.5	—
6.5.8.1	NRZI Threshold	—	—
6.5.8.2	NRZI Gain Adjustment	6.5.5	—
6.5.8.3	NRZI Read Skew	6.5.8.1, 6.5.8.2	6.5.9
6.5.8.4	NRZI Character Gate	—	—
6.5.8.5	PE Threshold	—	—
6.5.8.6	PE Gain	6.5.5	—
6.5.9	Write Deskew Adjustment	6.5.1, 6.5.8	—

Acceptable limits are defined in each adjustment procedure, taking into consideration the assumed accuracy of the test equipment specified. When the measured value is within designated parameters, no adjustment should be made. Should the value fall outside specified limits, adjustments should be made in accordance with the relevant procedure. Make the adjustment as close as possible to the designated value.

If difficulties arise during any alignment, refer to Paragraph 6.6 (Troubleshooting) for fault isolation procedures.

Refer also to Paragraph 6.6.1 for a description of the M8940 (MTA module) maintenance features which facilitate the performance of adjustments off-line.

6.5.1 Power Distribution

The power supply and regulators are not adjustable. The following procedure is given to verify that all operating dc voltages are present.

WARNING
Dangerous voltages are present in the power supply.

1. Ensure the transport is plugged into the proper ac power source and that the transformer primary taps are configured for the proper voltage range (jumpers on terminal block A1 – TB1). (Refer to Table 2-1 for proper jumper configuration.)

2. Remove the lower front dress panel from the cabinet. Open the rear door. Pull the two front stabilizer arms out of the cabinet. Release the service lock and swing the transport base assembly out to gain access to the card cage assembly.

3. Ensure the 861 power control circuit breaker (front) is on as well as the power supply circuit breaker (rear).

4. With a digital volt meter (DVM) check all the unregulated dc voltages at fuses F1 through F7 with respect to chassis ground. The fuses are located on the power supply fuse panel. Refer to Figure 6-1 for fuse locations and Table 6-5 for proper voltage readings. If incorrect go to Section 6.6 for troubleshooting information.

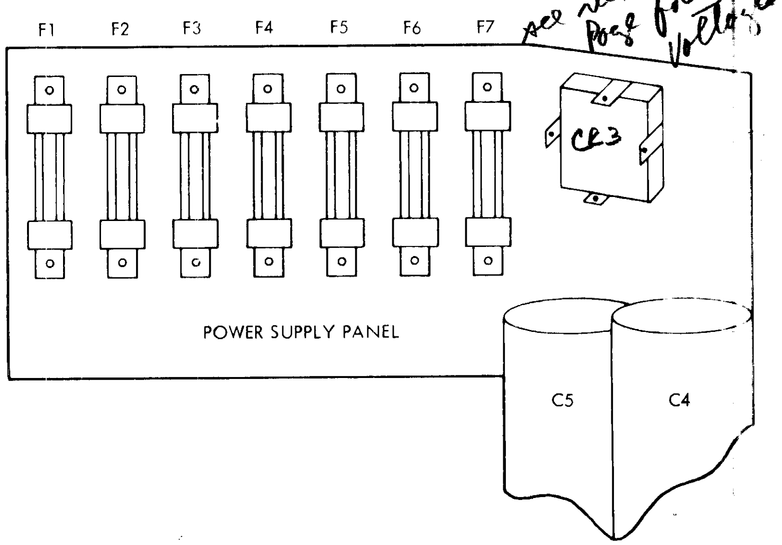


Figure 6-1 Power Supply Fuse Panel

Table 6-5 Power Supply Voltage Readings

Fuse	Circuit Function	Type	Measured Voltage (dc) Minimum	Nominal	Maximum
F1	+12 V	10 A FB	+9.5	+10.5	+11.5
F2	+24 V	5 A FB	+22.0	+24.0	+26.0
F3	-24 V	5 A FB	-22.0	-24.0	-26.0
F4	+36 V (C)	20 A FB	+35.0	+37.5	+40.0
F5	-36 V (C)	20 A FB	-35.0	-37.5	-40.0
F6	+36 V (T)	20 A FB	+38.0	+40.0	+42.0
F7	+36 V (S)	20 A FB	+38.0	+40.0	+42.0

5. With a DVM check all the regulated voltages by monitoring TP11, TP15, and TP18 with respect to TP1 on the capstan/regulator PCBA. Figure 6-2 illustrates the locations of the test points and adjustments.

    a. TP11
        - +5.00 Vdc minimum
        - +5.15 Vdc nominal
        - +5.30 Vdc maximum

    b. TP15
        - +14.0 Vdc minimum
        - +15.0 Vdc nominal
        - +16.0 Vdc maximum

    c. TP18
        - -14.0 Vdc minimum
        - -15.0 Vdc nominal
        - -16.0 Vdc maximum

6.5.2 EOT/BOT Adjustment

The following procedure describes the adjustment of the EOT/BOT amplifier on the base assembly interconnect PCBA.

NOTE
There are two variations of the base assembly interconnect board. The interconnect F PCBA (Figure 6-3A) and the interconnect F1 PCBA (Figure 6-3B).

1. Verify power supply voltages according to Paragraph 6.5.1.

2. On the interconnect F1 PCBA, connect a DVM with its positive lead to TP6 and its negative lead to TP5 (Figure 6-3). (Interconnect F PCBA: TP1 for positive lead, TP2 for negative lead)

3. Open the transport front door and the buffer box door.

4. On a work tape, attach an EOT reflective tab about one inch in front of the BOT tab.

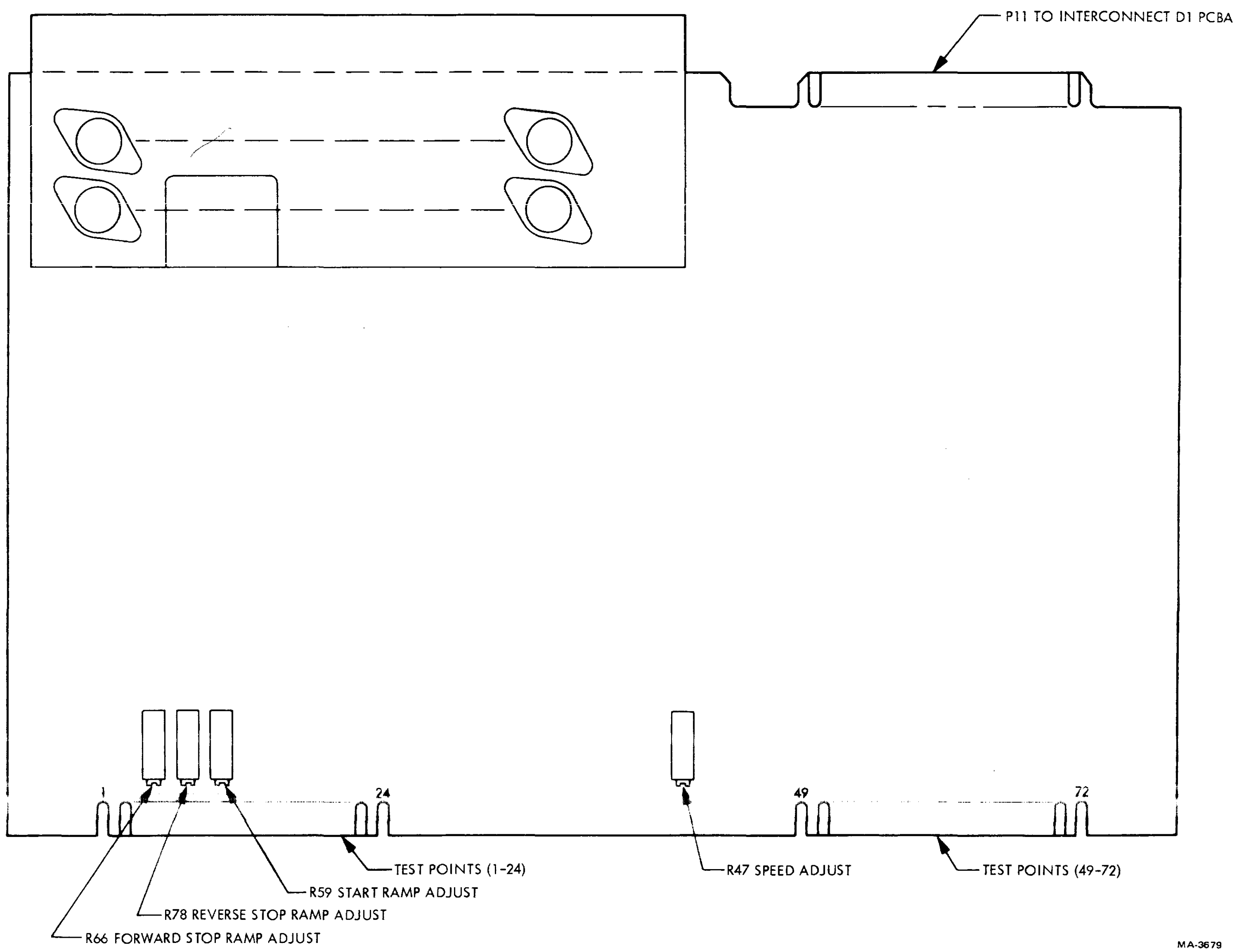
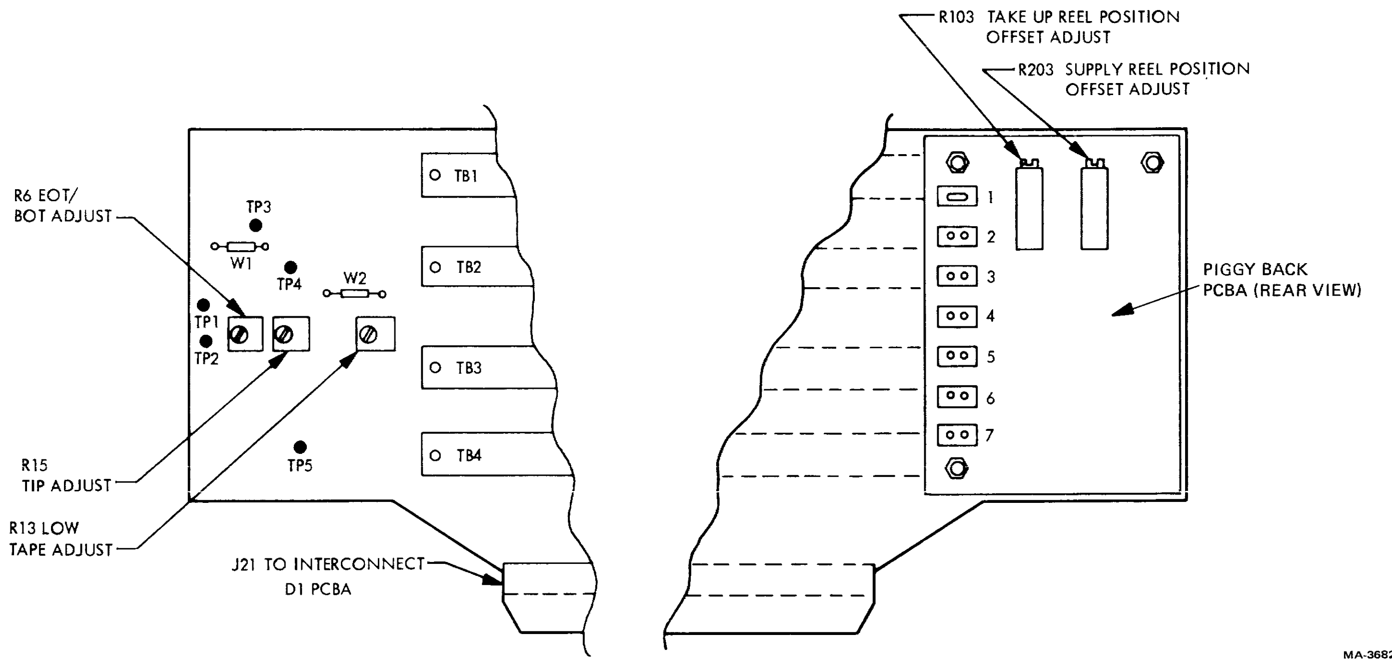
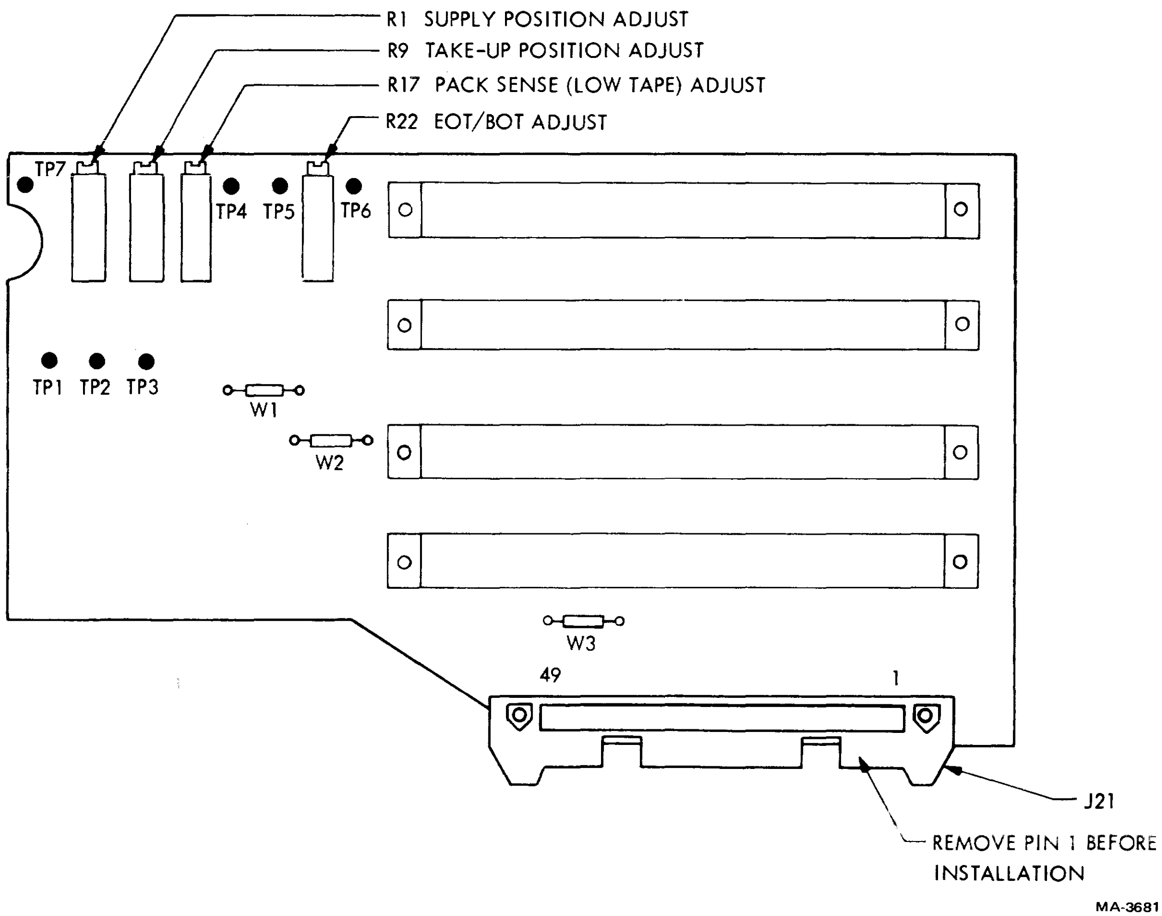


Figure 6-2 Capstan/Regulator PCBA Adjustments and Test Points



a. Interconnect F PCBA

Figure 6-3 Interconnect F/F1 PCBA Adjustments and Test Points



b. Interconnect F1 PCBA

Figure 6-3 Interconnect F/F1 PCBA Adjustments and Test Points

5. Install the work tape reel on the supply hub. Thread the tape so that the EOT and BOT reflective tabs are not under the sensors (Figure 6-4). Maintain tension with one end of the tape by holding the tape on the capstan. The tape must contact the head surface.

6. Monitor the DVM. The voltage displayed should be between:

   a. +0.1 Vdc maximum
   b. -0.1 Vdc minimum.

7. If the voltage in step 6 is out of tolerance, adjust potentiometer R22 on the interconnect F1 PCBA for 0 Vdc (Figure 6-3) (Interconnect F, adjust R6).

8. Pull the work tape to move the BOT tab under the sensor and monitor the DVM. The voltage display should be equal to or more negative than -2.0 Vdc.

9. Pull the work tape to move the EOT tab under the sensor and monitor the DVM. The voltage display should be equal to or more positive than +2.0 Vdc.

10. Remove the work tape and disconnect the DVM.

NOTE
If either voltage is out of tolerance, the EOT/BOT assembly may have to be cleaned or replaced.

6.5.3 Tape in Path Sensing Circuit Adjustment (Interconnect F Only)
The following procedure describes the adjustment of the TIP circuit.

1. Verify power supply voltages according to Paragraph 6.5.1.

2. On the interconnect F PCBA, connect a DVM with its positive lead to TP3 and its negative lead to TP5. Figure 6-3A shows the location of the adjustment and the test points.

3. Open the transport front door and buffer box door.

4. Install a work tape reel on the supply hub and thread the tape (Figure 6-4). Maintain tension with one end of the tape by holding the tape on the capstan. The tape must contact the head surface.

5. Monitor the DVM; the voltage display should be +0.50 Vdc maximum.

6. If the voltage is out of tolerance adjust potentiometer R15 on the interconnect F PCBA (Figure 6-3A).

7. Pull the work tape out of the tape path.

8. The voltage displayed should be equal to or more positive than +4.0 Vdc.

9. Remove the work tape and disconnect the DVM.

NOTE
If the voltage is out of tolerance, the tip assembly may have to be cleaned or replaced.

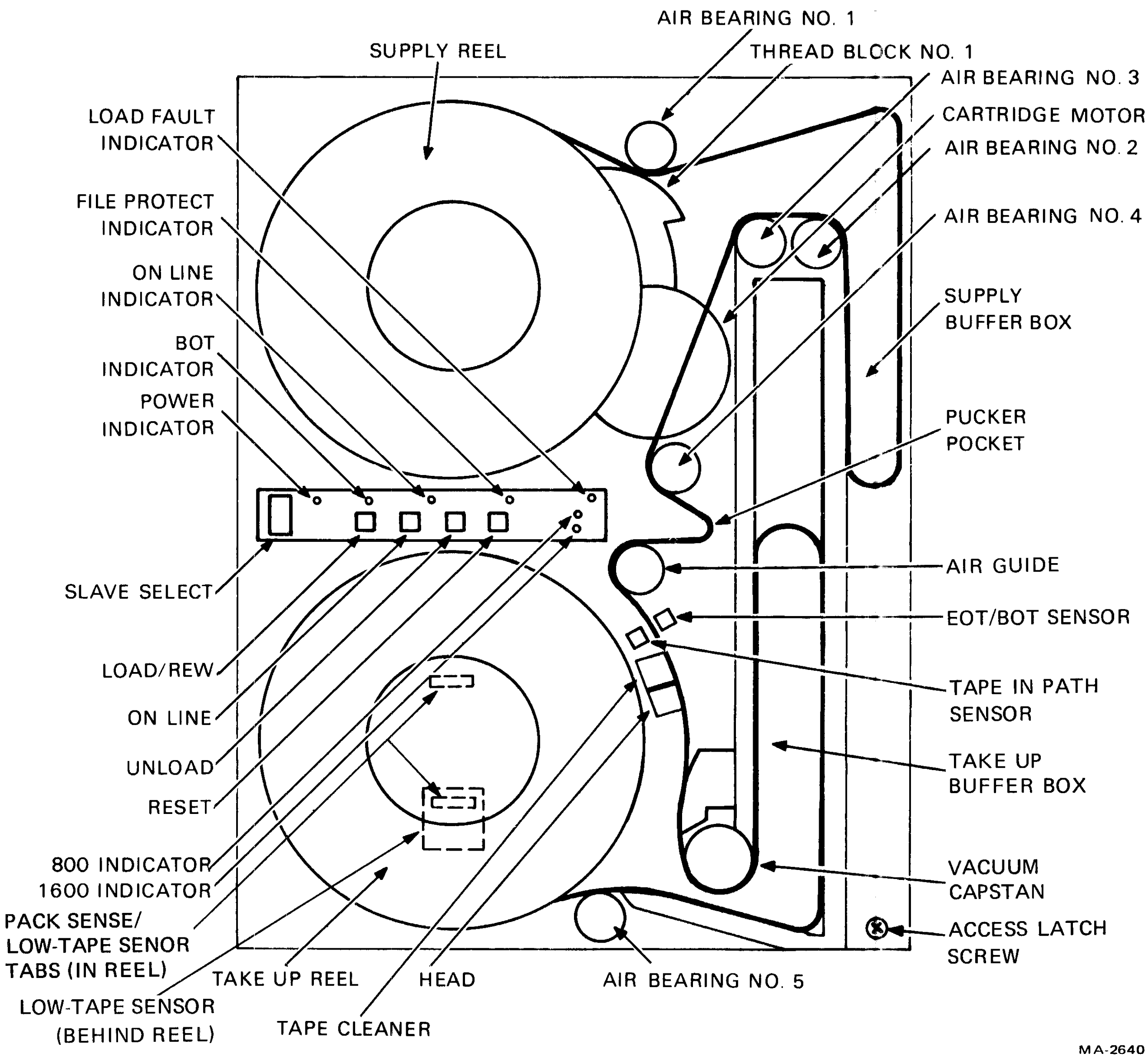


Figure 6-4 Base Assembly, Front Components

6.5.4 Low-Tape Sensor Adjustment (Pack Sense Assembly)

The following procedure describes the adjustment of the low tape sensing circuit.

1. Verify power supply voltages according to Paragraph 6.5.1.
2. On the interconnect F1 PCBA, connect a DVM with its positive lead to TP4 and its negative lead to TP7 (Figure 6-3). (Interconnect F PCBA: TP4 for positive lead, TP5 for negative lead.)
3. Open the transport front door.
4. Rotate the takeup reel until the sensor tab (located on the inside of the outer flange of the reel) is in line with the low tape sensor which is behind the reel (Figure 6-4).
5. Monitor the DVM; the voltage displayed should be +0.50 Vdc maximum.
6. If the voltage is out of tolerance, adjust potentiometer R17 on the interconnect F1 PCBA (Figure 6-3). (Interconnect F; adjust R13.)
7. Rotate the takeup reel until the tab is off the sensor.
8. The voltage displayed should be equal to or more positive than +4.0 vdc.

NOTE

If either voltage is out of tolerance, the pack sense assembly may have to be cleaned or replaced.

6.5.5 Capstan Servo Adjustments

The following are the procedures for adjusting the capstan speed, start ramp, and forward and reverse stop ramps.

1. Verify power supply voltages according to Paragraph 6.5.1.
2. Load any prerecorded 9-track NRZI 32 c/mm (800 bpi), all ones, 267 mm (10-1/2 in) tape to BOT.* Place the transport on-line.

---

*To create an all ones NRZI tape, perform the following steps:

1. Load a work tape, with write ring, to BOT and place the transport on-line.
2. Set the switches on the M8940 MTA module (Figure 6-18) in the following order:
   S6 – right (stop)
   S4 – right (test mode)
   S2 – right (run continuous)
   S3 – left (NRZI)
   S5 – left (forward)
   S7 – left (write)
   S6 – left (run)
3. Allow the tape to be written to EOT.
4. When EOT is reached set the switches in the following order:
   S7 – right (read)
   S5 – right (reverse)
   S6 – right (stop)
   S4 – left (normal mode)
5. Place the transport off-line and rewind the tape.

NOTE
Steps 3 through 7 describe the procedure for adjusting tape speed.

3. Set the switches on the M8940 MTA module in the following order:

   S6 – right (stop)
   S4 – right (test)
   S2 – right (run continuous)
   S5 – left (forward)
   S7 – right (read)
   S6 – left (run)

   The switches are numbered from right to left and are outlined in Figure 6-18.

4. Measure the capstan speed directly in rpm with the hand-held optical tachometer (DEC P/N 29-11635). Ensure that the tachometer is fitted with the rubber cone type adapter. To measure the capstan speed, place the tip of the tachometer cone into the small dimple at the rear of the capstan/tach shaft and read the rpm directly from the tachometer LEDs. The reading for 125 in/s should be in the range of 1481 to 1529 rpm.

5. If the rpm measured in step 4 is out of range, adjust potentiometer R47 on the capstan/regulator PCBA (Figure 6-2) for 1505 rpm.

6. Stop the tape by returning MTA switch No. 6 to the right.

NOTE
An alternate procedure for measuring capstan speed is to measure the frequency of the tach pulses. Connect a scope to control M PCBA, TP40 (Figure 6-5). The time period from trailing edge to trailing edge should be 80 μs $\pm$0.8 μs.

7. If it was necessary to adjust capstan speed, then the NRZI and PE gains must be adjusted (Paragraphs 6.5.8.2 and 6.5.8.6).

NOTE
Steps 8 through 12 describe the procedure for adjusting the forward start ramp.

8. Connect an oscilloscope input lead to TP901 on the data L PCBA and the ground lead to TP74. Refer to Figure 6-6 for location of test points.

9. Connect the scope external sync to TP21 on the control M PCBA (Figure 6-5). Refer to Figure 6-7 for scope settings.

10. Set M8940 MTA switch S2 left (start/stop) and then S6 left to run. The tape should now be running forward in start/stop mode.

11. Observe the scope waveform and refer to Figure 6-7. The forward start ramp rise time (0 – 95 percent) should be in the range of 2.85 ms to 3.15 ms.

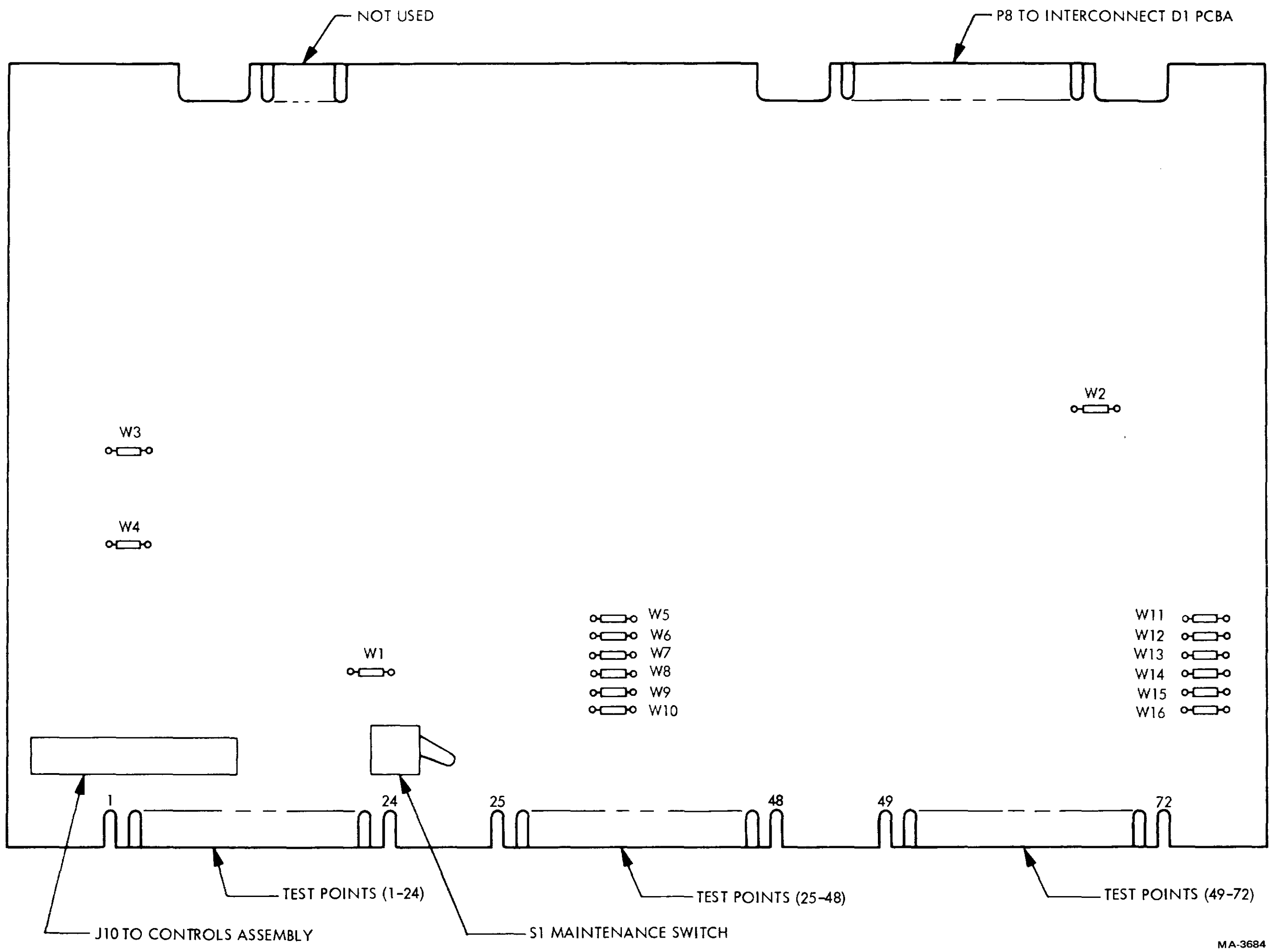


Figure 6-5 Control M PCBA Adjustments and Test Points

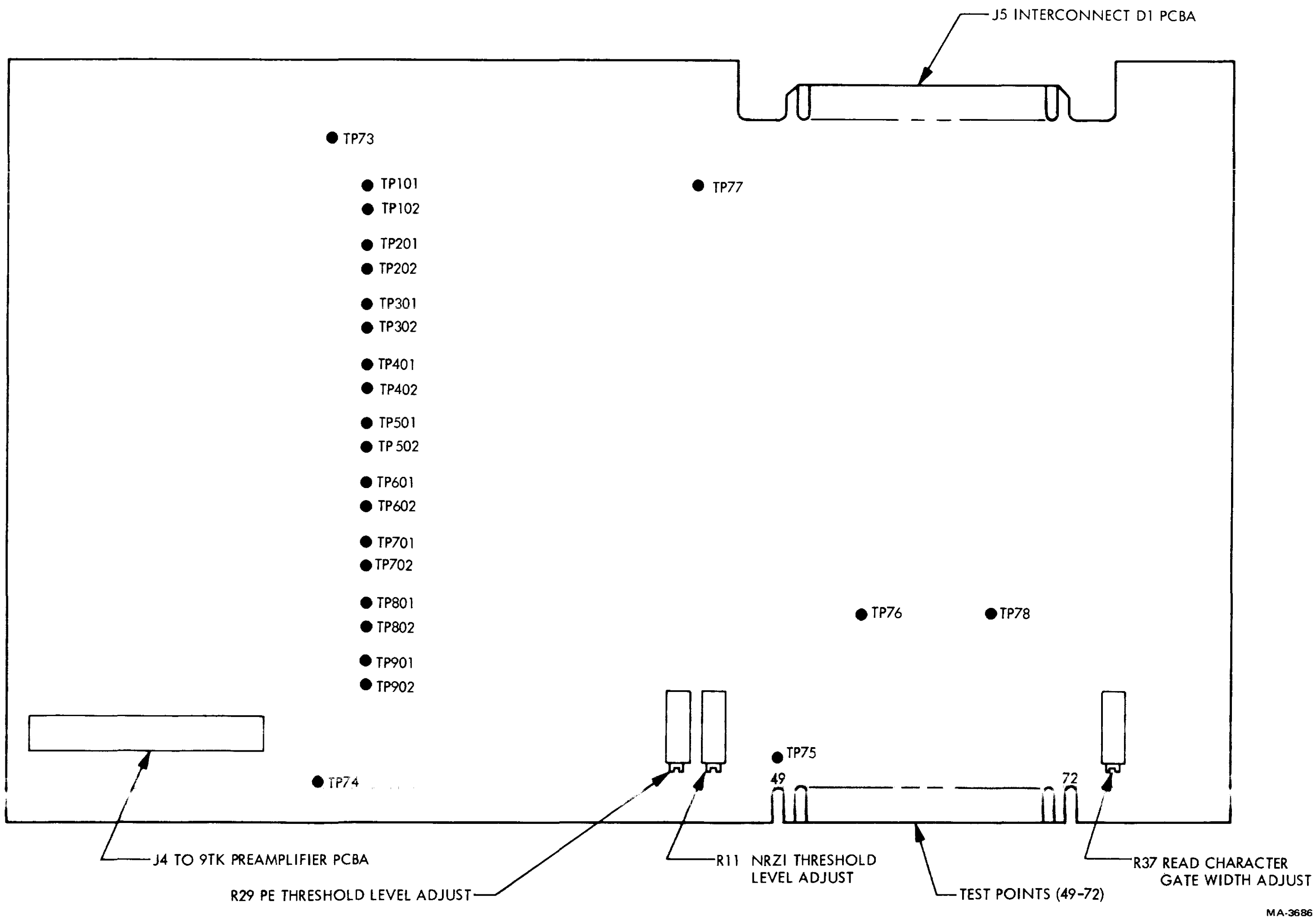


Figure 6-6 Data L PCBA Adjustments and Test Points

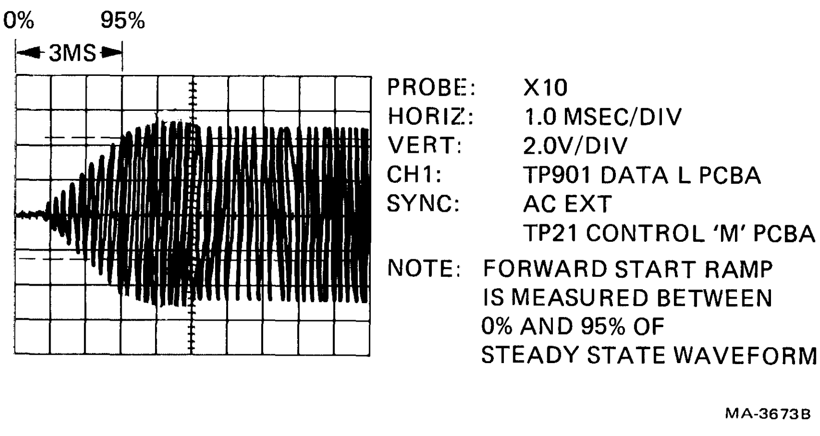


Figure 6-7 Forward Start Ramp

12. If the rise time is out of tolerance, adjust potentiometer R59 on the capstan/regulator PCBA for 3.0 ms (Figure 6-2).

NOTE

Steps 13 through 15 describe the procedure for adjusting the forward stop ramp.

13. Resynchronize the scope to obtain the forward stop ramp as illustrated in Figure 6-8a. The forward stop ramp fall time (100 – 5 percent) should be in the range of 2.85 to 3.15 ms and there should be no overshoot.

14. If the fall time is out of tolerance, adjust potentiometer R66 on the capstan/regulator PCBA for 3.0 ms (Figure 6-2). It is important that there be no overshoot in the stop ramp waveform (Figure 6-8b).

15. Stop the tape by returning switch S6 to the right.

NOTE

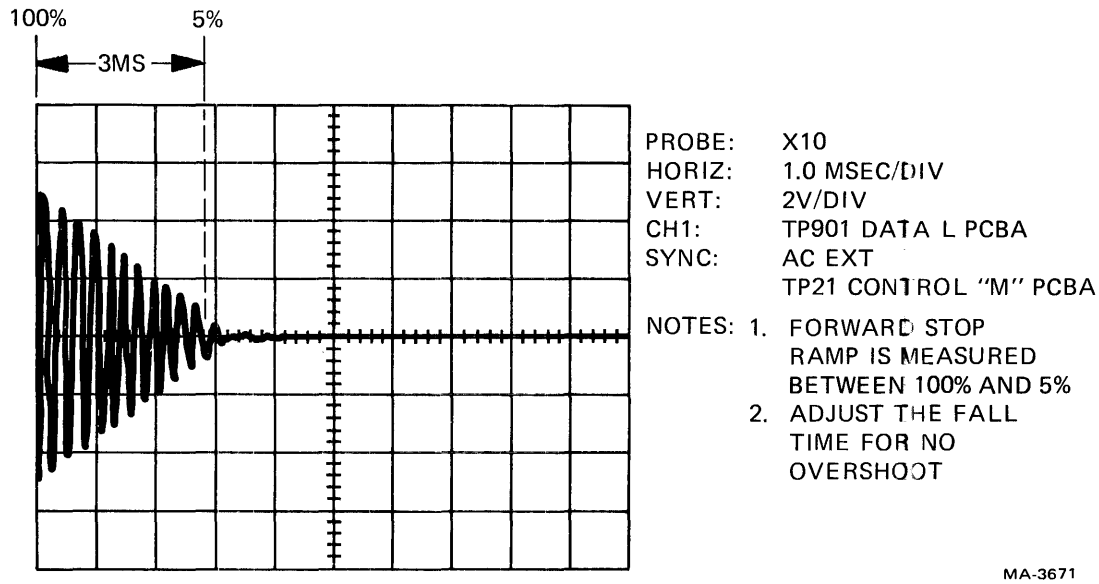
Steps 16 through 19 describe the procedure for adjusting the reverse stop ramp.

16. Set M8940 MTA switch S5 to the right (reverse) and then S6 to the left (run). The tape should now be running reverse in start/stop mode.

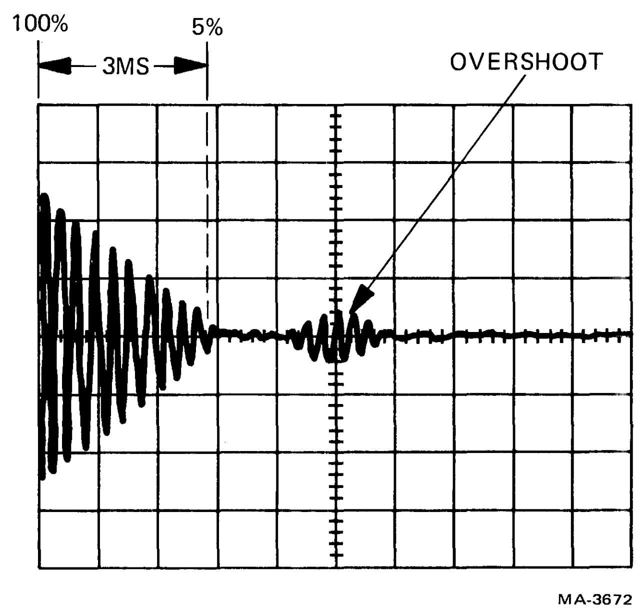
17. Resynchronize the scope to obtain the reverse stop ramp as illustrated in Figure 6-9. The reverse stop ramp fall time (100 to 5 percent) should be in the range of 2.85 ms to 3.15 ms and there should be no overshoot.

18. If the fall time is out of tolerance, adjust potentiometer R78 on the capstan/regulator PCBA for 3.0 ms (Figure 6-2). It is important that there be no overshoot in the stop ramp waveform.

19. Stop the tape by returning switch S6 to the right, and unload the tape.



a. Correct Waveform



b. Incorrect Waveform Showing Overshoot

Figure 6-8 Forward Stop Ramp

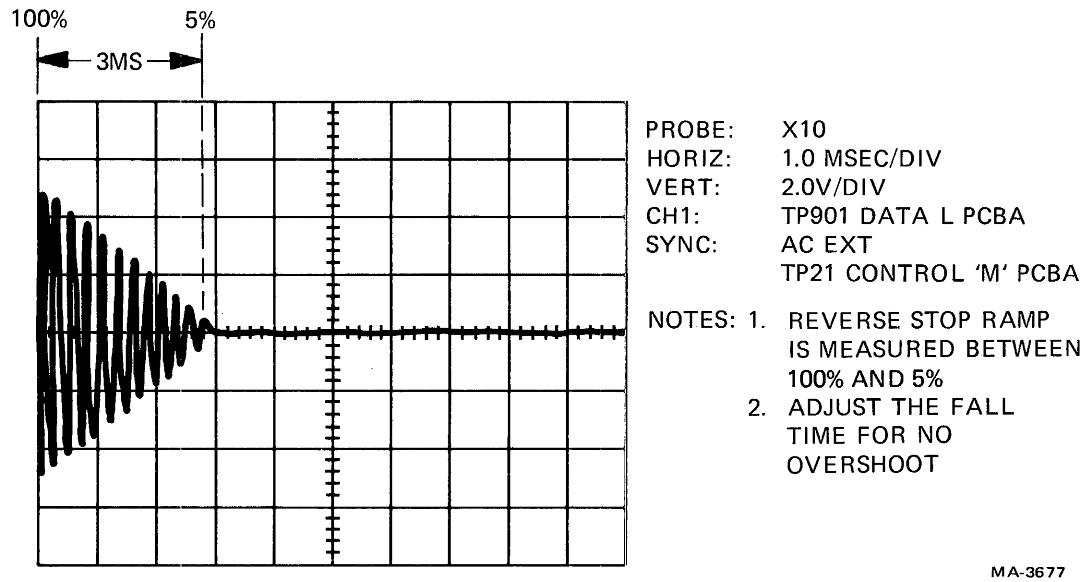


Figure 6-9 Reverse Stop Ramp

6.5.6 Vacuum and Air Pressure Adjustments

6.5.6.1 System Vacuum Adjustment – (Figure 6-10 and Table 6-6)

1. Turn transport power on.
2. Mount and load a 267 mm (10-1/2 in) reel of tape.
3. Open base assembly to gain access to the rear.

Table 6-6 Vacuum and Pressure Valve Components

Figure 6-10 Reference	Description
A	System vacuum test point
B	Reel motor connections
C	Butterfly valve adjustment screw
D	Takeup reel vacuum adjustment screw
E	Vacuum present switch
F	Takeup reel vacuum port
G	Tape on reel switch
H	Vacuum input (to pneumatic assembly)
I	Butterfly valve lock nut
J	Air bearing pressure adjustment screw
K	Pressure input (to pneumatic assembly)
L	Thread block pressure adjustment screw
M	Thread block pressure port
N	Air bearing pressure port

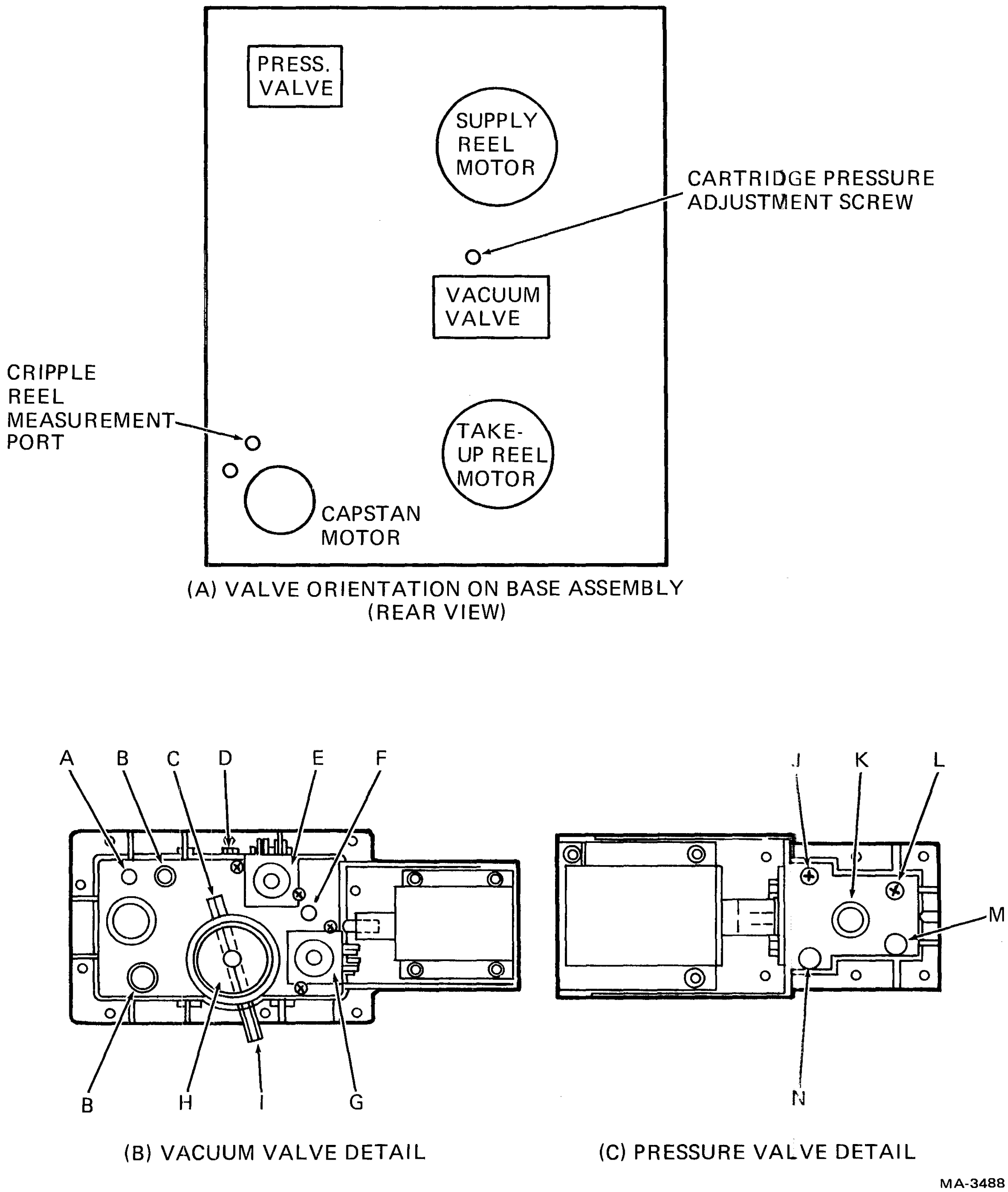


Figure 6-10 Vacuum Valve and Pressure Valve

4. Remove the red cap from the cripple reel measurement port and connect a differential air gauge with a range of 0 to 1016 mm (0 to 40 in) of water. Use the low pressure input of the air gauge to measure vacuum.

5. Place maintenance switch S1 on the control M PCBA (Figure 6-5) toward the front of the transport to drive tape forward.

6. Observe the air gauge while tape is running forward. Check for a system vacuum reading of 686 to 736 mm (27 to 29 in) of water.

7. If the reading is out of tolerance, loosen the butterfly valve lock nut (I) and turn the adjustment screw (C) for a reading of 711 mm (28 in) of water. While holding the screw, tighten the lock nut and observe the air gauge to make sure the adjustment has not changed.

8. Stop the tape and unload it. Remove the air gauge and replace the red cap.

9. Check the takeup reel vacuum per Paragraph 6.5.6.2.

6.5.6.2 Takeup Reel Vacuum Adjustment – (Figure 6-10 and Table 6-6)

1. Before this adjustment is attempted, ensure that system vacuum is within the specified limits as outlined in Paragraph 6.5.6.1.

2. Turn transport power off and remove tape from the supply reel.

3. Place disable servo switch S1 on the reel servo PCBA (Figure 6-12) toward the rear of the transport.

4. Remove red cap from takeup reel vaccum port (F).

5. Connect a differential air gauge with a range of 0–1016 mm (0–40 in) of water to the takeup reel vacuum port. Use the low pressure input to the air gauge to measure vacuum.

6. Turn transport power back on.

7. Press and release the LOAD/REW switch.

8. Immediately rotate the takeup reel three full turns to deactivate the load fault zero function.

9. Observe air gauge and check for a reading between:

   508 mm (20 in) of water, maximum
   457 mm (18 in) of water, minimum.

CAUTION

The specified duty cycle for vacuum and air pressure solenoids is intermittent – three minutes on and nine minutes off. Therefore, the unit should not be held in this mode for over three minutes maximum, after which the coil should be allowed to cool for nine minutes.

10. If the reading is out of tolerance, loosen the takeup reel vacuum adjustment screw (D) and slide the friction plate forward or backward to obtain a reading of 483 mm (19 in) of water.

11. Tighten screw while observing air gauge to ensure adjustment is not disturbed.

12. Press and release RESET button.

13. Remove air gauge and replace red cap. Place reel servo disable switch S1 in the forward direction (servo enable position).

NOTE
The two vacuum adjustments (Paragraphs 6.5.6.1 and 6.5.6.2) are interactive and after performing one, the other should be rechecked.

6.5.6.3 Air Bearing Pressure Adjustment – (Figure 6-10 and Table 6-6)

1. Turn transport power on.

2. Mount and load a 267 mm (10-1/2 in) reel of tape.

3. Open base assembly to gain access to the rear.

4. Remove red cap from air bearing pressure port (N) and connect a differential air gauge with a range of 0–34 kilopascal (0–5 psi). Use the high pressure input of air gauge to measure pressure.

5. Place maintenance switch S1 on control M PCBA (Figure 6-5) toward the front of the transport to drive tape forward. 3rd board

6. Observe the air gauge while tape is running foward and check for an air bearing pressure reading between:

   24 kilopascals (3.5 psi) maximum
   21 kilopascals (3.0 psi) minimum.

7. If reading is out of tolerance, loosen the lock nut and adjust the air bearing pressure adjustment screw (J) for a reading of 22 kilopascals (3.25 psi).

8. Tighten lock nut while observing air gauge to ensure adjustment is not disturbed.

CAUTION
Excessive torque on the lock nut will damage threads of the port. Extreme care must be exercised.

9. Stop the tape, remove the air gauge and replace red cap.

10. Unload the tape.

6.5.6.4 Thread Block and Cartridge Pressure Adjustment – (Figure 6-10 and Table 6-6)

NOTE
Both the thread block pressure and cartridge pressure must be adjusted at the same time since one adjustment directly affects the other.

1. Turn transport power off.

2. Place the servo disable switch S1 on the reel servo PCBA (Figure 6-12) toward the rear of the transport (servo disable position).

3. Remove the red cap from the thread block pressure port (M) and connect a differential air gauge with a range of 0 – 1016 mm (0–40 in) of water. Use the high input to the air gauge to measure pressure.

4. Turn transport power back on.

5. Press and release LOAD/REW on the control panel. Immediately rotate takeup reel six full turns by hand. This deactivates load fault zero and load fault three, and causes the pressure solenoid to energize.

CAUTION
The specified duty cycle for vacuum and air pressure solenoids is intermittent – three minutes on and nine minutes off. Therefore, the unit should not be held in this mode for over three minutes maximum, after which the coil should be allowed to cool for nine minutes.

6. Observe air gauge and check for a reading between:

   660 mm (26 in) of water maximum
   559 mm (22 in) of water minimum.

7. If the reading is out of tolerance, loosen the lock nut on the thread block pressure adjustment screw (L) and adjust the screw for 610 mm (24 in) of water. Tighten lock nut while observing air gauge to ensure adjustment is not disturbed.

CAUTION
Excessive torque on the lock nut will damage the threads of the port. Extreme care must be exercised.

8. Press and release RESET on the control panel.

9. Disconnect air gauge and replace red cap on the thread block pressure port.

10. On the front panel, remove the hex socket head screw from the cartridge pressure port in the lower cartridge restraint (Figure 6-11) and install the tube fitting (DEC P/N 29-23228).

11. Connect a differential air gauge with a range of 0 – 1016 mm (0 – 40 in) of water, to the tube fitting using the high input to the gauge.

12. Press and release LOAD/REW on the control panel. Immediately rotate takeup reel six full turns by hand. This deactivates load fault zero and load fault three, and causes the pressure solenoid to energize.

remember to reset switch to normal

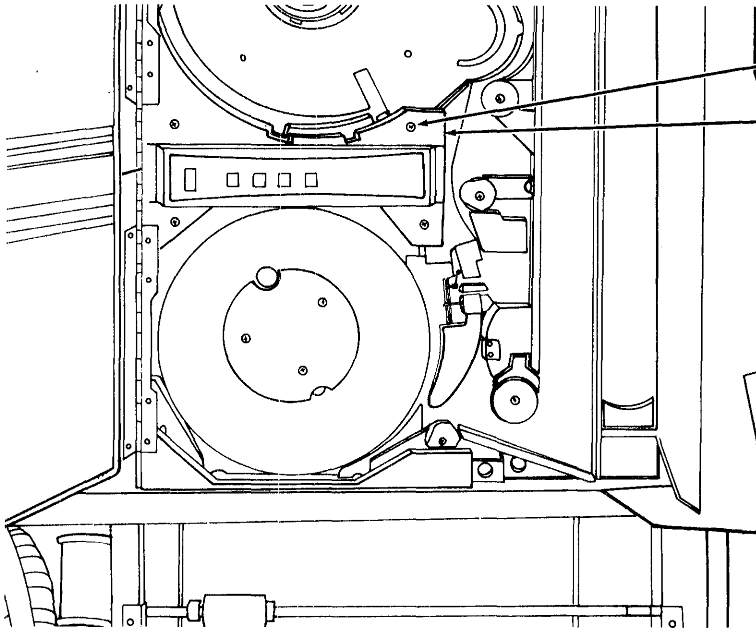


Figure 6-11 Cartridge Pressure Check Point

CAUTION

The specified duty cycle for vacuum and air pressure solenoids is intermittent – three minutes on and nine minutes off. Therefore, the unit should not be held in this mode for over three minutes maximum, after which the coil should be allowed to cool for nine minutes.

13. Observe the air gauge and check for a reading between:

    76 mm (3 in) of water maximum
    50.8 mm (2 in) of water minimum.

14. If the reading is out of tolerance, adjust the cartridge pressure adjustment screw (Figure 6-10A) for a reading of 63.5 mm (2.5 in) of water.

15. Press and release RESET on the control panel.

16. Disconnect air gauge, remove tube fitting and replace socket-head screw.

17. Steps 3 through 16 may have to be repeated several times to ensure integration of adjustments. Be sure to observe all cautions.

NOTE

An alternative method to the preceding steps would be to acquire two differential air gauges. Connect both gauges to the respective ports and make adjustments while observing both gauges.

18. Place the servo disable switch S1, on the reel servo PCBA, toward the front of the transport (servo enable position).

6.5.7 Reel Servo Adjustments

The reel servo adjustments provide for adjusting the reel servo offset, supply and takeup reel load speeds, and tape loop position. The adjustments are interactive, therefore they all should be performed together (Paragraph 6.5.7 must be performed in its entirety). Refer to Figure 6-12 for location of reel servo adjustments and test points.

6.5.7.1 Reel Servo Offset Adjustment

1. Verify power supply voltages according to Paragraph 6.5.1.

2. Turn transport power off.

3. Disconnect the takeup reel servo motor leads at the motor.

4. Turn transport power back on.

5. Open the transport front door and remove the supply reel tape.

6. Press and release the LOAD/REW switch. Immediately turn the takeup reel three full turns by hand. This will defeat activating load fault zero.

CAUTION

The specified duty cycle for the vacuum and air pressure solenoids is intermittent – three minutes on and nine minutes off. Therefore, the unit should not be held in this mode for over three minutes maximum, after which the coil should be allowed to cool for nine minutes.

7. With no reel on the supply motor hub, making it as light as possible, check the supply motor hub for motion. There should be no motion at this time because the logic sees a small reel and does not activate the backwrap function.

8. If motion occurs, adjust potentiometer R76 on the reel servo PCBA for no motion of the supply reel hub.

NOTE

If R76 is adjusted, it should be set first at the point where the supply reel hub just starts to turn in the clockwise direction, then backed off until the reel hub stops turning.

9. Press and release the RESET control.

10. Turn transport power off.

11. Reconnect the takeup reel motor leads.

12. Turn transport power back on.

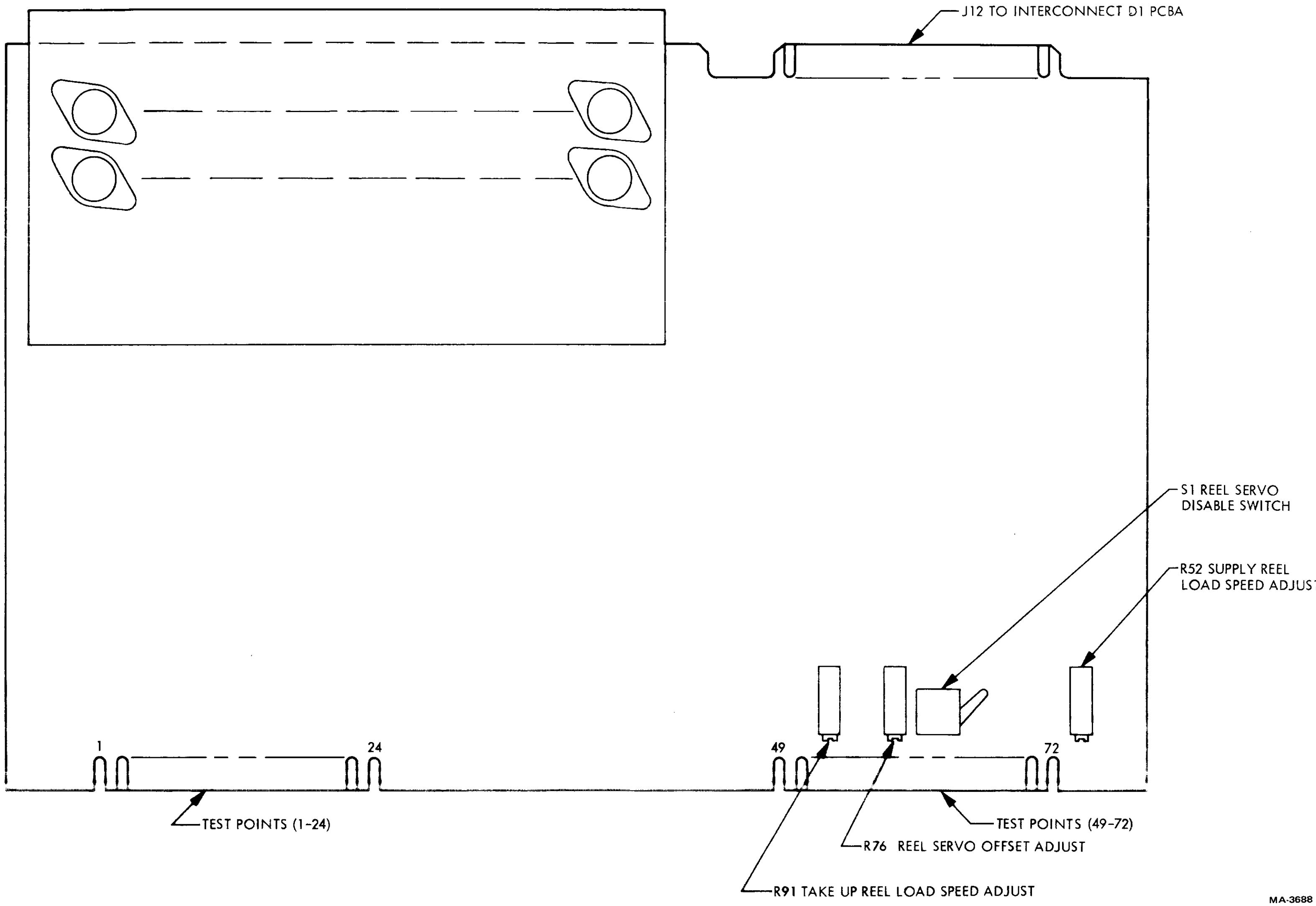


Figure 6-12 Reel Servo PCBA Adjustments and Test Points

6.5.7.2 Supply Reel Load Speed Adjustment

Using hand held tachometer

1. Turn transport power off.

2. Connect reel servo PCBA test points TP60 (NAE) and TP69 (NSRF1) to TP49 (ground).

3. Turn transport power on; the supply reel should be rotating in a clockwise direction.

4. Measure the supply reel speed directly in rpm with the hand held tachometer (DEC P/N 29-11635). Ensure that the tachometer is fitted with the rubber cone type adapter. To measure the supply reel speed, place the tip of the tachometer cone into the small dimple at the rear of the supply reel servo motor shaft and read the rpm directly from the tachometer LEDs. The reading should be in the range of 50 to 60 rpm.

5. If the speed is out of tolerance, adjust potentiometer R52 on the reel servo PCBA for 55 rpm.

6. Turn transport power off and remove the ground jumpers.

Without hand held tachometer
The following is an alternate supply reel load speed adjustment for instances when a tachometer is not available.

1. On the supply hub, mount a 267 mm (10-1/2 in) reel of tape with the leader taped down to the reel.

2. Place a short piece of masking tape at a convenient point on the front panel trim adjacent to the supply reel.

3. Place a short piece of masking tape on the supply reel adjacent to the masking tape affixed in step 2.

4. Turn transport power off.

5. Connect TP60 (NAE) and TP69 (NSRF1) on the reel servo PCBA to TP49 (ground).

6. Turn transport power on. The supply reel should rotate in the clockwise direction.

7. Observe the masking tape on the supply reel. Using a stop watch, time ten rotations of the supply reel masking tape as it passes the tape on the trim.

NOTE
Be sure to start and stop the stop watch when the two pieces of masking tape are coincident.

8. Observe the elapsed time indicated by the stop watch; the display time should be between:

   12.0 s maximum (50 rpm)
   10.0 s minimum (60 rpm).

9. If the displayed time is out of tolerance (step 8), adjust potentiometer R52 on the reel servo PCBA for an elapsed time of 11 seconds (55 rpm) while performing steps 7 and 8.

10. Turn transport power off.

11. Remove grounds from reel servo PCBA and remove masking tape.

6.5.7.3 Takeup Reel Load Speed Adjustment

Using hand held tachometer

1. Turn transport power off.

2. Connect reel servo PCBA test points TP60 (NAE) and TP57 (NTRF) to TP49 (ground).

3. Turn transport power on. The takeup reel should be rotating in a clockwise direction.

4. Measure the takeup reel speed directly in rpm with the hand held tachometer (DEC P/N 29-11635). Ensure that the tachometer is fitted with the rubber cone type adapter. To measure the takeup reel speed, place the tip of the tachometer cone into the small dimple at the rear of the takeup reel servo motor shaft and read the rpm directly from the tachometer LEDs. The reading should be in the range of 162 to 198 rpm.

5. If the speed is out of tolerance, adjust potentiometer R91 on the reel servo PCBA for 180 rpm.

6. Turn transport power off and remove the ground jumpers.

Without hand held tachometer
The following is an alternate takeup reel load speed adjustment for instances when a tachometer is not available.

1. Turn transport power off.

2. Connect TP60 (NAE) and TP57 (NTRF) to TP49 (ground) on the reel servo PCBA.

3. Turn transport power on. The takeup reel should rotate in the clockwise direction.

4. Connect an oscilloscope input lead to TP43 (low tape sensor input) of the control M PCBA (Figure 6-5).

5. Observe the oscilloscope. The time between leading edges of two consecutive pulses should be between:

   183.7 ms maximum (162 rpm)
   150.3 ms minimum (198 rpm).

6. If the time displayed is out of tolerance (step 5), adjust potentiometer R91 on the reel servo PCBA for 167 ms (180 rpm).

7. Turn transport power off. Remove grounds and scope leads.

6.5.7.4 Tape Loop Position Adjustment

NOTES

1. **Check, and adjust if necessary, all vacuum and pressure readings outlined in Paragraph 6.5.6 before attempting to adjust the loop positions.**

2. **If the loop positions are so far out of adjustment that interlock (fail safe) is broken, then proceed to step 1 and execute the entire procedure. Otherwise, proceed to step 23.**

1. Turn power to the transport off.

2. Set control M PCBA maintenance switch S1 in the center position (Figure 6-5).

3. Set reel servo disable switch S1, located on the reel servo PCBA, toward the rear (disable) (Figure 6-12).

4. Connect control M PCBA test points TP62 (NINTLK) and TP71 (PNV return) to TP25 (ground).

5. Disconnect one capstan motor lead.

6. Mount a full 267 mm (10-1/2 in) reel of tape without cartridge on the supply hub. Open the buffer box door and hand thread the leader through the tape path. Wind approximately 9.1 m (30 ft) of tape on the takeup reel. Close the buffer box door.

7. Turn transport power back on. Vacuum and pressure will come on.

8. Manually rotate the supply reel clockwise to put tape into the supply buffer column. Rotate the reel such that the tape forms a loop and that the end of the loop is located in the middle of the park zone. [The park zone is defined as the series of thirteen small holes in the center of the buffer column (Figure 6-13)]. Hold the reel and apply masking tape to the outer flange and the transport to prevent the loop from being pulled down the buffer column by the vacuum.

9. Hold the tape against air bearing No. 4 (Figure 6-4) with your finger and manually rotate the takeup reel counterclockwise to form a loop in the takeup buffer column. Continue rotating the takeup reel until the loop is in the middle of the park zone and then tape the reel as in step 8. Release the tape at air bearing No. 4.

10. Recheck that both loops are positioned in the middle of the park zone.

11. Press RESET on the control panel.

12. Connect a DVM to the reel servo PCBA as follows: positive lead to test point TP55 (TPOS) and negative lead to TP49 (ground).

13. Observe the DVM. The voltage displayed should be between:

    +0.2 Vdc maximum
    -0.2 Vdc minimum.

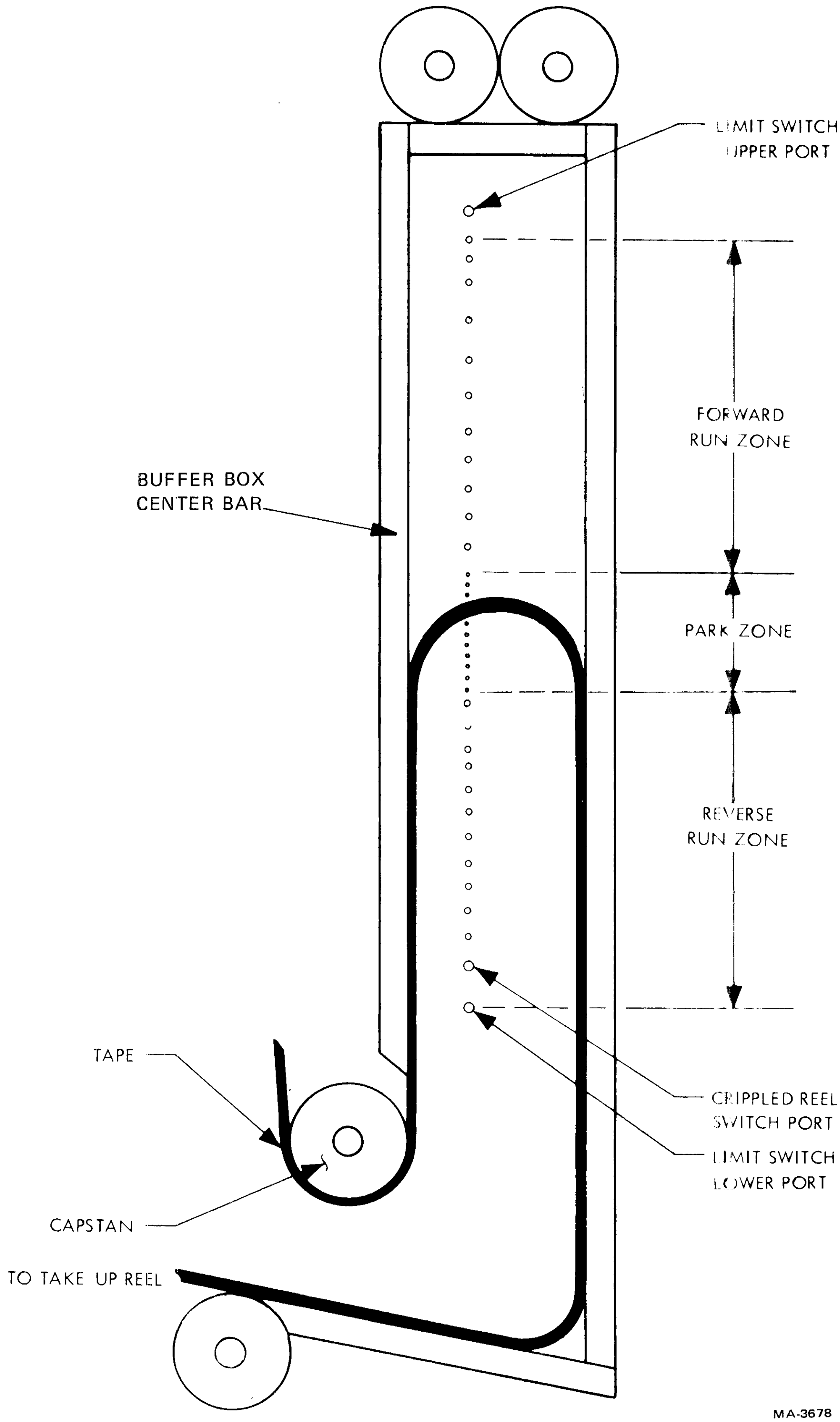


Figure 6-13 Buffer Column Park Zone

14. If the voltage is out of tolerance adjust potentiometer R9 on the interconnect F1 PCBA (R103 on interconnect F PCBA) for 0 Vdc (Figure 6-3).

15. Connect the DVM positive lead to reel servo PCBA TP66 (SPOS).

16. Observe the DVM. The voltage displayed should be between:

    +0.2 Vdc maximum
    -0.2 Vdc minimum.

17. If the voltage is out of tolerance adjust potentiometer R1 on the interconnect F1 PCBA (R203 on interconnect F PCBA) for 0 Vdc.

NOTE

These voltages are produced on the base assembly by the respective pressure transducers. Therefore, while performing steps 12 through 17 it is imperative that the air measurements are within specifications and that the loops are positioned in the middle of the park zones (Note 1 under Paragraph 6.5.7.4).

18. Turn transport power off.

19. Remove ground wires from TP62 and TP71 on the control M PCBA.

20. Enable the reel servos by placing reel servo PCBA switch S1 toward the front.

21. Reconnect the capstan motor lead.

22. Remove the masking tape from both reels and rotate one of the reels to take up slack.

23. Turn transport power on and load a full 267 mm (10-1/2 in) reel of tape.

24. Place maintenance switch S1, on the control M PCBA (Figure 6-5) towards the front of the transport. The tape should be moving in the forward direction.

25. Allow the tape to move forward to the midpoint (1200 ft) and then stop it.

26. Place a piece of masking tape on the buffer box window, so that it covers the center box bar. This bar separates the supply column from the takeup column. Mark the upper and lower limits of the supply park zone on the right side of the masking tape and the upper and lower limits of the takeup park zone on the left side of the masking tape.

27. Connect a jumper between TP31 (shuttle maintenance test point) and TP25 (ground) on the control M PCBA. The transport will run in the shuttle mode continuously.

28. Observe the supply tape loop (in the righthand column) for equal movement above and below the park zone. This is done by marking the masking tape and measuring the distance from the park zone (Figure 6-13).

29. If the marks on the masking tape are unequal, adjust potentiometer R1 on the interconnect F1 PCBA (R203 on interconnect F PCBA) for equal distances above and below the park zone.

NOTE

If the tape loops cannot be adjusted so that they are precisely equidistant above and below the park zone, the longer distance should be at the end of the column closest to atmospheric pressure; i.e., upper end of supply column and lower end of takeup column.

30. Observe the takeup tape loop (in the lefthand column) for equal movement above and below the park zone. This is done by marking the masking tape and measuring the distances from the park zone (Figure 6-13).

31. If the marks on the masking tape are unequal, adjust potentiometer R9 on the interconnect F1 PCBA (R103 on interconnect F PCBA) for equal distances above and below the park zone. (Refer to note following step 29.)

32. Observe the tape loop travel in the supply and takeup columns. The loops must not break interlock and the maximum travel forward to reverse is:

    330 mm (13 in) for the supply loop
    280 mm (11 in) for the takeup loop.

33. Remove the masking tape from the buffer box door.

34. Remove the jumpers from TP31 and TP25 on the control M PCBA.

35. With control M switch S1, allow the tape to move forward to the EOT marker.

36. Perform a rewind command.

37. Observe both tape loops for travel. Neither must break interlock.

6.5.8 Read Adjustments

The read adjustment paragraph provides the procedures for adjusting the functions needed to ensure read data integrity. It also provides the order in which each function should be checked or adjusted.

NOTE

Prior to starting the read adjustments it is necessary to ensure that the tape path is clean (Paragraph 4.3.4), the voltages are correct (Paragraph 6.5.1), and the capstan servo adjustments are correct (Paragraph 6.5.5).

The following functions should now be checked or adjusted in the order given.

1. NRZI threshold adjustment
2. NRZI gain adjustment
3. NRZI read skew adjustment
4. NRZI character gate adjustment
5. PE threshold adjustment
6. PE gain adjustment

6.5.8.1 NRZI Threshold Adjustment

1. Turn transport power on.

2. Open the transport base assembly to gain access to the card cage.

3. Connect a DVM with its positive lead to data L PCBA test point TP69 (NRZP) and its negative lead to TP49 (GND) (Figure 6-6).

4. Configure the M8940 (MTA) maintenance switches as follows.

S3	Left	(NRZI)
S4	Right	(Test)
S6	Right	(Stop)
S7	Right	(Read)

   Refer to Figure 6-18 for switch locations.

5. Mount and load a work tape to BOT. Place the transport on-line.

6. Observe the DVM. The voltage displayed should be between these readings.

   +1020 MV maximum
   +780 MV minimum

7. If the voltage displayed is out of tolerance, adjust data L PCBA potentiometer R11 for a reading of 900 MV.

NOTE
This adjustment procedure sets the low NRZ1 read threshold value, and once performed, all NRZ1 threshold voltages should be within specification. To verify all NRZI threshold valves refer to Paragraph 6.6.7.1.

8. Remove the tape and the DVM.

6.5.8.2 NRZI Gain Adjustment

NOTE
The capstan servo adjustments (Paragraph 6.5.5) affect NRZI gain. Ensure that these adjustments are within tolerance before doing the NRZI gain adjustment.

1. Turn transport power off.

2. Remove and extend the data L PCBA using the extender PCBA (DEC P/N 29-23218). For instructions on how to use the extender refer to Paragraph 6.6.2.

3. Turn transport power on.

4. Mount and load a master output tape. Place the transport on-line. Ensure that the master output tape is write enabled.

5. Record an all 1s NRZI pattern on the tape by setting the M8940 (MTA) maintenance switches as follows:

S6	Right	(Stop)
S2	Right	(Continuous)
S3	Left	(NRZI)
S4	Right	(Test)
S5	Left	(Forward)
S7	Left	(Write)
S6	Left	(Run)

6. Allow the tape to be written to EOT then set the M8940 maintenance switches as follows:

S7	Right	(Read)
S5	Right	(Reverse)
S6	Right	(Stop)

7. Place the transport off-line and rewind the tape to BOT.

8. Connect an oscilloscope to data L PCBA test point TP101 and probe ground to TP49. Set the scope to: Vert = 0.2 V/ div, horiz = 50 μs/div, sync + int ac.

9. Place the transport on-line and then set the M8940 maintenance switches as follows:

S5	Left	(Forward)
S6	Left	(Run)

10. Observe the oscilloscope. The peak-to-peak voltage should be between:

    11 V P-P minimum
    13 V P-P maximum

11. If the voltage is out of tolerance adjust potentiometer R107 on the 9TK preamplifier PCBA (Figure 6-14) for 12 V P-P.

12. Connect the scope to test points TP201 through TP901 and repeat steps 10 and 11. Adjust the appropriate potentiometer if necessary. (Refer to Table 6-7 for test point/potentiometer correlation.)

NOTE

If the tape should reach EOT before the check/adjustment procedure is finished, repeat steps 5 through 7 and continue. The amplitudes must be adjusted on the first read pass.

13. Set M8940 switch S6 to the right (stop) and unload the tape. Remove the oscilloscope probe but do not reinsert the data L PCBA at this time since it will be necessary to gain access to its test points in the phase encoded (PE) gain adjustment procedure.

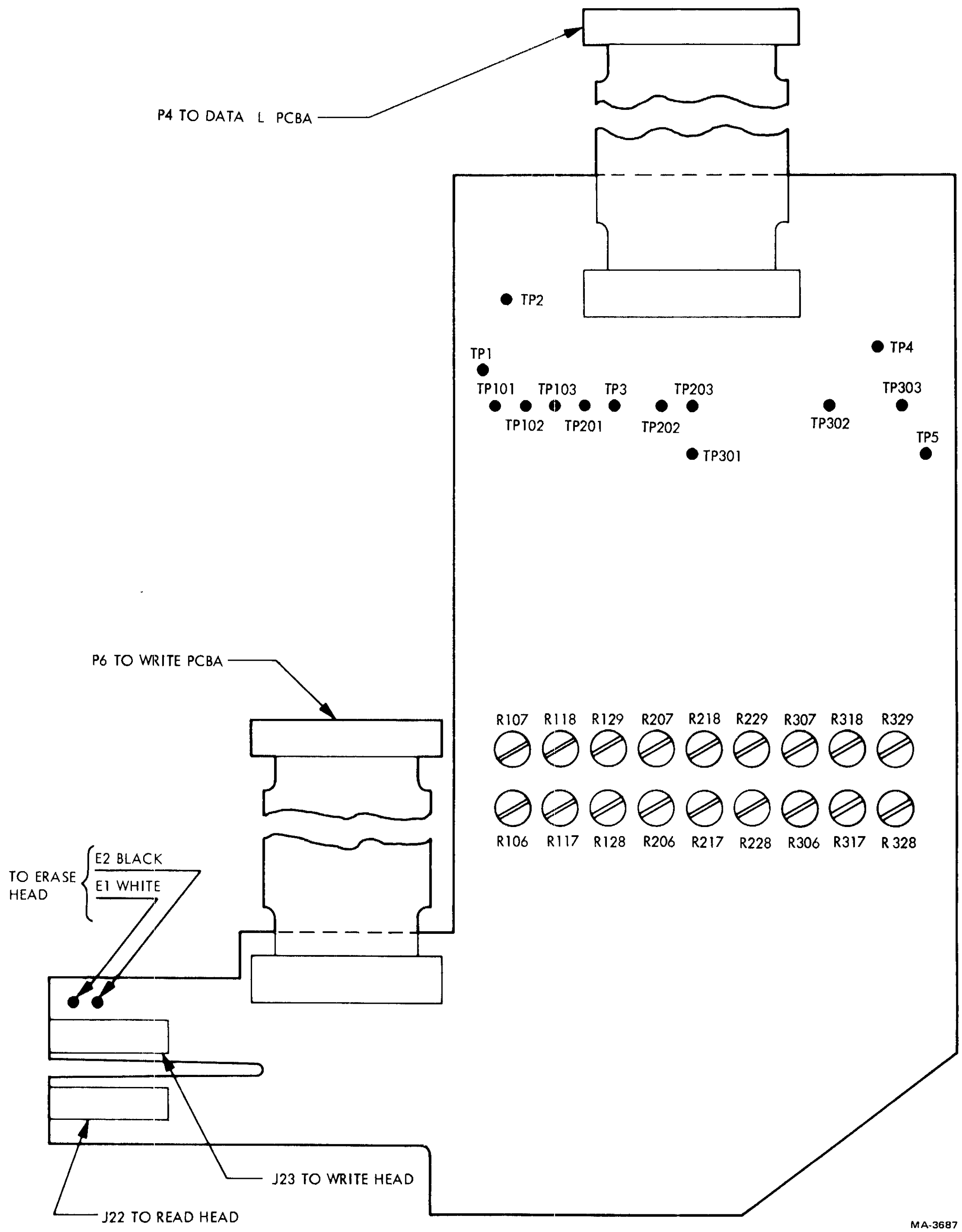


Figure 6-14 9TK Preamplifier PCBA Adjustments and Test Points

Table 6-7 NRZI Channel Test Points and Adjustments

Channel	Data L Test Point	9TK Preamplifier Adjustment
P	TP101	R107
0	TP201	R118
1	TP301	R129
2	TP401	R207
3	TP501	R218
4	TP601	R229
5	TP701	R307
6	TP801	R318
7	TP901	R329

6.5.8.3 NRZI Read Skew Adjustment (Azimuth)

NOTE

It is imperative that the NRZI threshold adjustment (Paragraph 6.5.8.1) and NRZI gain adjustment (Paragraph 6.5.8.2) are within specification before the NRZI read skew adjustment is performed as these parameters affect NRZI read skew.

1. Set the M8940 (MTA) maintenance switches as follows:

S2	Right	(Continuous)
S3	Left	(NRZI)
S4	Right	(Test)
S5	Left	(Forward)
S6	Right	(Stop)
S7	Right	(Read)

   Refer to Figure 6-18 for location of maintenance switches.

2. Mount and load a write protected master skew tape to BOT. Place the transport on-line.

3. Connect an oscilloscope to data L PCBA test point TP53 and ground to TP49. Set the scope to: Vert = 0.2 V/Div, Horiz = 0.5 μs/Div, Sync + int dc.

4. Set M8940 switch S6 to the left (Run). The tape should be running forward.

5. Observe the oscilloscope. The skew pulsewidth (plus jitter component) in forward must not exceed 1.2 μs.

6. If the skew is out of tolerance, adjust the azimuth angle of the read/write head to obtain a skew within this value. Adjust the head for minimum positive pulsewidth. The head may be adjusted by inserting a 1/8 inch Allen driver through the buffer box door and into the tape cleaner cap-clip housing (Figure 6-15).

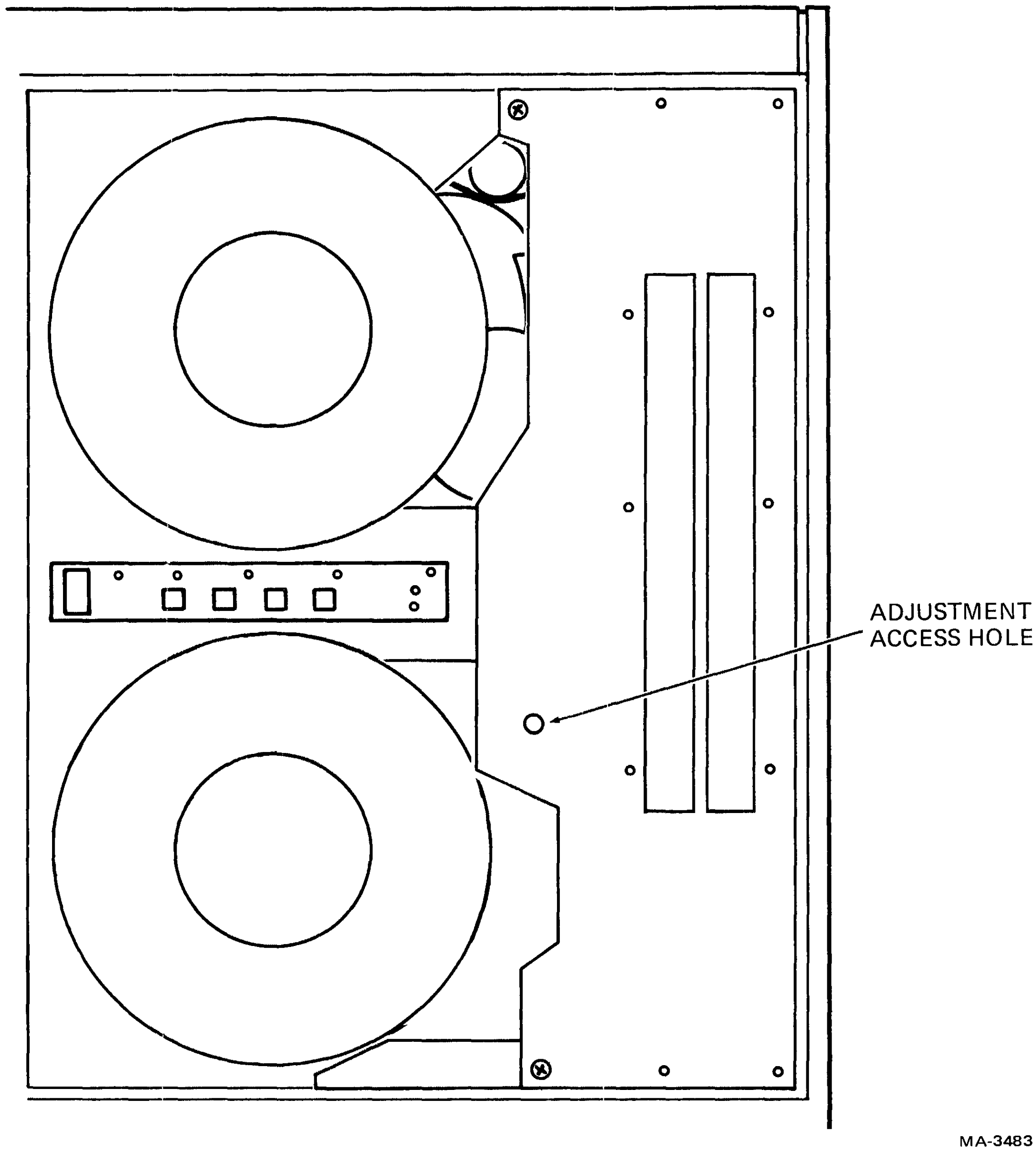


Figure 6-15 Location of NRZI Read Skew Azimuth Adjustment

7. Set M8940 switch S5 to the right and allow the master skew tape to run in a reverse direction. The skew pulsewidth must not exceed 1.2 μs. If it does, the capstan motor tracking may have to be fine tuned (Paragraph 6.7.5, steps 23–30).

8. Allow the master skew tape to continue in reverse to BOT and remove it.

NOTE

If the head azimuth was adjusted in step 6, the write deskew adjustment must be performed (Paragraph 6.5.9).

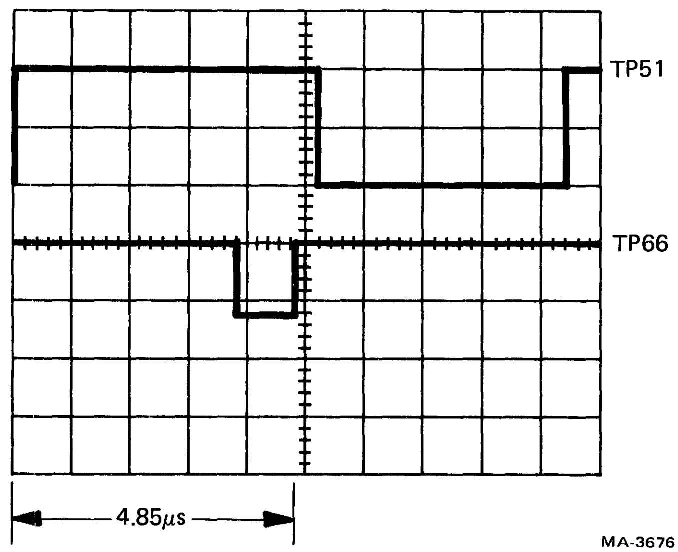


Figure 6-16 IRDS Delay

6.5.8.4 NRZI Character Gate Adjustment

1. Set the M8940 (MTA) maintenance switches as follows:

S2	Right	(Continuous)
S3	Left	(NRZI)
S4	Right	(Test)
S5	Left	(Forward)
S6	Right	(Stop)
S7	Right	(Read)

   Refer to Figure 6-18 for switch locations.

2. Mount and load a write protected master skew tape to BOT. Press ON LINE.

3. Connect an oscilloscope to data L test points (Figure 6-6) as follows:

   Connect Vertical CH 1 to TP51 (Any – H)
   Connect Vertical CH 2 to TP66 (IRDS)
   Ground both probes to TP49
   Set the scope as follows: Vert = 0.2 V/Div; Horiz = 1 μs/Div; Sync = + Int (CH1) dc

4. Set M8940 switch S6 to the left (Run). The tape should be running forward.

5. Verify that the delay between the leading edge (positive going) of the TP51 waveshape and the trailing edge (positive going) of TP66 is between:

   4.7 μs minimum
   5.0 μs maximum

   Refer to Figure 6-16.

6. If the delay measured in step 5 is out of tolerance, adjust R37 on the data L PCBA for a delay of 4.85 μs.

7. Set M8940 switch S5 to the right and allow the master skew tape to reverse direction to BOT. Remove the scope probes and the master skew tape.

6.5.8.5 Phase Encoded (PE) Threshold Adjustment

1. Set the M8940 (MTA) maintenance switches as follows:

S3	Right	(PE)
S4	Right	(Test)
S6	Right	(Stop)
S7	Right	(Read)

Refer to Figure 6-18 for switch locations.

2. Mount and load a work tape to BOT. Place the transport on-line.

3. Connect a DVM with its positive lead to data L PCBA test point TP71 and negative lead to TP49 (Figure 6-6).

4. Observe the DVM. The voltage displayed should be +360 ± 40 MV.

5. If the voltage displayed is out of tolerance, adjust data L PCBA potentiometer R29 for +300 MV.

NOTE
This adjustment procedure sets the low PE read threshold value, and once performed, all PE threshold voltages should be within specification. To verify all PE threshold values, refer to Paragraph 6.6.7.1.

6. Remove the tape and the DVM.

6.5.8.6 Phase Encoded (PE) Gain Adjustment

NOTE
The capstan servo adjustments (Paragraph 6.5.5) affect PE gain. Ensure that these adjustments are within tolerance before doing the PE gain adjustment.

1. Mount and load a master output tape. Place the transport on-line. Ensure that the master output tape is write enabled.

2. Record an all 1s PE pattern on the tape by setting the M8940 (MTA) maintenance switches as follows:

S6	Right	Stop
S1	Right	3200 FCI
S2	Right	Continuous
S3	Right	PE
S4	Right	Test
S5	Left	Forward
S7	Left	Write
S6	Left	Run

3. Allow the tape to be written to EOT then set the M8940 maintenance switches as follows:

S7	Right	Read
S5	Right	Reverse
S6	Right	Stop

4. Place the transport off-line and rewind the tape to BOT.

5. Connect an oscilloscope to data L PCBA test point TP102 and probe ground to TP49. Set the scope to: Vert = 0.2 V/ Div, Horiz = 50 μs/Div, sync + int ac.

6. Place the transport on-line and then set the M8940 maintenance switches as follows:

S5	Left	Forward
S6	Left	Run

7. Observe the oscilloscope. the peak-to-peak voltage should be between:

    11 V P-P minimum
    13 V P-P maximum.

8. If the voltage is out of tolerance adjust potentiometer R106 on the 9TK preamplifier PCBA (Figure 6-14) for 12 V P-P.

9. Connect the scope to test points TP202 through TP902 and repeat steps 7 and 8. Adjust the appropriate potentiometer if necessary. Refer to Table 6-8 for test point/potentiometer correlation.

Table 6-8 PE Channel Test Points and Adjustments

Channel	Data L Test Point	9TK Preamplifier Adjustment
P	TP102	R106
0	TP202	R117
1	TP302	R128
2	TP402	R206
3	TP502	R217
4	TP602	R228
5	TP702	R306
6	TP802	R317
7	TP902	R328

NOTE

If the tape should reach EOT before the check/adjustment procedure is finished, repeat steps 2 through 4 and continue. The amplitudes must be adjusted on the first read pass.

10. Set M8940 switch S6 to the right (Stop) and unload the tape. Remove the oscilloscope probe.

11. Turn the transport power off and return the data L PCBA to its slot.

6.5.9 Write Deskew Adjustment

The following provides the procedures for adjusting write deskew.

1. Ensure that the power supply voltages are within the tolerances specified in Paragraph 6.5.1.

2. Ensure that the read adjustments are within the tolerances specified in Paragraph 6.5.8.

3. Set the M8940 (MTA) maintenance switches as follows:

S2	Right	Continuous
S3	Left	NRZI
S4	Right	Test
S5	Left	Forward
S6	Right	Stop
S7	Left	Write

   Refer to Figure 6-18 for switch locations.

4. Mount and load a 267 mm (10-1/2 in) full work tape to BOT. Place the transport on-line.

5. Connect an oscilloscope to data L PCBA test point TP53 (TSKEW) and ground to TP49 (Figure 6-6). Set the scope as follows: Vert. = 0.2 V/Div; horiz = 0.2 μs/div; sync = + int dc.

6. Set M8940 switch S6 to the left (Run). The tape will now be running forward and writing.

7. Observe the oscilloscope. The pulsewidth displayed should be equal to or less than 1.8 μs.

8. If the pulsewidth displayed is out of tolerance, turn potentiometers R101 through R901 on the write PCBA 15 turns counterclockwise, or until end of potentiometer is sensed (Figure 6-17).

9. Observe oscilloscope while writing an all ones NRZI pattern on all channels. Adjust R101 through R801 clockwise until the pulsewidth displayed increases, then back off until the pulsewidth is the same as before.

10. While observing the oscilloscope, adjust R901 for minimum pulsewidth.

11. Set M8940 switch S6 to the right to stop the tape. Set switches S7 to the right (read) and S4 left (normal mode). Rewind the work tape and remove the scope probe.

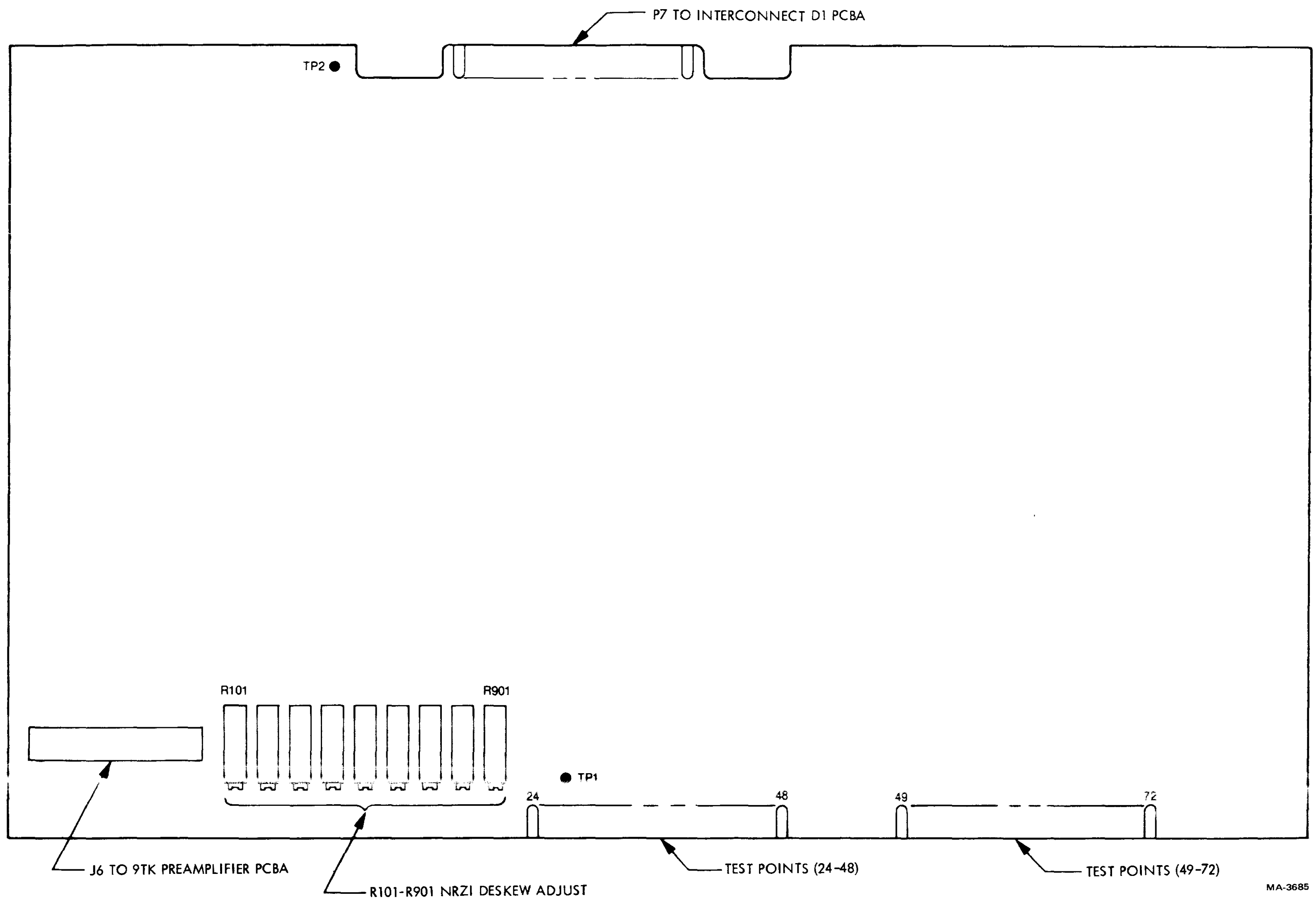


Figure 6-17 Write PCBA Adjustments and Test Points

6.6 TROUBLESHOOTING

Troubleshooting the TU77 Transport consists of using this section as a guide in conjunction with system software on-line diagnostics, standalone diagnostics, and the off-line maintenance features found within the transport. Aids to the troubleshooting process are the system software device error log reports, the theory discussion found in Chapter 5, and the transport functional block diagrams and logic/schematic diagrams found in Volume 1.

6.6.1 Using the M8940 MTA Module

This section describes how the M8940 is to be used as an aid in performing transport adjustments, alignments, and troubleshooting.

6.6.1.1 Functional Description – The M8940 MTA is the interface between the TM03 formatter and TU77 transport logic and handles read/write data, status, and command information. It also provides the field maintenance engineer with a central point for issuing commands to the transport while performing adjustments and alignments off-line. Thus maximum computer system availability is achieved.

The M8940 has seven command switches, three status LEDs, and twenty-three test points for troubleshooting purposes. Figure 6-18 illustrates the placement of these components and Tables 6-9, 6-10, and 6-11 list their functions. A more detailed description of M8940 theory may be found in Paragraph 5.4.

Table 6-9 M8940 MTA Test Points

TP Number	Signal Name
1	IRD0-H
2	IRD1-H
3	IRD2-H
4	IRD3-H
5	IRD4-H
6	IRD5-H
7	IRD6-H
8	IRD7-H
9	IRDP-H
10	IRDS-H
11	IWD7
12	IWD6
13	IWD5
14	IWD4
15	IWD3
16	IWD2
17	IWD1
18	IWD0
19	IWDP-L
20	IFPT-L
21	IRWD-L
22	ILDP-L
23	IONL

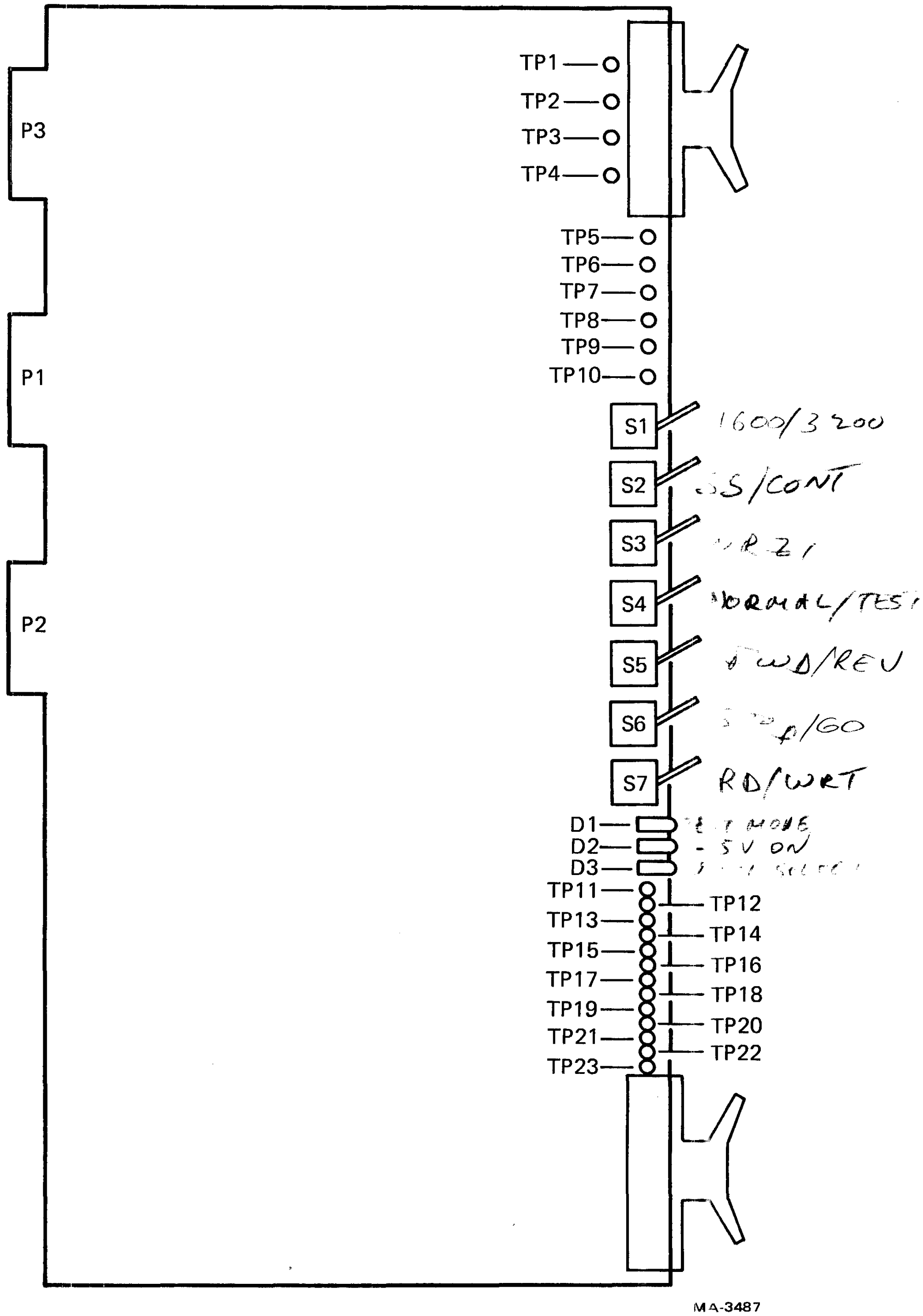


Figure 6-18 M8940 MTA Switches and Test Points

Table 6-10 M8940 MTA LEDs

D Number	Function
D1	Test mode
D2	+5 V on
D3	Unit select

Table 6-11 M8940 MTA Switch Functions

	Switch Number	Function	
		Left Position	Right Position
RIGHT	S1	1600 FCI*	3200 FCI*
	S2	Start/Stop	Run continuous
	S3	NRZ1	PE
	S4	Normal	Test
	S5	Forward	Reverse
	S6	Run	Stop
LEFT	S7	Write	Read

NOTES

1. **When in test write mode, a tape must have a write enable ring or else the write/erase heads will be disabled.**

2. **All the MTA switches are dynamic; that is the user may change densities, write frequency, start/stop, etc., whether tape is moving or not.**

3. **When creating a tape in test mode, upon reaching EOT, switch No. 7 should be returned to the read (right) position. If not, when performing a reverse/rewind to return to BOT, the tape will be overwritten.**

4. **Switch No. 4 must be placed in the normal (left) position before returning the transport to operating system on-line usage.**

*Phase encoded write only.

6.6.1.2 Use Procedure – When the M8940 is in test mode, (Switch No. 4 to the right) all data and command information from the TM03 formatter is inhibited from reaching the transport. The maintenance switches on the M8940 now provide command and data information. The source of this information is transparent to the transport logic. Therefore, the transport under test must be placed on-line with the control panel ON LINE switch in order to place the M8940 in test mode with Switch 4. Also, when in test mode, the unit select switch on the control panel has no effect and may be placed in any position.

The right LED (D1) will be illuminated when in test mode. The other two LEDs (D2 = +5 V and D3 = Unit select) and all test points may be observed and monitored both in test mode and normal mode (on-line with the system).

6.6.2 Using the PCBA Extender (DEC P/N 29-23218)

The PCBA extender is used as an aid in troubleshooting the TU77 transport as well as facilitating certain adjustment procedures. The data L, write, and control M PCBAs may be extended for access one at a time. The M8940 (MTA) may not be extended but is accessible by removing the cabinet top cover. The capstan/regulator and reel servo PCBAs may not be extended due to heat sinking requirements. Refer to Figure 6-19 for an illustration of the PCBA extender.

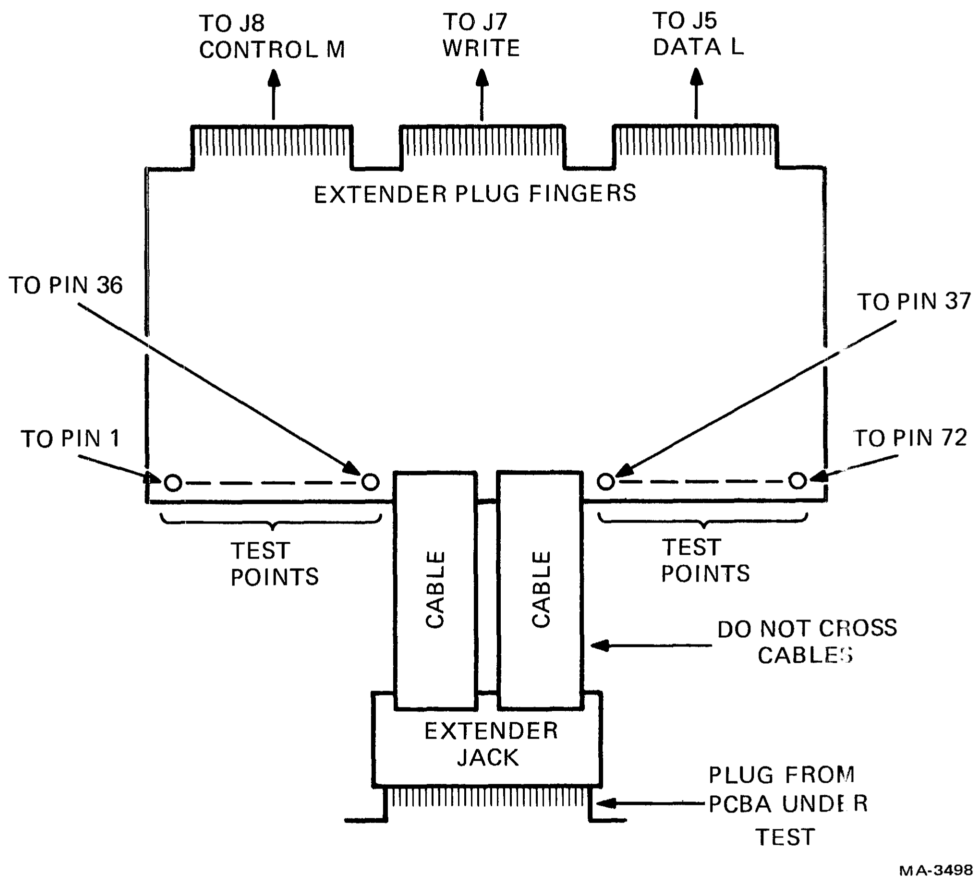


Figure 6-19 PCBA Extender

To extend a PCBA, first remove the PCBA retainer clip (Figure 2-6), then remove the PCBA to be extended from the card cage. Insert the extender into the slot vacated and push it firmly into the interconnect D1 PCBA. The orientation of the extender must be observed as it can be inserted in two ways. The correct way depends on the PCBA to be extended.

The extender is etched on both sides near the plug fingers. One side is etched READ (TOP) and the opposite side is etched CONTROL (TOP) and WRITE (TOP). Thus, if the data L PCBA is to be extended the extender must be inserted into the card cage with the READ (TOP) etch pointing up, and if the control M or write PCBAs are to be extended the extender must be inserted into the card cage with the CONTROL (TOP) and WRITE (TOP) pointing up. The extender jack is then pushed on to the extended PCBA's plug fingers.

Note that the extender jack is connected to the extender with two flat cables. Orient the extender jack with the two cables flat as shown in Figure 6-19. The jack must not be rotated 180 degrees (indicated by twisted cables) as this would not make proper connections between the extended PCBA and the interconnect D1 PCBA.

The extended PCBA is supported at an angle within the card cage assembly by four nylon brackets protruding from the side, so that it is accessible to service personnel. The two bottom brackets are angled out and up and fit in between the PCBA board and the support bar running underneath the PCBA's test points. See Figure 6-20 for an illustration of a PCBA in the extended position.

Seventy-two test points on the edge of the extender connect to the 72 pins on the interconnect D1 jack. Thus, service personnel have access to all connector pins on the PCBA under testing. The leftmost test point on the extender connects to pin 1 on the PCBA, the next test point to pin 2, and so on from left to right across the extender with the rightmost test point connected to pin 72 on the PCBA. The test points are on both sides of the extender and have the same left to right orientation with respect to the extended PCBA regardless of which side of the extender is up (Figure 6-19).

6.6.3 Power Supply Troubleshooting

This section contains a failure analysis of the power supply and power distribution. Refer to Paragraph 5.5 for theory, and Figures 5-17 through 5-21, and Figure 2 in Volume 1 for functional block diagrams. The individual power supply voltages are not adjustable and if a particular voltage is found to be out of acceptable range, a component or subassembly will have to be replaced.

WARNING

Use caution when making measurements and adjustments with power applied to the transport. Keep one hand behind your back or in a pocket, and do not come in contact with any metal parts on the transport.

Voltages in the 220 Vac range are present in the power supply/pneumatic assembly.

6.6.3.1 Troubleshooting Rules – When troubleshooting power supply problems, be sure to adhere to the rules listed below:

1. Ensure that power is off and the transport is unplugged before attempting to replace any defective components in the power supply/pneumatic assembly.

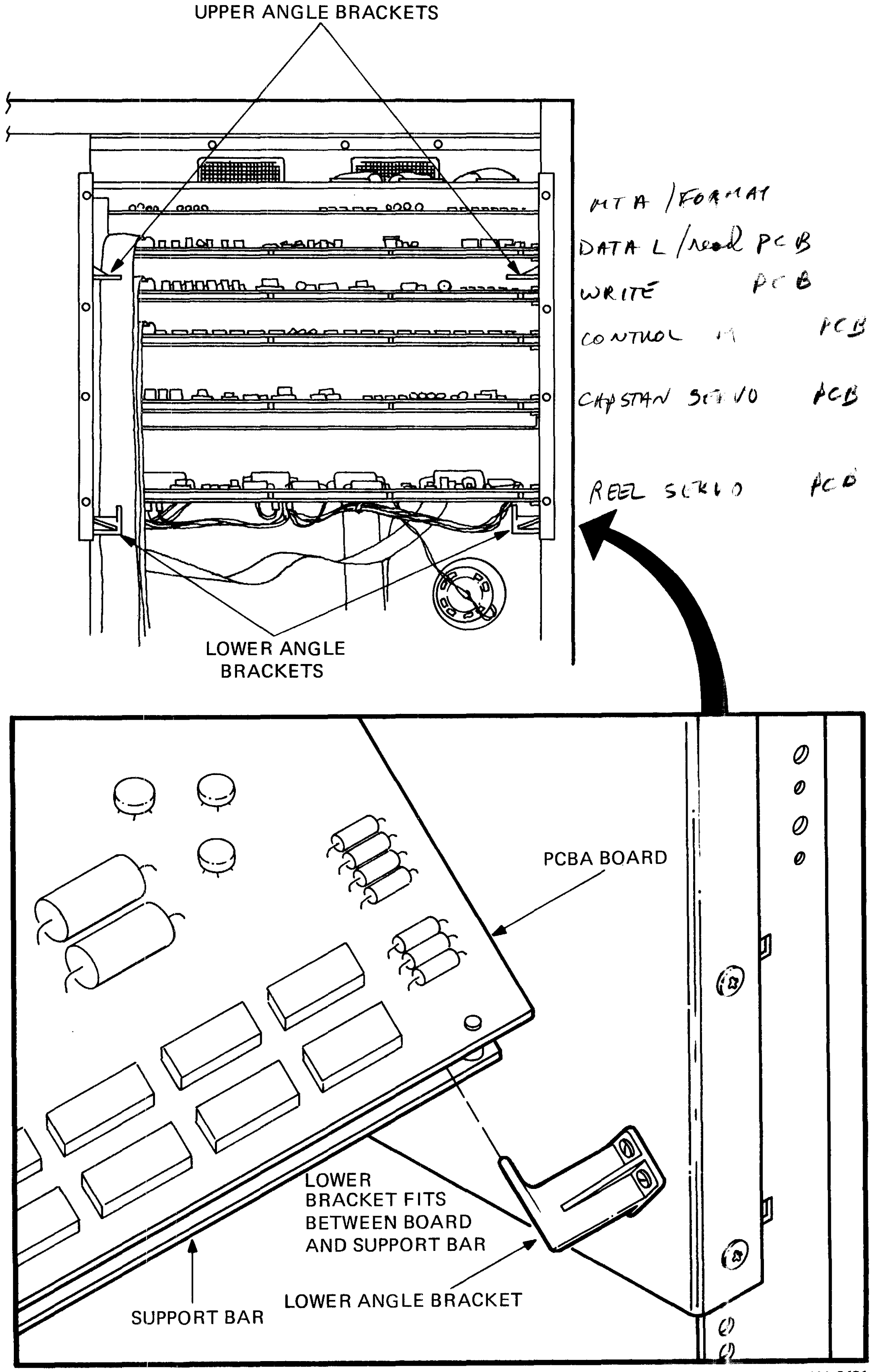


Figure 6-20 PCBA in Extended Position

2. The capstan/regulator PCBA may *not* be extended from the card cage for troubleshooting with power applied since it requires heat sinking. If this PCBA is suspected, a new PCBA must be substituted.

6.6.3.2 Troubleshooting Hints

1. Make a visual examination of the circuitry. Check for burnt printed circuit board etch/components/wiring, oil leakage from capacitors, and loose connections. A good visual check can prove to be a quick method of locating the cause of a malfunction.

2. The +5, +15 and -15 V regulators contain overvoltage crowbar detection circuitry. A supply may crowbar and bring the output down to zero volts due to an intermittent regulator. Turning the transport power off then back on will usually release the crowbar.

6.6.3.3 Troubleshooting Charts – In troubleshooting the various areas of the power supply/distribution system, refer to the following troubleshooting chart (Table 6-12). For fuse locations refer to Figure 6-1.

Table 6-12 Power Supply Troubleshooting Chart

Problem	Check For:	Result	Cause
No operator panel lights/no functions	Fans and blower at rear operating	No	Problem is in 861 power control or line voltage
		Yes	Breaker CB1 tripped Check +5 V (TP11 of capstan/reg PCBA) Power jumpers incorrect at A1-TB1
No +5 V at TP11 of capstan (regulator PCBA)	+12 V at A2-TB1-6	No	Troubleshoot +12 V
		Yes	Bad capstan/regulator PCBA Burnt etch on interconnect D1 PCBA
+5 V output too low	-	-	Bad capstan/regulator PCBA Bridge rectifier CR2 partially open
No +12 V (A2-TB1-6)	8.5 Vac at A2-TB1-10	Yes	Fuse F1 blown Bridge rectifier CR2 open Capacitor C3 shorted
		No	Transformer T1 defective
No +15 V (TP15 of capstan/ regulator PCBA)	+24 V at A2-TB1-7	No	Troubleshoot +24 V
		Yes	Bad capstan/regulator PCBA Burnt etch on interconnect D1 PCBA

Table 6-12 Power Supply Troubleshooting Chart (Cont)

Problem	Check For:	Result	Cause
No -15 V (TP18 of capstan/ regulator PCBA)	-24 V at A2-TB1-8	No	Troubleshoot -24 V
		Yes	Bad capstan/regulator PCBA Burnt etch on interconnect D1 PCBA
No +24 V (A2-TB1-7)	-	-	Fuse F2 blown Bridge rectifier CR1 open Capacitor C1 shorted Bad transformer T1
No -24 V (A2-TB1-8)	-	-	Fuse F3 blown Bridge rectifier CR1 open Capacitor C2 shorted Bad transformer T1
No +36 V (A2-TB1-1)	-	-	Fuse F4 blown
No +36 V (Reel servo PCBA TP12)	-	-	Fuse F6 blown
No +36 V (Reel servo PCBA TP4)	-	-	Fuse F7 blown
No +36 V anywhere	-	-	Bridge rectifier CR3 open Capacitor C4 shorted
No -36 V (A2-TB1-5)	-36 V at Reel servo PCBA TP10 and TP18	Yes	Fuse F5 blown
		No	Bridge rectifier CR3 open Capacitor C5 shorted

6.6.4 Load Cycle Troubleshooting

When a load fault occurs, specific test points can be checked to give clues as to the trouble area. Seven test points are specified and load fault troubleshooting flow diagrams are provided, one associated with each of the test points. The seven load faults are numbered 0 through 6 to correspond with the loading flowchart in the engineering print set of Volume 1 (control M logic print No. 104745, sheet 5 of 5).

The autoload cycle requires that all vacuums and pressure be within specification and all power supply, control, capstan servo, and reel servo functional circuitry be operational. Prior to pursuing a path through these troubleshooting flows, the loading flowcharts and suggested corrections (Figures 2-17, 2-18, 3-4, and 3-6) should be followed. Refer also to engineering print No. 104745, (control M PCBA) sheet 5 of 5, for a functional loading flowchart and Figure 6-21 for an autoload timing diagram. Figure 4 in Volume 1 illustrates the major signals necessary to accomplish a load cycle.

6.6.4.1 Load Faults -- When a load fault occurs (flashing load fault LED on control panel) it may be categorized into one of seven possible load fault areas. In order to determine what area caused the fault, and thus correct the source of this problem, test points on the control M PCBA must be scoped. Table 6-13 lists the load fault numbers and their associated test points. During a normal load cycle the signal level at the test points will remain high. Any test point that pulses low or goes low during the cycle indicates the load fault area number and the troubleshooting flow diagram to be used. Figures 6-22 through 6-28 are the load fault flow diagrams.

Table 6-13 Load Fault Categories

Load Fault Number	Control M PCBA Test Point	Category Description
0	TP14	No load count sequencing pulses from takeup reel
1	TP27	Cartridge fault (not sensed as being closed or open)
2	TP32	Cartridge fault (not sensed as being open)
3	TP35	Air fault at sequence count C3 time
4	TP42	Two attempts (one attempt for small reel) have been made to load tape without success
5	TP41	Tape leader fault
6	TP28	Set loops fault

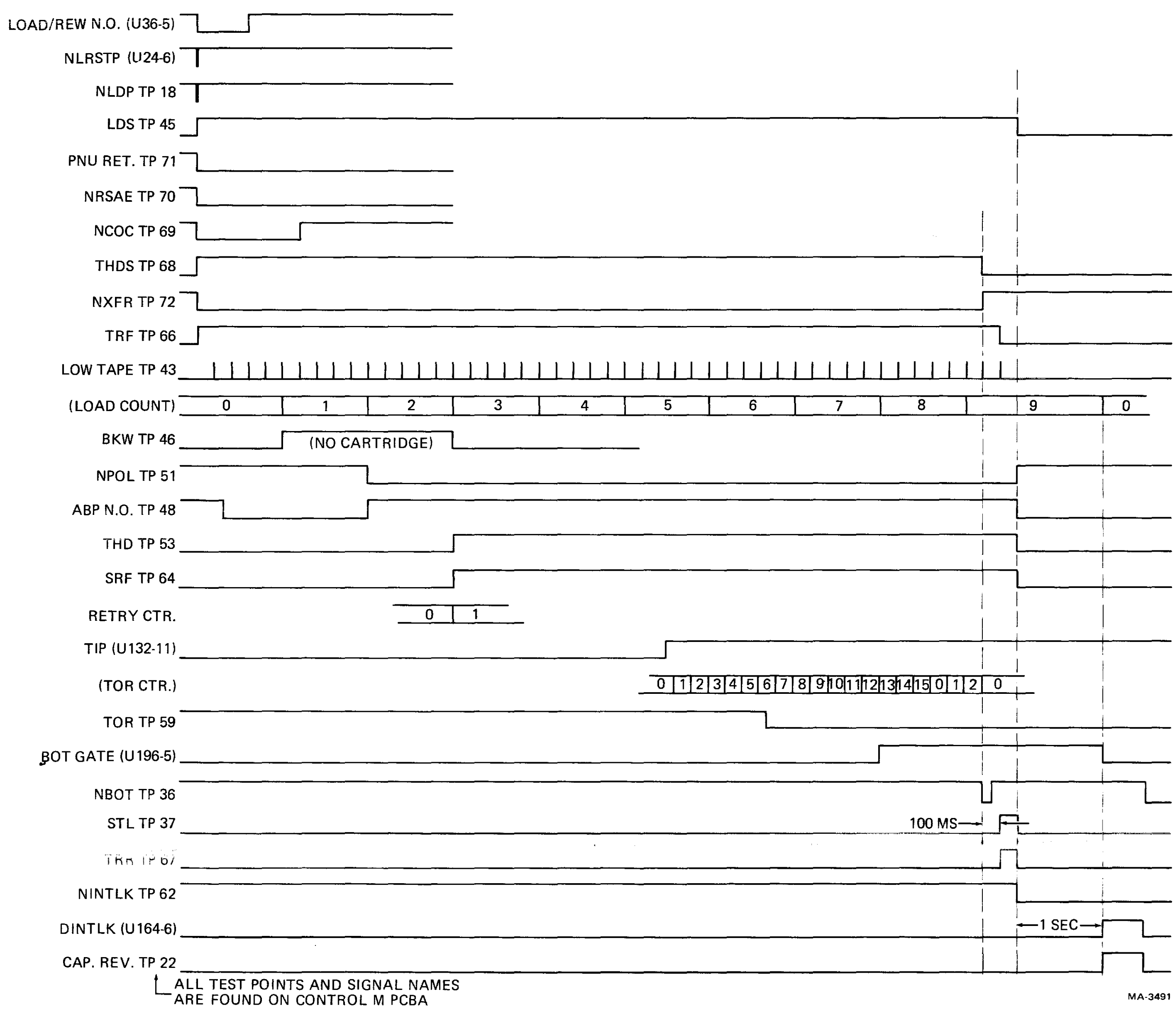


Figure 6-21 Autoload Timing Diagram

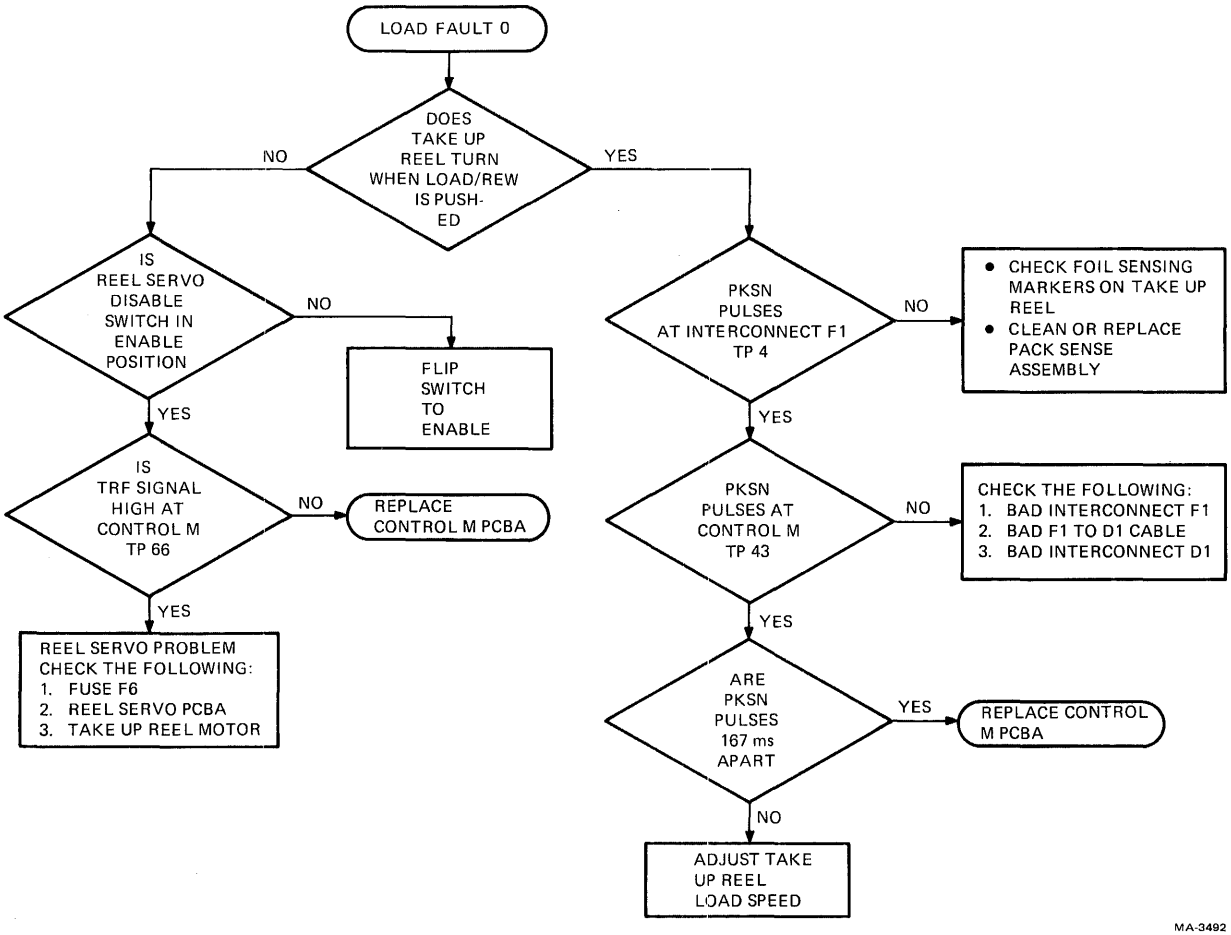


Figure 6-22 Load Fault 0 Flow Diagram

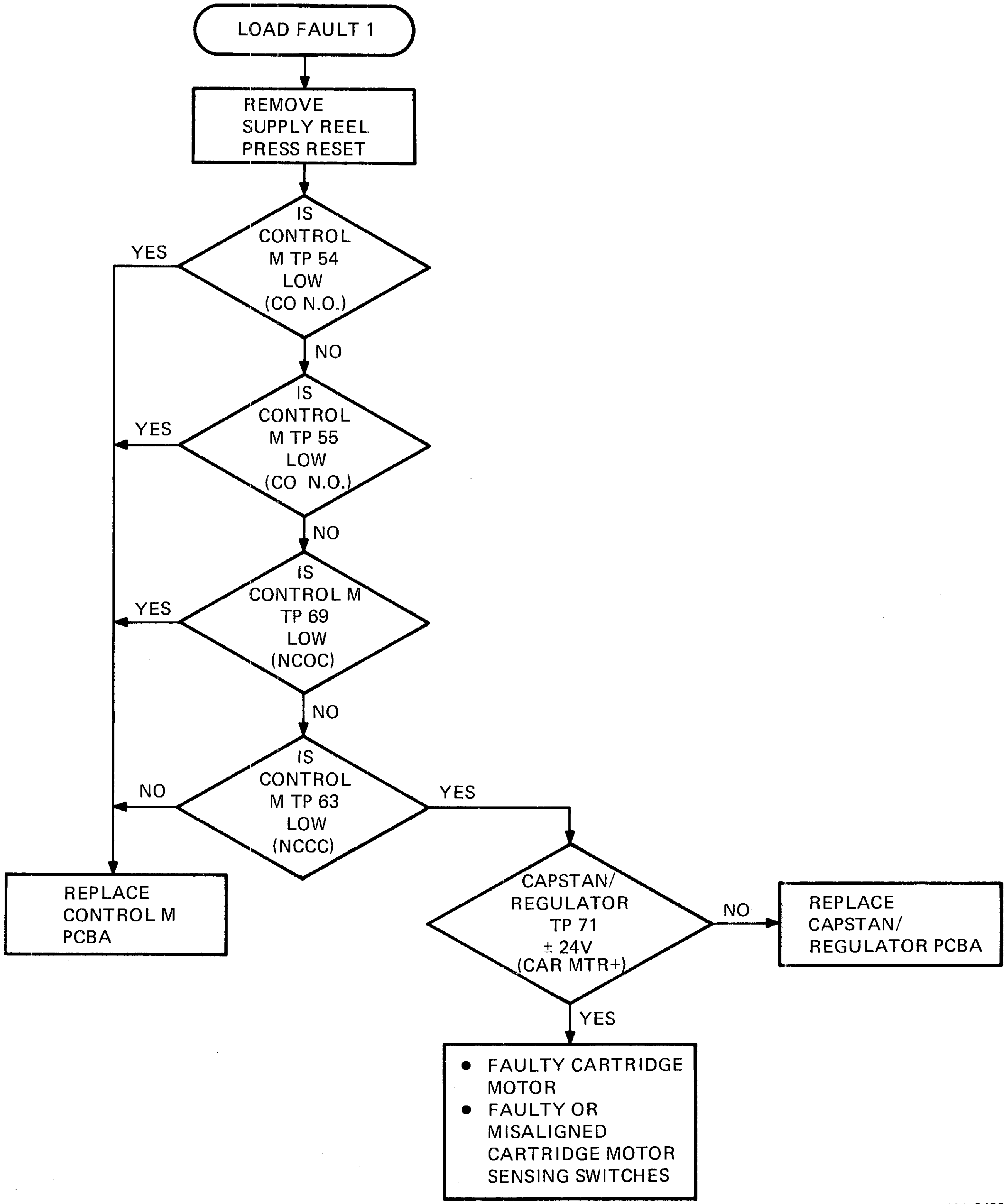


Figure 6-23 Load Fault 1 Flow Diagram

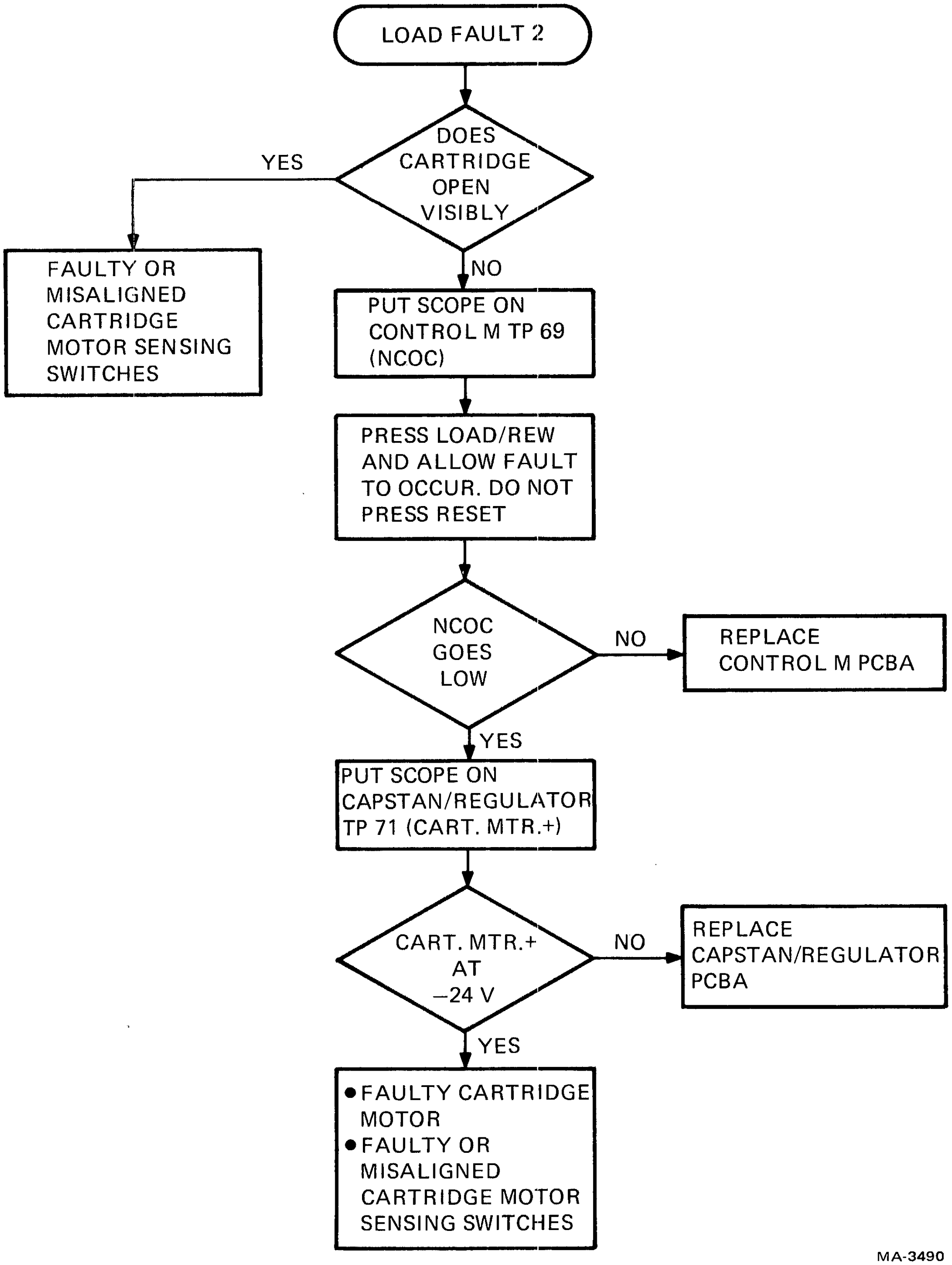


Figure 6-24 Load Fault 2 Flow Diagram

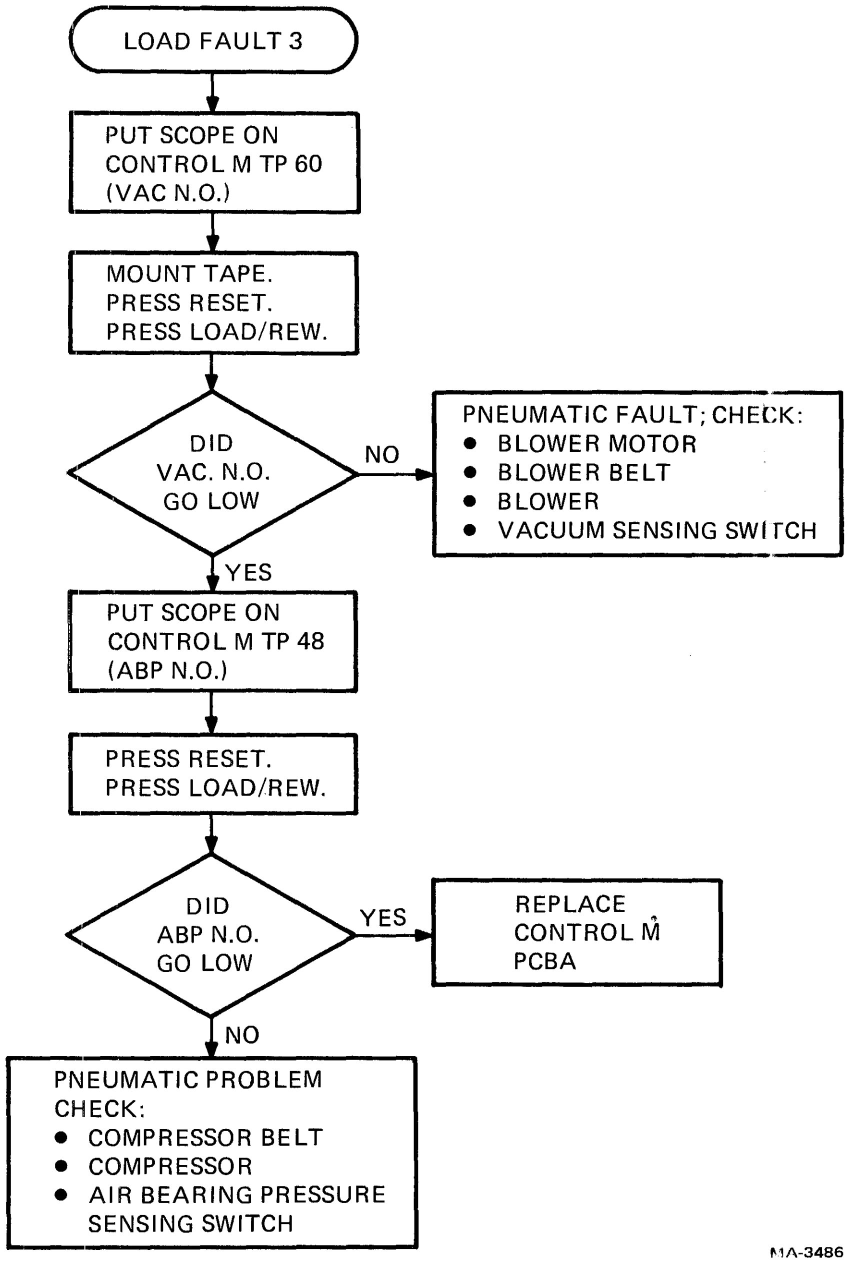


Figure 6-25 Load Fault 3 Flow Diagram

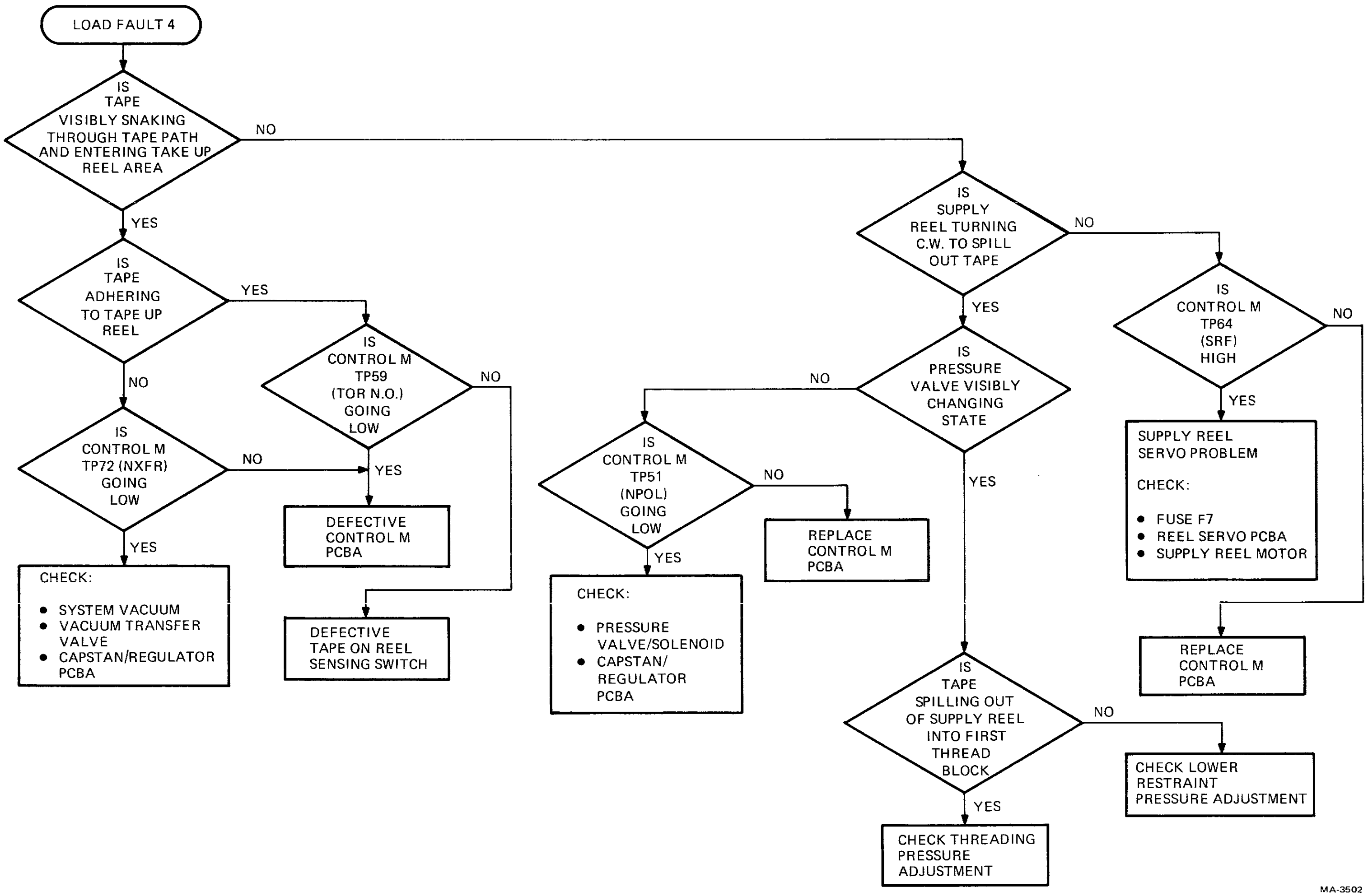
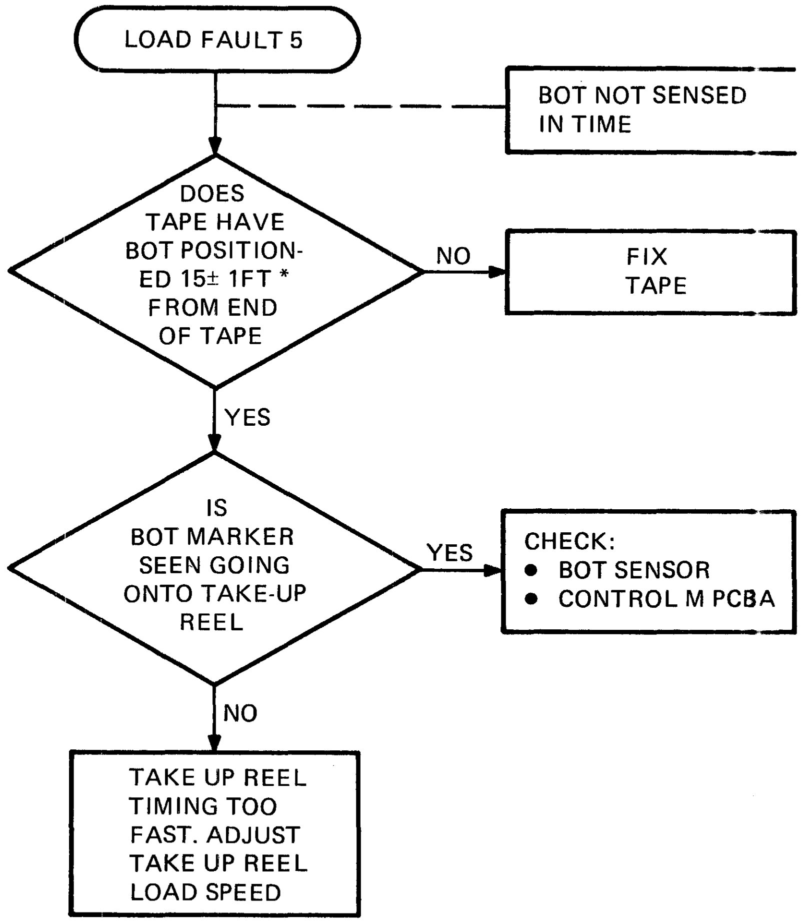


Figure 6-26 Load Fault 4 Flow Diagram



*15 FT. IS OPTIMUM. TRANSPORT WILL LOAD AT UP TO 30 FT.
IF PROBLEMS ARE EXPERIENCED DUE TO LEADER BEING TOO LONG, CUT IT DOWN TO 15 FT.

MA-3493

Figure 6-27 Load Fault 5 Flow Diagram

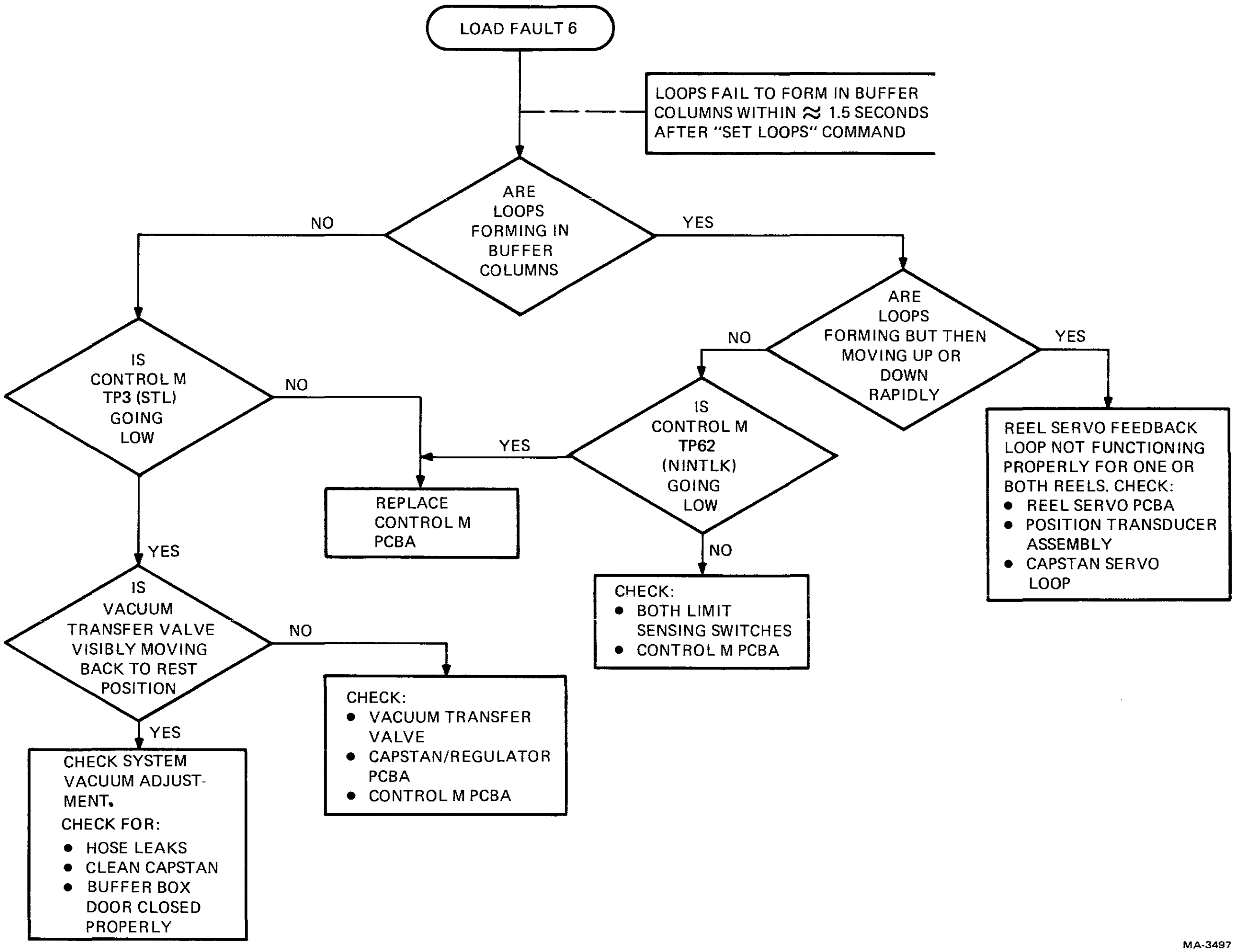


Figure 6-28 Load Fault 6 Flow Diagram

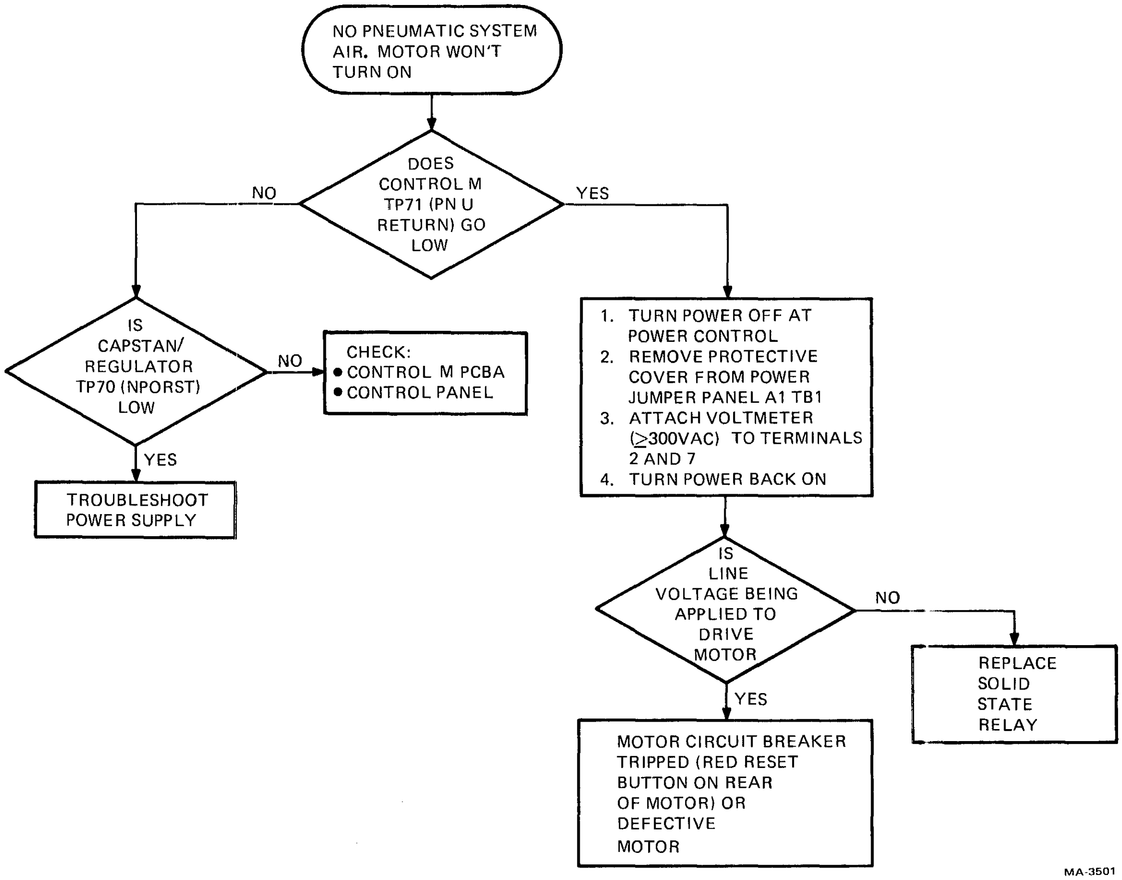


Figure 6-29 Pneumatic Troubleshooting Flow Diagram

6.6.5 Pneumatic System Troubleshooting

WARNING

If the ac motor in the power supply/pneumatic assembly has stopped because of overheating it will restart when the temperature is normal. Always turn off or disconnect ac power before working near motor pulleys and belts.

The pneumatic system located in the power supply/pneumatic assembly and distributed on the base assembly provides positive (pressure) and negative (vacuum) air to accomplish loading and running operations.

The accompanying flowchart (Figure 6-29) is used to troubleshoot a major pneumatic system failure. In order to track down more subtle failures, first perform a visual inspection of the system. Check for holes, cracks, or pinches in any of the hoses or tubing. Check the condition and tension of both drive belts. Perform a check of all positive and negative air valves as outlined in Paragraph 6.5.6. Both the muffler filter and air filter at the input of the positive air system are changed during semiannual PM. However, a particularly dirty environment could cause these filters to clog prematurely and thus should be suspected. Refer also to the air/load control functional block diagram, Figure 4, sheet 2 of 2, in Volume 1, for a schematic of the air system.

6.6.6 Reel Servo Troubleshooting

All circuitry used to drive both the takeup reel and the supply reel is contained on one PCBA (reel servo PCBA) located in the card cage assembly. Inputs to the reel servo PCBA are summarized in Table 5-2 and consist of power, control signals, and feedback signals. If the reel servo PCBA is suspected, it must be replaced since it may not be extended for troubleshooting due to heat sinking requirements. (Refer to Figure 5 in Volume 1 for a functional block diagram of the reel servo. Refer also to Figure 6-30 for a simplified schematic diagram of the supply reel servo.)

Check all input power sources and voltages developed on the reel servo PCBA. Table 6-14 lists the test points, the voltage names, and the proper readings with allowable tolerances. Check the test points with a DVM using test point 49 as a ground reference.

Table 6-14 Reel Servo PCBA Operating Voltages

Test Point	Voltage Name	Voltage Reading	Voltage Source
TP62	+15 V	+15 ±1.0	Capstan/regulator PCBA
TP64	-15 V	-15 ±1.0	
TP12	+36 V(s)	+40 ±2	Power Supply/pneumatic Assembly
TP18	-36 V(s)	-40 ±2	
TP4	+36 V(t)	+40 ±2	
TP10	-36 V(t)	-40 ±2	
TP53	+5 V(s)	+5.3 ±0.3	Reel servo PCBA

A servomechanism is more difficult to troubleshoot in a dynamic condition than a quiescent condition. The TU77 reel servo physically consists of the reel servo PCBA, the reel servo motor, the loop position transducer, and loose coupling (feedback) provided by the tape loop in the buffer column. (For a block diagram refer to Figure 5-29.) Thus when encountering a reel servo problem, with no indication of what element of the loop is causing the problem, it is advantageous to replace the reel servo PCBA initially since it is the element most prone to failure. If this fails to correct the problem, proceed to check the various feedback elements. Loop position feedback elements for each servo consist of position transducers, limit sensors, and the crippled reel sensor (takeup reel only).

Use the following procedure to check the feedback elements of the reel servo loop. Refer to Figure 6-13 for an illustration of the takeup buffer column, its zones, and sensing switch ports. The supply buffer column is similar but minus the crippled reel switch port.

1. Perform a check of all system vacuum measurements (Paragraph 6.5.6).
2. Turn transport power off.
3. Set reel servo disable switch S1, located on the reel servo PCBA, toward the rear (disable).
4. Ground control M PCBA test points TP62 (NINTLK) and TP71 (PNU RET).
5. Disconnect one capstan motor lead.
6. Mount a 10-1/2 inch reel of tape on the supply hub (without cartridge).

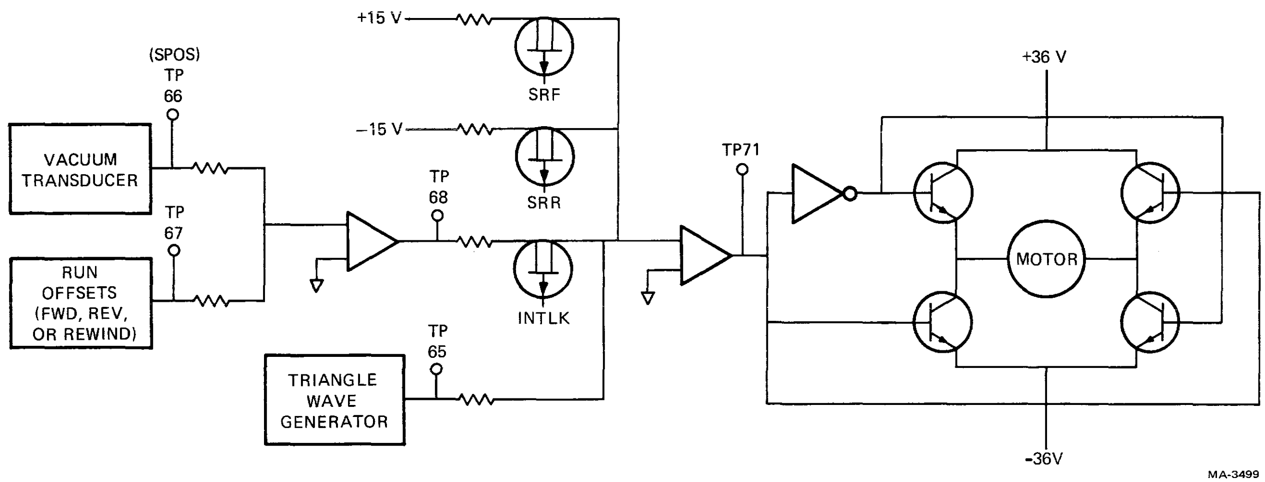


Figure 6-30 Supply Reel Simplified Schematic Diagram

7. Open the buffer box door and hand thread the leader through the tape path. Wind approximately 9 m (30 ft) of tape onto the takeup reel. Close the buffer box door.

8. Turn transport power back on. Pneumatics should be enabled with vacuum applied to the buffer columns and pressure to the air bearings.

NOTE

If either reel starts rotating at this point, replace the reel servo PCBA.

9. Manually rotate the supply reel clockwise and allow a loop to form. Position the loop in the park zone. Apply masking tape to the reel's outer flange and the transport to prevent the loop from being pulled down toward the source of vacuum.

10. Hold the tape against air bearing No. 4 (Figure 6-4) with your finger and manually rotate the takeup reel counterclockwise to allow a loop to form. Position the loop in the park zone and release your finger. Tape the takeup reel to prevent it from moving.

11. Press RESET on the control panel.

12. With a scope, monitor control M test points TP57 (S. LIMIT N.O.) and TP61 (T. LIMIT N.O.) with reference to TP49 (0 V). Both test points should be at or near ground. Any momentary jumps up to +5 V indicate an intermittent limit switch or air leak in the associated tubing.

13. Connect the scope to reel servo TP66 (SPOS) and ground to TP49 (0 V). Set the scope to 1 V per div vertical, and 20 ms per cm horizontal with the baseline in the center.

14. Remove the tape from the supply reel and rotate it so that the loop in the supply column extends down to the lower limit switch and observe the voltage on the scope. Note the reading and rotate the reel so that the loop extends to the upper limit switch and observe the voltage on the scope. Note the reading and add the unsigned value of the readings together. The result should be in the range of 3.6 to 4.2 V.

NOTE

The 0.6 V tolerance is due to the system vacuum setting, the position adjustment setting on interconnect F1 PCBA, and individual characteristics of the position transducer.

15. Retape the supply reel and remove the tape from the takeup reel. Repeat step 14 for the takeup reel and the takeup column while monitoring reel servo test point TP55 (TPOS).

16. If the result in step 14 or 15 is out of range, and the buffer column vacuum is known to be within tolerance, the fault is with either the position transducer or the interconnect F1 PCBA.

17. Place the scope on interconnect F1-TB1-13 with the ground probe on TB1-14. With the takeup loop above the crippled reel port (atmosphere) TB1-13 should be at +5 V. With the loop below the crippled reel port TB1-13 should be at or near ground. Anything else indicates a defective crippled reel sensor or associated tubing.

18. Turn transport power off and remove the jumpers. Connect capstan motor lead and set reel servo disable switch to front. If after eliminating the reel servo PCBA and the feedback element, the problem still exists, the reel motor should be replaced.*

6.6.6.1 Dynamic Brake Check – This procedure is to be accomplished when the reel servo PCBA is replaced or when tape damage due to power failure is suspected.

1. Open the transport front door and install a 267 mm (10-1/2 in) reel of work tape. Load the tape to BOT.
2. Set control M PCBA switch S1 towards the front of the transport. The tape should be moving in the forward direction.
3. Allow the tape to run to its midposition.
4. With tape running turn transport power off.
5. Open the buffer box door. The tape should not have spilled excessively in either column.
6. Examine the tape in the tape path. It should not show any damage.
7. Replace the tape in the tape path and rotate one reel to take up slack.
8. Turn transport power on and perform a midreel load.
9. With tape rewinding to BOT at high speed turn transport power off.
10. Repeat steps 5 through 8.
11. Unload the tape.

6.6.7 Data Paths Troubleshooting

Figures 6-31 (Write Path) and 6-32 (Read Path) are provided as an aid in troubleshooting the data paths. They provide a correlation between physical data tracks and data bit nomenclature from the TM03 through the TU77. (Refer also to Figures 7 and 8 in Volume 1 for a functional overview of the Write and Read Data paths.)

6.6.7.1 Thresholds – The thresholds established on the data L PCBA determine the minimum allowable analog signal to be strobed into the data buffers as actual data. If the thresholds are not set properly (Paragraphs 6.5.8.1 and 6.5.8.5) or have drifted, then noise may be detected as data or actual data may not be detected. Using a DVM, check for the thresholds listed in Table 6-15.

---

*Motors can develop shorted windings due to overheating. Also, they have a life span associated with the brushes/commutator.

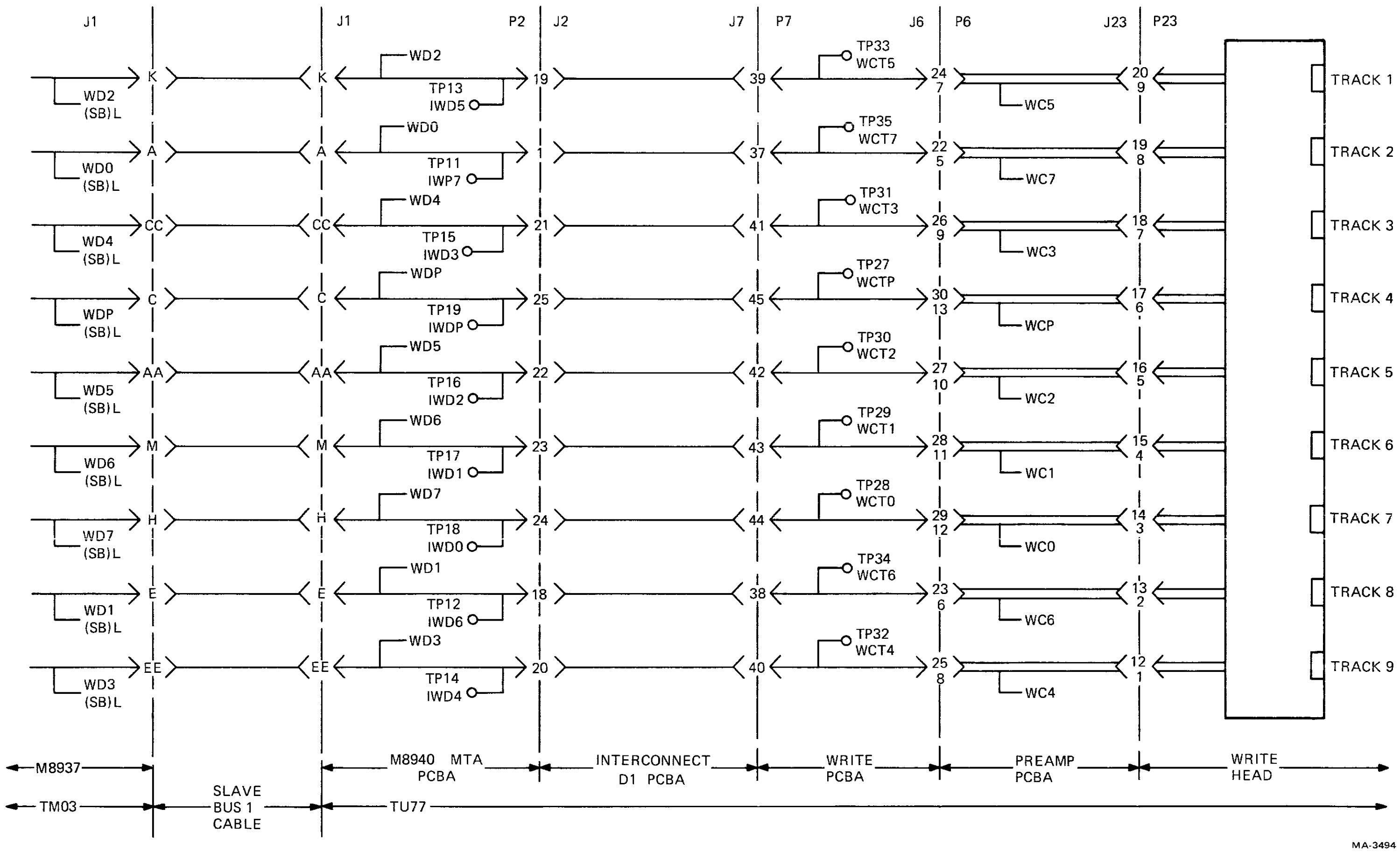


Figure 6-31 Write Data Path Test Points

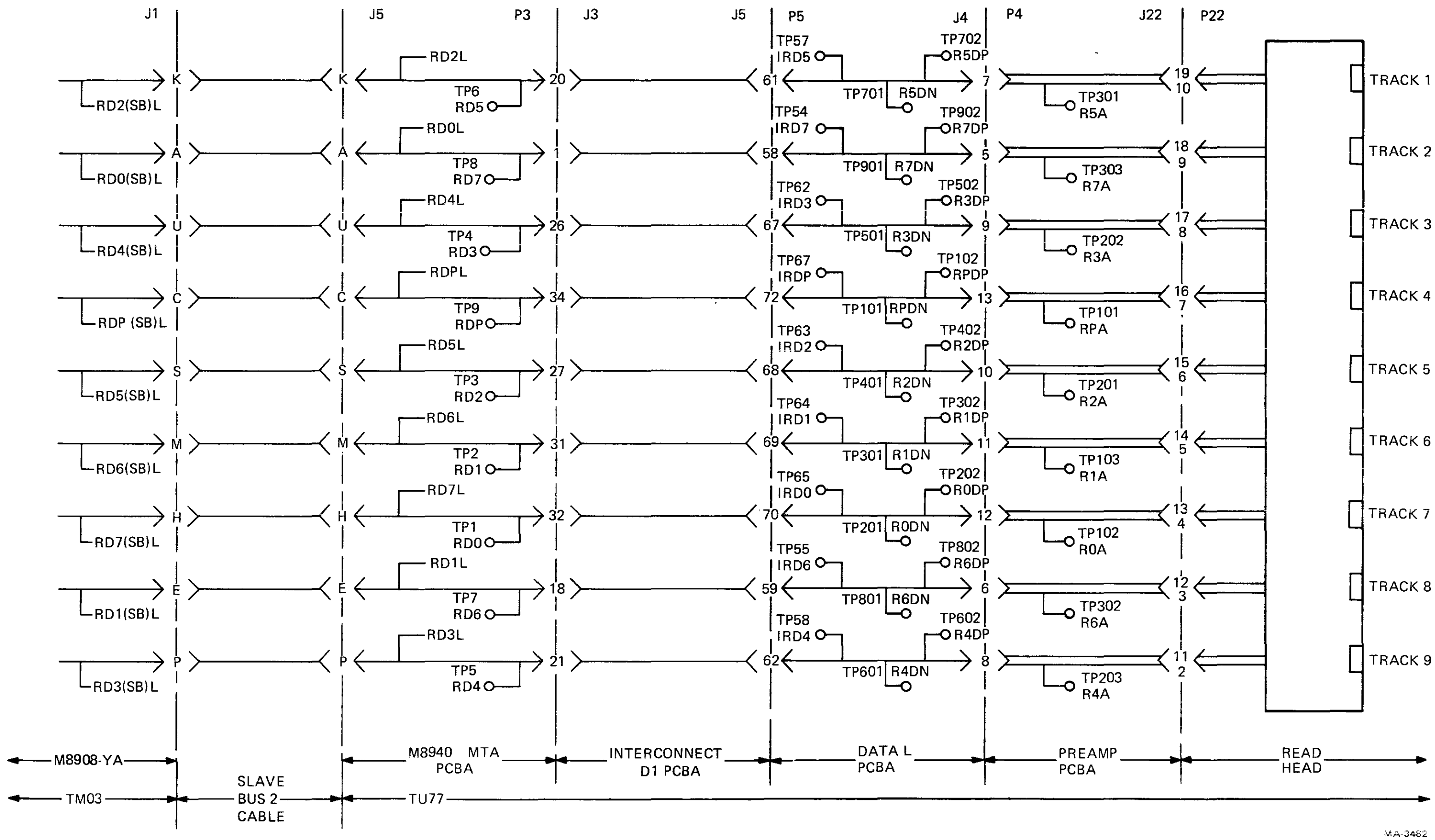


Figure 6-32 Read Data Path Test Points

Table 6-15 Data L Read Thresholds

Data L Test Point	Function	Threshold Voltage
TP69	NRZI Write	+2.7 V ± 120 MV
TP69	NRZI Read low	+900 MV ± 120 MV
TP69	NRZI Read high	+1.2 V ± 120 MV
TP70	NRZI Write	−2.7 V ± 120 MV
TP70	NRZI Read low	−900 MV ± 120 MV
TP70	NRZI Read high	−1.2 V ± 120 MV
TP71	PE Write	+1.5 V ± 120 MV
TP71	PE Read low	+300 MV ± 60 MV
TP71	PE Read high	+600 MV ± 120 MV

6.7 REMOVAL AND REPLACEMENT PROCEDURES

This section details step-by-step removal and replacement procedures for all field replaceable parts that require such instructions. Illustrations are referenced as needed by the procedures. References will be made to any adjustments required due to the replacement of a particular part. (For a cross-reference on part removal/replacement and associated adjustments, refer to Table 6-16.)

6.7.1 Head Wear Check and Replacement Procedure

The read-write-erase head assembly may require replacement for one of two reasons: internal fault in the head, or excessive wear. Head wear can be verified by measuring the depth of the wear on the head crown. In those heads which have guttering (grooves cut on the crown on each side of the tape path), the head should be replaced when it has worn down to the depth of the gutter. In those heads which do not have guttering, the head wear should be measured with a brass shim that is 0.254 mm (0.010 in) thick. The shim width should be less than the minimum tape width, 12.598 mm (0.496 in). Place the shim in the worn portion of the head crown with one side butted against the outer worn edge. The head should be replaced when the upper surface of the shim is below the unworn surface of the head crown, i.e., the head has worn to a depth greater than 0.254 mm (0.010 in).

Table 6-16 Parts Replacement/Adjustment Cross Reference

Paragraph	Removal or Replacement Procedure	Check/Adjustment
6.7.1	Head Replacement Procedure	6.5.8, 6.5.9
6.7.2	Tape Cleaner Removal, Cleaning and Alignment	—
6.7.3	Air Guide Disassembly and Cleaning	—
6.7.4	Air Bearing Removal and Cleaning	—
6.7.5	Capstan Motor Replacement	6.5.8, 6.5.6.1, 6.5.6.2
6.7.6	Supply Reel Motor Replacement	6.5.7.2, 6.5.7.4
6.7.7	Vacuum Reel Assembly Replacement and Takeup Reel Motor Replacement	6.5.7.3, 6.5.7.4
6.7.8	Cartridge Actuator Motor Replacement	—
6.7.9	Control Assembly Removal and Replacement	—
6.7.10	Blower/Compressor AC Motor Replacement	6.5.6
6.7.11	Blower Removal and Replacement	6.5.6
6.7.12	Compressor Removal and Replacement	6.5.6
6.7.13	Air Valve Solenoid Replacement	—
6.7.14	PCBA Removal/Replacement	—
6.7.14.1	M8940 MTA PCBA	—
6.7.14.2	Data L PCBA	6.5.8.1, 6.5.8.2, 6.5.8.4, 6.5.8.5, 6.5.8.6
6.7.14.3	Write PCBA	6.5.9
6.7.14.4	Control M PCBA	—
6.7.14.5	Capstan Servo PCBA	6.5.1, 6.5.5, 6.5.8.2, 6.5.8.6
6.7.14.6	Reel Servo PCBA	6.5.1, 6.5.7, 6.6.6.1
6.7.14.7	Preamp PCBA	6.5.8.2, 6.5.8.6
6.7.14.8	Interconnect F1	6.5.2, 6.5.4, 6.5.7.4
6.7.14.9	Interconnect D1	—

Replacement of the head is accomplished as follows (Figure 6-33):

1. Turn transport power off.
2. Open the transport front door and the buffer box door; swing the base assembly out.
3. Remove the four hex-head screws holding the 9TK preamplifier PCBA bracket to base assembly.
4. Grasp the head assembly and remove two socket-head screws holding the head against the head-mounting plate.
5. Carefully tip the bracket and disconnect the head from the PCBA. Remove the erase head leads from the PCBA.
6. Check the head mounting plate and the replacement head for cleanliness of the mounting surfaces.

NOTE
The mounting surfaces must be free of all foreign substances or excessive skew may result.

To install the new head, repeat steps 3 through 5 in reverse order, but do not tighten the head-mounting screws or the PCBA bracket mounting screws. Note that white lead to erase head connects to E1 and black lead to E2.

7. Initially align head by visually aligning lower edge of head with inclined edge of base metallic overlay. (Refer to Note 2 of Figure 6-33.) Bias head assembly by pressing it towards the right, into tape path, with finger pressure. Ensure erase head contacts a sample section of magnetic tape. Lightly tighten the head-mounting screws. Connect erase head wires to PCBA making sure the white wire is closest to the operator.
8. Turn transport power on.
9. Load an all ones NRZI 32 c/mm (800 cpi) tape on the transport and bring to Load Point.
10. Operate the transport in a shuttle mode (i.e., forward then reverse) by grounding TP31 on control M PCBA (Figure 6-5).
11. Using oscilloscope, observe waveform at TP101 through TP901 on data L PCBA (Figure 6-6).
12. While operating in the shuttle mode, mechanically rotate the 9TK preamplifier PCBA until the observed amplitude difference between forward and reverse operation is less than 600 mV peak-to-peak. Grasp the 9TK preamplifier PCBA on both the front and rear of base assembly to rotate it.
13. Open buffer box door and verify that the erase head is in contact with tape. Repeat step 12 if necessary.
14. Tighten head mounting screws and PCBA mounting bracket screws.

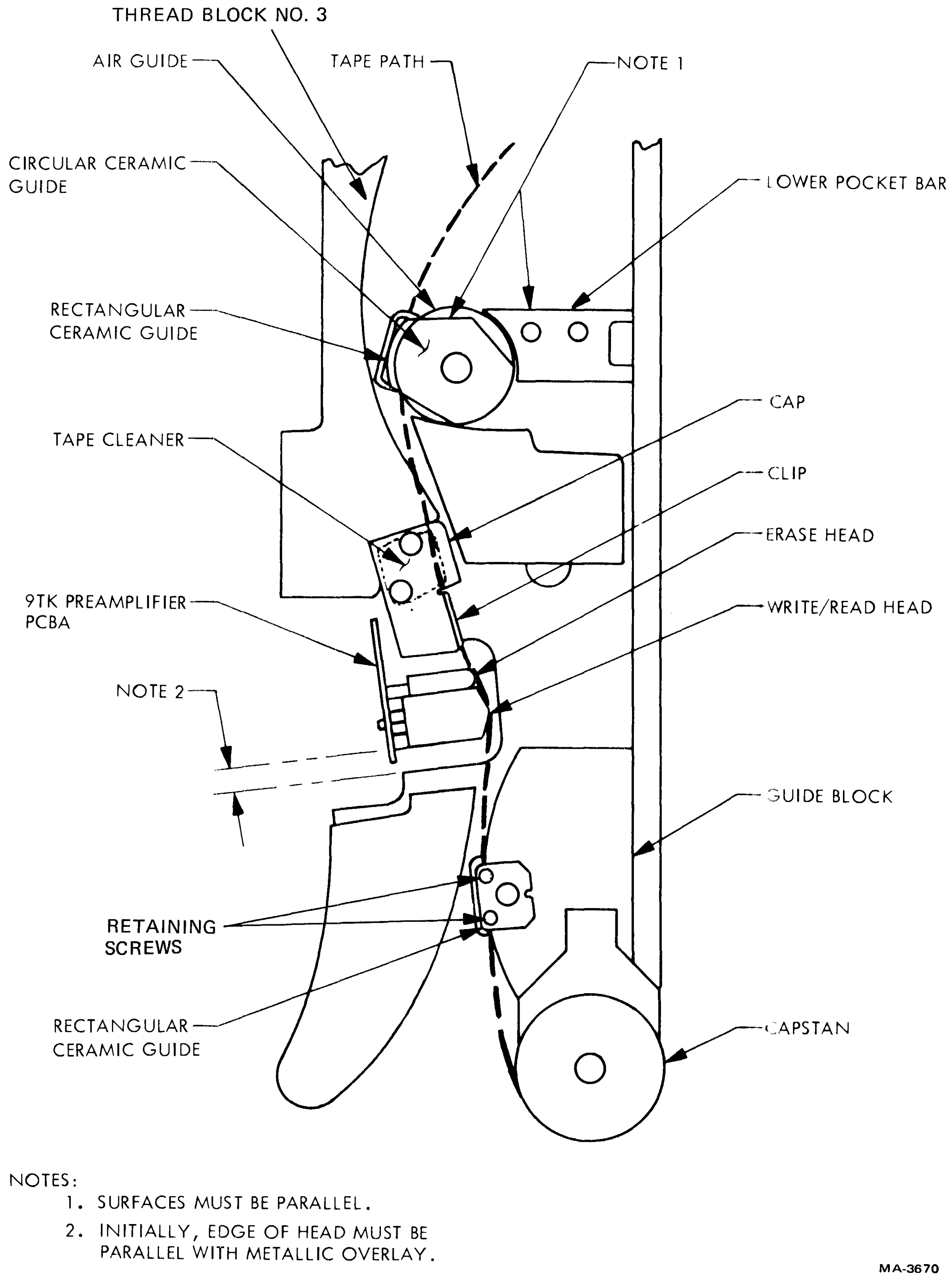


Figure 6-33 Read/Write Head, Tape Cleaner, and Air Guide Removal and Replacement

15. Perform related adjustments:

    - Read Adjustments Paragraph 6.5.8
    - Write Deskew Adjustment Paragraph 6.5.9

6.7.2 Tape Cleaner Removal, Cleaning, and Alignment
The tape cleaner may be removed and reinstalled as follows:

1. Open transport door and the buffer box door.

2. Remove two screws attaching tape cleaner and its cap to the base casting (Figure 6-33).

3. Clean tape cleaner, cap, clip, and metal overlay on base casting with a lint-free cloth moistened in 91 percent isopropyl alcohol. Wipe the tape cleaner blades and mounting surfaces carefully to remove all oxide and dirt.

4. Reinstall tape cleaner and cap with clip on base assembly. Bias the cleaner with finger pressure directed towards the right (towards the tape). Rotate cap so that formed clip is 1.524 mm (0.06 in) away from tape path. Slide clip against erase head.

6.7.3 Air Guide Disassembly and Cleaning
The following details the procedure for disassembling and cleaning the air guide.

1. Open transport door.

2. Remove seven trim assembly mounting screws, and trim assembly from unit.

3. Open the buffer box door.

4. Remove thread block 3 (Figure 6-33) permitting it to hang by its leads.

5. Remove circular ceramic guide from air guide on front of base assembly (Figure 6-33).

NOTE
Do not remove air guide from base assembly.

6. Carefully insert the lens of a penlight into the front of the air guide. Using a small mirror, ensure that all orifices are open.

7. Open any closed orifice by inserting a length of 34 AWG wire or one strand of 19 strand 27 AWG wire. Wire diameter should be 0.16002 mm (0.0063 in).

8. Wipe external bearing surfaces and ceramic guide with a lint-free cloth moistened with 91 percent isopropyl alcohol.

9. Assemble circular ceramic guide to air guide with edge parallel to edge of lower pocket bar (Note 1 in Figure 6-33).

10. Reassemble thread block 3 to base assembly, adjusting its tip so it is 0.762 mm (0.03 in) outside of the tape path at the tape cleaner (Figure 6-33). Perform the adjustment by stretching a section of magnetic tape from the lower pocket bar past the head and guide block around the capstan.

11. Replace trim assembly.

6.7.4 Air Bearing Removal and Cleaning

There are five air bearings, excluding the air guide (Figure 6-34). The air guide disassembly and cleaning is given in Paragraph 6.7.3. The air bearing procedure describes removal of the air bearings for cleaning. Since there are three different bearing versions on a transport, they should be disassembled and reassembled one at a time.

1. Open the transport front door and buffer box door.

2. Remove air bearing No. 1 (Figure 6-34). Clean parts using 91 percent isopropyl alcohol and a lint-free cloth. Examine air bearing orifices by inserting a penlight into the bearing. Open clogged orifices using 30 AWG wire. Clean all surfaces of the air bearing, the circular ceramic guide (where used) and the bearing mounting area on metal overlay of the base assembly.

3. A nonmetallic straight edge is useful to rotationally align the air bearings on the base assembly. A straight edge can be cut from the cardboard on the back of any tablet. Cut the piece 152.4 mm long by 6.35 mm wide (6 in by 1/4 in). The straight edge simulates the tape contact tangent line with the first row of holes.

4. Reassemble air bearing No. 1 to base assembly. Rest cardboard against adjacent buffer box bar and bearing. Rotate bearing until first row of orifices are tangent to cardboard (Point A) and remaining orifices are in tape path area regions to float the magnetic tape (Area B). Shiny side of ceramic guide is mounted towards the magnetic tape. Align ceramic guide as illustrated in Figure 6-34.

5. Follow the same procedure for air bearings No. 2, 4, and 5. This procedure is also used for bearing No. 3 except that tangent point A is aligned with adjacent bearing No. 2.

6.7.5 Capstan Motor Replacement

The capstan motor and mounting plate is replaced as an assembly. The motor and mounting plate is replaced using the following procedure.

1. Turn transport power off.

2. Disconnect wires, hose, and tube at the motor. Remove tachometer wires from interconnect F1 PCBA.

3. Remove the two hex nuts, lock washers, cups, and Belleville washers, retaining motor plate to the base assembly at two locations (Figure 6-35).

4. Cradle motor in hand. At front of base assembly, remove socket-head cap screw (fixed point) (Figure 6-35), containing Belleville washers and plain washer, freeing the motor.

5. Carefully slide motor off two adjusting studs. View the front of base assembly to ensure that capstan clears metal overlay and base casting.

6. Install the replacement motor, repeat steps 2 through 5 in reverse order.

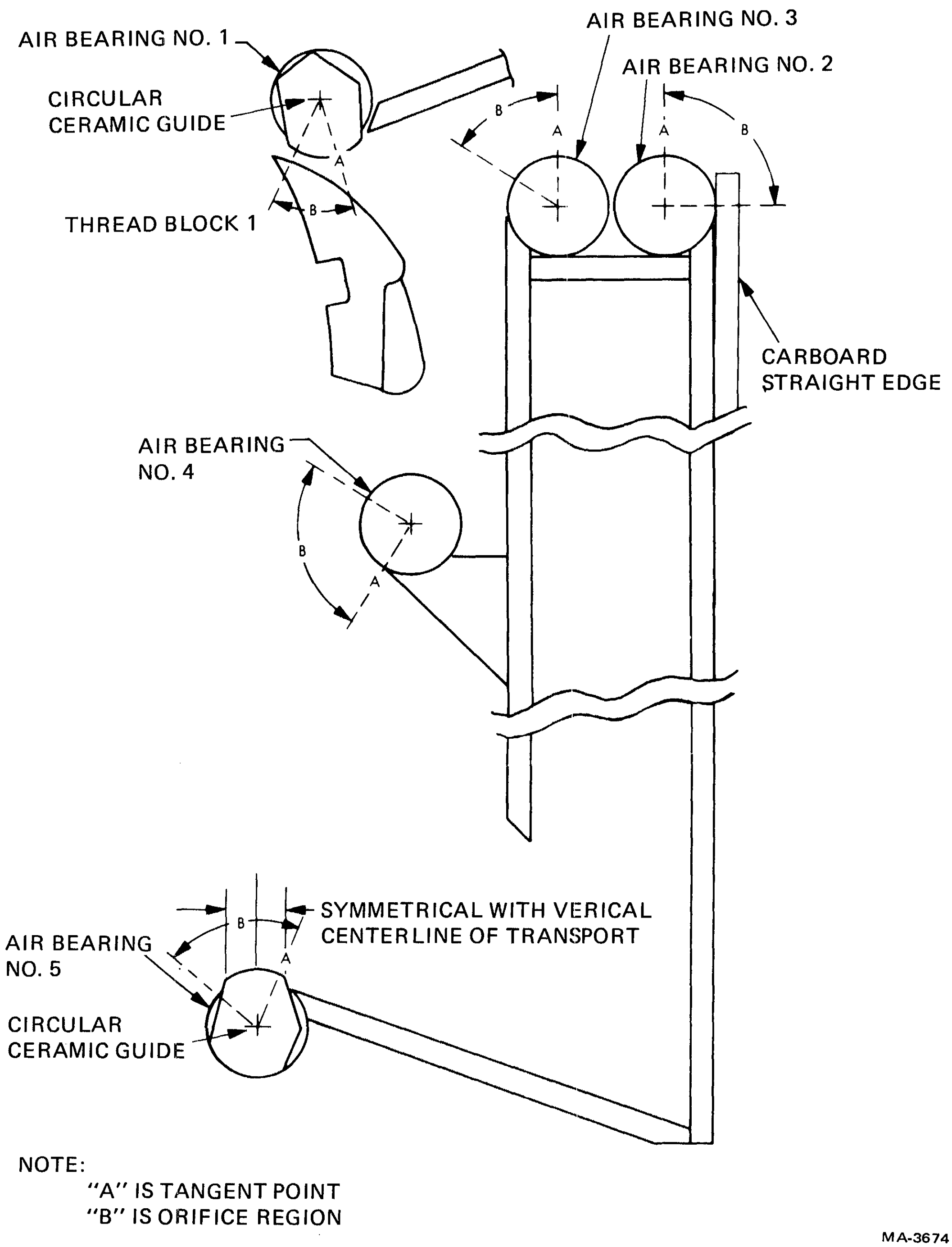


Figure 6-34 Air Bearing and Ceramic Guide Orientation

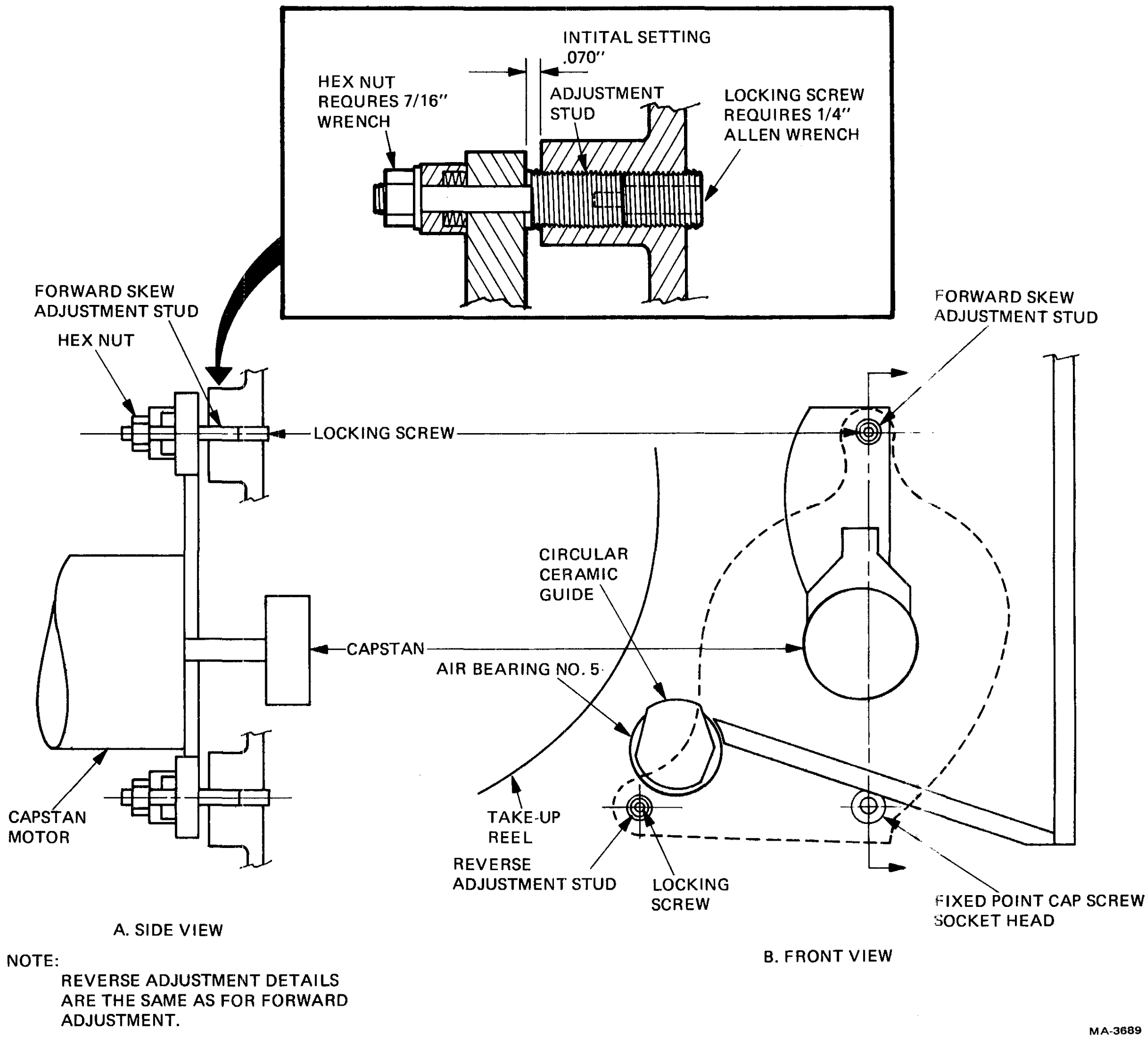


Figure 6-35 Capstan Motor Mounting

NOTE
The following steps provide the procedure to achieve capstan perpendicularity, a necessary requirement to ensure proper tape tracking over the guide block/head area. Coarse adjustment of tape tracking is performed in steps 7 through 22. A fine tuning of tape tracking is accomplished in steps 23 through 30.

7. Turn transport power on.
8. Mount and load a work tape to BOT.

NOTE
The tape may incur some edge damage in this procedure. When finished, cut off that portion of tape used in the process and install a new BOT tab.

9. Place control M PCBA switch S1 (Figure 6-5) toward the front of the transport and drive the tape forward for about 15 m (50 ft). Place the switch back in the center position.
10. Turn transport power off.

NOTE
If floating thread block No. 9 has a viewing window, proceed to step 12 as it is not necessary to remove the thread block.

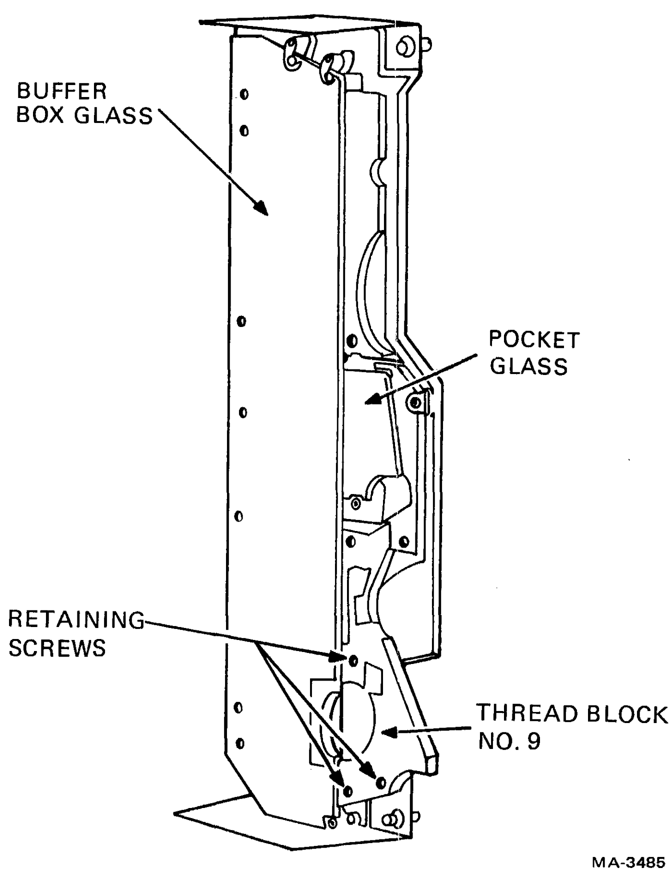


Figure 6-36 Floating Thread Block No. 9

11. Remove floating thread block No. 9 on the buffer box door assembly (Figure 6-36). Remove the block by holding it against the door and removing the three retaining screws and washers. Lift the block out of the door being careful not to loose the springs underneath the block.

12. On the rear of the base assembly, at the capstan motor mounting plate, loosen the two hex nuts 1/4 turn. These hex nuts are the ones referred to in step 3. They are located at the forward and reverse tracking adjustment points.

13. On the front of the base assembly, approximately 50.8 mm (2 in) down from the capstan, loosen the fixed point socket-head cap screw 1/4 turn (Figure 6-35).

14. Loosen the capstan motor forward and reverse adjustment locking screws one full turn.

15. Remove the outside rectangular ceramic guide from the guide block by removing the two retaining screws and washers (Figure 6-33).

CAUTION
The thin ceramic guides are easily broken. Handle with extreme care.

16. Gently retract the spring-loaded ceramic guides at both the guide block and the air guide so that they lock back. Use a nonmetallic instrument, such as the bare end of a cotton-tipped swab to retract the guides. Retraction is accomplished by pushing the guide straight back with the swab positioned in the middle of the guide.

17. Close the buffer box door assembly.

18. Perform a systems vacuum check (Paragraphs 6.5.6.1 and 6.5.6.2).

19. Turn transport power on and perform a midreel load.

20. Run the drive forward using maintenance switch S1 on the control M PCBA. Adjust forward adjustment stud* from the front of the base assembly (Figure 6-37) so tape edge is aligned with guide block edge in the area from which the rectangular ceramic guide was removed. Clockwise adjustment shifts tape away from base casting.

21. Run the drive in reverse using maintenance switch S1 on control M PCBA and adjust reverse adjustment stud from the front of the base assembly (Figure 6-37) so tape edge is aligned with the guide block.

22. Repeat steps 20 and 21 until tape is aligned with the guide block and no front-to-back movement occurs with tape moving in either direction. Shuttle maintenance test point TP31 on control M PCBA may be grounded to TP25 to run the transport in the shuttle mode.

23. Unload work tape and load a master skew tape to fine tune tape tracking.

24. Connect channel 1 of an oscilloscope to TP203 (read head No. 4) of the 9TK preamplifier PCBA (Figure 6-14) and channel 2 to TP301 (read head No. 5). Ground oscilloscope to TP 2. Sync internal positive on channel 1.

25. Run tape forward and reverse by grounding shuttle maintenance test point TP31 on control M PCBA.

*Tape must be stopped and buffer box door opened each time forward stud is adjusted.

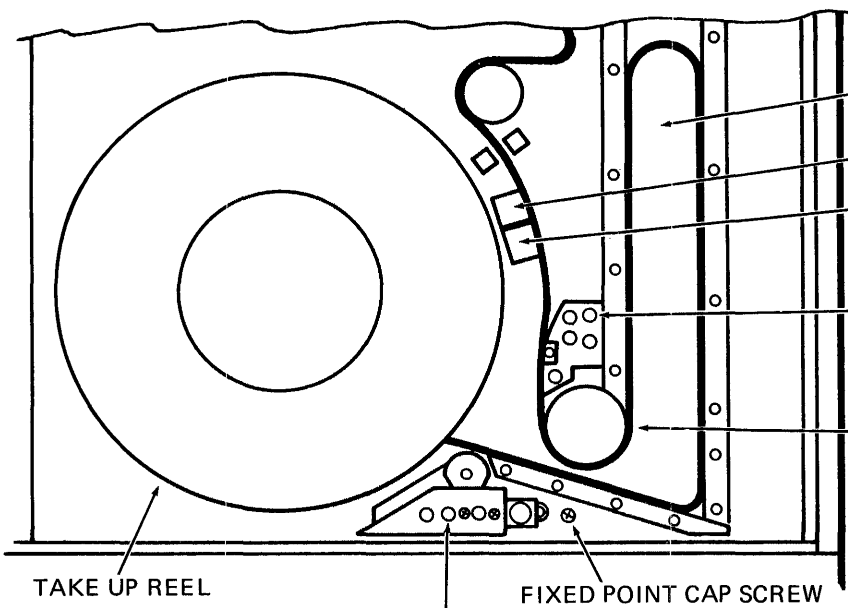


Figure 6-37 Capstan Tape Tracking Adjustment Studs

26. Observe the oscilloscope and adjust the capstan tracking adjustment studs* (Figure 6-37) for minimum differential between TP203 and TP301 (outside two tracks of the read head).

NOTE
Only very slight adjustments are required. Achieving no differential at this point may not be possible due to misalignment of head azimuth plate.

27. If coincidence cannot be achieved, ensure that the differential is minimal and equal but opposite in the forward direction versus reverse direction. This indicates that tape tracking is straight forward and reverse, and that the head azimuth plate needs to be aligned (Paragraph 6.5.8.3).

28. Tighten locking screws, hex nuts and socket-head cap screw, observing oscilloscope to ensure that adjustments are not disturbed.

29. Remove jumper from TP31 on control M PCBA. Remove oscilloscope connection from 9TK preamplifier PCBA.

30. Unload the master skew tape.

CAUTION
Do not rewind. A master skew tape should be run forward and reverse at normal drive speed only to preserve its integrity.

*Tape must be stopped and buffer box door opened each time forward stud is adjusted.

31. Return spring-loaded ceramic guides to their operating position by pressing the guide on corners with a cotton-tipped swab.

32. Install fixed ceramic guide, being careful not to crack it.

33. Reinstall thread block No. 9 (if it was removed).

34. Perform the read adjustments (Paragraph 6.5.8).

6.7.6 Supply Reel Motor Replacement

The supply reel motor may be replaced as follows.

1. Turn transport power off.

2. Open the transport front door and buffer box door.

3. Remove the supply reel plastic overlay on the front of the base casting by removing five small Phillips-head screws.

4. Loosen the two reel hub retaining screws without removing the hex nuts. Use a 5/32-inch ball-end hex driver inserted through the cutout in the casting behind the hub at the 12 o'clock position. Normally only finger pressure is required to prevent the nuts of these screws from turning. A small open-end wrench may be used and can be inserted from the front of the base assembly through the access cavities in the base casting behind the reel hub.

5. With the straddle plates of the reel hub in a horizontal position, and hex nuts facing down, remove the hub from motor shaft.

6. At rear of base assembly, disconnect motor leads and cooling tubes from motor.

NOTE

Note the elbow alignments with respect to the motor and base assembly so that the elbows of the replacement motor can be properly oriented.

7. While supporting the motor, remove four motor-mounting screws on the front of the base assembly. Remove the motor from the rear.

8. Install the replacement motor, aligning elbows properly. Center motor in base casting clearance bore using centering tool (DEC P/N 29-23206). Tighten screws.

9. On the back of base assembly, slip the tubes over the elbows. Tighten hose clamps and attach motor leads.

10. On the front of base assembly, slip reel hub over motor shaft seating straddle plate on flat of shaft. Push hub towards base casting and lightly tighten both clamping screws. Adjust the hub flange so that it measures 11.4554 to 11.7094 mm (0.451 to 0.461 in) from the machined boss on the base casting. This machined boss is directly behind the flange at 2 o'clock position.

11. Torque both clamping screws evenly to 2.7 newton-meters (24 inch-pounds).

12. Replace the supply reel overlay.

13. Turn transport power on.

14. Perform related adjustments:

    Supply reel load speed (Paragraph 6.5.7.2)
    Tape loop position (Paragraph 6.5.7.4).

6.7.7 Vacuum Reel Assembly Replacement and Takeup Reel Motor Replacement

Replace the vacuum reel assembly and the takeup reel motor as follows. You must remove the vacuum reel assembly in order to remove the takeup reel motor.

1. Turn transport power off.

2. Open the transport front door. Remove the seven trim assembly mounting screws and the entire trim assembly.

3. Open the buffer box door and base assembly.

4. On back of base assembly below the takeup reel motor, remove access plug to the vacuum reel hub.

5. Through the access hole, loosen both screws retaining hub to shaft.

6. Remove vacuum reel at front of base assembly.

NOTE
If only the vacuum reel assembly is to be replaced, proceed to step 10. If the takeup reel motor is to be replaced proceed with step 7.

7. At rear of base assembly, disconnect motor leads and cooling tubes from motor. Note the elbow alignments with respect to the motor and base assembly so that the elbows of the replacement motor can be properly oriented. While supporting the motor, remove the four mounting screws on front of base assembly and remove motor from rear.

8. Install replacement motor, aligning the elbows properly. Center motor in base casting clearance bore using centering tool (DEC P/N 29-23206) and tighten screws.

9. On the back of base assembly, slip the tubes over elbows. Tighten hose clamps and attach motor leads.

10. Reinstall vacuum reel using buffer box bar (DEC P/N 29-23207) just above the lowest air bearing. Insert the bar between the vacuum reel flanges.

11. Center reel flanges with respect to the bar and tighten screws on the vacuum reel hub. Rotate reel and listen for any rubbing with base casting bore. Repeat steps 10 and 11 if necessary.

12. Reassemble access plug and trim assembly.

13. Turn transport power on.

14. Perform related adjustments:

    Takeup reel load speed (Paragraph 6.5.7.3)
    Tape loop position adjustment (Paragraph 6.5.7.4).

6.7.8 Cartridge Actuator Motor Replacement

Replace the cartridge actuator motor as follows.

1. Turn transport power off.

2. Open the transport front door and the buffer box door.

3. Remove the supply reel plastic overlay on the front of the base casting by removing five small Phillips-head screws.

4. Remove arm from motor shaft by loosening set screw (Figure 6-38).

NOTE
Note color and location of the two leads with respect to the motor so they can be properly connected to replacement motor.

5. On the back of the base assembly, remove clamp from around motor and radio frequency interference (RFI) filter. Remove the RFI filter from the motor leads by sliding off the filter top cover and lifting the wires off the pins. Remove four motor mounting screws and remove the motor.

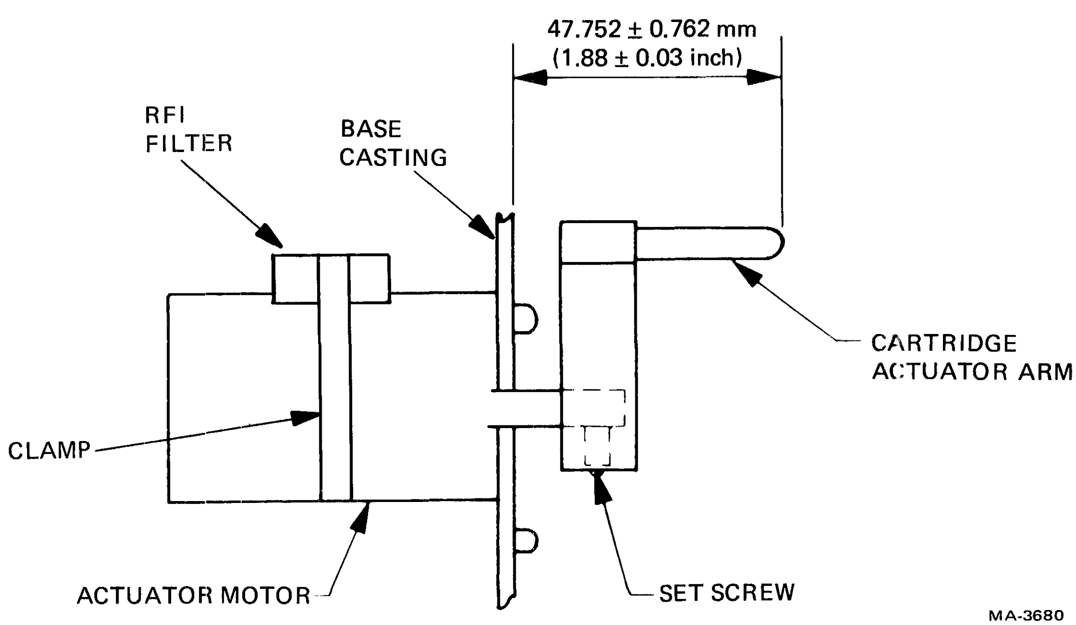


Figure 6-38 Cartridge Actuator Motor

6. Install the new motor with the four mounting screws. Set arm height shown in Figure 6-38 and tighten set screw.

7. Install a new RFI filter (DEC P/N 29-23279) by laying the motor leads into the two channels of the filter body and pressing them onto the pins so that the pins puncture the wire insulation. Slide the filter top on. Install the clamp around the motor and RFI filter and tighten it so that the pin protruding from the filter bottom makes good contact with the motor housing.

CAUTION
Do not allow the clamp to touch the motor electrical terminals.

8. Turn transport power on.

9. Press LOAD/REW control. Arm must rotate clockwise, then stop without bouncing and motor must stop driving. Adjust bottom limit switch if necessary.

10. Press RESET control. Arm must swing counterclockwise, then stop without bouncing and motor must then stop driving. Adjust top limit switch if necessary.

11. Reassemble supply reel overlay.

6.7.9 Control Assembly Removal and Replacement

Remove and replace the control assembly as follows.

1. Turn transport power off at the cabinet power control.

2. Open the transport front door. Remove the seven trim assembly mounting screws and the entire trim assembly.

3. Open the base assembly. Disconnect P10 from the control M PCBA and free the flat cable from the retaining clamps.

4. At the front of the base assembly, remove the four control assembly mounting screws and slide the flat cable through the base casting.

5. Install the replacement assembly in reverse order.

6.7.10 Blower/Compressor AC Motor Replacement

Remove and replace the blower/compressor ac motor as follows.

WARNING
If the motor has stopped because of overheating, it will restart when the temperature is normal. Always turn off or disconnect ac power before working near motor pulleys and belts.

1. Turn transport power off at the cabinet power control and disconnect the power cord.

CAUTION

Do not attempt this, or any other removal/replacement procedure within the pneumatic/power supply assembly without first removing the 220 V power cord.

2. Remove belt guard and remove both belts by manually rotating pulleys clockwise and slipping belts off. It is not necessary to loosen compressor or blower mounting screws.

3. Remove pulley set from motor shaft. Do not separate the pulley set.

4. Remove transformer mounting screws in front of power pack assembly and lift transformer to gain access to motor.

CAUTION

The transformer should not be lifted by one person. An assistant will be necessary for this operation.

5. Remove cover to motor leads and remove leads.

6. Remove four mounting screws at rear of power pack assembly and remove motor from the front.

7. Install replacement motor.

8. Reassemble in reverse order aligning pulley on shaft set (Figure 6-39). Manually rotate motor clockwise and check that both belts track completely on pulleys. Some slight shift of motor pulley may be necessary.

9. Reconnect power cord and turn transport power on at the power control.

10. Perform vacuum and air pressure adjustments (Paragraph 6.5.6).

6.7.11 Blower Removal and Replacement

Remove and replace the blower as follows.

1. Turn transport power off at the cabinet power control and disconnect the power cord.

2. Remove belt guard. Remove hose from top of blower.

3. Loosen blower mounting screws. Slide blower left and slip belt off pulley (Figure 6-39).

NOTE

Do not loosen blower pulley from shaft. Replacement blowers have pulley properly located on shaft.

4. Remove capacitor chassis mounting screws in front of power pack assembly. Position chassis towards transformer.

5. Remove hose from end of blower.

6. Remove blower mounting screws and remove blower.

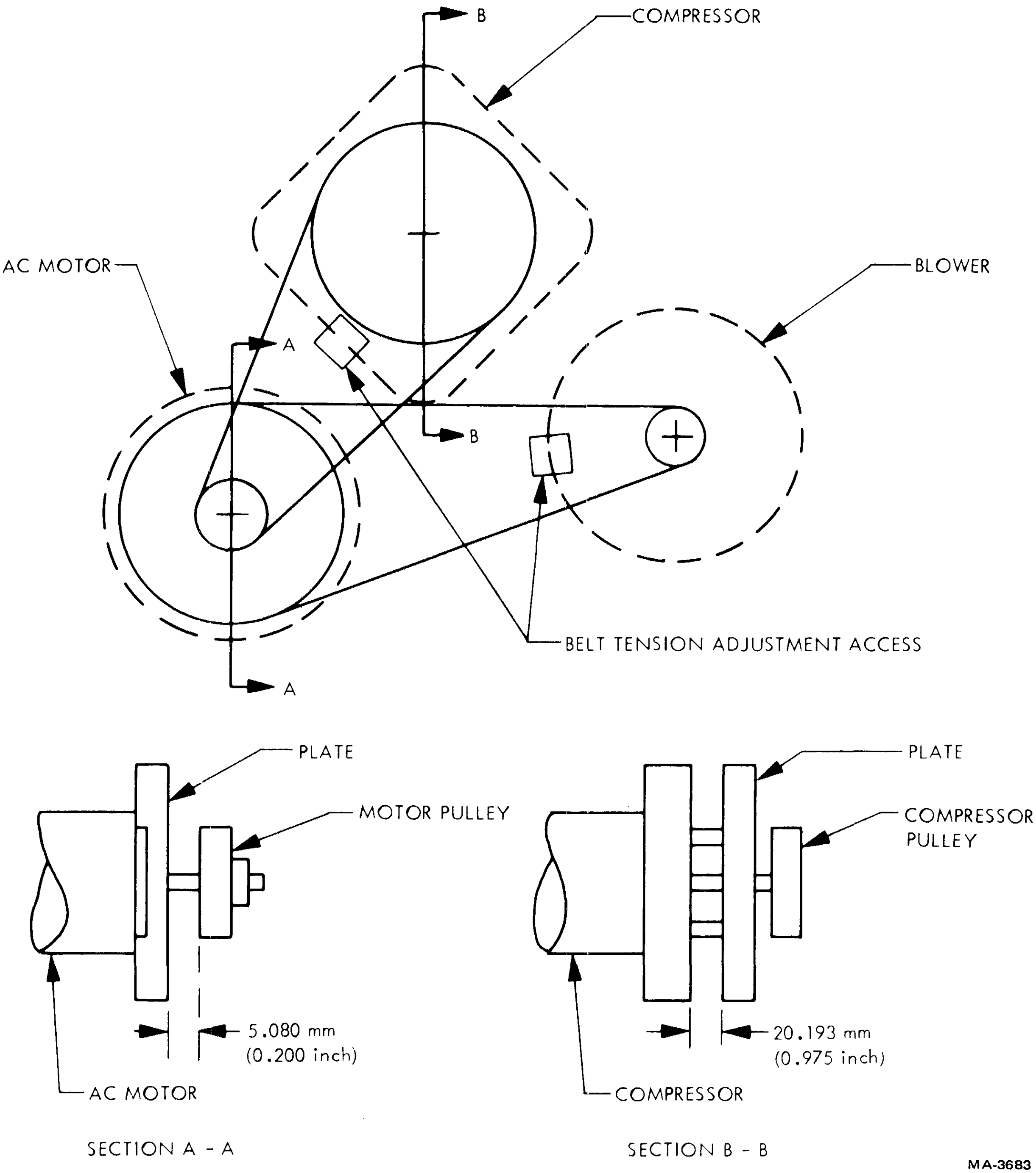


Figure 6-39 Blower and Compressor Pulley Alignment

7. Install replacement blower.

8. Reassemble in reverse order using steps 3 through 6.

9. Exert approximately 111.2 N (25 lb) of force on blower to tension the belt while tightening the three blower mounting screws. A slot is provided in the mounting plate to pivot a large screwdriver against the blower housing for tensioning the belt.

10. Attach hose to top of blower and assemble belt guard.

11. Connect the power cord and turn transport power on at the power control.

12. Perform vacuum and air pressure adjustments (Paragraph 6.5.6).

6.7.12 Compressor Removal and Replacement
Remove and replace the compressor as follows.

1. Turn transport power off at the cabinet power control and disconnect the power cord.

2. Remove belt guard. Remove tubes from top of compressor.

3. Loosen compressor mounting screws. Slide compressor left and slip belt off pulley.

4. Remove pulley from compressor.

5. Remove capacitor chassis mounting screws in front of power pack assembly and position chassis towards transformer.

6. Remove compressor mounting screws and remove compressor.

7. Transfer fittings to replacement compressor.

8. Install replacement compressor.

9. Reassemble in reverse order using steps 3 through 6 and setting pulley position according to Figure 6-39.

10. Exert approximately 111.2 N (25 lb) force on compressor to tension the belt while tightening the four compressor mounting screws. A slot is provided in the mounting plate to pivot a large screwdriver against the compressor housing for tensioning the belt.

11. Attach tubes to top of compressor. Manually rotate motor pulley clockwise and check that compressor belt does not overhang pulleys; readjust compressor pulley if necessary.

12. Connect the power cord and turn transport power on at the power control.

13. Perform vacuum and air pressure adjustments (Paragraph 6.5.6).

6.7.13 Air Valve Solenoid Replacement

When replacing the solenoid on either the vacuum or pressure transfer valve assembly, you must adjust the solenoid as follows.

1. Loosen the solenoid mounting screws slightly to allow freedom of movement.

2. Turn transport power off.

3. Ground the appropriate test point to enable solenoid current:

   Vacuum transfer valve   Control M TP72 (NXFR)
   Pressure transfer valve   Control M TP51 (NPOL)
   Ground to TP49.

4. Turn transport power on. The solenoid should be energized.

5. With the solenoid energized and the valve poppet pulled in, grasp the solenoid body and apply pressure away from the valve body until no movement of the actuator rod is detected. Tighten the mounting screws without relaxing pressure.

6. Remove the ground jumper.

6.7.14 Printed Circuit Board Assembly (PCBA) Removal and Replacement

This section lists the procedures to remove and replace all PCBAs.

6.7.14.1 M8940 Magnetic Tape Adapter PCBA (Slot 1)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 2-6).

3. Remove the six (or three) slave cables from jacks J1 through J6.

4. Grasp the plastic handles at the edges of the PCBA and pull straight out of the interconnect D1 backplane.

NOTE
Perform step 5 only if this is the only TU77 in the system or the end TU77 of a slave bus daisy chain.

5. Remove the five resistor terminator DIP chips (Figure 2-13 for location) and transfer them to the new PCBA to be installed, taking note of orientation.

6. Cut the serial number jumpers, W1 through W16 on the new PCBA to match those on the original.

7. Insert the new PCBA and reconnect the six (or three) slave cables. Ensure maintenance switch S4 is to the left (normal).

8. Install the PCBA retainer clip.

9. Turn transport power on and ensure that the "+5 volt present" LED (middle) is lit. If not, remove power immediately and troubleshoot problem.

10. Run the appropriate diagnostics to confirm transport operation.

6.7.14.2 Data L PCBA (Slot 2)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 2-6).

3. Remove the read data cable from J4.

4. Pull the PCBA straight out of the interconnect D1 backplane and insert the new PCBA in its place.

5. Reconnect the read cable.

6. Install the PCBA retainer clip.

7. Turn transport power on and ensure that the "+5 volt present" LED (middle LED on the M8940) is lit. If not, remove power immediately and troubleshoot problem.

8. Perform the following adjustment procedures:

   NRZI threshold (Paragraph 6.5.8.1)
   NRZI gain (Paragraph 6.5.8.2)
   NRZI character gate (Paragraph 6.5.8.4)
   PE threshold (Paragraph 6.5.8.5)
   PE gain (Paragraph 6.5.8.6).

9. Run the appropriate data reliability diagnostic.

6.7.14.3 Write PCBA (Slot 3)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 2-6).

3. Remove the write data cable from J6.

4. Pull the PCBA straight out of the interconnect D1 backplane and insert the replacement PCBA in its place.

5. Reconnect the write cable.

6. Install the PCBA retainer clip.

7. Turn transport power on and ensure that the "+5 volt present" LED (middle LED on the M8940) is lit. If not, remove power immediately and troubleshoot problem.

8. Perform the write deskew adjustment (Paragraph 6.5.9).

9. Run the appropriate data reliability diagnostic.

6.7.14.4 Control M PCBA (Slot 4)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 2-6).

3. Remove the control cable from J10.

4. Pull the PCBA straight out of the interconnect D1 backplane.

5. Ensure jumpers W1 through W16, on the new PCBA, are cut according to the original PCBA. (Engineering Dwg. No. 104745 sheet 1, Table II, Version -02).

6. Insert the new PCBA and reconnect the control cable.

7. Install the PCBA retainer clip.

8. Switch S1 on the new PCBA should be in the center position.

9. Turn transport power on and ensure that the "+5 volt present" LED (middle LED on the M8940) is lit. If not, remove power immediately and troubleshoot problem.

10. Run the appropriate diagnostics to confirm transport operation.

6.7.14.5 Capstan Servo PCBA (Slot 5)

1. Turn transport power off.

2. Unscrew, but do not remove, the six hex-cap screws holding the PCBA heat sink to the card cage heat sink at the rear. This is accomplished with the 5/32-inch ball end driver and extension.

3. Pull the PCBA out of the card cage. Some rocking action may be necessary in order to free the heat sink due to adhesion of the thermal compound.

4. Spread a thin film of thermal compound on the mating surface of the new PCBA and install it. Tighten the screws securely.

5. Turn transport power on and ensure that the "+5 volt present" LED (middle LED on M8940) is lit. If not, remove power immediately and troubleshoot problem.

6. Perform the following checks/adjustment procedures.

   Power distribution (Paragraph 6.5.1)
   Capstan servo adjustments (Paragraph 6.5.5)
   NRZI gain adjustment (Paragraph 6.5.8.2)
   PE gain adjustment (Paragraph 6.5.8.6).

7. Run the appropriate diagnostics to confirm transport operation.

6.7.14.6 Reel Servo PCBA (Slot 6)

1. Turn transport power off.
2. Remove the four reel motor connecting wires at the bottom of the PCBA.
3. Unscrew, but do not remove, the six hex-cap screws holding the PCBA heat sink to the card cage heat sink at the rear. This is accomplished with the 5/32-inch ball end driver and extension.
4. Pull the PCBA out of the card cage. Some rocking action may be necessary in order to free the heat sink due to adhesion of the thermal compound.
5. Spread a thin film of thermal compound on the mating surface of the new PCBA and install it. Tighten the screws securely.
6. Replace the four reel motor connecting wires.
7. Turn transport power on and ensure that the "+5 volt present" LED (middle LED on M8940) is lit. If not, remove power immediately and troubleshoot problem.
8. Perform the following checks/adjustment procedures.

   Power distribution (Paragraph 6.5.1)
   Reel servo adjustments (Paragraph 6.5.7) PG 6-24
   Dynamic brake check (Paragraph 6.6.6.1) PG 6-63

9. Run the appropriate diagnostics to confirm transport operation.

6.7.14.7 Preamp PCBA

1. Turn transport power off.
2. Open the transport front door and the buffer box door. Swing the base assembly out.
3. Unplug the read data cable from J4 on the data L PCBA.
4. Unplug the write data cable from J6 on the write PCBA.
5. Free the two data cables from all retaining clamps.
6. Remove the four screws holding the preamp PCBA to its mounting bracket and rotate the board away from the bracket while releasing the read/write connectors at the rear of the head assembly. Unplug the erase head wires from pins E1 and E2.
7. Pull PCBA and cables out of the base assembly.
8. Install the new PCBA in reverse order ensuring that the phenolic insulator is between PCBA and bracket. Note that the white erase head lead connects to E1 and the black lead to E2.

9. Perform the following adjustment procedures:

   NRZI gain (Paragraph 6.5.8.2)
   PE gain (Paragraph 6.5.8.6).

10. Run the appropriate data reliability diagnostic to confirm transport operation.

6.7.14.8 Interconnect F1 PCBA

1. Turn transport power off.

2. Swing the base assembly out.

3. Disconnect the flat cable from J21 on interconnect F1.

4. Record the wire color and connection point of all wires making connection at TB1, TB2, TB3 and TB4. Remove the wires.

5. Remove the PCBA from the base assembly by alternately unscrewing the four retaining screws no more than two turns each, in rotation, around the PCBA until all are free.

CAUTION

The screws are held captive to the PCBA spacers and if each screw is entirely removed, independent of the others, the PCBA will undergo a torsional strain which may fracture the etched conductors.

6. Install the new PCBA in reverse order noting the procedure and caution in step 5.

7. Perform the following adjustment procedures:

   EOT/BOT (Paragraph 6.5.2)
   Low tape sensor (Paragraph 6.5.4)
   Tape loop position (Paragraph 6.5.7.4).

8. Run the appropriate diagnostics to confirm transport operation.

6.7.14.9 Interconnect D1 PCBA

1. Turn transport power off at the power control.

2. Remove all card cage PCBAs according to Paragraphs 6.7.14.1 through 6.7.14.6.

3. Open the cabinet rear access door.

4. Remove the plastic shield over terminal strip TB1 at the rear of the interconnect D1 PCBA.

5. Record the wire color of wires connecting to TB1. Remove the wires.

6. Remove flat cable from J24 on interconnect D1.

7. Remove seven cap-head retaining screws and pull the PCBA out of the front of the cabinet.

8. The new PCBA will have two jumpers (W1 and W2) between J201 and J204. Cut jumper W2.

9. Install the new PCBA in reverse order.

10. Run the appropriate diagnostics to confirm transport operation.

APPENDIX A
GLOSSARY

A.1 GENERAL NOTES

1. I, prefixed to a mnemonic term, designates an interface I/O signal. If the term contains a suffix R (receiver), the signal is an input (with respect to the tape transport). Similarly, a suffix D (driver) implies an output signal. Low = true for all I/O signals.

NOTE

Care should be exercised to avoid confusing specialized uses of I, R, and D, such as I for inverted in NRZI, R for read, and D for data.

2. N, prefixed to a mnemonic term has a meaning similar to a logic bar or not symbol. N implies that the true signal identified by the remainder of the term is electronically low (low = true) at the critical point in the circuit identified by the term.

3. Status signals are true if the condition monitored is true; e.g., LOAD FAULT is true if the tape is improperly loaded.

4. Mnemonics for signals derived from circuits controlled by switches (automatic as well as manual) may include N.O. (normally open) or N.C. (normally closed).

5. D is prefixed to a term to mean that the signal has been delayed with reference to the signal identified by the remainder of the term.

Mnemonic	Meaning
ABP	Air Bearing Pressure
ACCL	Acceleration
ACCEL	Acceleration
BOT	Beginning of Tape
BPI	Bits Per Inch
BWC	Bandwidth Control
C0–C4	Load/Unload Sequence Count 0 through 4 (High = True)
CC N.O.	Cartridge Closed (Low = True)
CENBL	Capstan Enable
CLK	Clock
CLKA	Clock A (1 MHz)
CLKB	Clock B (100 KHz)
CLKC	Clock C (10 KHz)
CLKD	Clock D (100 Hz) Not Used
CLKE	Clock E (10 Hz)
CLKF	Clock F (1 Hz)
CLKG	Clock G (0.5 Hz)
CLR	Clear

Mnemonic	Meaning
CM	Capstan Motor
CO N.O.	Cartridge Open (Low = True)
CONT	Continuous
CPU	Central Processor Unit
CRC	Cyclic Redundancy Check
CRCC	Cyclic Redundancy Check Character
CRNO	Crippled Reel Normally Open (Low = True)
DDI	Data Density Indicator Signal
DEN	Density
DINTLK	Delayed Interlock Pulse
DIP	Dual In-Line Package
DIR	Direction of Capstan Motion
DONL	Delayed On-Line Signal
DRV	Drive
DT	Drive Type
DVR	Driver Output of Capstan Summing Amplifier
EDN	Erase Drive Current
EMD	Enable Motion Delay
END PT	End Point
EOT	End of Tape
F	Frequency
FCI	Flux Changes per Inch
FF	Flip-Flop
FPT	File Protected (High = True)
F/V	Frequency-to-Voltage Converter
FWD	Forward
HI DEN	High Density
I	I/O (see Note 1)
IBOT	Beginning of Tape Interface Output (Low = True)
ID	Identification
IDDI	Data Density Indicator Signal Output (Low = True)
IDDS	Data Density Select Input
IEOT	End of Tape Output Signal (Low = True)
IFPT	File Protect Signal at Interface (Low = True)
ILDP	Load Point (Low = True when tape is at load point)
INIT	Initialize
INRZ	NRZI Interface Command (Low = True for NRZI select)
INTLKP1	Pulsed Interlock (occurs after INTLK before DINTLK)
IONL	On-Line Signal at Interface (Low = True)
IPS	Inches Per Second
IRD	Interchange Read
IRD0–IRD7	Read Data Bit 0 through 7 Output, respectively. Interface signal (Low = True)
IRDP	Read Data Parity Output. Interface Signal (Low = True)
IRDS	Read Data Strobe. Interface Signal (Low = True)
IRDY	Tape Transport Ready Output. Interface Signal (Low = True)
IRG	Inter-Record Gap
IRTH1	Read Threshold Level 1 Character Gate Input. Interface Signal (Low = True)
IRTH2	Read Threshold Level 2 Threshold Input. Interface Signal (Low = True)
IRWC	Rewind Command Input. Interface Signal (Low = True)
IRWD	Rewinding Signal Output. Interface Signal (Low = True)
IRWU	Rewind and Unload Command Input. Interface Signal (Low = True)
ISFC	Synchronous Forward Command Input. Commands tape forward motion for either reading or writing (Low = True).

Mnemonic	Meaning
ISGL	Single (not used)
ISLT0	Select Transport No. 0 input. Interface Signal (Low = True)
ISLT1	Select Transport No. 1 input. Interface Signal (Low = True)
ISLT2	Select Transport No. 2 input. Interface Signal (Low = True)
ISLT3	Select Transport No. 3 input. Interface Signal (Low = True)
ISPEED	Speed Selection Input (not used)
ISRC	Synchronous Reverse Command Input. Commands tape motion in reverse at reading speed.
ISWS	Set Write Status. Interface Signal (Low = True)
ITACH	Tachometer Output. Interface Signal (Low = True)
IWARS	Write Amplifier Reset Strobe. Interface Signal (Low = True)
IWD0–IWD7	Write Data Bit 0 through 7, respectively. Interface Signal (Low = True)
IWDP	Write Data Parity. Interface Signal (Low = True)
IWDS	Write Data Strobe. Interface Signal (Low = True)
I7TK	Seven Track Interface Signal (not used)
I9TK	Nine Track Inteface Signal (Low = True)
LDP	Load Point
LD/REW	Load/Rewind
LED	Light Emitting Diode
LO DENSITY	Low Density (for PE mode)
LOAD FAULT	Load Fault Warning Signal
LRC	Longitudinal Redundancy Check
LRCC	Longitudinal Redundancy Check Character
MOL	Medium On-Line
MOT	Motion
MRL	Mid-Reel Load
ms	Millisecond
MTA	Magnetic Tape Adapter
MUX	Multiplexer
N>80%	Capstan speed is greater than 80% (Low = True)
NAOK	Air OK (Low = True)
NBOT	Beginning of Tape (Low = True)
NCO–4	Load/Unload Sequence count 0 through 4 (Low = True)
NCCC	Cartridge Closed Command (Low = True)
NCOC	Cartridge Open Command (Low = True)
NDINTLK	Delayed Interlock Signal (Low = True)
NDRV	Capstan Drive (Low = True)
NGOP	Go Pulse (Low = True)
NHID	High Density Signal (High = PE; Low = NRZI)
NHIDI	High Density Signal Inverted. (Disables NRZI Gain Circuits) (Low = True)
NLDC	Load Clock (Low = True)
NLDFS	Load Fault Status (Low = True)
NLDP	Load Pulse (Low = True)
NLDS	Load Status (Low = True)
NLO	Load and On-Line (Low = True)
NLOIP	Loss of Interlock Pulse (Low = True)
NLRST	Load Reset (Low = True)
NLTP	Low Tape Pulse (Low = True)
NMRL	Mid-Reel Load (Low = True)
NMRSTP	Master Reset Pulse (Low = True)
NPE	Phase Encoded (Low = True)
NPOL	Pressure On-Line (Low = True)

Mnemonic	Meaning
NPORST	Power Reset. Reset signal generated when power is turned on (Low = True)
NREWP	Rewind Pulse (Low = True)
NRSAE	Reel Servo Amplifier Enable (Low = True)
NRST1	Reset 1 (Low = True)
NRTY	Retry (Repeat load attempt) (Low = True)
NRWC	Rewind Command (Low = True)
NRWR	Rewind Ramp (Low = True)
NRWS	Rewind Status (Low = True)
NRZEN	NRZI Enable
NRZI	Non-Return to Zero, Inverted
NRZIT	NRZI Threshold Enable
NSFC	Synchronous Forward Command to move tape in forward direction at reading and writing speed (Low = True)
NSLTA	Transport Select Signal (Low = True)
NSMR	Small Reel Sense Signal (Low = True)
NSRC	Synchronous Reverse Command for reverse motion at reading speed (Low = True)
NSTART	Capstan Start Command (Low = True)
NTAP2	Tach Pulse 2 (squared and set at 20 μs pulses) (Low = Tach mark sensed true)
NTEN	Tach Enable (Low = True)
NTEST	Test Signal (Low = True) not used
NTESTA	Test Signal to select transport (Low = True) not used
NTIP	Tape in Path (Low = True)
NTRWC	Test Rewind Command (Low = True) not used
NTSFC	Test Synchronous Forward Command to move tape forward at reading and writing speed (Low = True) not used
NTSRC	Test Synchronous Reverse Command to move tape in reverse at reading and writing speed (Low = True) not used
NTSKEW	Test Skew Signal (Low = True)
NTSTR	Test Write Strobe (Low = True) not used
NTWRC	Test Write Command (Low = True) not used
NULC	Unload Command (Low = True)
NULRW	Rewind and Unload Command (Low = True)
NUNL	Unload (Low = True)
NUNLC	Unload Command (Low = Trqe)
NUNLC1	Unload Command 1 (Low = True)
NUNLC2	Unload Command 2 (Low = True)
NUNL1	Unload Status 1 (Low = True)
NWCTP	Write Current Toggle Pulse (Low = True)
NWCT0–NWCT7	Write Current Toggle Bit 0 through 7, respectively (Low = True)
NWLFB	Write Lockout Signal Feedback
NRWT	Write Signal (Low = True)
NWSPE	Write Strobe Phase Encoded (Low = True)
NW/TDS	Write and/or Test Data Strobe (Low = True)
NXFR	Energize Vacuum Transfer Solenoid (Low = True)
ONL	On-Line
ONLA	On-Line (Fanned out from point A.)
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PE	Phase Encoded
PES	Phase Encoded Status
PET	Phase Encoded Threshold

Mnemonic	Meaning
PETL	Phase Encoded Threshold Set at Low Level
PKSN	Pack Sense
PLE	Pressure Line Enable
PLS	Pulse
PNU	Pneumatic (Blower System on) Command
PNU RETURN	Pneumatic System Return Signal
PSOL	Pressure Solenoid Command
RD	Read Data
RD0–RD7	Read Data Bit 0 through 7, respectively (High = True)
RDP	Read Data Parity Bit (also used as feedback to Read Character Generator and to produce RDS)
RDS	Read Data Strobe
RDY	Ready
REC	Record
REV	Reverse or Capstan Reverse
REW	Rewind
REWGEN	Rewind Generator
RH0–RH7	Read Head Output Bit 0 through 7, respectively
RH0A–RH7A	Read Head Output Amplified (after Dual Gain Amplifier) for bits 0 through 7, respectively
RHP	Read Head Output for Parity Bit (to Preamplifier)
RHPA	Read Head Output for Parity Bit Amplified (after Dual Gain Amplifier)
RIEN	Read Interface Enable
ROM	Read Only Memory
RSD	Read Strobe Delay
RSDO	Read Strobe Delay Over
RST	Reset
RWD	Rewind
RWND	Rewind
RWS	Rewind Status
SB	Slave Bus
SCSH	Supply Crossover High
SCSL	Supply Crossover Low
SDWN	Settle Down
SEL	Select
SELA	Select A
SLA	Slave Attention
SLIMIT	Supply Tape – Loop Limit
SLTA	Transport Selected by Controller
SN	Serial Number
SPOS	Supply (Loop) Position
SPR	Slave Present
SRF	Supply Reel Forward
SRO	Selected, Ready and On-Line Signal
SRR	Supply Reel Reverse
SS	Slave Select
SSC	Slave Status Change
STRB	Strobe
TACH	Tachometer
TACHP	Tachometer Output Pulse to Interface
TAP1	Tach Pulses No. 1 (squared)
TAP2	Tach Pulses No. 2 (squared and set at 20 μs each)

Mnemonic	Meaning
TFWD	Test Forward
TIP	Tape In Path
TLIMIT	Takeup Tape - Loop Limit
TOR	Tape On Reel
TPOS	Takeup (Loop) Position
TRF	Takeup Reel Forward
TRR	Takeup Reel Reverse
TRV	Test Reverse
TST	Test
TUR	Tape Unit Ready
UNL	Unload
VAC	Vacuum Applied
VLE	Vacuum Line Enable
VRC	Vertical Redundancy Check
WC0-WC7	Write Current Bit 0 through 7, respectively
WCCG	Write Current Control Gain Signal
WCCR	Write Current Control Ramp
WCP	Write Current Parity Bit
WCS	Write Current Strobe
WCT0-WCT7	Write Control Toggle Bit 0 through 7, respectively
WCTP	Write Current Toggle Parity Bit
WD	Write Data
WDS EN	Write Data Strobe Enable
WE	Write Enable
WHD	Write High Density
WLO	Write Lockout
WPINO	Write Protect Solenoid Set
WRL	Write Lock
WRT	Write or Write Signal
WRT CLK	Write Clock
WRT PWR	Write Power
W/TD0-W/TD7	Write/Test Data Bit 0 through 7, respectively
W/TDP	Write/Test Data Parity Bit
W/TDS	Write/Test Data Strobe
WTE	Write Toggle Enable
7TK	Seven Track (not used)
9TK	Nine Track

APPENDIX B
FLOWCHART GLOSSARY

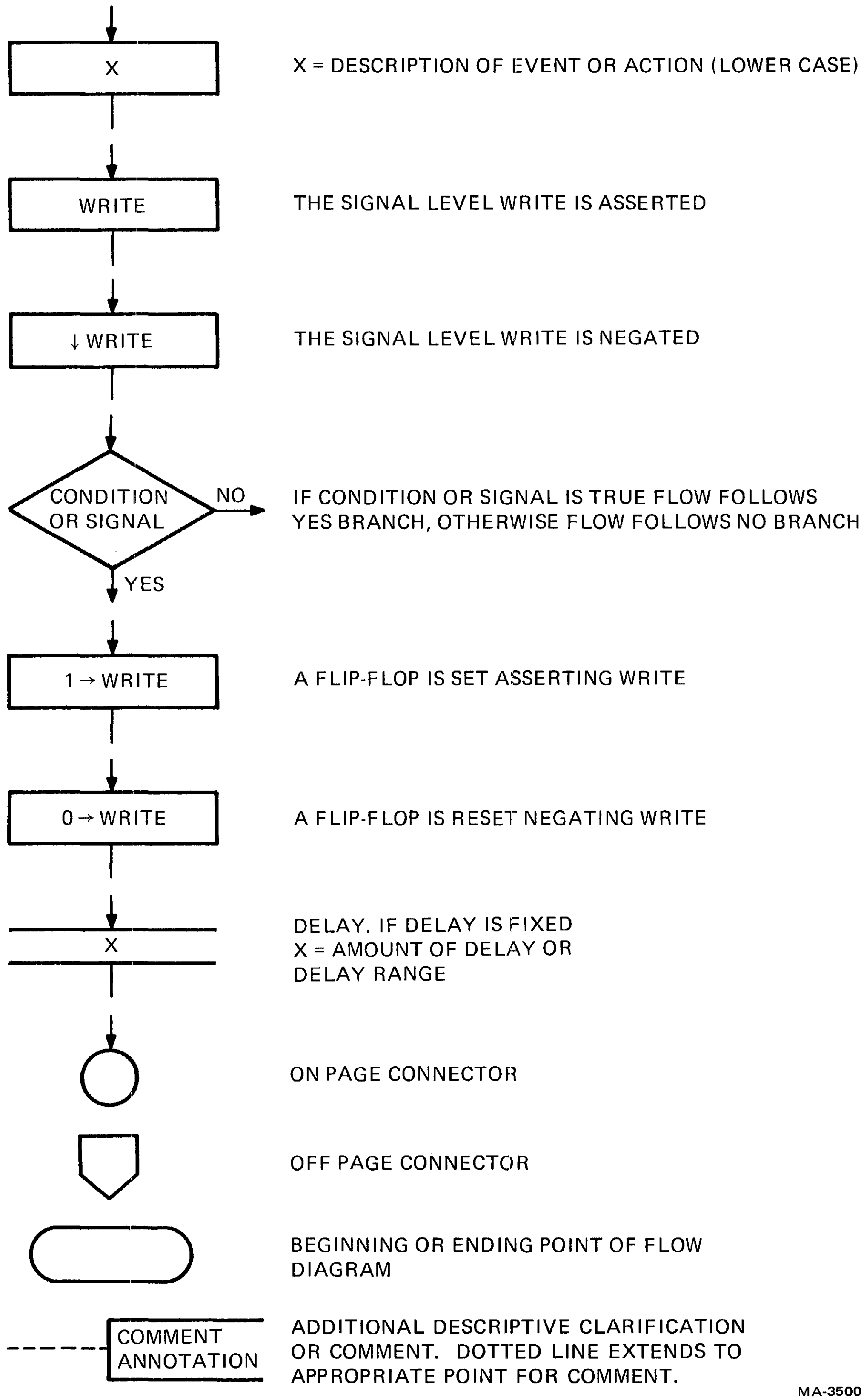


Figure B-1 Flowchart Glossary

APPENDIX C
RECORDING TECHNIQUES

C.1 NRZI (Non-Return to Zero Inverted)

C.1.1 Definition

NRZI is a recording technique which requires a change of state (flux change) to write a 1, and no change of state (no flux change) to write a 0.

C.1.2 Format

C.1.2.1 Cyclic Redundancy Check Character (CRCC) – This is a check character that is written four character spaces after the last character of an NRZI record (9-channel only). CRCC is derived by a complex mathematical formula applied to the characters written in the record. The result of this manipulation (CRCC) can be used to recover a lost bit in a record read from tape.

C.1.2.2 Longitudinal Parity Check Character (LRCC) – This check character is written four character spaces after CRCC (9-channel). LRCC consists of one bit of even parity for each track of data. For example, if track 1 had an odd number of 1s written in a record, then a 1 must be written in the LRCC bit associated with track 1.

C.1.2.3 Tape Mark – A 9-channel NRZI tape mark consists of one tape character (23_8), followed by seven blank spaces, and then LRCC (23_8) (CRCC is not written). Figure C-1 illustrates 9-channel NRZI tape format.

C.2 PE (Phase Encoding)

C.2.1 Definition

Phase encoding is a recording technique in which a flux reversal occurs for each bit of information written on the tape. A 1 can be defined as a positive level followed by a negative transition, while a 0 can be defined as a negative level followed by a positive transition.

Sequential flux transitions on the tape are either at the data rate or at twice the data rate. Sequential 1s or sequential 0s will cause flux reversals to occur at twice the data rate (Figure C-2a). Alternate 1s and 0s cause flux reversals to occur at the data rate (Figure C-2b).

C.2.2 Format

To ensure proper extraction of PE data from the serial stream of transitions coming off the tape, PE data must be recorded in a precise format. A PE record consists of preamble, data, and postamble.

1. Preamble: Forty characters of 0s in all nine tracks, followed by a character of 1s in all nine tracks.

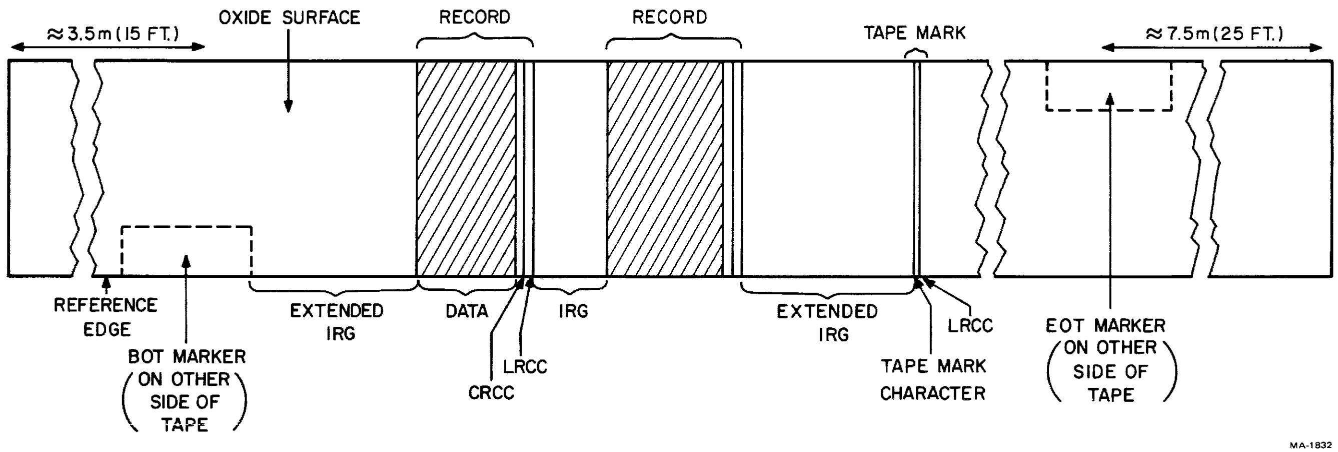
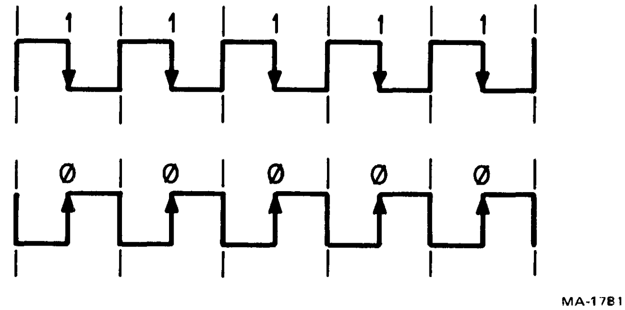
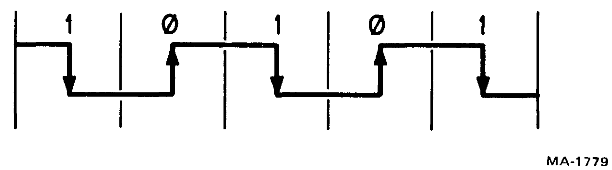


Figure C-1 NRZI Format (Nine-Channel)



a. Sequential Ones and Sequential Zeros



b. Alternate Ones and Alternate Zeros

Figure C-2 PE Waveforms

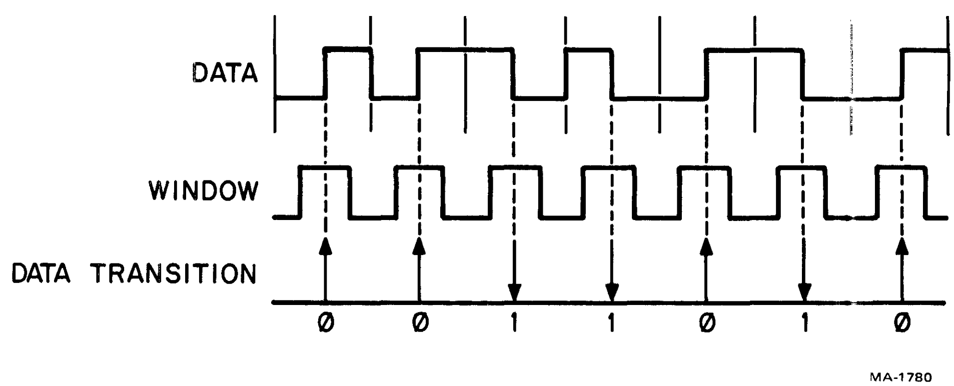


Figure C-3 Data Window

2. Postamble: One character of 1s in all nine tracks, followed by 40 characters of 0s in all nine tracks.

The PE read electronics uses a data window to isolate data transitions (Figure C-3). Zeros in the preamble are used to set the window in position when reading in a forward direction, while 0s in the postamble perform this function when reading in the reverse direction. The all-1s character in the preamble and postamble is used to mark the beginning of data.

C.2.2.1 Tape Mark – A PE tape mark consists of forty 0s in tracks 1, 2, 4, 5, 7, and 8 (bit positions 0, 1, 2, 5, 7, and 8) with tracks 3, 6, and 9 (bit positions 4, 6, and 3) dc erased.

C.2.2.2 Identification Burst (IDB) – The IDB identifies the tape as being a PE tape. It consists of alternating 1s and 0s in the parity track (track 4) with all other tracks erased. The IDB is located at BOT, and has a minimum length of 4.3 cm (1.7 in). Figure C-4 illustrates PE tape format.

C.2.3 PE Characteristics

Phase encoding, also referred to as Manchester, Williams, Ferranti method for phase modulation, is currently used in high-density (1000–2000 bpi) magnetic tape stores. A cell is occupied by a square wave with one cell period. The usual convention is that it represents a logical 0 if the first half of the square-wave is positive and the second half is negative; for a logical 1 it is the opposite. In other words, a positive-to-negative transition, in the middle of a cell, represents a logical 0. A flux transition from negative to positive, in the middle of a cell, signifies a logical 1. If two identical symbols – two logical 0s or two logical 1s – follow each other, there is an interbit flux transition at the boundary of the cell. This interbit flux transition will be ignored by the readback circuitry. PE is self-clocking as there is always a flux transition per cell.

Comparing NRZI with PE, it would appear at first that as phase modulation requires more transitions per bit than NRZI, it would permit lower maximum bit density. There are however, more important considerations. In NRZI coding, the spacing of subsequent transitions may vary from a minimum, determined by the chosen bit density for a string of logical 1s, to a large value for a long string of 0s. This random variation of transitions causes peak shift and amplitude fluctuations. In a phase-encoded system, the ratio of maximum to minimum spacing is 2. Although, in a system with fixed magnetic and mechanical parameters, pulse crowding and peak shift phenomena are reached at a lower bit packing density with PE than with NRZI coding, the peak shift and amplitude fluctuation in PE are well defined and constant.

The comparison of the frequency spectra of NRZI and PE systems reveals another important difference between the two. The noise* spectrum of a practical system exhibits large peaks at the low frequency end. Although the highest frequency in a PE system is twice that of the corresponding NRZI, the required band does not extend to low frequencies and a better signal-to-noise ratio can be achieved.

With respect to the coding system's sensitivity to read errors, some broad qualitative conclusions are obtained. If in an NRZI coding system a single 1 or a single 0 is misread, it will have no effect on the interpretation of the next data bits in the sequence. [As NRZI is not self-clocking, in a parallel-recording multitrack system each character must have at least one low-transition (i.e., logical 1) in it from which the read clock is derived.]

In a typical phase-encoded readback channel, the read clock is derived from the data flux transition. The read logic separates the bit flux transitions, which occur in the middle of the cell, from the interbit transitions at the cell boundaries by opening a window at the expected bit transition time (Figure C-3). The possible consequences of a single-bit dropout are illustrated in Figure C-5. It is assumed that the dropout occurs in the position of a bit-transition in a long chain of logical 1s. The interbit transition following the dropout will now generate the next clock pulse. The subsequent logical 1s are misread until synchronism is regained. Thus a single bit-transition dropout can cause an error burst extending over many bit lengths. In actual systems the possibility of this type of error is avoided by provision of a phase-lock oscillator. The oscillator is normally resynchronized at every bit flux transition, but can maintain synchronism over a certain number of bits without resynchronization.

*Noise includes all unwanted signals as well as random noise.

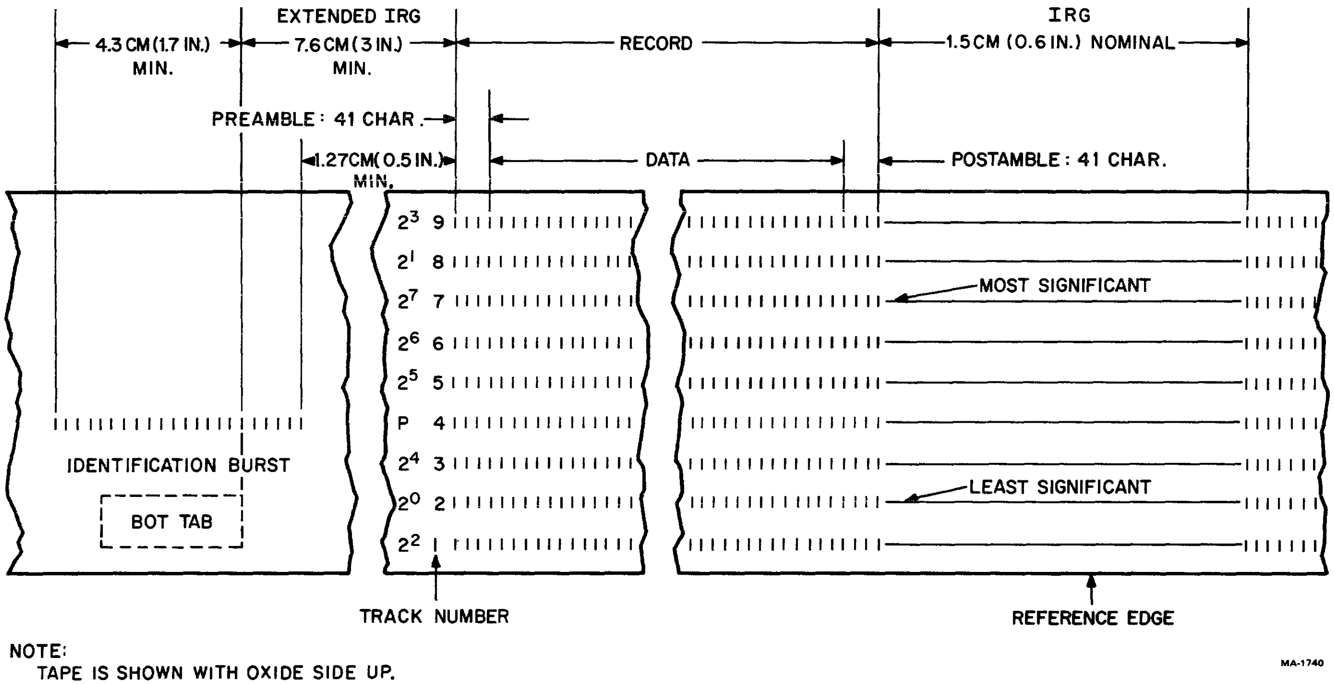


Figure C-4 PE Recording Format

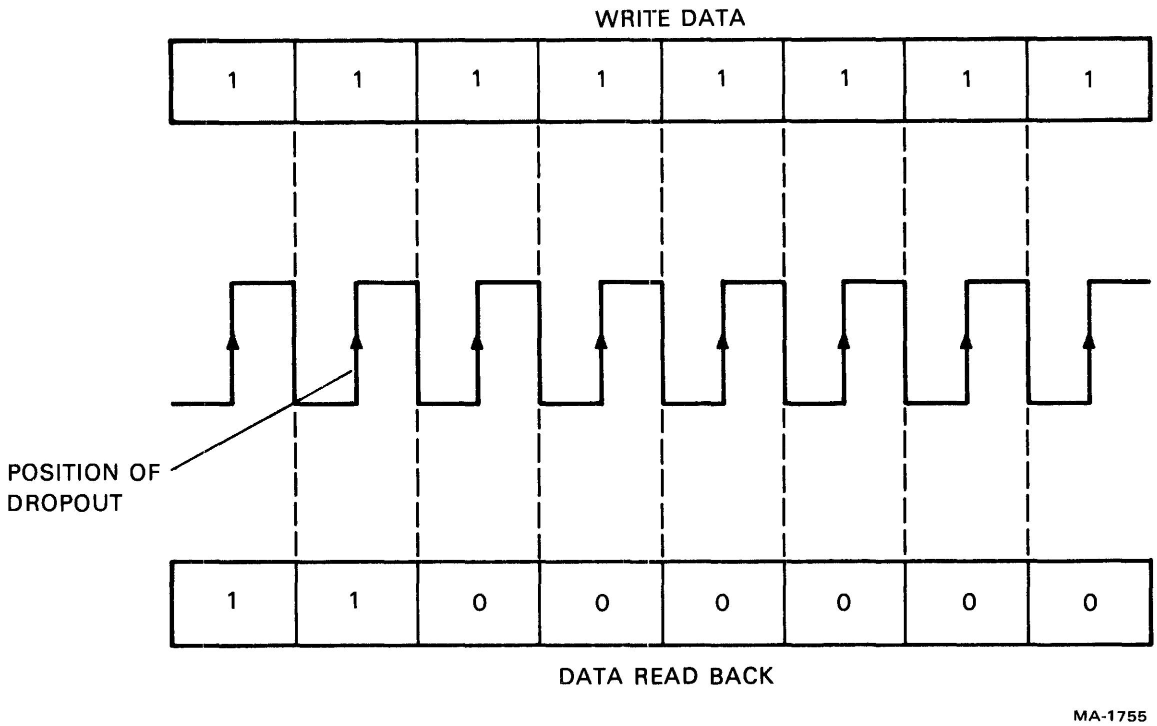


Figure C-5 Potential Error Caused by Single Bit Dropout in PE

The checklist of PE reads is as follows.

1. Efficiency is low (50 percent). There are two flux reversals per bit.

2. Correlation is good; there is the maximum possible difference between logical 0 and 1.

3. Bandwidth requirement is fair, does not extend to low frequencies, but maximum frequency is twice that of NRZI at the same density.

4. The system is self-clocking.

5. Read resolution is poor, limited to a half-bit period.

6. Circuit complexity is higher than for NRZI.

7. Noise immunity is good; peak shift and amplitude fluctuation is predictable and constant at any one recording density.

The phase-encoded format (Figure C-4) does not utilize the CRC and LRC characters for error checking. Each data block is preceded by 40 all-0s bytes followed by a single all-1s byte (preamble) and is terminated by a single all-1s byte followed by 40 all-0s bytes (postamble). The preamble synchronizes the read detection circuits so that 1s and 0s are correctly identified in the data bytes which follow. The symmetry of preamble and postamble permits reading in either direction. At the load point (beginning of tape), an identification burst consisting of 1600 FCI, is written in the parity track. Odd character parity is specified. The tape mark consists of 64 to 256 flux reversals at 3200 FCI in tracks 1, 2, P, 5, 7, 8. The remaining tracks are dc erased.

In phase-encoded systems there is, contrary to NRZI coding, a continuous readback signal. Due to the bandwidth limitation of the record/reproduce chain and the inherent properties of the recording media, this signal appears as a near-sinusoidal signal. In high-density phase-encoded systems, the zero-crossings of this quasi-sinusoidal signal can be used for accurate location of the readback pulse. This detection system is used for some single-track serial recordings.

APPENDIX D
INTERFACE WIRE LIST AND TRANSPORT INTERCONNECTIONS

Table D-1 Slave Bus 1 Interface Signals

Connector	Pin	Signal	Connector	Pin	Signal
J1/J2	A	WD0 (SB1)	J1/J2 (cont)	B	GND
	C	WDP (SB1)		D	GND
	E	WD1 (SB1)		F	GND
	H	WD7 (SB1)		J	GND
	K	WD2 (SB1)		L	GND
	M	WD6 (SB1)		N	GND
	P	REC (SB1)		R	GND
	S	ACCL (SB1)		T	GND
	U	SS01 (SB1)		V	GND
	W	LRC STRB (SB1)		X	GND
	Y	SS02 (SB1)		Z	GND
	AA	WD5 (SB1)		BB	GND
	CC	WD4 (SB1)		DD	GND
	EE	WD3 (SB1)		FF	GND
	HH	SS00 (SB1)		JJ	GND
	KK	SLAVE SET PLS (SB1)		LL	GND
	MM	EMD (SB1)		NN	GND
	PP	INIT PLS (SB1)		RR	GND
	SS	DRV CLR PLS (SB1)		TT	GND
	UU	STOP (SB1)			
	VV	+5 V (SB1)			

Table D-2 Slave Bus 2 Interface Signals

Connector	Pin	Signal	Connector	Pin	Signal
J5/J6	A	RD0 (SB2)	J5/J6 (cont)	UU	REV (SB2)
	C	RDP (SB2)		VV	+5 V (SB2)
	E	RD1 (SB2)		B	GND
	H	RD7 (SB2)		D	GND
	K	RD2 (SB2)		F	GND
	M	RD6 (SB2)		J	GND
	P	RD3 (SB2)		L	GND
	S	RD5 (SB2)		N	GND
	U	RD4 (SB2)		R	GND
	W	RSDO (SB2)		T	GND
	Y	BOT (SB2)		V	GND
	AA	END PT (SB2)		X	GND
	CC	SET SSC (SB2)		Z	GND
	EE	RWND (SB2)		BB	GND
	HH	SET VPE (SB2)		DD	GND
	KK	TUR (SB2)		FF	GND
	MM	WRT CLK (SB2)		JJ	GND
	PP	FWD (SB2)		LL	GND
	RR	CLOCK (SB2)		NN	GND
	SS	WRITE (SB2)		TT	GND

Table D-3 Slave Bus 3 Interface Signals

Connector	Pin	Signal	Connector	Pin	Signal
J3/J4	A	MOL (SB3)	J3/J4 (cont)	AA	DT01 (SB3)
	B	PES (SB3)		CC	WRL (SB3)
	C	7CH (SB3)		EE	DEN00 (SB3)
	D	SN00 (SB3)		HH	DT00 (SB3)
	E	SN02 (SB3)		KK	SDWN (SB3)
	F	SN05 (SB3)		MM	SLA (SB3)
	H	SN04 (SB3)		PP	IRD (SB3)
	J	SN06 (SB3)		RR	SPR (SB3)
	K	SN01 (SB3)		SS	DEN02 (SB3)
	L	SN07 (SB3)		UU	DEN01 (SB3)
	M	SN08 (SB3)		VV	+5 V (SB3)
	N	SN09 (SB3)		Z	GND
	P	SN10 (SB3)		BB	GND
	R	SN11 (SB3)		DD	GND
	S	SN12 (SB3)		FF	GND
	T	SN13 (SB3)		JJ	GND
	U	SN14 (SB3)		LL	GND
	V	SN15 (SB3)		NN	GND
	W	SN03 (SB3)		TT	GND
	X	DT02 (SB3)			
	Y	RWS (SB3)			

Table D-4 M8940 MTA to Transport Interface

Connector	Pin	Signal	Connector	Pin	Signal
J1/P1	1	NPORST	J2/P2	1	IWD7
	2	IEOT		2	Ground
	3	ILDP		3	Ground
	4	IFPT		4	Ground
	5	IRWD		5	Ground
	6	IONL		6	Ground
	7	IRWU		7	Ground
	8	ISWS		8	Ground
	9	ISLT0		9	Ground
	10	IRWC		10	Ground
	11	IDDI		11	Ground
	12	ISRC		12	Ground
	13	IDDS		13	Ground
	14	ISFC		14	Ground
	15	Not Used		15	Ground
	16	IWARS		16	Ground
	17	Not Used		17	Ground
	18	+5 V		18	IWD6
	19	IRDY		19	IWD5
	20	NSEL		20	IWD4
	21	NTSKEW		21	IWD3
	22	Not Used		22	IWD2
	23	Ground		23	IWD1
	24	Ground		24	IWD0
	25	Ground		25	IWDP
	26	Ground		26	ITACH
	27	Ground		27	Not Used
	28	Ground		28	ISLT3
	29	Ground		29	IRTH2
	30	Ground		30	IRTH1
	31	Ground		31	ISLT2
	32	Ground		32	IWARS
	33	Ground		33	ISLT1
	34	Ground		34	IWDS

Table D-4 M8940 MTA to Transport Interface (Cont)

Connector	Pin	Signal	Connector	Pin	Signal
J3/P3	1	IRD7		18	IRD6
	2	Ground		19	NTSTR
	3	Ground		20	IRD5
	4	Ground		21	IRD4
	5	Ground		22	NTEST
	6	Ground		23	ISGL
	7	Ground		24	I7TK
	8	Ground		25	INRZ
	9	Ground		26	IRD3
	10	Ground		27	IRD2
	11	+5		28	+5
	12	+5		29	+5
	13	+5		30	+5
	14	Ground		31	IRD1
	15	Ground		32	IRD0
	16	Ground		33	IRDS
	17	Ground		34	IRDP

Table D-5 Power Distribution on Interconnect D/D1 PCBA

Level/Signal	Termination			
	From	To	To	To
+12 Vdc	A2TB1-6	J11-15,55		
+24 Vdc	A2TB1-7	J11-16,56	P21-22,23,24*	J24-27,28,29*
-24 Vdc	A2TB1-8	J11-20,60		
+36 V(C)	A2TB1-1	J11-1,2,41,42		
DC COM 2	A2TB1-4	J11-9,10,11,49, 50,51		
-36 V(C)	A2TB1-5	J11-12,13,52,53		

Table D-5 Power Distribution on Interconnect D/D1 PCBA (Cont)

Level/Signal	Termination			
	From	To	To	To
DC COM 1	A2TB1-9	J11-26,27,66,67		
8.5 Vac	A2TB1-10	J11-40		
CM(+)	A2TB1-3	J11-6,7,8,46 47,48		
CM(-)	A2TB1-2	J11-3,4,5,43, 44,45		
0 V(L)	J11-26,27,66,77	P21-11,12,14*	J5-3,4,39,40	J7-15,16,17, 51,52,53
		J24-37,39,40* J8-22,58	J12-4,5,21,22	
0 V(I)	J11-26,27,66,77	J1-23 through 34	J2-2 through 17	J3-2 through 10, 14 through 17
		J5-26 through 36,38	J7-1 through 10	J8-38
		J101-2 through 14,16,17	J102-1 through 18	J103-A,B,C,D,J through V
		J201-20 through 34	J202-2 through 17	J203-2 through 10, 14 through 17
		J204-2 through 17		
+5 V(L)	J11-22,23,62,63	P21-2,4* J24-47,49*	J1-18	J3-11,12,13,28, 29,30
		J5-8,9,44,45	J7-18,19, 54,55	J8-21,57
		J12-1,2,18,19	J101-S	W1-1
+5 V(I)	J203-11,12,13, 28,29,30	J201-18	W2-1	
+5 V(T)	W1-2,W2-2	J5-7,43 J204-1,18	J7-21,57	J8-37
+15 V	J11-21,61	J5-5,41 J12-6,23	J7-22,58 P21-39*	J8-56 J24-12*
-15 V	J11-14,54	J5-6,42 J12-7,24	J7-23,59 P21-33,36*	J8-55 J24-15,18*

*On interconnect D1 PCBAs only, J24 connector is provided for the ribbon cable terminated by P21, which plugs into J21 on interconnect F/F1 PCBA.

Table D-6 Deck Interface Ribbon to Interconnect D/D1 PCBA

Level/Signal	Termination				
	From	To	To	To	To
TACH	P21-44	J24-7	J8-53		
TACH COM	P21-46	J24-5	J8-54		
SPARE 2	P21-49	J24-2		J11-68	
S.POS	P21-37	J24-14			J12-20
T.POS	P21-21	J24-30			J12-3
0V(R)	P21-19	J24-32			J12-34
SPARE	P21-1	J24-50			
S.LIMIT	P21-6	J24-45	J8-1		J12-30
T.LIMIT	P21-10	J24-41	J8-2		J12-31
CR N.O.	P21-8	J24-43		J11-80	
NEOT	P21-50	J24-1	J8-50		
TIP	P21-45	J24-6	J8-49		
NBOT	P21-42	J24-9	J8-52		
PKSN	P21-30	J24-21	J8-42		
NSMR	P21-3	J24-48	J8-8		
CART N.O.	P21-43	J24-8		J11-79	
CO	P21-41	J24-10	J8-10		
CC	P21-40	J24-11	J8-11		
CART M+	P21-31,34	J24-20,17		J11-30,70	
CART M−	P21-25,26	J24-25,26		J11-31,71	
C.SOLRET	P21-17,20	J24-31,34		J11-34,74	
SPARE 1	P21-5,7	J24-44,46		J11-36,76	
VAC	P21-48	J24-3	J8-3		
VAC.SOL.RET.	P21-15,18	J24-33,36		J11-32,72	
WP2	P21-35,38	J24-13,16			
WP1N.O.†	P21-29,32	J24-19,22		J11-69	J7-60,24
W.P.SOL.RET.	P21-27,28	J24-23,24		J11-33,73	
P.SOL.RET.	P21-13,16	J24-33,38		J11-35,75	
ABPNO	P21-9	J24-42	J8-4		
TOR	P21-47	J24-4	J8-9		

*On interconnect D1 PCBAs only, J24 connector is provided for the ribbon cable terminated by P21, which plugs into J21 on interconnect F/F1 PCBA.

†Also WRT PWR

Table D-7 Internal Control Signals on Interconnect D/D1 PCBA

Level/ Signal	Termination From	To	To	To	To	To
NSLTA	J8-23	J5-46				
NHID	J8-25*	J5-10	J7-61			J103-7
NWRT	J8-26	J5-47	J7-25			
9TK	J8-27	J5-11	J7-62			
MOTION	J8-28	J5-48	J7-26			
FPT	J8-60			J11-19		
BOT	J8-48	J5-12				
NMOT	J8-51			J11-24		
SRF	J8-29				J12-17	
SRR	J8-30				J12-16	
TRF	J8-31				J12-15	
TRR	J8-32				J12-14	
MRL	J8-5				J12-28	
REWR				J11-78	J12-13	
REV	J8-66		J7-63	J11-18	J12-33	
NDRV	J8-65			J11-64	J12-27	
N>80%	J8-67			J11-25		
NTAP2	J8-62			J11-57		
NTEN	J8-63			J11-17		
NINTLK	J8-69			J11-65	J12-8,25	
NRWR	J8-33			J11-38		
NRSAE	J8-34			J11-58	J12-11	
NCCC	J8-70			J11-29		
NCOC	J8-71			J11-28		
NXFR	J8-72			J11-39		
NTP	J8-64			J11-59		
NPORST	J11-37,77	J1-1 J12-9,26	J7-11 J201-1	J8-61		
PNU RET	J8-68	A2TB1-11				

*NPE on J8-25

Table D-8 Interface Control Signals on Interconnect D/D1 PCBA

Level/ Signal	Termination			
	From	To	To	To
ISFC	J101-C	J1-14	J201-14	J8-20
IODS	J101-D	J1-13	J201-13	J8-19
ISRC	J101-E	J1-12	J201-12	J8-18
IDDI	J101-F	J1-11	J201-11	J8-17
IRWC	J101-H	J1-10	J201-10	J8-16
ISLT0	J101-J	J1-9	J201-9	J8-15
ISWS	J101-K	J1-8	J201-8	J8-14
IRWU	J101-L	J1-7	J201-7	J8-13
IONL	J101-M	J1-6	J201-6	J8-12
IRWD	J101-N	J1-5	J201-5	J8-47
IFPT	J101-P	J1-4	J201-4	J8-46
ILDP	J101-R	J1-3	J201-3	J8-45
IRDY	J101-T	J1-19	J201-19	J8-7
IEOT	J101-U	J1-2	J201-2	J8-44

Table D-9 Interface Read Signals on Interconnect D/D1 PCBA

Level Signal	Termination				
	From	To	To	To	To
IRDP	J103-1	J3-34	J5-72	J203-34	
IRDS	J103-2	J3-33	J5-71	J203-33	
IRD0	J103-3	J3-32	J5-70	J203-32	
IRD1	J103-4	J3-31	J5-69	J203-31	
IRD2	J103-8	J3-27	J5-68	J203-27	
IRD3	J103-9	J3-26	J5-67	J203-26	
INRZ	J103-10	J3-25	J5-66	J203-25	
I7TK	J103-11	J3-24	J5-65	J203-24	
ISGL	J103-12	J3-23	J5-64	J203-23	
ISPEED	J103-13	J3-22	J5-63	J203-22	
IRD4	J103-14	J3-21	J5-62	J203-21	
IRD5	J103-15	J3-20	J5-61	J203-20	
IRD6	J103-17	J3-18	J5-59	J203-18	
IRD7	J103-18	J3-1	J5-58	J203-1	
NSEL			J5-22		J1-20

Table D-10 Interface Write Signals on Interconnect D/D1 PCBA

Level Signal	Termination								
	From	To	To	To	To	To	To	To	To
IWDS	J102-A		J2-34		J7-47	J202-34			
ISLT1	J102-B	J101-A	J2-33			J202-33		J8-39	
IWARS	J102-C	J101-15	J2-32	J1-16	J7-46	J202-32	J201-16		
ISLT2	J102-D	J101-18	J2-31			J202-31		J8-40	
IRTH1	J102-E		J2-30			J202-30			J5-2
IRTH2	J102-F		J2-29			J202-29			J5-1
ISLT3	J102-H	J101-V	J2-28			J202-28		J8-41	
IWDP	J102-L		J2-25		J7-45	J202-25			
IWD0	J102-M		J2-24		J7-44	J202-24			
IWD1	J102-N		J2-23		J7-43	J202-23			
IWD2	J102-P		J2-22		J7-42	J202-22			
IWD4	J102-R		J2-21		J7-41	J202-21			
IWD3	J102-S		J2-20		J7-40	J202-20			
IWD5	J102-T		J2-19		J7-39	J202-19			
IWD6	J102-U		J2-18		J7-38	J202-18			
IWD7	J102-V		J2-1		J7-37	J201-1			
ITACH	J102-K		J2-26			J202-26		J8-6	

Digital Equipment Corporation • Maynard, MA 01754