EK-2TU78-TM-001

TU78 Magnetic Tape Transport Technical Manual
Volume 2

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TU78 Magnetic Tape Transport Technical Manual Volume 2

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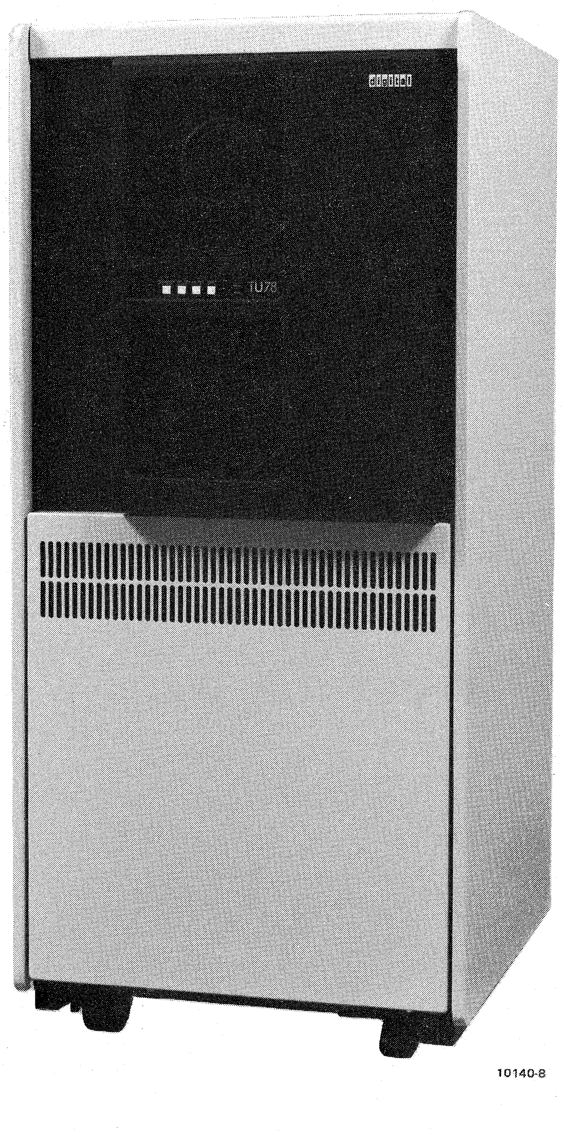

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CHAPTER 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The TU78 magnetic tape transport writes and reads data in 9-track phase-encoded (PE) or group code recording (GCR) format. Bit density is 1600 bits per inch (bits/in) for the PE format and 6250 bits/in for the GCR format. The transport can read data in the forward or reverse direction. The read/write tape speed for both directions is 125 inches per second (in/s). Nominal rewind time for a 731.5 m (2400 ft) reel is 65 seconds.

The TU78 interfaces with the system processor via the MASSBUS, a MASSBUS controller, and a TM78 tape formatter. Up to four TU78s may be driven by a single TM78 formatter. Figure 1-1 illustrates the basic TU78 system configuration. The TM78 tape formatter and its power supply (H7422-AB) are housed in the TU78 cabinet, an H9500 corporate cabinet. (The specific model of the H9500 cabinet series used for the TU78 is H9602-KA. However, this manual refers to the cabinet as the H9500.) The TU78s containing a TM78 are called master units; TU78s without the TM78 are called slave units. Both master and slave units contain an 874-E power controller. Earlier TU78 models contain an 872-E power controller. The two types are electrically identical, but differ slightly in the location of remote control jacks.

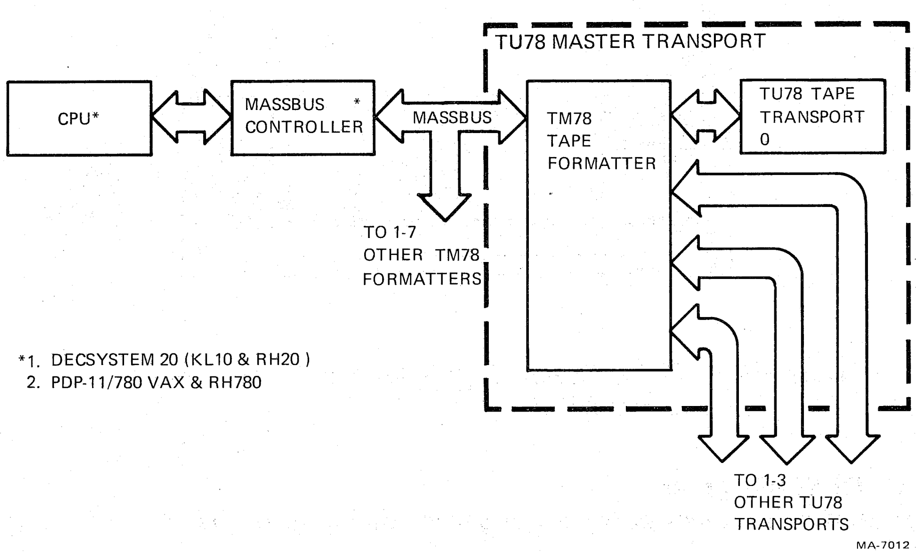


Figure 1-1 Basic System Configuration

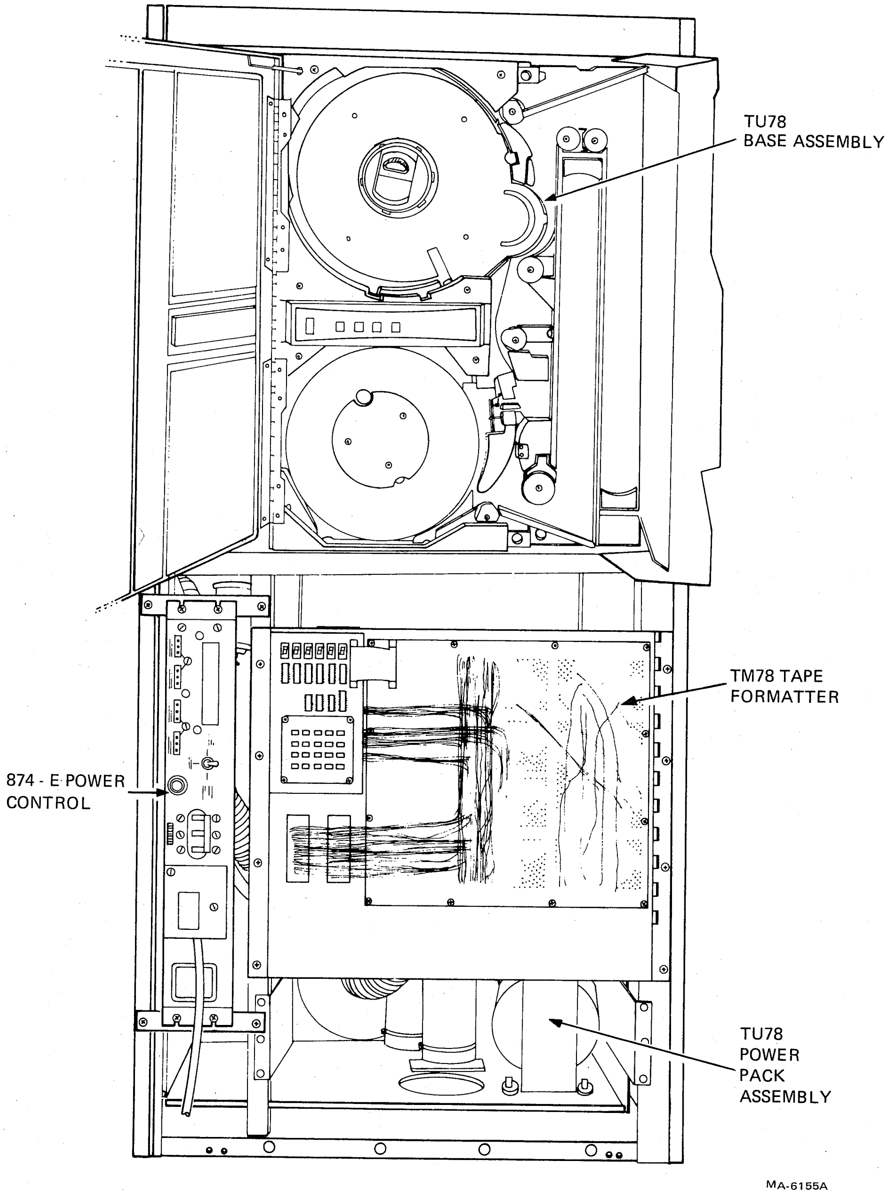


Figure 1-2 TU78 Master Tape Transport (Sheet 1 of 2)
a. Front View

1.2 PHYSICAL DESCRIPTION

Figure 1-2 illustrates the locations of the major subassemblies of the TU78. They are listed below.

TM78 tape formatter (master TU78 only)
H7422-AB power supply (master TU78 only)
874-E power controller
TU78 transport (base assembly, card cage area, and power pack assembly)

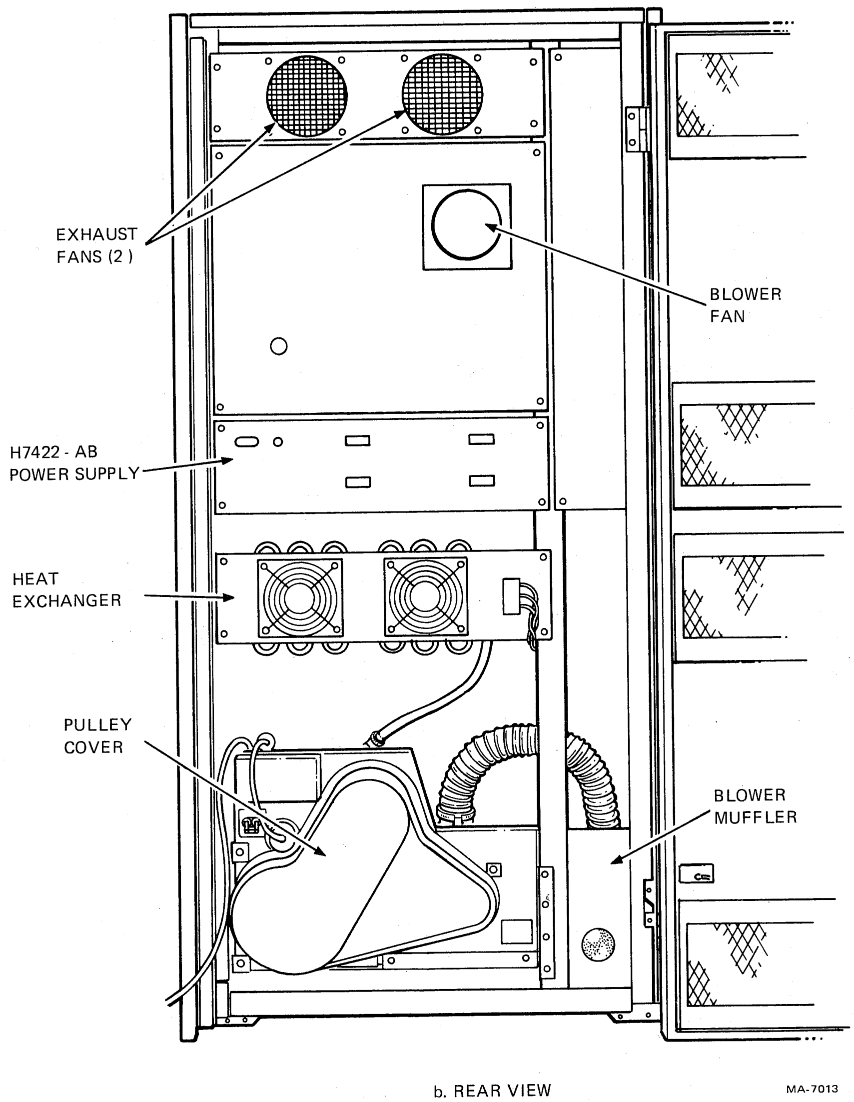


Figure 1-2 TU78 Master Tape Transport (Sheet 2 of 2)
b. Rear View

Figure 1-3 identifies the components of the base assembly. They are listed below.

Control assembly (PN 29-23771)
Reel sense assembly (PN 29-23216)
Backwrap defeat switch (PN 29-23297)
Reel hub assembly (PN 29-23475)
Buffer box door assembly (PN 29-23215)
Tape in path (TIP) assembly (PN 29-23243)
EOT/BOT assembly (PN 29-23242)
Head (PN 29-23767)
Cartridge interlock switch (PN 29-16280)
Upper restraint (PN 29-23225)
Lower restraint (PN 29-23224)

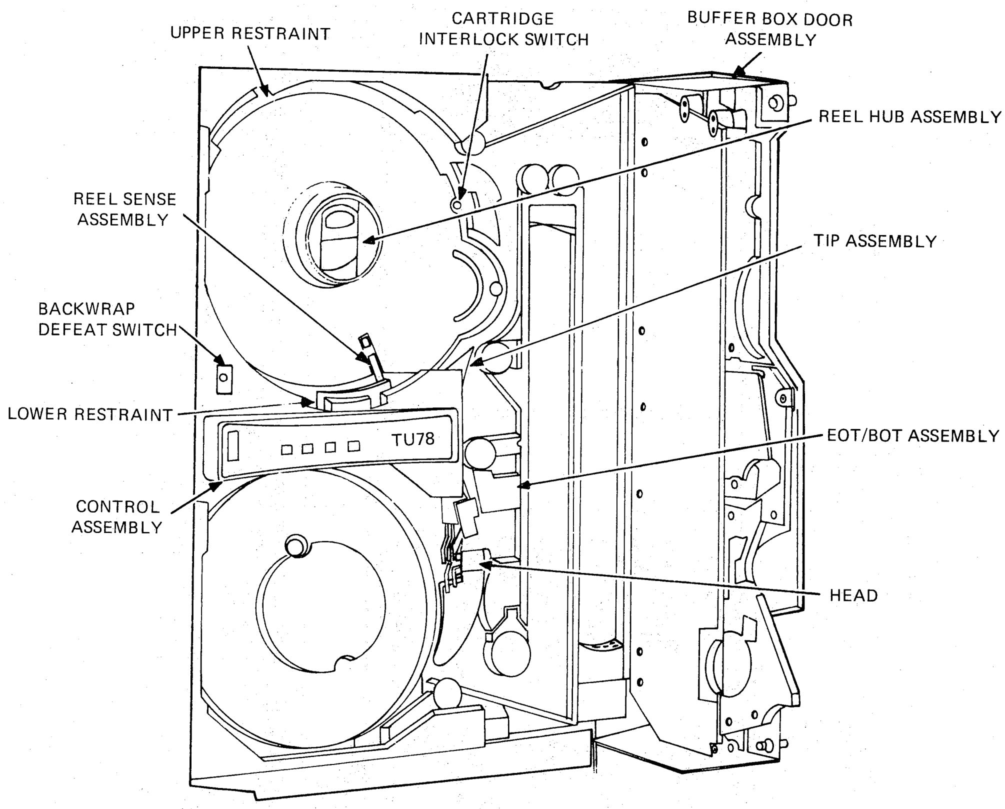


Figure 1-3 Base Assembly (Sheet 1 of 2)
a. Front View

Cartridge motor (PN 29-23280)
Pressure switch (pneumatic interlock) (PN 29-23239)
Pressure valve assembly (PN 29-23249)
Interconnect F1 printed circuit board (PCB) (PN 29-23770)
Reel motor assemblies (2) (PN 29-23236)
Write protect assembly (PN 29-23235)
Vacuum valve assembly (PN 29-23248)
Pressure switches (vacuum) (2) (PN 29-23238, 29-23239)
Pack sense assembly (PN 29-23217)
Capstan motor assembly (PN 29-23768)
Service lock
Preamp PCB (PN 29-23766)
Vacuum transducer assembly (PN 29-23246)
Pressure switch (column limit) (4) (PN 29-23238)

Figure 1-4 illustrates the card cage area containing the following items.

Multiple interface adapter (MIA) PCB (PN 29-23769)
Read PCB (PN 29-23762)
Write PCB (PN 29-23763)
Control M2 PCB (PN 29-23764)

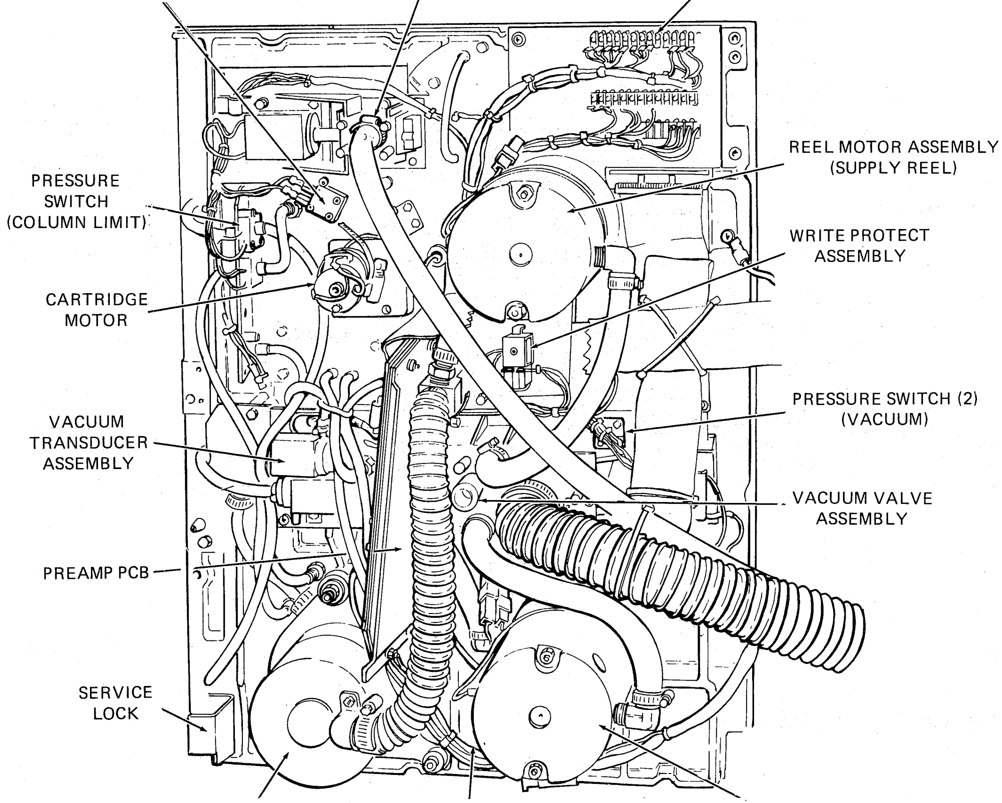


Figure 1-3 Base Assembly (Sheet 2 of 2)
b. Rear View

Capstan/regulator PCB (PN 29-23765)
Reel servo PCB (PN 29-23231)
Exhaust fans (2) (PN 12-17916-02)
Interconnect D1 PCB (not shown in Figure 1-4) (PN 29-23211)

Figure 1-5 illustrates the power pack assembly containing the following items.

Rectifiers (3) (PN 29-23311, 29-23312)
Vacuum hose
Fuse panel
Air filter (PN 29-23259)
Blower with serial number below SP002386 (PN 29-23298)
Blower with serial number SP002386 and above (PN 29-24013)
Pulley cover
Power transformer terminal strip
Compressor (PN 29-23257)
Motor (PN 29-23287)
Transformer (PN 29-23258)
Muffler (PN 29-23220)
Heat exchanger fan (PN 12-17916-02)

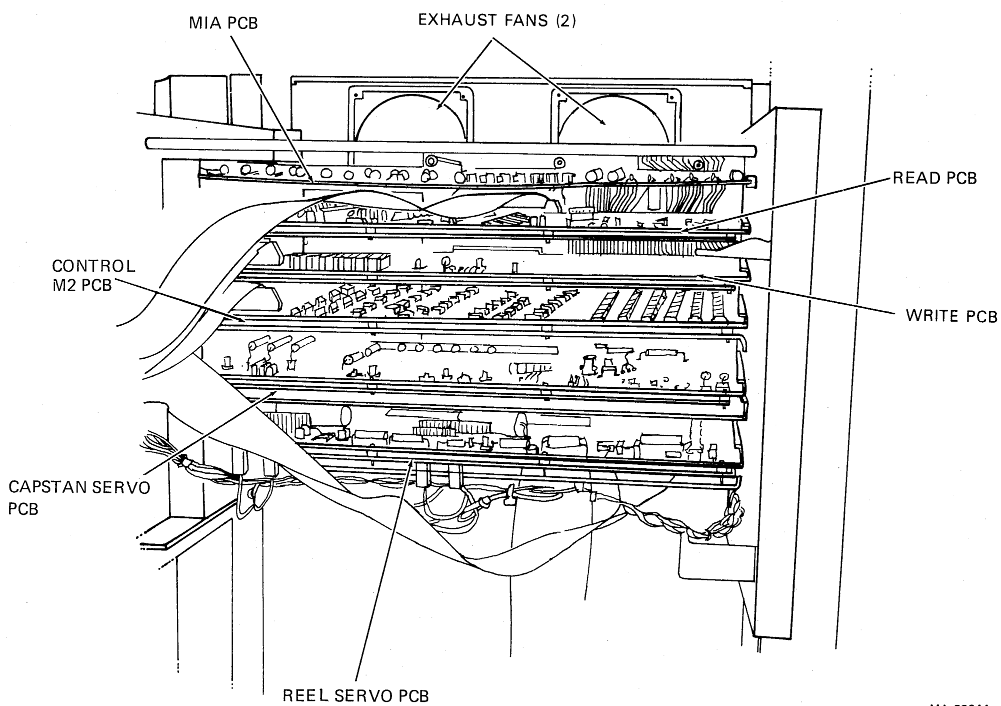


Figure 1-4 Card Cage Area

1.3 FUNCTIONAL DESCRIPTION

Figure 1-6 illustrates the various TU78 configurations possible from the MASSBUS. The TM78 tape formatter interfaces with up to four TU78 transports to the MASSBUS. Additional TM78s may be added (a maximum of eight), with each formatter interfacing up to four additional TU78s. Thus, the maximum configuration interfacing a MASSBUS controller consists of 8 TM78 formatters and 32 TU78 transports. A TM78 may also be dual-ported so that each subsystem can be driven by two host CPUs.

The TM78 tape formatter is housed in the TU78 cabinet. Those cabinets containing a TM78 (and its H7422-AB power supply) are called master transports. Those cabinets without the TM78 and H7422-AB are called slave transports. The TU78 master transport is identical to the TU78 slave transport.

Figure 1-7 is a functional block diagram of a TU78 master tape transport. During a write operation the TM78 accepts write data from the MASSBUS and formats it into 8-bit data characters for the TU78 transport. MASSBUS data is in the following formats: PDP-10 compatible, PDP-10 core dump, PDP-10 high-density compatible, PDP-10 high density dump, PDP-10/11/15 image, PDP-11 normal or PDP-15 normal. The TM78 disassembles Massbus data under control of the CPU which specifies the data format. During a read operation, 8-bit characters received from the transport are formatted into data words and placed on the MASSBUS. The TM78 assembles the data characters into the MASSBUS format specified by the CPU. The TM78 rwrites and reads data in either 1600 bits/in PE or 6250 bits/in GCR formats.

During a write operation, the TM78 assembles 8-bit tape characters and sends them to the TU78 over the TU bus. Error detection is accomplished by parity checks (PE and GCR modes), and (GCR mode only) by cyclic redundancy checks (CRC) and auxiliary cyclic redundancy checks (ACRC). Error detection occurs for both read and write operations. During a write operation, a read-after-write function

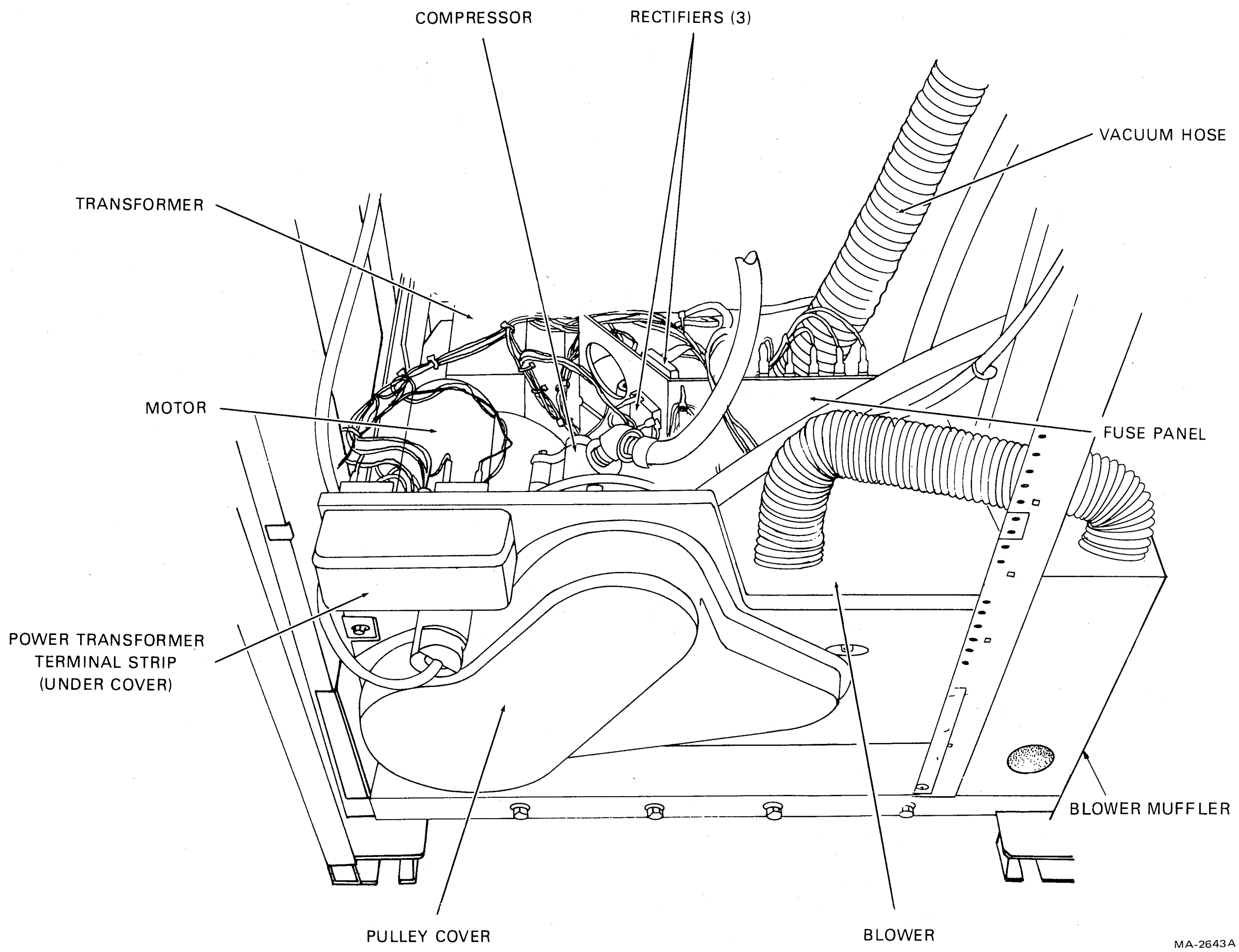


Figure 1-5 Power Pack Assembly (Rear View)

is performed: the TM78 reads data just written and performs error checking. During a read operation the TM78 can perform automatic error correction. Single-track errors can be corrected in PE; and using a special error correction character (ECC) double-track errors can be corrected in GCR.

The TM78 also controls and monitors tape transport operation. It receives operational commands from the host CPU, selects the desired transport, and issues functional (data transfer) and motion (non-data transfer) commands. It monitors transport operation and provides error and status information to the host CPU.

The H7422 power supply provides regulated ±5 V and ±15 Vdc operating voltage for the TM78. Power fail signals AC LO and DC LO are also supplied to the TM78.

The 874-E power control supplies ac power to the transport cabinet. It provides filtering for the ac input power supplied to switched outlets when the remote power on/off line is enabled from the host CPU via the remote switching control bus. There is no power on/off control on the TU78 control panel, transport power is controlled by the host CPU. The switched ac is supplied to the H7422 power supply and TM78 cooling fan (master TU78 only), the transport power pack, the three cabinet cooling fans, and the compressor heat exchanger.

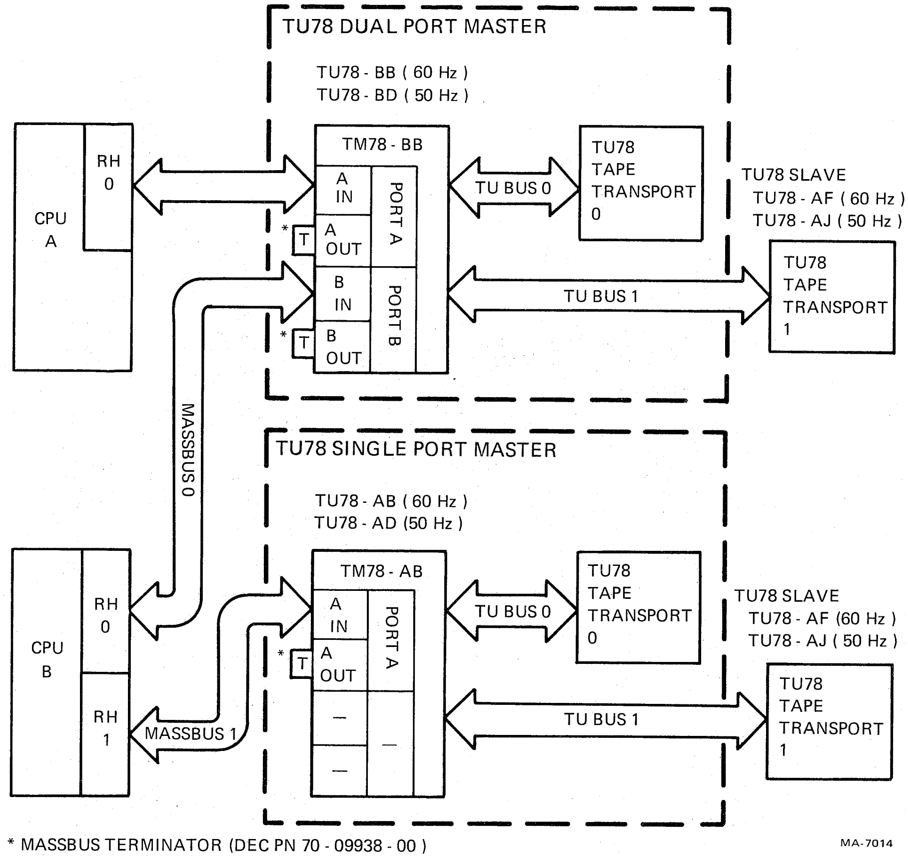


Figure 1-6 Possible TU78 Configurations

The basic TU78 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
MIA 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. This signal is summed with the basic command signal in order to maintain the correct capstan velocity at all times.

The reel servo subsystems control the speed of the tape reels in order to maintain optimum tape tension between the supply and 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 and take-up reels contains two tape loops in the buffer box (supply loop and take-up loop). The separately formed loops are 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.

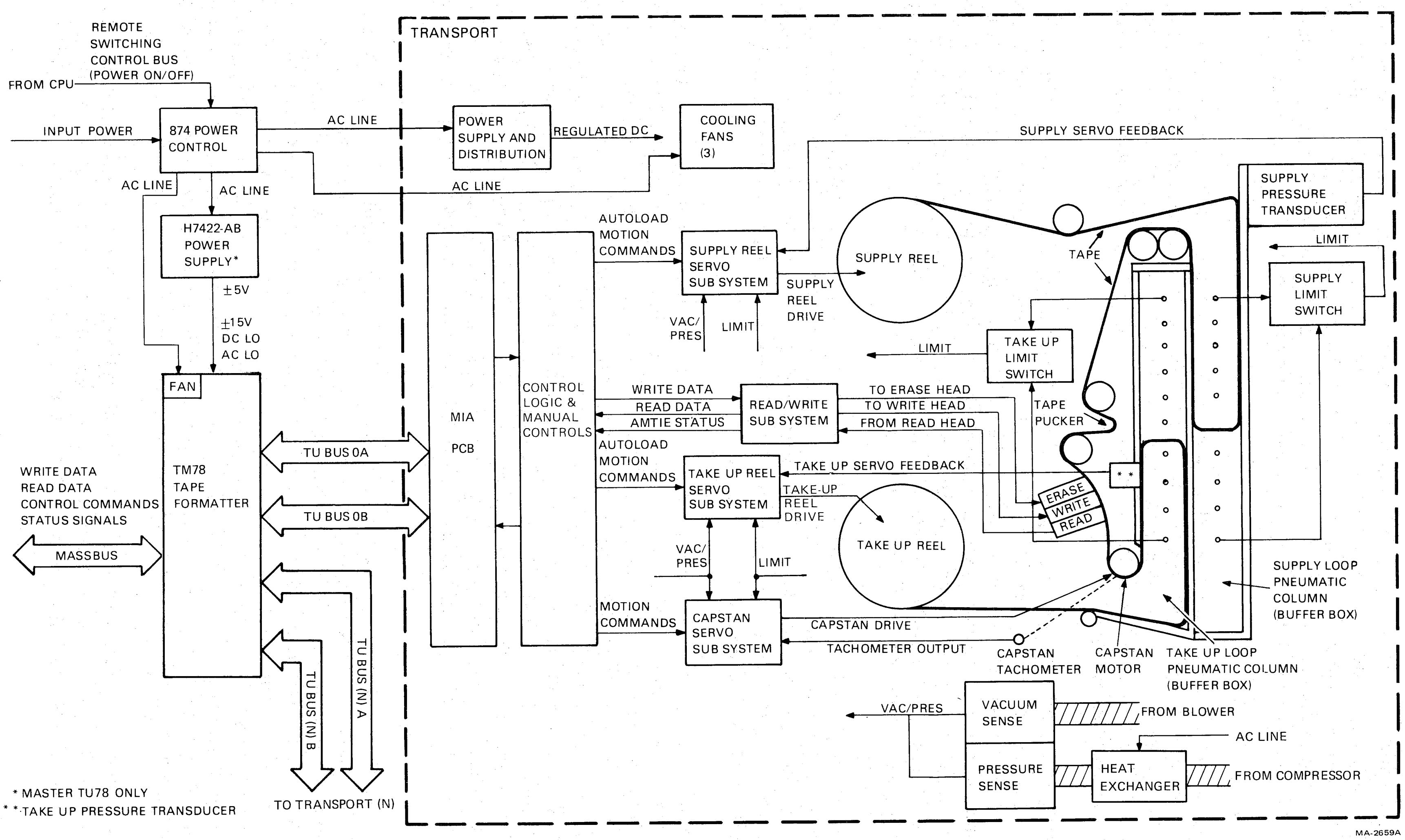


Figure 1-7 Master TU78 Functional Block Diagram

Signals developed within the pneumatic subsystem initiate servo operation. The subsystem senses that the tape loop position has changed as a result of forward or reverse tape motion. Air is drawn from the closed ends of the two buffer boxes creating a vacuum and 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.

There is a separate chamber behind each buffer box, connected to the box by a series of holes. The spacing and arrangement of these holes is such that, if the loop becomes larger, more holes are exposed to the positive (atmospheric) pressure inside the loop, and fewer to the lower pressure (vacuum) area outside the loop. This causes pressure in the chamber to rise. Conversely, if the loop becomes smaller, the pressure in the chamber decreases.

Pressure transducers are connected to the supply and take-up chambers. They interpret pressure variations in order to provide the supply and take-up servo feedback signals. The pressure sensitive signals feed back to the reel servos to adjust the velocity of the reel motors for the proper loop in the two buffer boxes. The uppermost and lowermost holes in each buffer column are limit ports. These connect to supply and take-up limit switches which feed back to both the supply and take-up servos. If the tape crosses a limit port in either the supply or take-up columns, a disabling signal couples back to the servos, stopping both reel motors before tape damage occurs.

A pneumatic interlock shuts down the capstan servo and reel servos if a pneumatic failure is detected. The pneumatic subsystem contains a blower which creates the vacuum for the tape columns, and a compressor which generates pressure for the tape path bearings. Sensing devices monitor vacuum and pressure. If either is lost, the sensing device sends a VAC/PRES signal to the three servo subsystems, stopping the servo motors before tape damage occurs.

The read/write subsystem processes data and transfers it to and from the magnetic tape. The read function processes data picked up from the tape by the read heads. It translates information from the recorded PE or GCR format to digital data acceptable to the external controlling circuits. The function includes the read-after-write capability that permits the formatter to verify execution of write command while writing is in progress. The write function prepares incoming data for recording in PE or GCR format and writes the information on the tape in the selected format. The read/write subsystem also develops amplitude track in error (AMTIE) status signals. It sends nine AMTIE signals to the formatter, one for each track, which become active when the strength of the analog signal read from tape falls below a specified threshold. During a write function this causes the operation to be retried. During a read function, AMTIE signals assist the formatter in developing pointers for the error correction process.

The control logic and manual control circuit interfaces other TU78 subsystems. The control logic transfers read/write data to and from the read/write subsystem. It also transfers the operational commands to the capstan servo. During the autoload sequence, logic circuits control the sequence steps by issuing appropriate commands to the reel servos. The control logic monitors and controls timing of the autoload sequence steps and other operational sequences, such as rewind. It processes commands generated by the manual controls and applies them to the appropriate subsystem. Control logic also senses transport status (e.g., transport selected, on-line, EOT, BOT, etc.), and modifies signals to the read/write and servo subsystems. Logic lights the appropriate control panel indicators to indicate transport status. Transport status is sent to the TM78 formatter via the MIA interface module.

The MIA module couples control/status, read/write, and AMTIE signals from the tape unit bus (TU bus) to the transport. The MIA adapts signals on the TU bus to the format required by the transport, and vice versa. This includes multiplexing, de-multiplexing, signal gating, latching, and timing.

Power supply functions include ac rectification, filtering, dc regulation, and distribution of power to the various subsystems.

1.4 APPLICABLE DOCUMENTS

Table 1-1 lists documents applicable to the TU78 tape transport.

Table 1-1 Related Documents

Title	Doc No	Contents
TM78 Magnetic Tape Formatter User Guide	EK-0TM78-UG	Description, programming, and installation information
TM78 Magnetic Tape Formatter Technical Manual	EK-0TM78-TM	Theory of operation, programming information, installation, and maintenance of the TM78 formatter and H7422 power supply
TU78 Magnetic Tape Transport Technical Manual (Volume 1)	EK-1TU78-TM	Schematics and logic prints of TU78
TU78 Magnetic Tape Transport Technical Manual (Volume 2)	EK-2TU78-TM	Description, installation, operation, theory and maintenance of TU78
TU78 Subsystem Pocket Service Guide	EK-0TU78-PS	Summary of troubleshooting and maintenance procedures
TU78/TM78 Magnetic Tape Transport/Formatter IPB	EK-0TU78-IP	Exploded views and parts lists of TU78 AND TM78
TU78 Field Maintenance Print Set	MP01061	Engineering drawings for TU78 mechanics and cabinet
TM78 Field Maintenance Print Set	MP01061	Engineering drawings and parts lists for TM78 mechanics and logic
874 Power Controller IPB	EK-00874-IP	Exploded views and parts lists of 874

1.5 MECHANICAL AND ELECTRICAL SPECIFICATIONS

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

Table 1-2 Mechanical and Electrical Specifications

Tape (computer grade)	
Width	12.6492 mm ± 0.0508 mm (0.498 in ± 0.002 in)
Thickness	0.0381 mm (1.5 mil)
Tape tension	2.780 N (10.0 oz +0.0/−1.0 oz) nominal
Reel diameter (autoload)	266.7 mm (10.5 in) maximum (note 1) and Easy-Load cartridge 1 and 2
Recording modes	1600 bits/in (3200 FCI) PE 6250 bits/in (9042 FCI) GCR
Magnetic head	Dual stack (with erase head)
Tape speed	3.2 m/s (125 in/s)
Instantaneous speed variation	±3 percent
Long term speed variation	±1 percent (forward) ±2 percent (reverse)
Rewind time for 731.5 m (2400 ft) tape	65 seconds nominal (80 seconds maximum)
Tape cleaner	Dual blade type connected to vacuum supply
Interchannel displacement error	
Read	3.81 μm (150 μin) maximum (note 2)
Read-after-write	8.89 μm (350 μin) maximum (note 3)
Start/stop time	1.1 ms ± 0.1 ms
Start	1.3 ms ± 0.1 ms
Stop	1.1 ms ± 0.1 ms
Start distance	1.91 mm +0.25/−0.38 mm (0.075 in +0.010/−0.015 in)
Stop distance	2.16 mm +0.25/−0.38 mm (0.85 in +0.010/−0.015 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

Table 1-2 Mechanical and Electrical Specifications (Cont)

Load time	No greater than 10 seconds without a retry, and 20 seconds with a retry for 10.5 in reels
Unload time	Less than 7 seconds for 10.5 in reels
Write gap to read gap distance	0.381 cm ± 0.013 cm (0.150 in ± 0.005 in)
Weight	286 kg (630 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	15° to 32° C (59° to 90° F) (note 5)
Nonoperating temperature	−46° to 71° C (−50° to 106° F)
Operating altitude	0 m to 2134 m (0 ft to 7000 ft) (note 6)
Nonoperating altitude	9100 m (30,000 ft) maximum
Power	
Volts ac	188 V to 264 V at 60 Hz 198 V to 264 V at 50 Hz
Frequency	50 Hz ± 1 Hz or 60 Hz ± 1 Hz
Kilo volt amp (kVA)	
Standby (loaded)	1.5 kVA maximum (note 7)
Start/stop	2.4 kVA maximum (note 7)

NOTES

1. **177.8 mm (7 in) and 216.0 mm (8.5 in) reels may be used but cannot be autoloaded.**
2. **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. **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. **Approximate distance from detection area to write head gap is 35.6 mm (1.40 in).**
5. **For data transfer, the operating temperature is dictated by 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 TU78 power pack.**
7. **Slave unit only. Add 700 W for master units.**

CHAPTER 2
OPERATION

2.1 CONTROLS AND INDICATORS

The TU78 operational controls and indicators are located on the transport control panel. The controls and indicators are illustrated in Figure 2-1. The controls are described in Table 2-1, the indicators in Table 2-2.

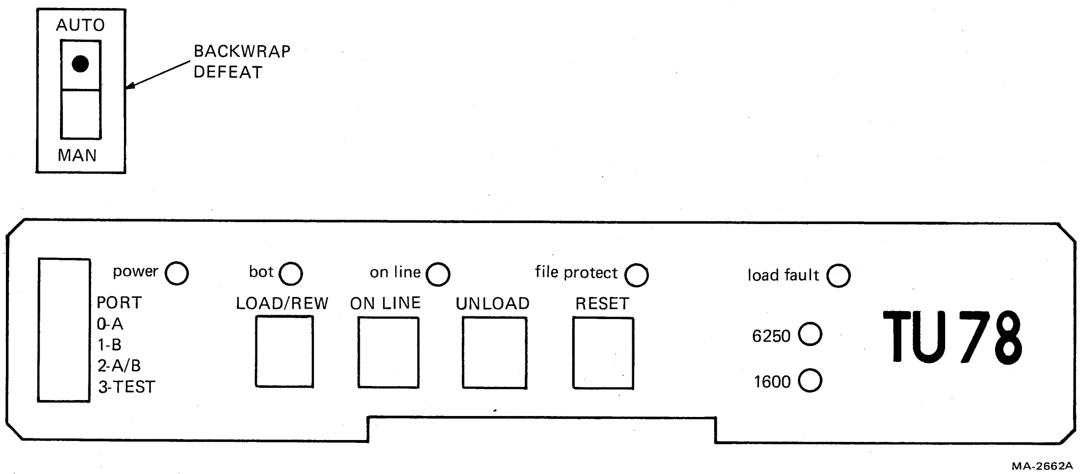


Figure 2-1 TU78 Control Panel

Table 2-1 TU78 Controls

Control	Function
Port Select Switch	Selects the MASSBUS I/O port(s) allowed to send commands to this tape transport.

Switch Position	Function
0	Transport connected to MASSBUS port A
1	Transport connected to MASSBUS port B
2	Transport connected to both MASSBUS ports A and B
3	Transport disconnected from both MASSBUS ports and placed in maintenance mode (available to TM78 formatter maintenance panel)

Table 2-1 TU78 Controls (Cont)

Control	Function
LOAD/REW	Initiates one of three sequences. 1. With no tape in path, initiates a load sequence. 2. With tape in path but not tensioned, initiates a midreel load sequence. In a midreel load sequence the tape loads and runs in 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.
ON LINE	Switches the transport off-line or on-line.
UNLOAD	If the TU78 is off-line, causes the tape to rewind and unload. If the tape is already at BOT, it unloads. If the TU78 is on-line, button has no effect.
RESET	Terminates all functions and clears a load fault.
BACKWRAP DEFEAT	AUTO (automatic) position: Allows a backwrap and retry for 10.5 inch reel, with or without a cartridge. MAN (manual) position: Inhibits a backwrap and retry for 10.5 inch reel without a cartridge.

Table 2-2 TU78 Indicators

Indicator	**Meaning**
Power	Presence of dc and secondary ac power.
BOT	Tape is at BOT.
On Line	TU78 is on-line. The transport reverts to the off-line mode if any of the following occur. 1. ON LINE button is pressed. 2. External rewind unload command is received. 3. Vacuum column interlock is broken. 4. AC power is lost. 5. RESET button is pressed.
File protect	Tape reel without a write enable ring has been loaded onto the transport.

Table 2-2 TU78 Indicators (Cont)

Indicator	Meaning
Load fault	Load fault has occurred. 1. Autoload sequence has failed to load a tape from a 267 mm (10.5 in) reel after two tries. 2. Load sequence has failed to load tape from a 216 mm or 178 mm (8.5 in or 7 in) reels.
1600	Tape transport set to read or write at 1600 bits/in (PE mode).
6250	Tape transport set to read or write at 6250 bits/in (GCR mode).

2.2 OPERATING PROCEDURES

2.2.1 Power

When the system CPU is turned on, power is applied to the TU78. The CPU remotely enables the 874-E power control, which in turn applies ac power to the TU78 cabinet.

2.2.2 Autoload/Manual Load Selection

Figure 2-2 illustrates various conditions and interlock settings that determine the selection of an autoload or manual load procedure.

The manual loading procedure must be used for a 216 mm or 178 mm (8.5 in or 7 in) reel. If a 267 mm (10.5 in) reel in a cartridge is used, the cartridge engages the cartridge interlock. This bypasses the autoload interlock and makes the autoload procedure necessary.

A full reel of tape must be used for an autoload sequence. Automatic loading requires that the outer turn of tape is between 1.59 cm and 0.64 cm (0.63 in and 0.25 in) from the outer edge of the reel (Figure 2-3). Thus 267 mm (10.5 in) reels which do not contain sufficient tape, must follow the manual load procedure.

2.2.3 Autoload

Follow the steps below in order to perform the autoload procedure.

1. Check that the tape path is clean. (Refer to Paragraph 4.3.4 for cleaning procedure.)

2. Check that the tape is a 267 mm (10.5 in) reel, and that it has a full reel of tape.

3. Check that the 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.

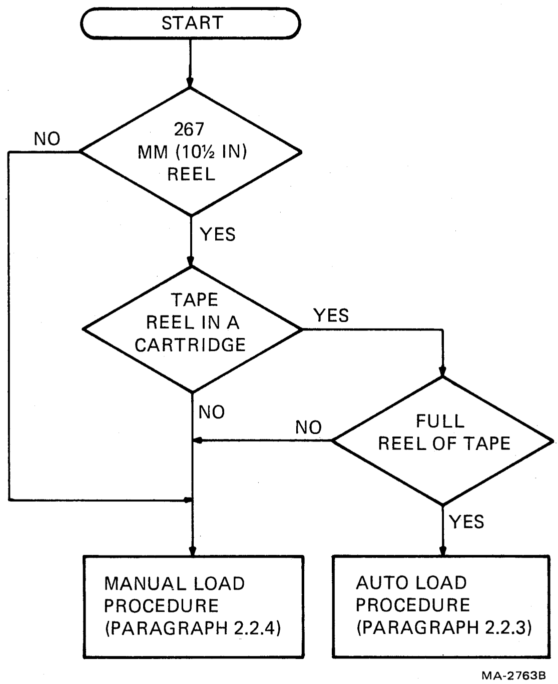


Figure 2-2 Autoload/Manual Load Selection

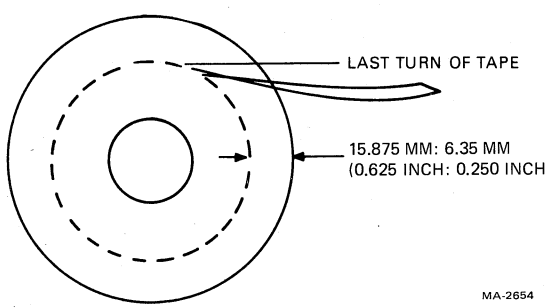


Figure 2-3 Tape Content Limit

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

5. If a write operation is to 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 unwinds if it 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. It opens automatically during the autoload sequence.

7. Carefully close the buffer door. Make sure it is closed securely.

8. Close the transport front door.

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

10. Follow the instructions and check for the events specified in Figure 2-4. 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 2-5 to identify tape path components.

2.2.4 Manual Load

Follow the steps below in order to perform the manual procedure.

1. Check that the tape path is clean. (Refer to Paragraph 4.3.4 for cleaning procedure.)

2. If a write operation is to 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 until it slips easily into place, and press the reel retaining actuator. The reel should be positioned so that the tape unwinds if it is turned clockwise.

4. Manually place the tape leader between thread block 1 and air bearing 1 (Figure 2-5).

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

5. Close the transport front door.

6. Check that power is applied to the tape transport (power light is on).

7. Follow the instructions and check for the events specified in Figure 2-6. 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 2-5 to identify tape path components.

®Easy-Load is a registered trademark of IBM, Inc.

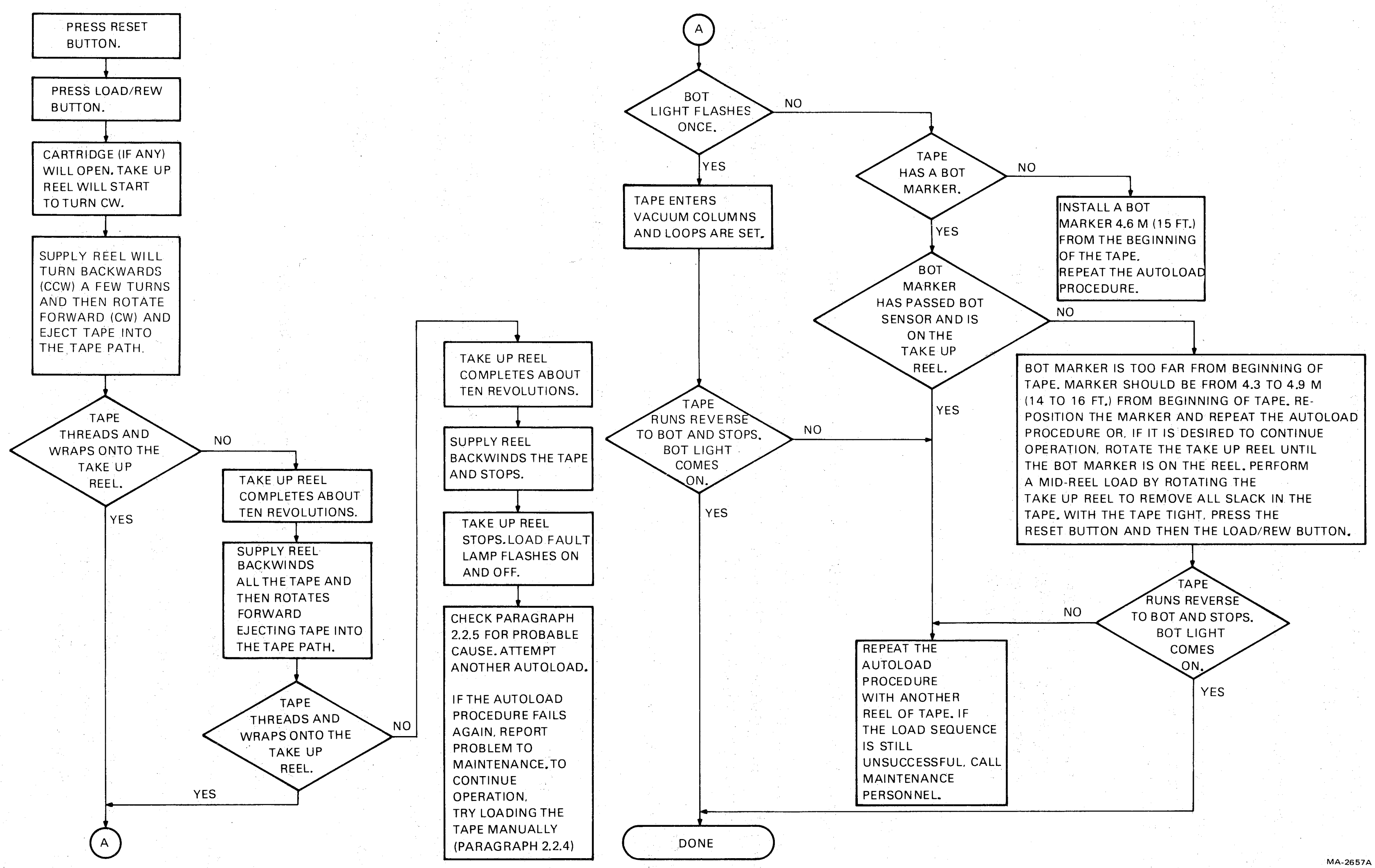


Figure 2-4 Autoload Sequence with Operator Troubleshooting

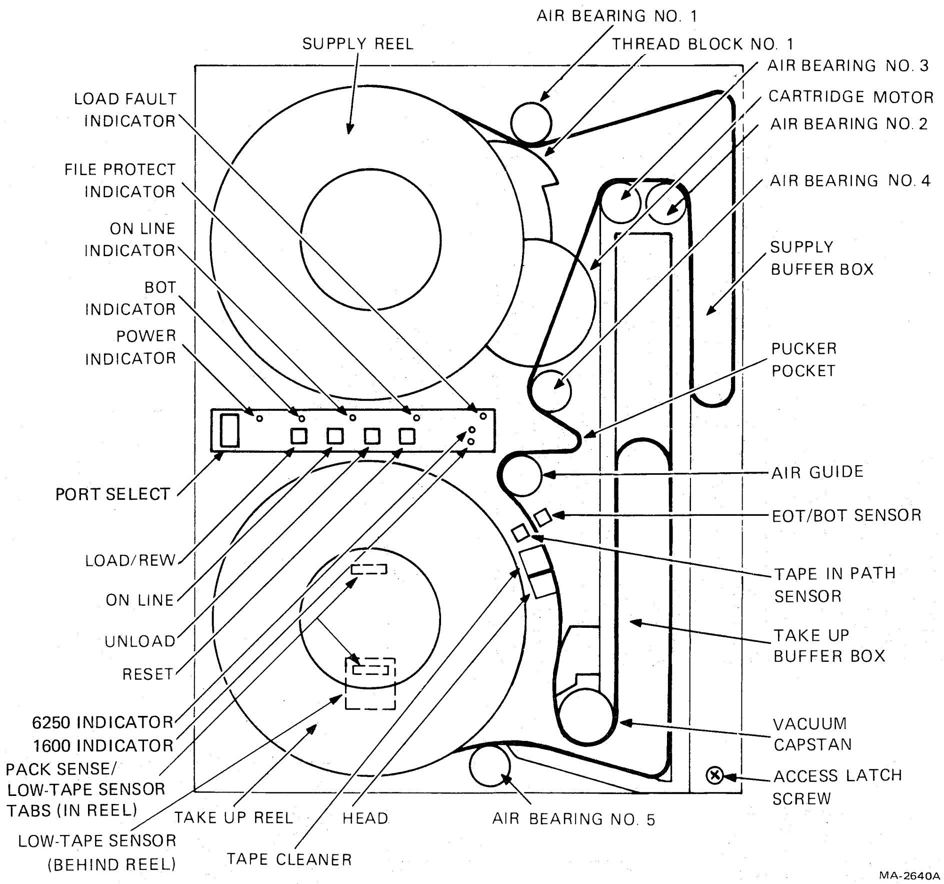


Figure 2-5 Tape Path and Controls

2.2.5 Probable Causes of Load Failure

The following is a list of procedures for repairing load failure.

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

2. Check that the front door is closed securely.

3. 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.

4. Check that the write enable ring is inserted in the tape reel if a write operation is to be performed. (File protect indicator should be out.)

5. If an autoload is being performed, check the following.

   a. A 267 mm (10.5 in) tape reel is on the supply hub

   b. The supply reel has a full reel of tape. The tape must be between 0.64 cm and 1.59 cm (0.25 in and 0.63 in) from the outer edge of the reel.

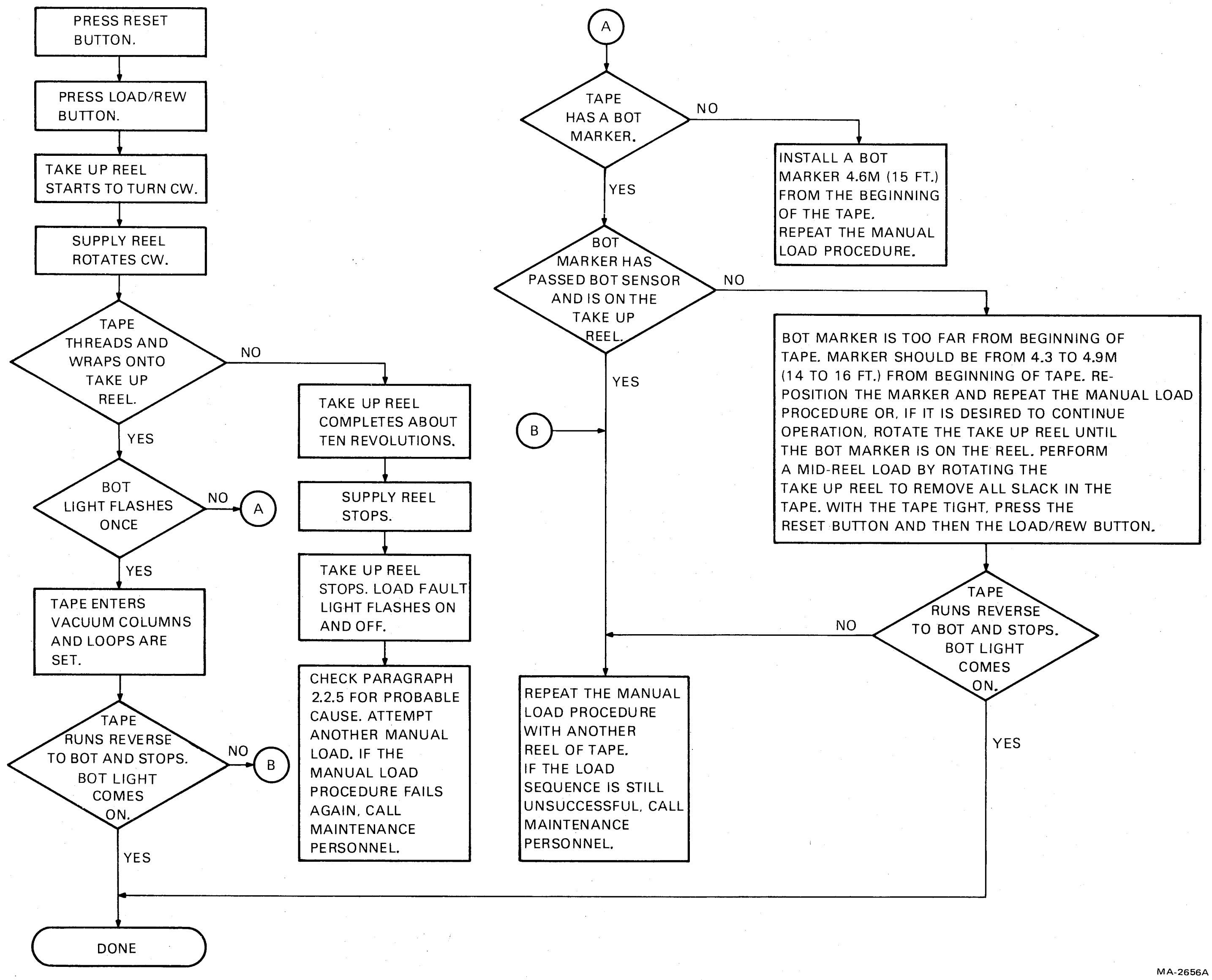


Figure 2-6 Manual Load Sequence with Operator Troubleshooting

2.2.6 Midreel Load

A midreel load is usually required after a power failure or a lost interlock. Follow the steps below to perform a midreel load.

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

CAUTION

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

2. Press the RESET button.

3. Close the front door.

4. Press the LOAD/REW button.

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

2.2.7 Unload

Follow the steps below to unload a tape.

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 backwinds onto the supply reel. If the tape is at midreel, it rewinds to BOT and then unloads (backwinds onto the supply reel).

2.2.8 Rewind

Press the LOAD/REW button, with tape tensioned and the transport off-line, to rewind the tape to BOT. When the button is pressed with the tape at BOT, no action occurs.

2.2.9 On-Line/Off-Line

Press the ON LINE button to place the transport on-line. This lights the on-line indicator. While on-line, the transport can accept external commands provided it is selected and ready. If the ON LINE button is pressed again, the transport goes off-line. The on-line indicator goes out. Also, the transport automatically goes off-line when any of the following conditions occur.

- An external rewind unload command is received
- Vacuum column interlock is broken
- AC power is lost
- RESET button is pressed
- Front door opens

CHAPTER 3
INSTALLATION

3.1 SITE PLANNING

3.1.1 Space Requirements

Figure 3-1 illustrates the space and service clearances required for the TU78 cabinet. There must be enough space to swing the TM78 out of the cabinet for servicing and open the front and rear doors on the TU78 tape transport.

3.1.2 Power Requirements

The TU78 tape transport can be operated from 188 Vac to 256 Vac at 60 Hz, or 198 Vac to 256 Vac, 50 Hz, with proper connections on the power chassis. Line voltage should be maintained to within ±10 percent of the nominal value. Frequency should not vary more than ±1 Hz.

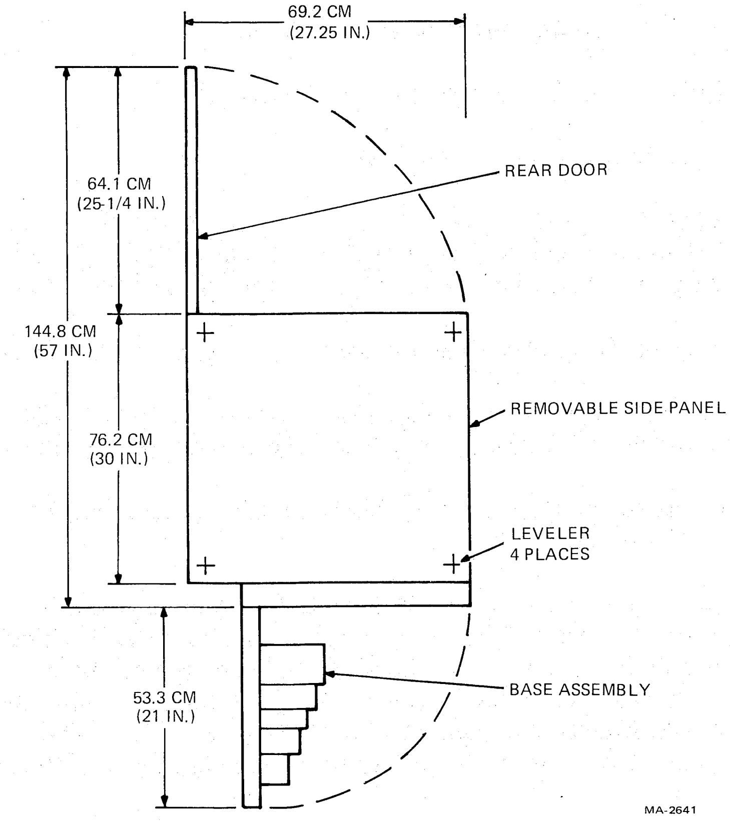


Figure 3-1 Space and Service Clearance (Top View)

3.1.3 Environmental Requirements

The TU78 transport should be located in an area free of excessive dust, dirt, corrosive fumes, and vapors. 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. A temperature range of 15° to 27° C (59° to 80° F); and relative humidity of 40 to 60 percent should be maintained.

3.2 UNPACKING AND INSPECTION

3.2.1 Unpacking

The TU78 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 an additional wooden container around the cardboard carton. The side panels of the container are bolted together.) Also mounted to the shipping skid are two wooden ramps which are repositioned during the unpacking procedure so that the cabinet may be rolled off the skid.

To unpack the TU78 from its shipping container, and remove the shipping skid, perform the following procedure. (Refer to Figure 3-2).

1. Cut and remove the plastic bands around the cardboard container. Remove the angle boards.

2. Cut the tape on the top and sides of the container.

3. Remove and dispose of the container. (It is not reusable.)

4. Remove the plastic bag from the cabinet.

5. Two hex head bolts hold the wooden ramps to the shipping skid. Unfasten the ramps by removing the bolts and associated washers. Both ramps are positioned between the TU78 cabinet and the shipping skid, and are visible from the front of the cabinet.

6. Slide the ramps out from under the cabinet and set them aside for assembly (step 9).

7. Unbolt the cabinet from the shipping skid. Remove four hex bolts that hold the cabinet frame to the skid deck (Figure 3-3). Discard the bolts, washers, and nuts.

8. Remove and discard the three wooden block spacers located between the cabinet frame and the skid deck (Figure 3-3).

9. Attach the two wooden ramps to the skid deck. Four tee nuts have been driven into the top of the skid deck on the left side for this purpose. (Refer to the exploded view of Figure 3-2 showing mounting details.) Position the aluminum bracket of one mounting ramp underneath the skid deck so that the holes in the bracket are lined up with the tee nuts. Fasten the bracket to the skid deck with two 1/4-20 × 3/4 hex bolts. (The bolts are shipped in the accessory package) Attach the second ramp to the skid deck in the same manner.

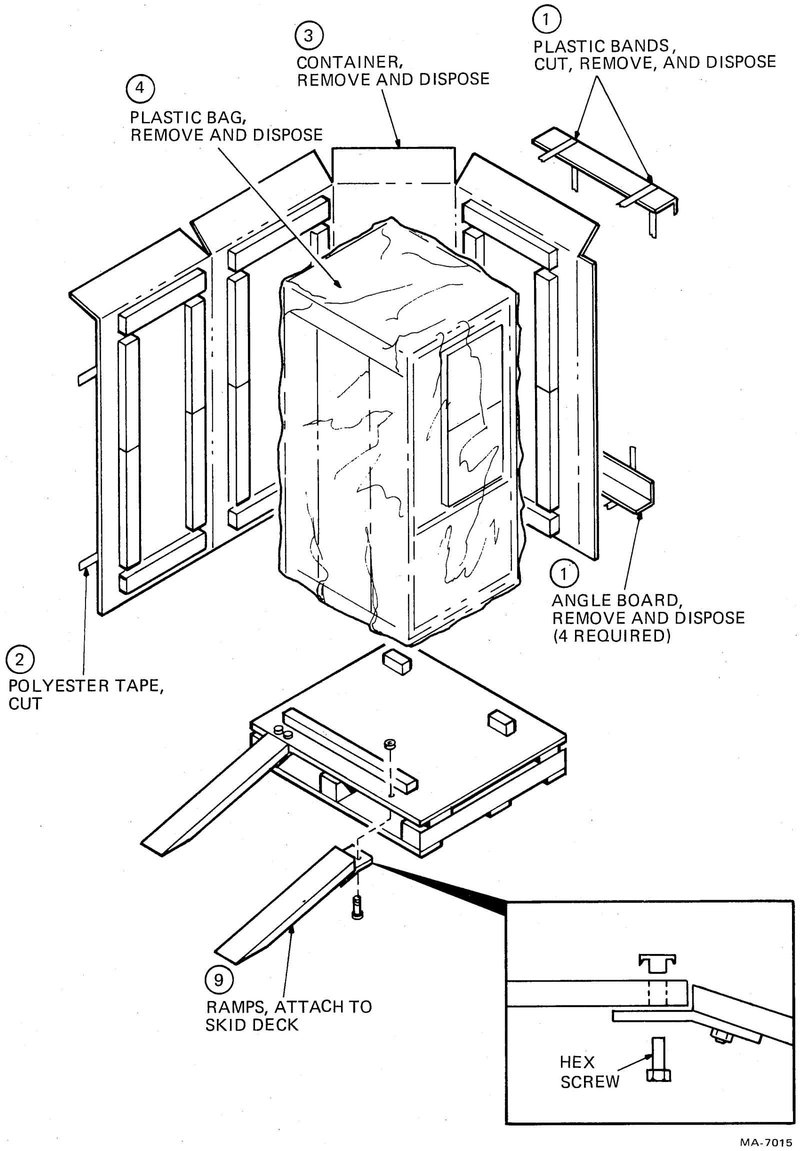


Figure 3-2 Unpacking the TU78

CAUTION

The following step requires two people to roll the TU78 down the wooden ramps. The majority of the weight of the TU78 is situated in the upper half of the cabinet, making it top-heavy. Do not attempt this procedure with only one person.

10. Roll the TU78 toward the left side of the side deck by pushing gently on the right side of the cabinet. With one person bracing a shoulder against the left front and the other person bracing a shoulder against the left rear of the cabinet, allow it to roll off the skid deck, down the wooden ramps and onto the floor.

11. Unfasten the wooden ramps. Discard them and the shipping skid.

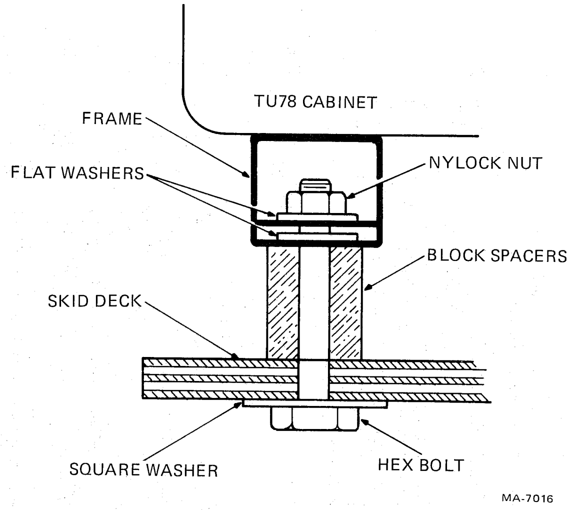


Figure 3-3 TU78 Mounting for Shipment

3.2.2 Inspection

After unpacking the TU78 transport, inspect it and report any damage to the responsible shipper and the local DIGITAL sales office. Perform the inspection according to the following steps.

1. Inspect all switches, indicators, and panels for damage.
2. Open TU78 front door. Fully depress 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 for 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 TU78 front door.

3.3 SINGLE TRANSPORT INSTALLATION

3.3.1 Mechanical Installation

After the shipping container and skid have been removed and visual inspection has been performed, roll the transport cabinet into position and proceed as follows.

NOTE

If the TU78 is placed next to another system cabinet, do not remove the adjoining side panels and bolt the cabinets together. Rather, leave the side panels on and position the TU78 side panel tight against the other cabinet's side panel. This maintains proper air flow in both cabinets.

1. An array of vertical slots constitutes the venting in the cabinet front panel. 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, and push on the latch while simultaneously pulling forward to release one corner of the front panel. In the same manner, while continuing to pull forward, 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 panel.

2. Remove the two leveler pads and four leveler feet that are blister wrapped 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 3-4).

4. Screw the leveler pads into the stabilizer arms.

5. Raise the interlock rods. Reinsert the stabilizer arms into the stabilizer sleeve assemblies.

6. Install the leveler feet in the lower corners of the cabinet frame (Figure 3-4).

7. Using a 9/16-inch wrench, lower the leveling feet until they make contact with the floor stabilizing the cabinet.

8. Using a level, 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 a 5/32-inch Allen wrench into the rear door latch, and turn one-quarter turn in a counterclockwise direction. Open the door.

11. Open the transport front door and the buffer box front door. Using a screwdriver, release the service lock located in the lower right corner of the base assembly. Swing the base assembly open.

    NOTE

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

12. Remove the PCB shipping bracket by pushing in on the lower front and pulling down from underneath (Figure 3-5).

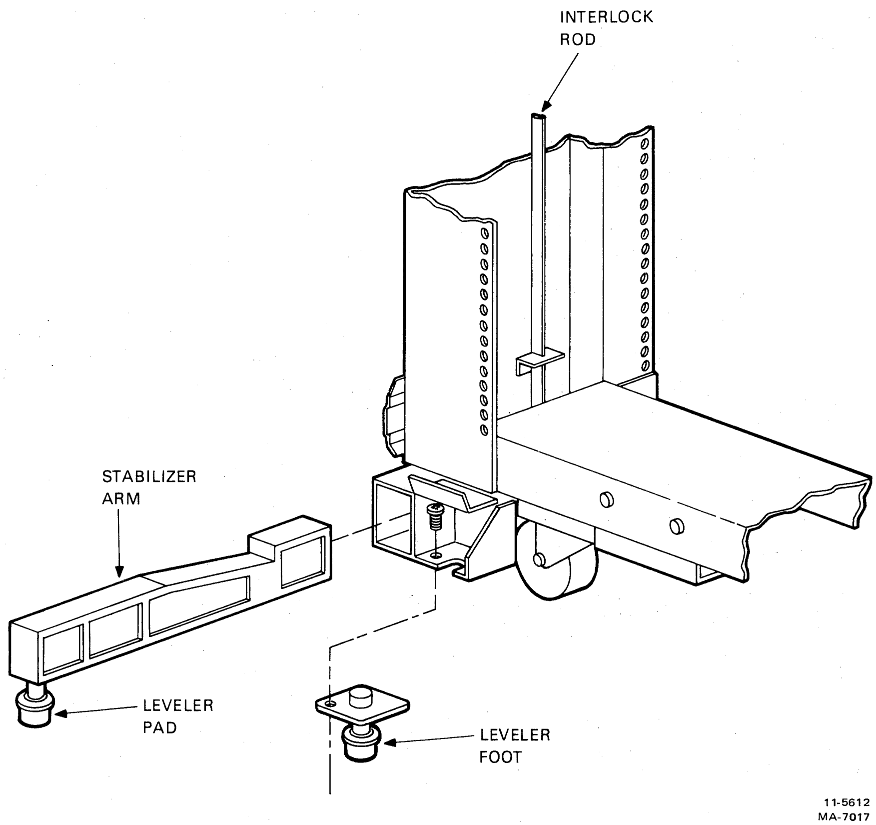


Figure 3-4 Location of Stabilizer Arm and Leveler Feet

13. Check seating of PCBs in their sockets.

14. Replace the PCB shipping bracket.

3.3.2 Power and Cabling

Figure 3-6 shows the TU78 ac power distribution system. Refer to this figure while making the following checks.

1. Check the following internal power cabling connections.

   a. Power cable from 874-E power controller switched outlet to transport power pack (Figure 3-6).

   b. Power cable from 874-E switched outlet to cabinet exhaust blowers.

   c. Power cable from 874-E switched outlet to pneumatic system heat exchanger blowers.

   d. Power cable from 874-E switched outlet to H7422 power supply (master TU78 only).

   e. Power cable from 874-E switched outlet to TM78 logic cage blower.

   f. DC power cable harness from H7422 power supply to TM78 logic gate (master TU78 only).

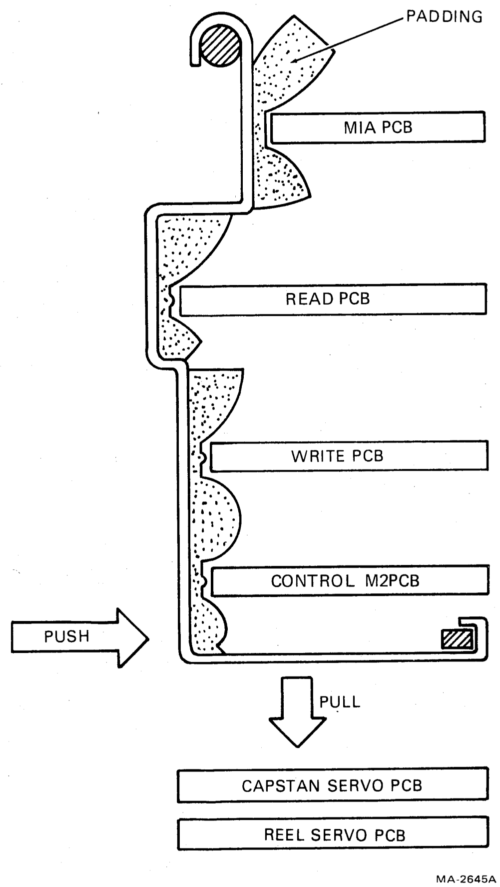


Figure 3-5 PCB Shipping Bracket (Side View)

2. Check that the power on/off circuit breaker on the 874-E is on and the remote/local switch is set to remote (Figure 3-7).

3. Check fuses on power pack fuse panel (Figure 1-5). It is necessary to swing the TM78 logic gate out on its hinge. The fuses can be seen from the front of the cabinet.

4. Remove the cover from the power transformer terminal strip (Figure 3-8). (The ac input plug on power pack must also be removed.) Check that the blue, brown, and white/red wires are connected to the lower terminals (Table 3-1). 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 3-8). Spin the ac motor pulley by hand, and check that the blower and compressor belts are tight and track properly.

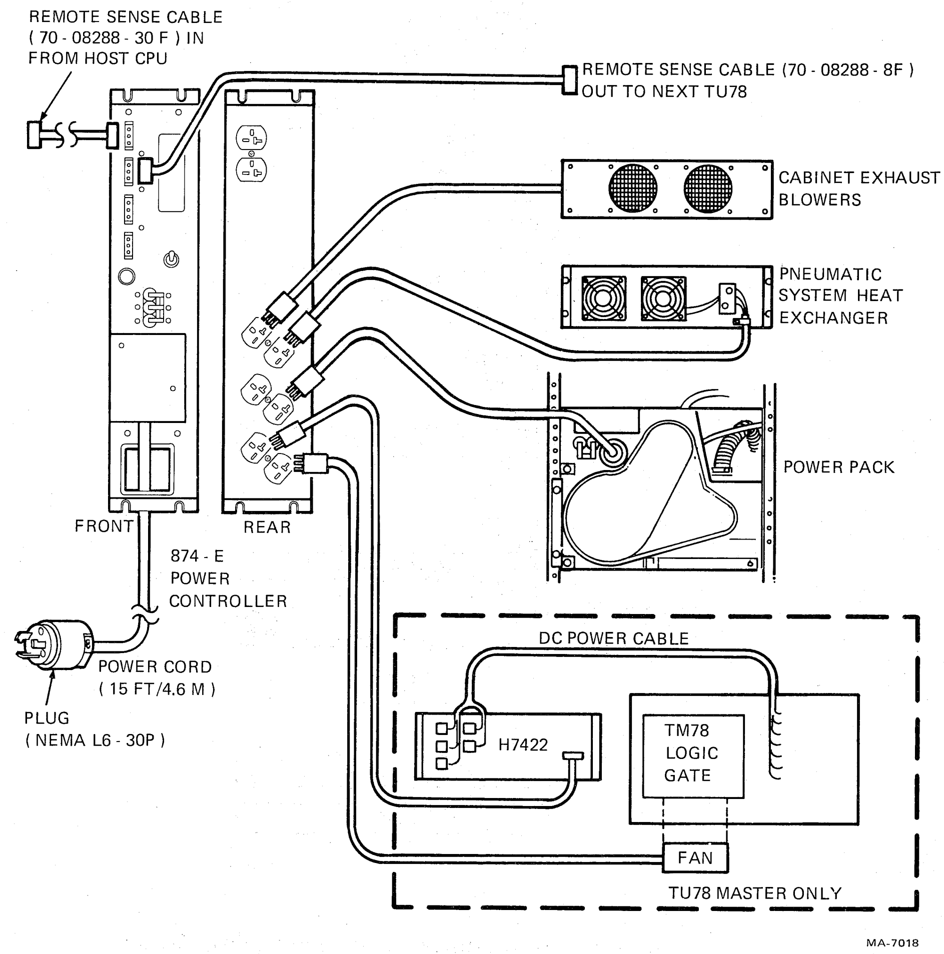


Figure 3-6 TU78 Power Distribution

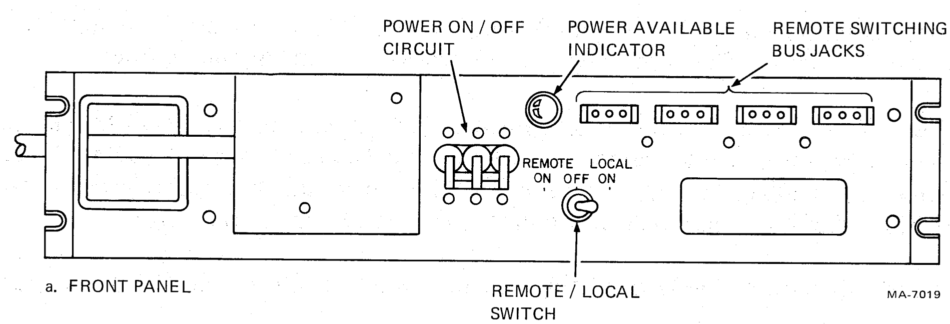


Figure 3-7 874-E Power Controller (Sheet 1 of 2)
a. Front Panel

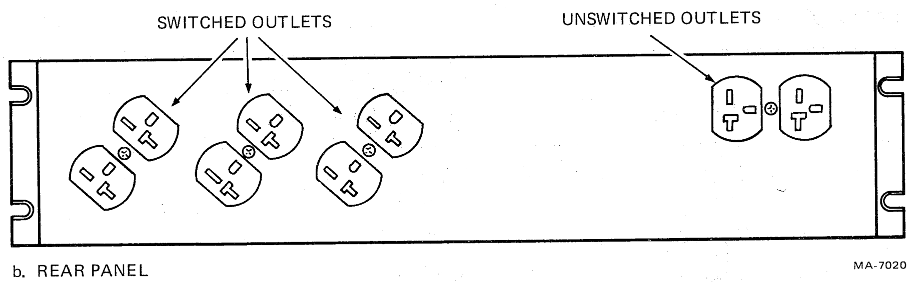


Figure 3-7 874-E Power Controller (Sheet 2 of 2)
b. Rear Panel

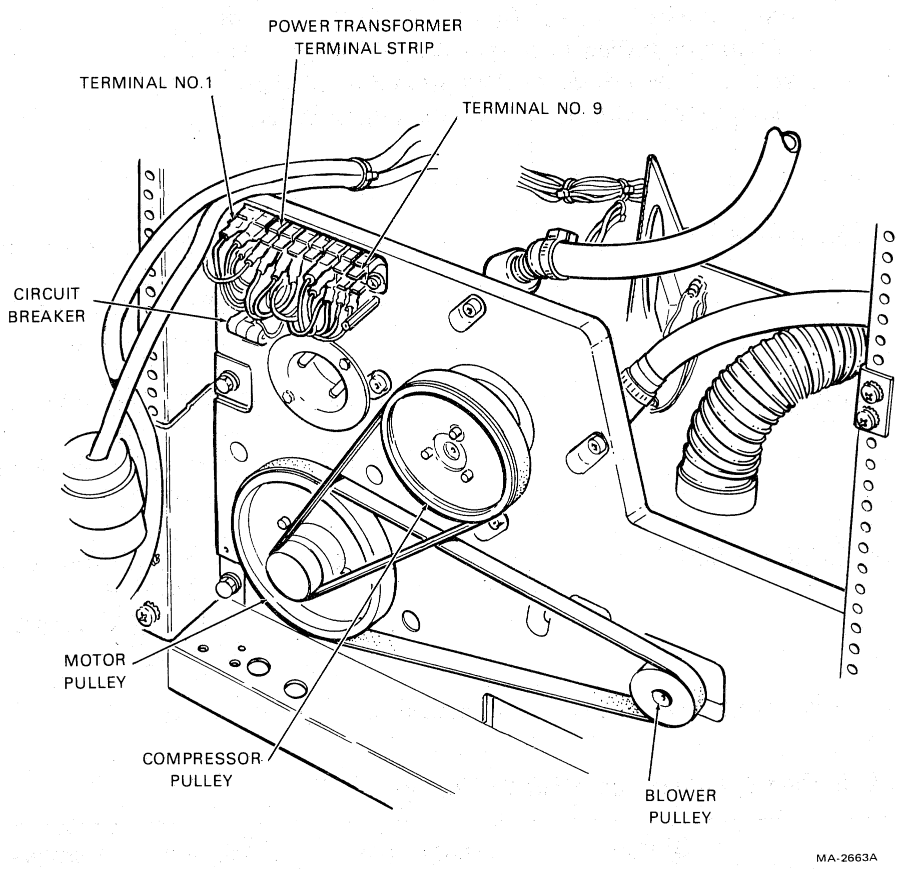


Figure 3-8 Rear of Power Pack with Pulley Cover Removed

Table 3-1 Primary Power Connections

Input Voltage	Blue 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

NOTE

All TU78 transports are manufactured to operate in the 0 to 610 m (0 to 2000 ft) range. If the transport you are installing is to operate at higher elevations, you must install one of the optional high altitude kits listed below. If not, replace the pulley cover.

The following optional high altitude kits are available.

- 610 to 1220 m (2000 to 4000 ft)
  - 60 Hz (PN A2W-0476-10 or 29-23985
  - 50 Hz (PN A2W-0476-11 or 29-23982)
- 1220 to 1830 m (4000 to 6000 ft)
  - 60 Hz (PN A2W-0477-10 or 29-23986)
  - 50 Hz (PN A2W-0477-11 or 29-23983)
- 1830 to 2133 m (6000 to 7000 ft)
  - 60 Hz (PN A2W-0478-10 or 29-23987)
  - 50 Hz (PN A2W-0478-11 or 29-23984)

Refer to Table 3-2 for a list of parts and associated part numbers for each kit.

Table 3-2 Pulley/Belt Part Numbers for Altitude Changes

Altitude	Freq.	Blower Belt	Compressor Belt	AC Motor Pulley	Compressor Pulley
610–1220 m	60 Hz	108479-03	108479-01	108478-06	102635-03
(2000–4000 ft)	50 Hz	108479-05	108479-08	108479-12	102635-03
1220–1830 m	60 Hz	108479-03	108479-01	108478-07	102635-03
(4000–6000 ft)	50 Hz	108479-12	108479-08	108478-11	102635-03
1830–2133 m	60 Hz	108479-11	108479-01	108478-08	102635-05
(6000–7000 ft)	50 Hz	108479-12	108479-01	108478-13	102635-05

Note: Vendor part numbers shown

NOTE

If the altitude kit is being installed on a TU78 with a serial number lower than SP02386, you must also install a new blower assembly (PN 29-24013).

Install the high altitude kit in the following way.

a. Turn transport power off at the cabinet power controller. Disconnect the ac line at the rear of the power pack by pulling the plug straight out.

CAUTION

Do not attempt this or any other removal or replacement procedure within the power pack assembly without first removing the 220 V power cord.

b. Remove the belt guard. Remove both belts by manually 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 smaller pulley (hub) for the reinstallation. Replace the larger pulley with the appropriate 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 proper high altitude compressor pulley.

e. Replace the belts with the appropriate 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 too loose, adjust the position of the blower or compressor.

f. Check that both belts track completely on the pulleys. If not, some shift of the motor pulleys may be necessary.

g. Replace the belt guard and the power cord.

h. Package the old belts and pulleys in a marked container, and leave it in the base of the transport. It is possible that the transport may be moved to a lower altitude in the future.

NOTE

For the following two steps, refer to the procedures found in the installation section (Chapter 3) of the TM78 User Guide or Technical Manual.

7. Connect the BC06S round MASSBUS cable to the input port connector.

8. Connect a MASSBUS terminator to the output port connector.

9. Connect the remote switching control bus from the CPU to one of the front jacks on the 874-E.

10. Using the green/yellow ground cable provided, ground the TU78 cabinet frame to the CPU cabinet frame. The grounding studs for the TU78 are located on the lower side frame members (Figure 3-11).

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

12. Check that system power is off at the CPU. Connect the ac power cable from the 874-E to the power source.

13. Perform acceptance testing (Paragraph 3.5).

3.4 MULTIPLE TRANSPORT INSTALLATION

3.4.1 Mechanical Installation

When an installation requires more than one transport, only the master transport is shipped with the side panels. During installation, remove one of the side panels, and bolt the master and slave transport(s) together. Then mount the removed side panel onto the end slave transport.

After removing the shipping containers and skids, perform the visual inspection of the transports. Then roll the transport cabinets into their approximate positions. Place the master transport to the left (facing front) of all other transports. This allows the TM78 keypad/display to be seen from the other transports in the line when the logic gate is swung out (Figure 3-9).

NOTE

If the TU78 on either end is placed next to another system cabinet, do not remove the adjoining side panels and bolt the cabinets together. Rather, leave the side panels on and position the TU78 side panel tight against the other cabinet's side panel. This maintains proper air flow in both cabinets.

Unless otherwise specified, perform the installation of each cabinet as follows.

1. An array of vertical slots constitutes the venting in the cabinet front panel. 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, and push on the latch while simultaneously pulling forward to release one corner of the front panel. In the same manner, while continuing to pull forward, 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 blister wrapped 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 3-4).

4. Screw the leveler pads into the stabilizer arms.

5. Raise the interlock rods. Reinsert the stabilizer arms into the stabilizer sleeve assemblies.

6. Install the leveler feet in the lower corners of the cabinet frame (Figure 3-4).

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.

8. Open the master transport front door. Using a screwdriver, release the service lock located in the lower right corner of the base assembly. Swing the base assembly open.

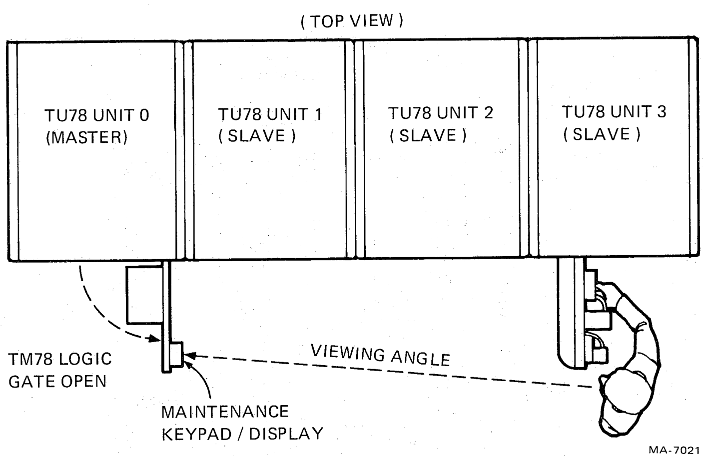


Figure 3-9 Cabinet Placement for Maintenance Display Visibility

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

9. Locate the fastener attached to the underside of the master transport top cover (Figure 3-10). Release the top cover by turning the fastener one-quarter turn in a counterclockwise direction. When it 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 it off. Rest the cover on top of the cabinet, leaving the ground wire connected.

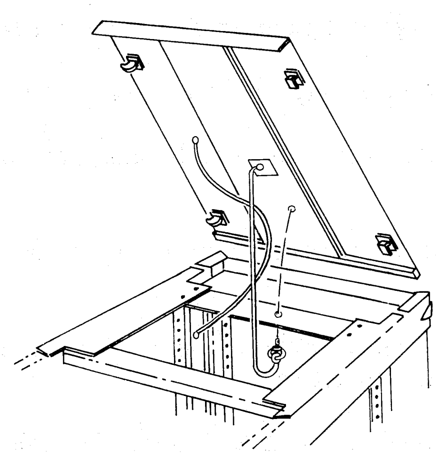


Figure 3-10 Top Cover Fastener

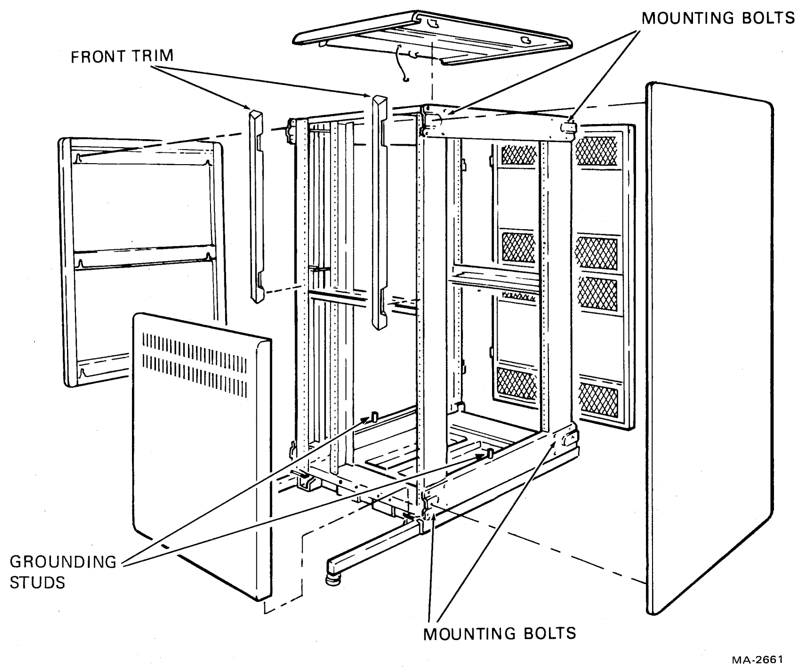


Figure 3-11 Cabinet with Side Panels and Top Cover Removed

10. Remove the end panel on the right side by grasping it on both sides and lifting it off the four mounting bolts. If the side panel does not lift off, it may be necessary to loosen the mounting bolts. In this case, remove the front panel trim to gain access to the upper front mounting bolt. To remove the trim, lift it up and out (Figure 3-11).

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.

13. Push the cabinets together so they are in adjoining positions with the mounting bolt plates side by side.

14. Using the short ground strap included with the slave transports, ground the master and slave cabinets together.

15. Using the green/yellow ground cable provided with the master, ground the master TU78 cabinet frame to the CPU cabinet frame.

16. Using a 9/16-inch wrench, lower the leveling feet of the highest cabinet until they make contact with the floor stabilizing the cabinet.

17. Using a level, adjust the feet until the cabinet is level.

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

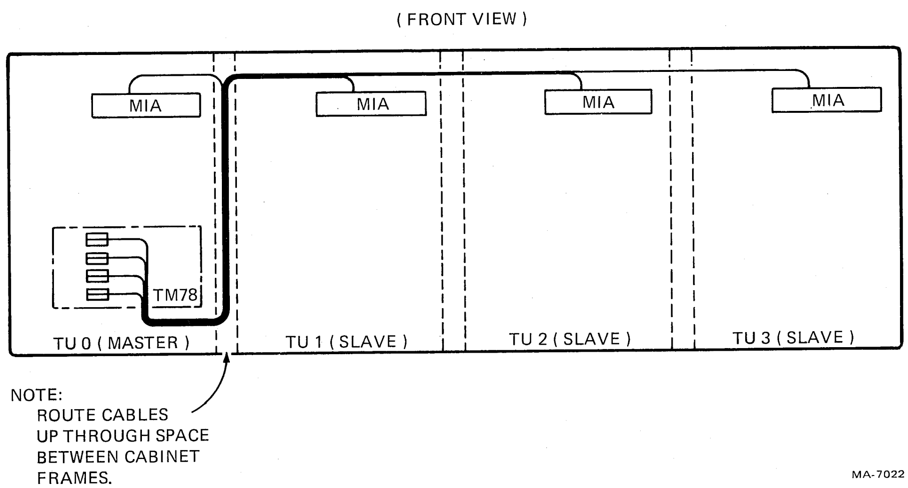


Figure 3-12 TU Bus Cable Routing for a Multiple Transport Configuration

NOTE

Before performing the next step, the TU bus cables for all slave transports must be laid in loosely between the master and first slave (Figure 3-12). There are two 4.6 m (15 ft) cables (PN 70-17382-15) for each slave. Orient the cables so that the red stripe on the side faces the rear of the cabinet. Do not tape the cables together since this would inhibit the replacement of a single cable in the event of failure.

19. Insert 1/4-inch bolts into the holes and secure them with kep nuts. Bolting the cabinets in this manner provides good horizontal alignment.

20. 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.

21. 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.

22. 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.

23. Set the side panel from the master transport next to the slave transport. Connect the panel ground strap to the cabinet frame. Mount the panel onto the side of the slave transport.

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

25. Insert a 5/32-inch Allen wrench into the rear door latch. Turn it one-quarter turn in a counterclockwise direction and open the door.

26. Open the base assembly of each transport. Remove the PCB shipping bracket by pushing in on the lower front and pulling down from underneath (Figure 3-5). Check seating of PCBs in their sockets. Replace the PCB shipping bracket.

3.4.2 Power and Cabling

Figure 3-6 shows the TU78 ac power distribution system. Refer to this figure while making the following checks.

1. Check the following internal power cabling connections for all the transports.

    a. Power cable from 874-E power controller switched outlet to transport power pack (Figure 3-6).

    b. Power cable from 874-E switched outlet to cabinet exhaust blowers.

    c. Power cable from 874-E switched outlet to pneumatic system heat exchanger blowers.

    d. Power cable from 874-E switched outlet to H7422 power supply (master TU78 only).

    e. Power cable from 874-E switched outlet to TM78 logic cage blower (master TU78 only).

    f. DC power cable harness from H7422 power supply to TM78 logic gate (master TU78 only).

2. Check that the power on/off circuit breaker on the 874-E is on and the remote/local switch is set to remote (Figure 3-7).

3. Check fuses on power pack fuse panel (Figure 1-5). The fuses can be seen from the front of the cabinet. (On the master transport, it is necessary to swing the TM78 logic gate out on its hinge.) A closer view can be obtained from the rear of the cabinet by looking over and down onto the fuse panel.

4. Remove the cover from the power transformer terminal strip (Figure 3-8). (The ac input plug on the power pack must also be removed.) Check that the blue, brown, and white/red wires are connected to the lower terminals (Table 3-1). 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 3-8).

    NOTE

    All TU78 transports are manufactured to operate in the 0 to 610 m (0 to 2000 ft) range. If the transport you are installing is to operate at higher elevations, you must install a high altitude belt and pulley kit. Refer to Paragraph 3.3.2, 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
For the following two steps, refer to the procedures found in the installation section (Chapter 3) of the TM78 User Guide or Technical Manual.

7. Connect the BC06S round MASSBUS cable to the input port connector.

8. Connect a MASSBUS terminator to the output port connector.

9. Install the TU bus cables between the TM78 in the master transport and the slave transport(s). Figure 3-12 shows the positioning of the cables relative to the cabinet frames. The TU bus for the master transport is prewired at the factory. Figure 3-13 shows the electrical connection for each TU bus cable. Start at the TM78 end of the cable and work toward the MIA (multiple interface adapter) end.

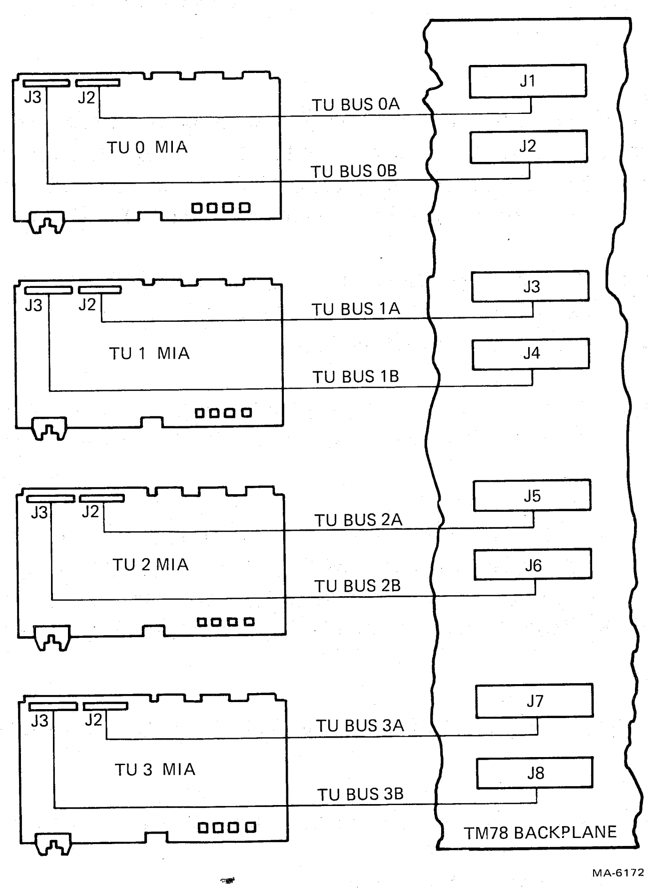


Figure 3-13 Radial TU Bus Connections

NOTE
The procedure for connecting the cable to the TM78 is found in the installation section (Chapter 3) of the TM78 User Guide or Technical Manual.

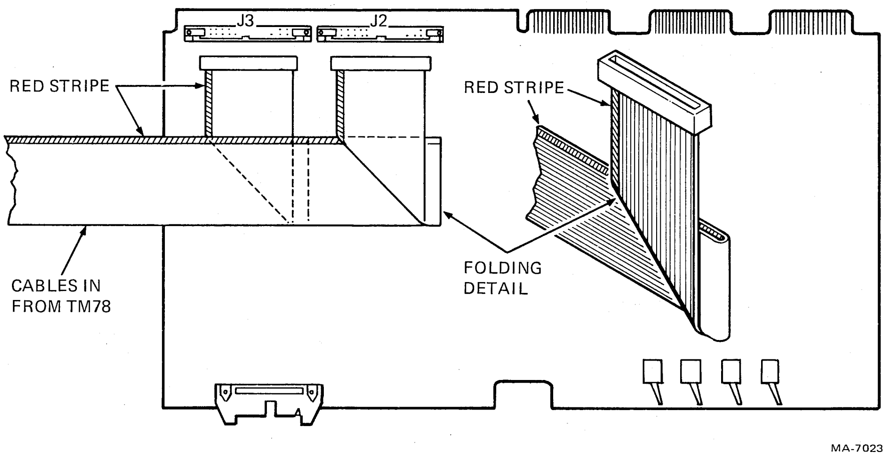


Figure 3-14 Cable Orientation on TU78 MIA PCBA (Slave Only)

10. The TU bus cables should exit up through the space between the frame members of the master and first slave transports. (Refer to note after Step 18, Paragraph 3.4.1). Fold all cables over and thread them through the space between the cabinet frame and the transport card cage side panels. The cables should lie flat over the MIA PCBs.

11. Dress and bend the cables as shown in Figure 3-14. Note the orientation of the red stripe. Plug the appropriate cables into the two MIA jacks (J2 and J3). Any slack in the cables should be taken up, folded, and tie-wrapped.

12. Repeat this procedure for each set of cables going to each slave transport. The cables for each succeeding transport should be layed over the preceding transports MIA card (Figure 3-12).

13. Daisy chain the remote switching control bus by connecting the bus from the CPU to one of the jacks on the front of the master transport's 874-E power controller. Using another cable, connect the bus from one of the other jacks on the 874-E to the 874-E in the next transport. Continue the daisy chain until all the TU78s are connected to the remote switching control bus.

14. Check that system power is off at the CPU. Connect the ac power cable from each 874-E to a power source.

15. Install cabinet front panels, and close and secure all base assemblies.

16. Perform acceptance testing (Paragraph 3.5).

3.5 ACCEPTANCE TESTING

This section describes all the acceptance tests required for the TU78 transport and the TM78 tape formatter. If they are performed satisfactorily, then the units have been installed and are operating properly.

Acceptance testing is divided into three categories: turn-on and loading checkout, subsystem quick check, and system level diagnostics. The turn-on and loading checkout verifies only basic functions of the transport and formatter. The subsystem quick check involves calling certain microcoded test routines from the TM78 maintenance panel. The system level diagnostics treat the formatter and transport as a subsystem, and exercise them to the fullest extent.

If unfamiliar with interlocks and other conditions affecting autoload/manual load selection, refer to Paragraph 2.2.2.

3.5.1 Turn-On and Loading Checkout

The turn-on and loading checkout applies power to the subsystem in order to observe the state in which the formatter comes up running and the transport comes up idle. This test also loads the transport under various conditions in order to check for the proper responses. The checkout utilizes flowcharts to show the proper sequence of events for each loading operations. The flowcharts include minor troubleshooting aids to help locate simple problems caused by bad tape or improper loading procedures. Perform the following operations in order.

3.5.1.1. Power On – Follow the instructions and check for the events specified.

1. Remove the lower front panel of the master transport to gain access to the TM78 formatter.

2. Turn both TM78 MASSBUS ports off-line by flipping TM78 backplane DIP switches 1 and 5 to the right (0) position.

3. Turn on power. This may be done remotely by turning on the host CPU, or locally by flipping the REMOTE/LOCAL switch located on the 874-E to LOCAL ON.

4. Check for the following.

   a. All fans in subsystem turn on.

   b. The following indicators on the TU78 control panel light: Power, File Protect, 6250. All other lights on the TU78 control panel remain unlit.

   c. The internal microcomputer exercises the TM78 maintenance panel display. This exercise consists of rotating the following characters through all six LEDs in the display: **0**, **1**, **2**, **3**, **4**, **5**, **6**, **7**, **-**, **H**, **E**, **L**, **P**. The rotating display allows you to check that each LED can produce each available character. It also indicates that the internal microcomputer is running.

      If the display does not rotate the characters, press and release the TM78 master reset button, located on the backplane just to the right of the DIP switches. If the display still does not rotate the characters, this indicates that there is a TM78 logic or power supply malfunction (assuming that the TM78 is off-line). Refer to the troubleshooting procedures found in Chapter 5 of the *TM78 Technical Manual*.

5. Perform the TM78 maintenance keypad tests. Press each key (except **ENA**) independently in order to produce its keypad matrix location in the display. The second LED digit indicates the column number and the fifth LED indicates the row number. The other LEDs display hyphens. Figure 3-15 illustrates the keypad with the assigned column and row numbers. When no key is pressed, the display reverts to the rotating character test.

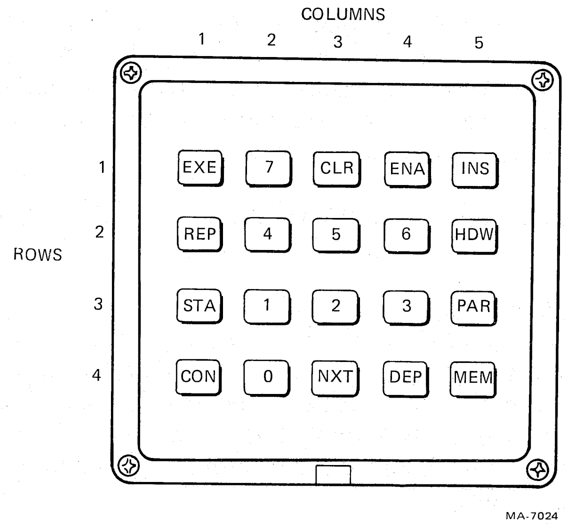


Figure 3-15 TM78 Maintenance Keypad

Now press the **ENA** (enable) key firmly for one second. This stops the microcomputer from running the maintenance display/keypad tests and display **HELLO** in the LEDs. Now the keypad is enabled and the microcomputer is waiting for a command. Press **ENA** again and the microcomputer disables the keypad and the display goes blank.

3.5.1.2 Load Sequence Without Tape – With no tape reel mounted on the supply hub, and the front door closed, follow the instructions and check for the events specified in Figure 3-16.

3.5.1.3 Inhibited Autoload Sequence – Install a write enable ring on a 267 mm (10.5 in) tape reel. Tape the leader to prevent magnetic tape from coming off the reel. Mount the reel onto the supply hub. Close the transport front door. Follow the instructions and check for the events specified in Figure 3-17.

3.5.1.4 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, crimp the end of the tape with the tape crimper (PN 47-00038). Do not remove the write enable ring. Close the transport front door. Follow the instructions and check for the events specified in Figure 3-18.

3.5.1.5 Manual Load Sequence – Install a write enable ring on a 216 mm or 178 mm (8.5 in or 7 in) tape reel. Mount the reel onto the supply hub. Check that the leader has no creases or rips. If necessary, crimp the end of the tape with the tape crimper. Insert 8 cm to 10 cm (3 in to 4 in) of tape into the threadblock column. Close the transport front door. Follow the instructions and check for the events specified in Figure 3-19.

3.5.1.6 Unload Sequence – Follow the instructions and check for the events specified in Figure 3-20.

3.5.1.7 Manual Load Repeatability – Perform the following steps.

1. Mount a 216 mm or 178 mm (8.5 in or 7 in) tape reel onto the supply hub.

2. Check that the leader has no creases or rips. If necessary, crimp the end of the tape with the tape crimper.

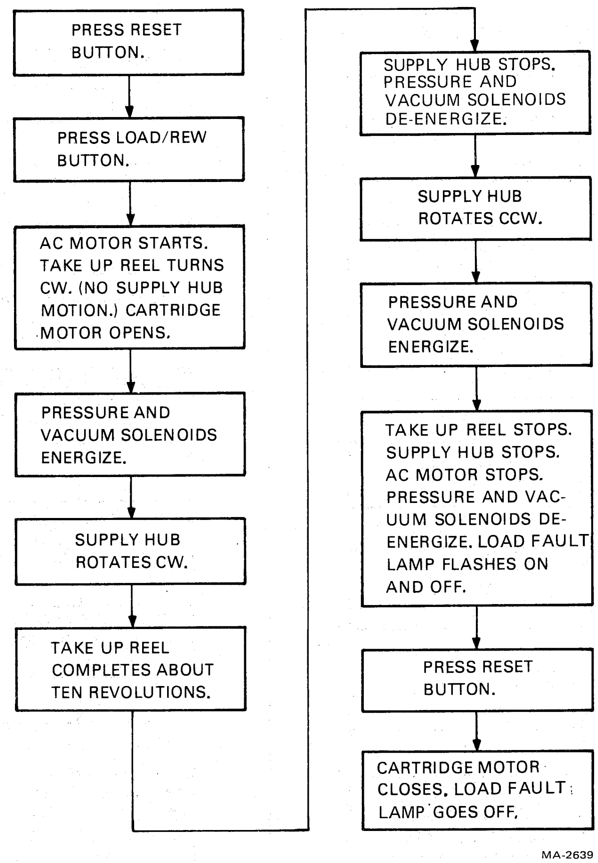


Figure 3-16 Load Sequence Without Tape

3. Insert 8 cm to 10 cm (3 in to 4 in) of tape into the threadblock column.

4. Close the transport front door.

5. Initiate a manual load by pressing and releasing the LOAD/REW button.

6. If the tape loads successfully, press the UNLOAD button to unload the tape.

7. Repeat steps 3, 4, 5, and 6 eight times. If a failure occurs within the 8 tests, continue manual loading up to 20 tests. There should be no more than 3 failures among 20 successive tests.

   After completing the manual load repeatability test, check the tape for damage caused by the tape transport. The tape should not show damage sufficient to cause a load failure or data errors.

3.5.1.8 Autoload Repeatability – Perform the following steps.

1. Mount a 267 mm (10.5 in) tape reel onto the supply hub.

2. Check that the leader has no creases or rips. If necessary, crimp the end of the tape with the tape crimper.

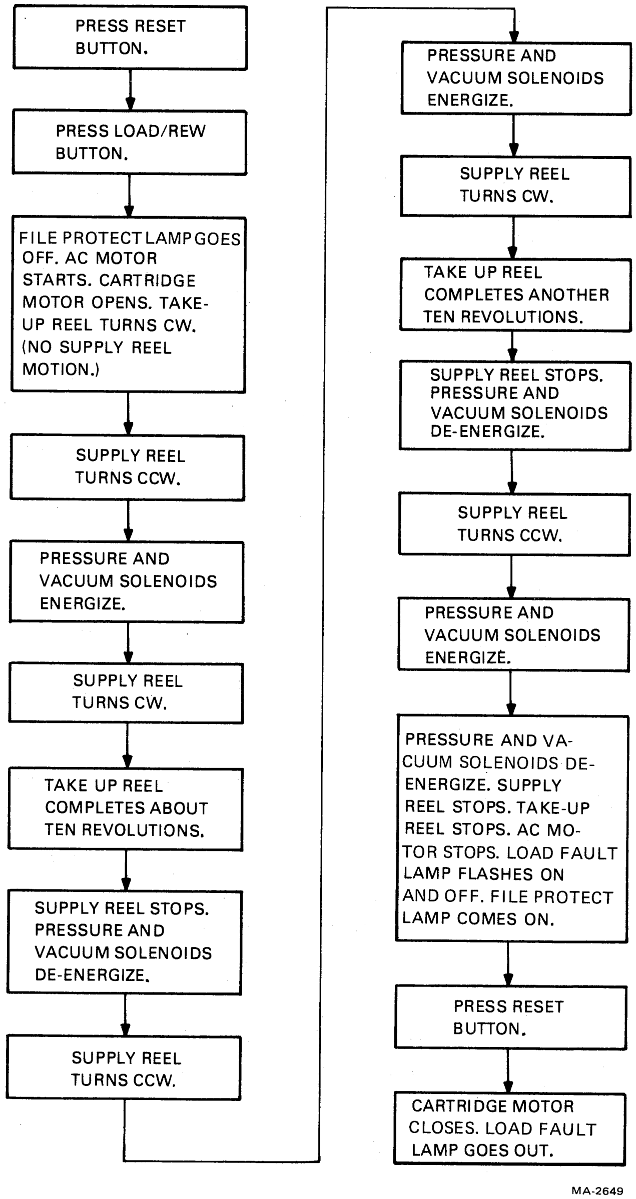


Figure 3-17 Inhibited Autoload Sequence

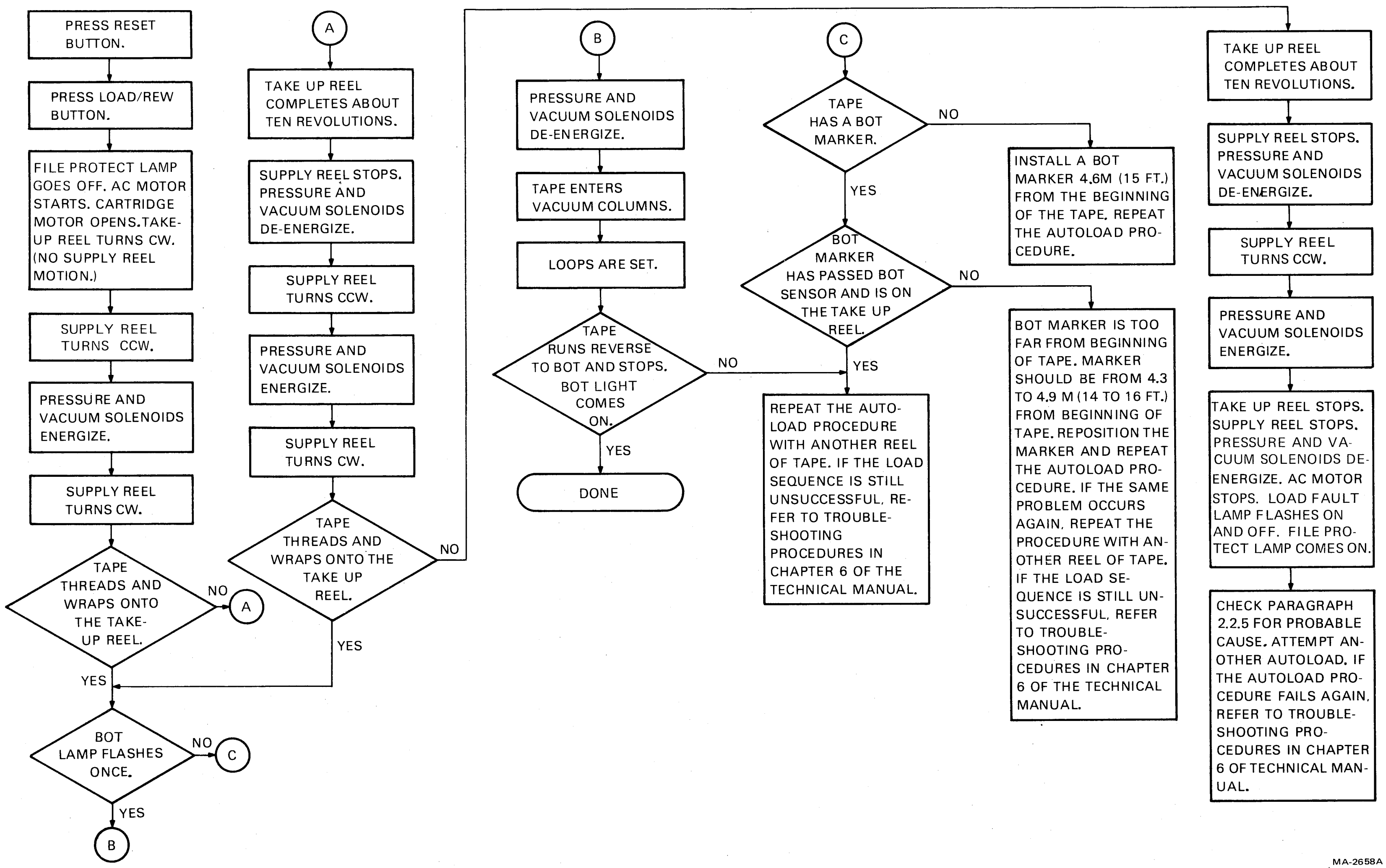


Figure 3-18 Autoload Sequence

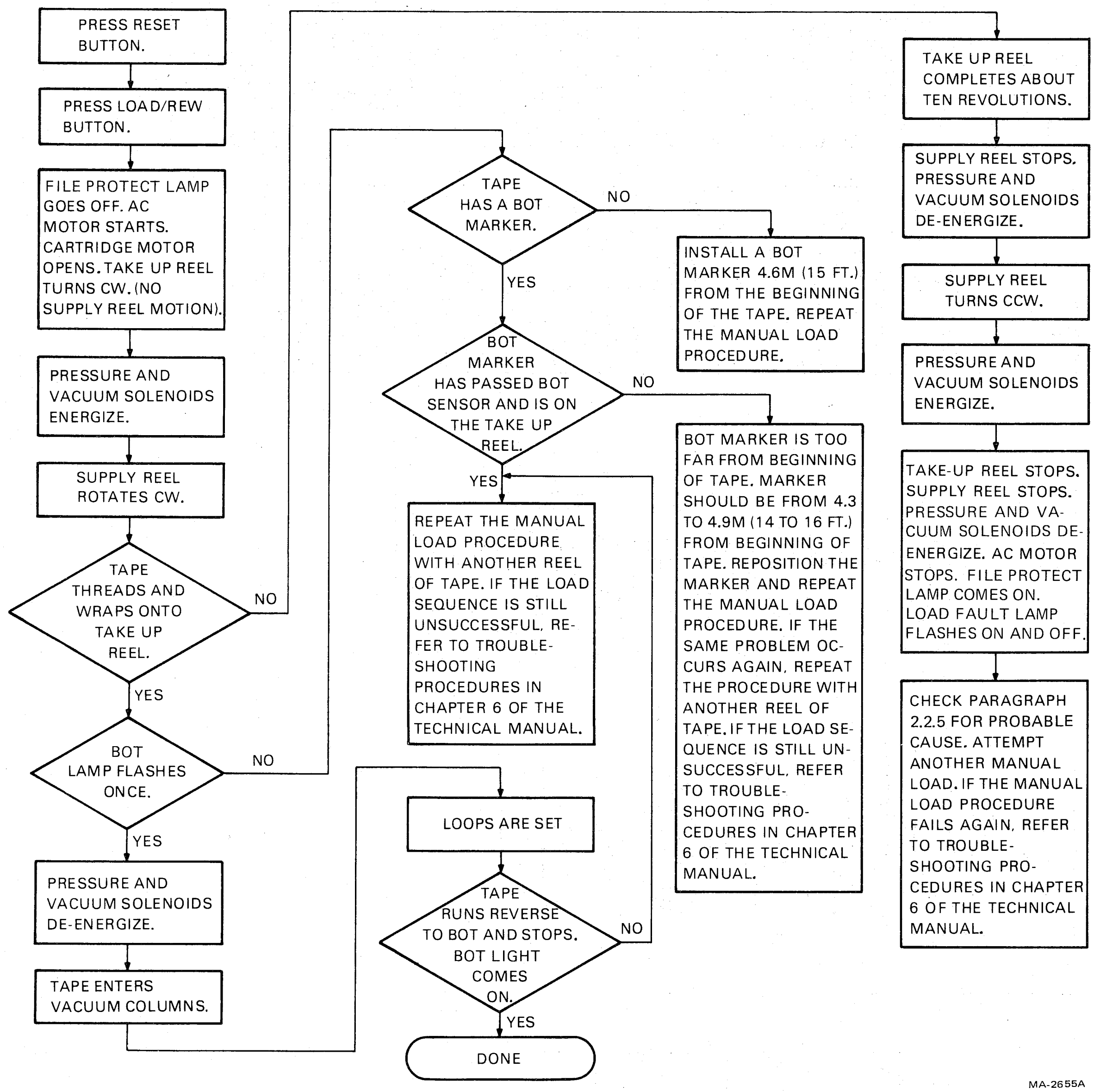


Figure 3-19 Manual Load Sequence

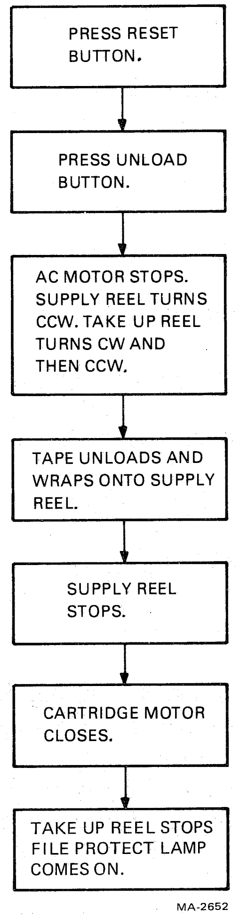


Figure 3-20 Unload Sequence

3. Close the transport door.

4. Initiate an autoload by pressing and releasing the LOAD/REW button.

5. If the tape loads successfully, press the UNLOAD button to unload the tape.

6. If autoload fails, the tape automatically tries to load a second time. If the second attempt fails, the load fault lamp flashes. This is counted as one failure.

7. Repeat steps 4, 5, and 6 nine times. If a failure occurs within the 9 tests, continue autoloading up to 20 tests. There should be no more than 2 failures among the 20 successive tests.

8. After completing the autoload repeatability test, check the tape for damage caused by the tape transport. The tape should not show damage sufficient to cause a load failure or data errors.

3.5.2 Subsystem Quick Check

Perform this test using the TM78 formatter for each TU78 transport, one at a time.

1. Load a write enabled scratch tape on the desired transport. Place the transport on-line.

2. Place the transport port select switch in the number 3 position (maintenance mode).

3. Enable the TM78 maintenance keypad by pressing the **ENA** key. The display should respond with **HELLO**.

4. Select the transport as follows.

   - Press **0** (parameter item #0).
   - Press **PAR**. (The display should flash parameter item 0, then display its contents.)
   - Enter the TU number to be exercised by pressing **0**, **1**, **2**, or **3**.
   - Press **DEP**. (The display should flash the new contents of parameter item 0).

5. Issue a Write GCR command to the transport.

   - Enter **63**. (The display should show **63**).
   - Press **EXE**.

   The subsystem executes the write GCR command, puts the results in the display, and waits for the next command. The results are in the format **II–FF**, where **II** is the interrupt code and **FF** is the failure code. The only two acceptable results are **01–00** (done with no errors), or **01–01** (done with a correctable error). Any other results are not acceptable, indicating a problem somewhere in the subsystem. Refer to the interrupt code/failure code cross-reference and troubleshooting sections of the *TM78 Technical Manual.*

   - The write GCR command may be executed again by pressing **EXE**, or repeatedly by pressing **REP.** To halt a repeated operation, press **CLR**.

6. Repeat the quick check (steps 1, 2, 4, and 5) for each transport in the subsystem.

7. Disable the keypad by pressing the **ENA** key. The display should go blank.

8. Turn both TM78 MASSBUS ports on-line, by flipping TM78 backplane DIP switches 1 and 5 to the left 1 position.

9. Verify each TU78 vacuum and pressure setting by performing the procedures in Paragraph 6.5.4. This is especially important if a high altitude belt/pulley kit has just been installed. Adjust any setting that is out of tolerance.

3.5.3 TM78/TU78 System Level Diagnostics

Mount and load a write enabled 267 mm (10.5 in) tape reel. Place the transport on-line and check that the on-line indicator lights. Set the transport port select switch to 0 or 1, depending upon the MASSBUS port being driven. If exercising a single port subsystem, set the switch to 0.

Table 3-3 lists the TM78/TU78 diagnostics for DECsystem-10/20, and VAX 11/780 systems. Load and run the appropriate diagnostics. Refer to the instructions in the diagnostic documentation and use the parameters specified in the following paragraphs.

Table 3-3 TM78/TU78 Diagnostics for Acceptance Testing

Title	DECSYSTEM-20	VAX	Description
Control Logic Test	DFTUI	EVMAE	Tests MASSBUS controller and TM78 formatter logic. Also tests subsystem basic command functions while checking for proper tape motion timing. Must be run from each CPU separately, through both MASSBUS ports (if dual port option present). Provides error information to user via console or line printer.
Data Reliability	DFTUJ	EVMAA	Tests TM78 circuitry and TU78 circuitry by writing and reading pre-determined data patterns and recording modes. Provides error information to user via console or line printer. May be run in dual port mode (from dual CPUs) driving two or more transports.

3.5.3.1 DECsystem 10/20 Diagnostics

DFTUI (Basic/Control Logic Supervisor)

1. Run one pass of test "accept" (TM78 acceptance) with all manual intervention tests enabled.

   Allow one pass with no errors.

2. Run "accept" for five passes with manual intervention tests disabled.

   Allow five passes with no errors.

DFTUJ (Data Reliability)

1. Allow one pass in default mode with the error criteria listed in Table 3-4.

Table 3-4 Maximum Error Rate Per Pass

Error Type	Write	Read	Read Reverse
Status Errors	0	0	0
Non-recoverable	0	0	0
Media	20	–	–
Double track corrections	–	1	1
Single track corrections	–	5	5
Data compare	–	0	0
Others	10	5	5

NOTES
One pass consists of writing and reading from BOT to EOT twice, once in each density mode.

If the TU78 does not meet these specifications, further passes are necessary to determine the validity of errors.

3.5.3.2 VAX 11/780 Diagnostics

Standalone Mode (Level 3)

1. Control Logic Test (EVMAE) – Boot the diagnostic supervisor (ESSAA) and configure system (select drives, RHs, etc.) to run TM78/TU78.

   Run the control logic test (EVMAE) for one pass with all manual intervention tests enabled. After loading the diagnostic supervisor, in order to print the subtest header information, type in SET TRACE.

   Proceed as follows after the supervisor prompt.

   DS>SET TRACE
   DS>RUN EVMAE/SEC:MANUAL

   Allow one pass with no errors.

   Run the control logic test again for five passes without the manual intervention tests as follows.

   DS>START/PASS:5

   Allow five passes with no errors.

2. Data Reliability (EVMAA) – Run the data reliability exerciser (EVMAA) for one pass. A pass comprises two complete tape passes (to EOT), once for PE format and once for GCR format.

Proceed as follows after the supervisor prompt.

DS>RUN EVMAA

or in conversation mode

DS>ST/SEC:CONVER

Allow one pass with the error criteria in Table 3-4.

On-Line Mode Under VMS (level 2)

1. Boot the VMS operating system and load the diagnostic supervisor (ESSAA). Run the data reliability test (EVMAA) for one pass, preferably with other users (jobs) running simultaneously.

   Allow one pass with the error criteria in Table 3-4. Make sure that the TU78 tape subsystem does not degrade total system performance in the on-line mode.

CHAPTER 4
CUSTOMER CARE
AND PREVENTIVE MAINTENANCE

4.1 CUSTOMER RESPONSIBILITIES

The following is a list of maintenance procedure for which the customer is responsible.

1. Obtain operating supplies, including magnetic tape and cleaning supplies.

2. Supply accessories, including cabinetry, tables, and chairs.

3. Maintain the required logs and report files consistently and accurately.

4. Make the necessary documentation available in a location convenient to the system.

5. Keep the exterior of the system and the surrounding area clean.

6. Make sure that ac plugs are securely plugged in each time equipment is used.

7. Perform specific equipment care operations described in Paragraph 4.2 and 4.3 at the suggested frequencies, or more often if usage and environment warrant.

4.2 MAGNETIC TAPE CARE

The following is a list of steps necessary for properly maintaining 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; it is imperative that the tape be kept clean.

2. Always store tape reels inside containers when they are 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. This 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 in any location where it might be affected by hot air.

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

4.3 PREVENTIVE MAINTENANCE

4.3.1 General

Digital Equipment Corporation tape transports are highly reliable precision instruments that 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 assists the customer in caring for his equipment and maintaining the highest level of performance and reliability.

4.3.2 Preventive Maintenance

To ensure trouble-free operation, a preventive maintenance schedule should be kept. This involves cleaning only a few items, but the cleanliness of these items is very important to proper tape transport operation. The frequency of the cleaning varies with the environment and degree of use of the transport. Therefore, it is difficult to define a general schedule for all machines. Daily cleaning is recommended for TU78 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. All items in the tape path should be cleaned on a daily basis. It is important to be thorough yet gentle and to avoid certain dangerous practices. 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 provided. Its material do not harm tape equipment and do not leave any residue behind to interfere with data reliability. The following paragraphs contain hints to make sure that the very best results are obtained.

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

WARNING

TF113 is a non-restricted, non-hazardous substance. However, avoid excessive skin contact. Do not allow it to come in contact with the eyes, and do not swallow it. Use only in a well-ventilated area.

Never dip a contaminated cleaning swab or wipe into the can. To transfer fluid onto the swab, pour a little into the cap and dip the swab into the cap. Discard the fluid remaining in the cap when the cleaning operation is complete.

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

Use the cleaning materials contained 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 might contact the

TM Trademark of Dow Chemical Company

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.

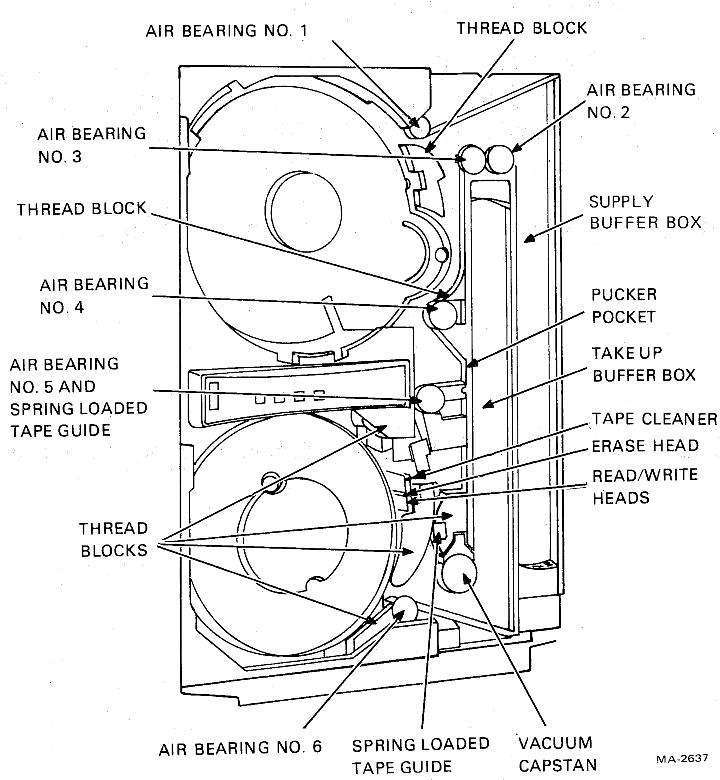
4.3.4 TU78 Tape Transport

Perform the following steps to clean the TU78 tape transport.

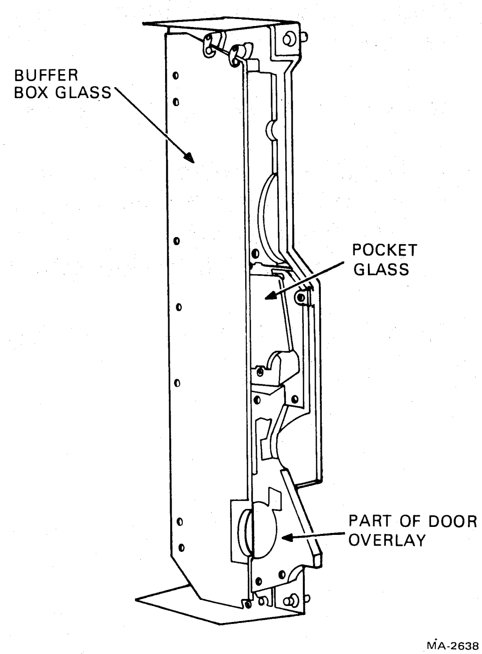
1. Dismount the tape from the unit.

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



Tape Path Items



Buffer Box Door

Figure 4-1 Transport Items for Daily Cleaning

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

3. When cleaning the thread blocks, be 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, be sure that 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.

4.4 ORDERING SUPPLIES, ACCESSORIES AND DOCUMENTATION

For information about supplies, accessories, and additional documentation for your TU78 tape transport (or for any DIGITAL equipment), contact your local sales office or call DIGITAL Direct Catalog Sales.

Continental US, 8:30 am to 6 pm (EST), call 800-258-1710
New Hampshire, 8:30 am to 6 pm (EST), call 603-884-6660
Chicago, 8:15 am to 6 pm (CT), call 312-640-5612
San Francisco, Alaska, and Hawaii, 8:15 am to 6 pm (PT), call 408-734-4915.

Terms and conditions include net 30 days and F.O.B. DIGITAL plant. Freight charges are prepaid by DIGITAL and added to the invoice. Minimum order is $100.00. (Minimum does not apply when full payment is submitted with an order). Checks and money orders should be made out to Digital Equipment Corporation.

Purchase orders for supplies, accessories, and documentation should be sent to the following address.

Digital Equipment Corporation
Accessories and Supplies Group
P.O. Box CS2008
Nashua, New Hampshire 03061

Purchase orders must show shipping and billing addresses and state whether a partial shipment will be accepted.

In addition to the hardware documentation listed in Table 1-1, the following accessories and supplies may be purchased to support the TU78 tape transport.

Item	Part No	Description
Magnetic Tape	TUM24-A	732 M (2400 ft) magnetic tape in autoload belt
Magnetic Tape	TUM24-AL	10 TUM24-A tapes
Magnetic Tape	TUM24-AM	50 TUM24-A tapes
Autoload Belts	TUM24-AX	10 autoload belts for 26.7 cm (10.5 in) diameter tape reels
Cleaning Kit	TUC01	Magnetic tape transport cleaning kit containing fluid, swabs, wipes, and cleaning instructions
Markers	90-09177-00	Magnetic tape foil sensing markers for re-creating EOT/BOT points

CHAPTER 5
THEORY OF OPERATION

5.1 GENERAL

This chapter describes basic functioning of the TU78 magnetic tape transport and 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 TU78. This chapter picks up where Chapter 1 leaves off.

The text is supported by applicable schematics, simplified detail diagrams, and other conventional illustrations. In addition, the following block diagrams for major functions are provided in the TU78 Magnetic Tape Transport Technical Manual, Volume 1.

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

Diagrams two through six each present one essential function, such as the reel servo function. Each diagram's subject is covered completely, if necessary 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. Schematics provide greater detail and are identified by hardware references on the functional block diagrams. TU78 engineering drawings are located in Volume 1 along with the six functional block diagrams.

TU78 functions are shown in detail in Figure 1, 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

Figure 1 illustrates the relationship between transport functions and interface connections to the multiple interface adapter (MIA) module.

Interface inputs and outputs are identified by connector and pin designations and 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 covered separately. Therefore connectors are not identified in Figure 1.

5.2 THEORY OF OPERATION SYMBOLOGY

Specific symbols and mnemonic standards are used in the text and drawings of this chapter. An exception is the paragraph on the multiple interface adaptor (MIA) interface module. The following explanations refer to other TU78 transport areas.

5.2.1 Functional Block Diagram Symbology

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

The block diagrams illustrate the purpose of the modules, cards, assemblies, or components involved in the overall operation. 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 special arrowheads and identified by signal flags. The weight of the signal lines show the significance of the signal in the discussion.

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

Signals generated in one function, and used in another, are interfaced by terminating the signal in a shadow box area representing the other function using the signal. Since all functions are located in hardware, all pins of plugs and jacks through which the signal passes are shown. This provides an easy method of tracing signals from one functional block diagram to another. Signal flags (mnemonic terms) help the user locate the desired signal faster. 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 one portion of the function interplays with other portions of the function. References to engineering drawings, schematics, etc., include document number and a zone code formed from the document sheet number, vertical coordinate number, and horizontal coordinate letter (for example, zone 2-4 F).

5.2.2 Schematic Diagram Symbology

Interface voltage levels between the MIA and the transport (at interconnect D1) are as follows.

Low (true) = 0 V
High (false) = +3 V

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

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 is always low = true.

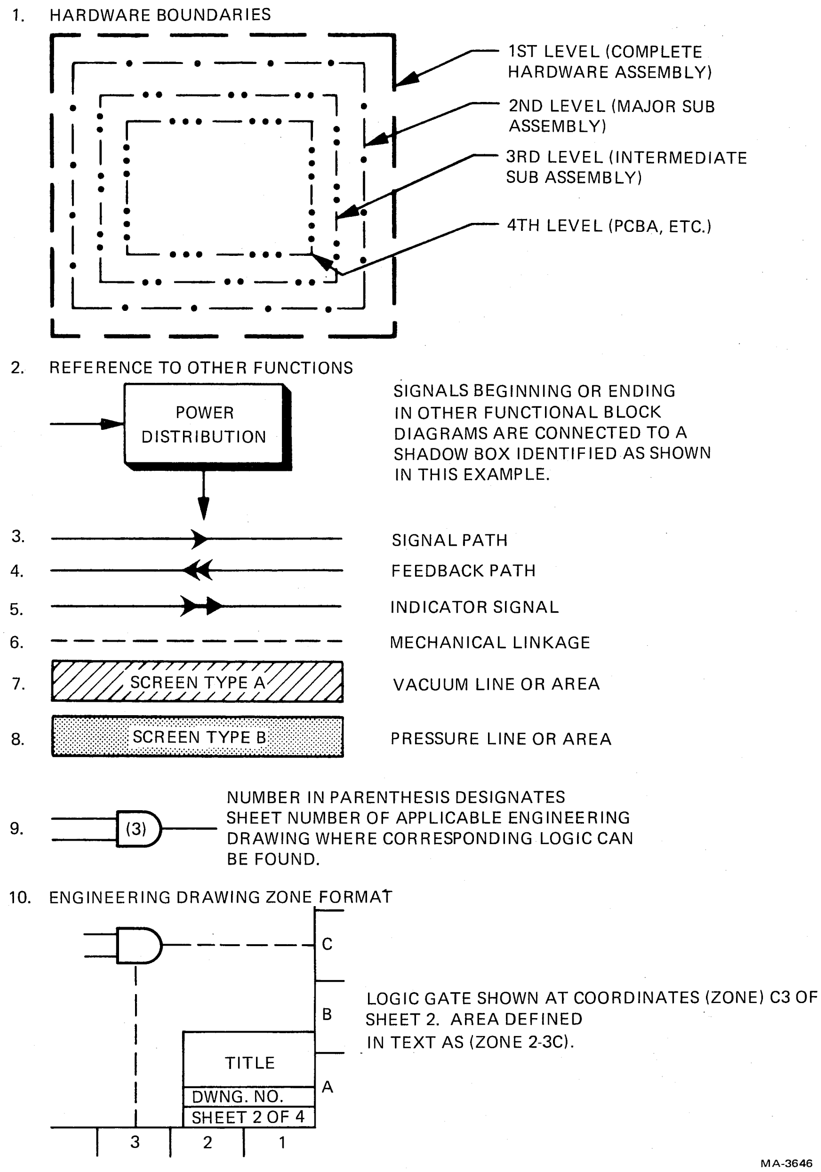


Figure 5-1 Functional Block Diagram Symbology

An interface signal that appears 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 symbols are 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 the expression to indicate output and input signals, respectively.

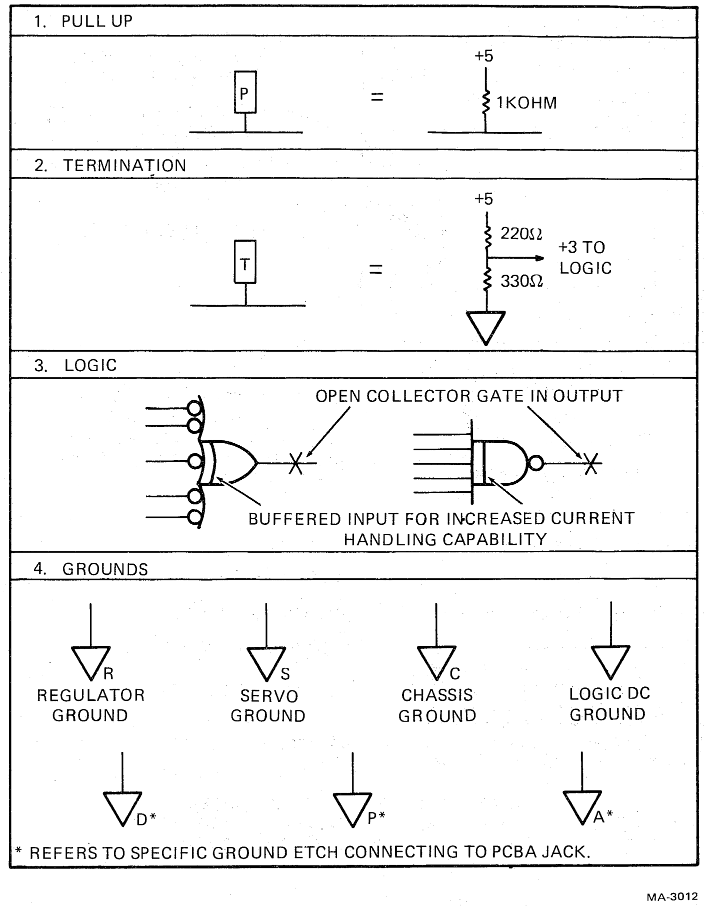


Figure 5-2 Schematic Diagram Symbology

An N is used in the beginning of a mnemonic term to indicate a NOT (low voltage level) state. In some documentation this is expressed by the overline or bar symbology (for example 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 symbols used on the schematic drawings are explained in Figure 5-2.

5.3 TU78 CABLING/INTERCONNECTIONS

5.3.1 Input/Output Cabling and Connectors

All input/output signals between the TM78 tape formatter and the TU78 transport are via the multiple interface adaptor (MIA) PCBA (Figure 5-3). The MIA receives the TU bus from the TM78 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, and J103 located on the top edge of the interconnect D1 PCBA, and J201, J202, J203, and J204 located on back of the interconnect D1 PCBA (Figure 5-4). Both sets of connectors are not used but can serve as test points for the transport interface signals. The functional block diagrams in Volume 1 of the Technical Manual show these connectors and identify the signals on each pin.

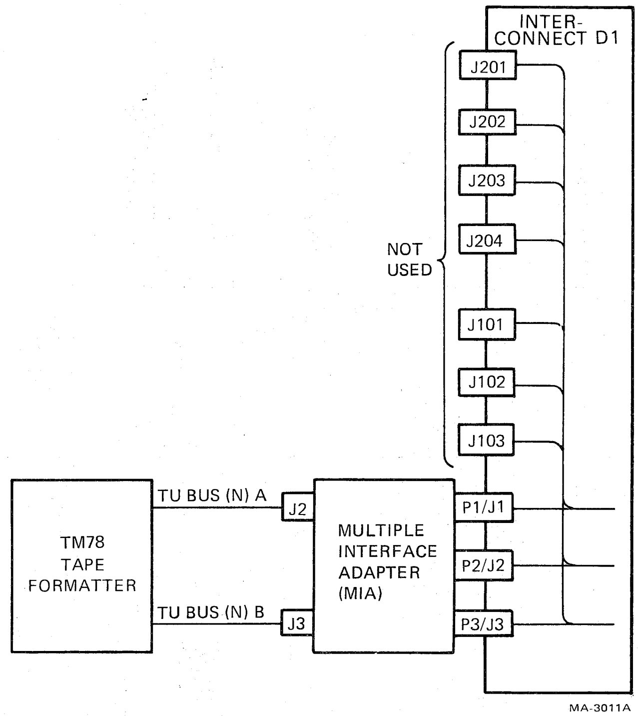


Figure 5-3 TU78 Interface Connections

5.3.2 Interconnect D1 PCBA

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 shown in Figure 5-4 and connections provided by the PCBA are listed in Appendix D. The interconnect D1 PCBA also connects to the interconnect F1 PCBA, via a cable, through jack J24 (Figures 5-4 and 5-5).

5.3.3 Interconnect F1 PCBA

The interconnect F1 PCBA, mounted on back 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 Number 107307. The interconnect F1 PCBA connects to the interconnect D1 PCBA, via a cable, through jack J21 (Figure 5-5). Terminal boards one through four allow connections to base assembly components.

5.3.4 Internal Interconnections

Interconnections between various functional PCBAs (control M2, write, etc.) are provided by the interconnect D1 PCBA, into which the other boards are plugged (Figure 5-4). 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 shown in Figure 5-5. Primary and secondary power circuit cables are described in Paragraph 5.4.

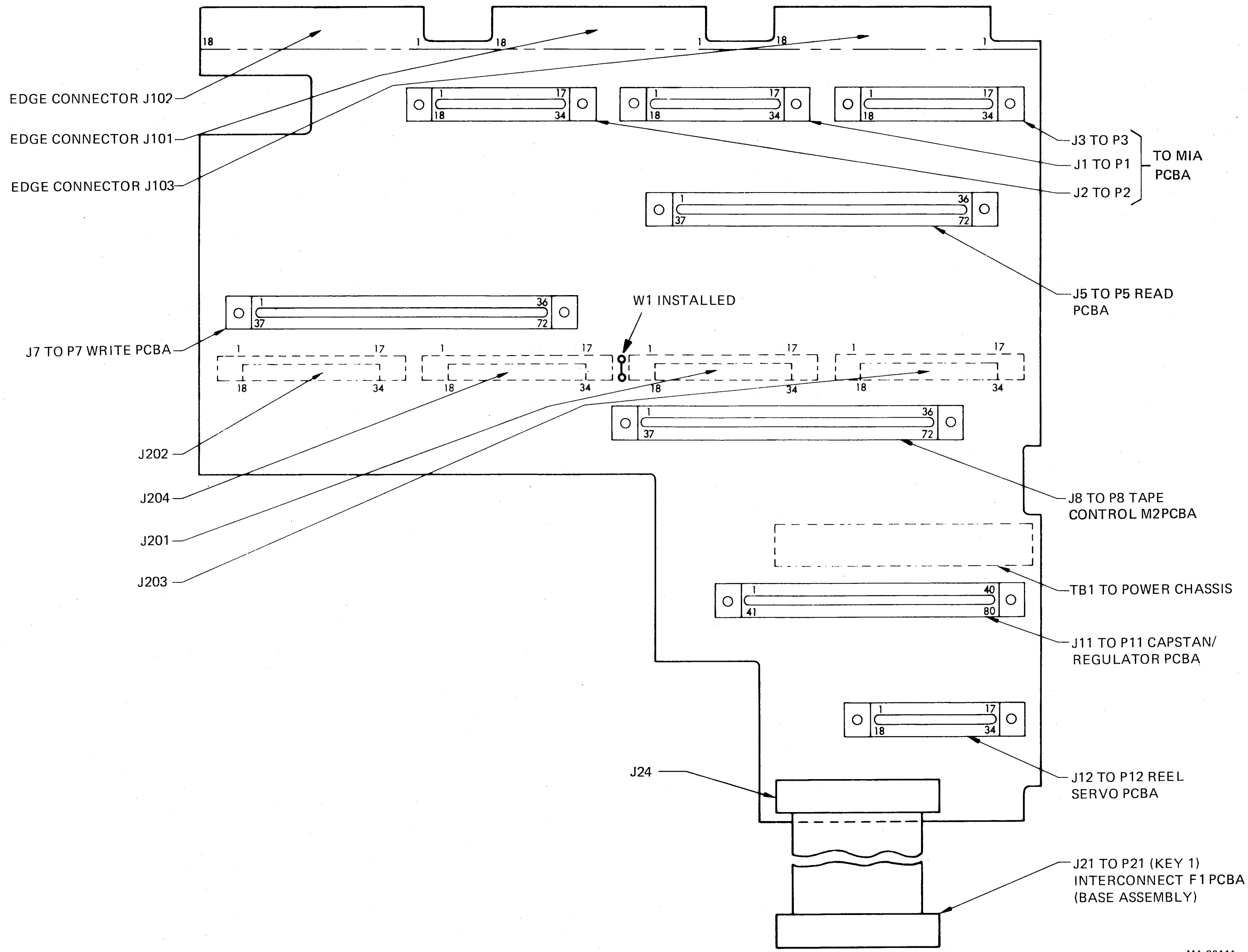


Figure 5-4 Interconnect D1 PCBA; Front View

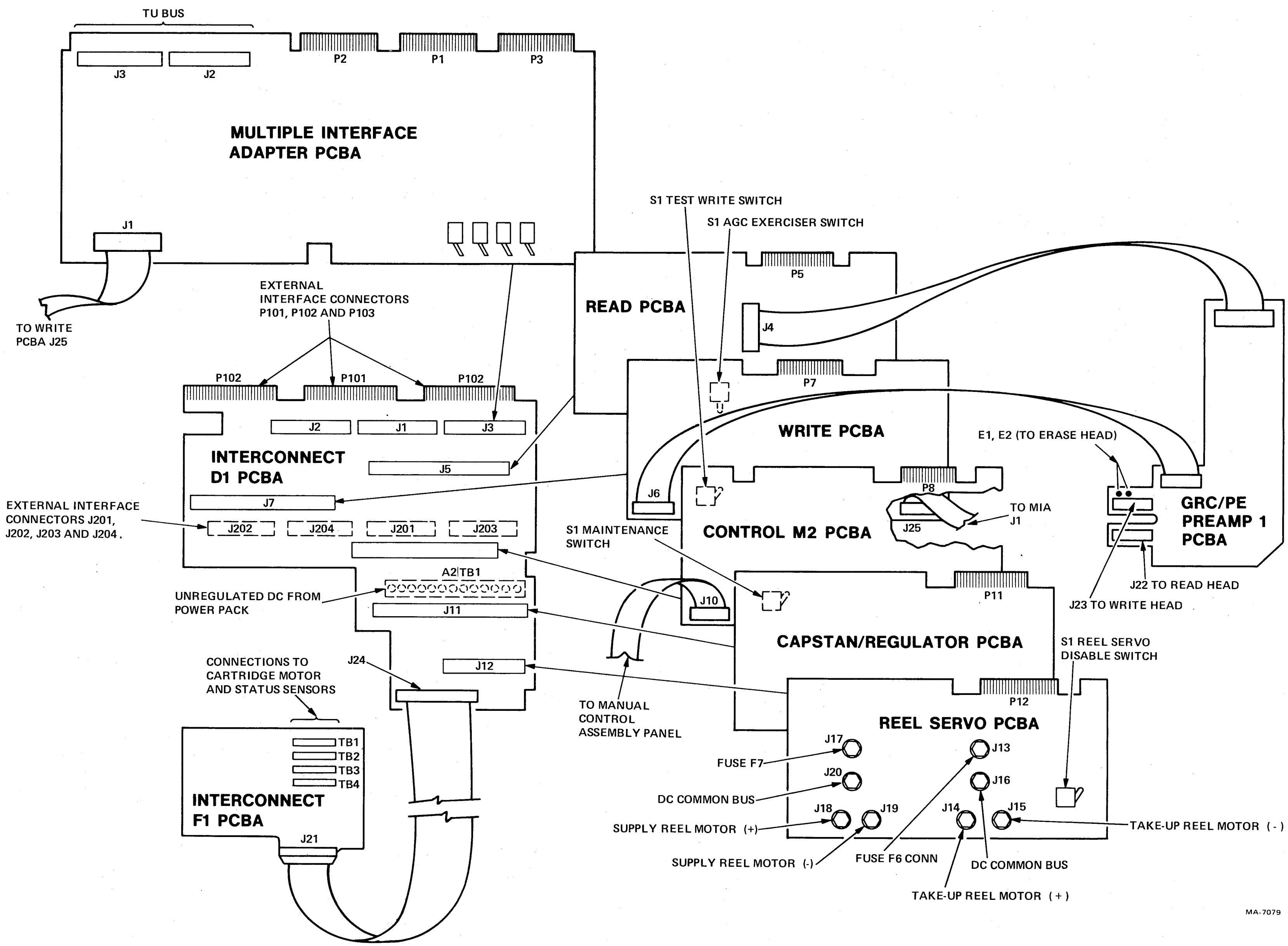


Figure 5-5 Circuit Card Interconnections

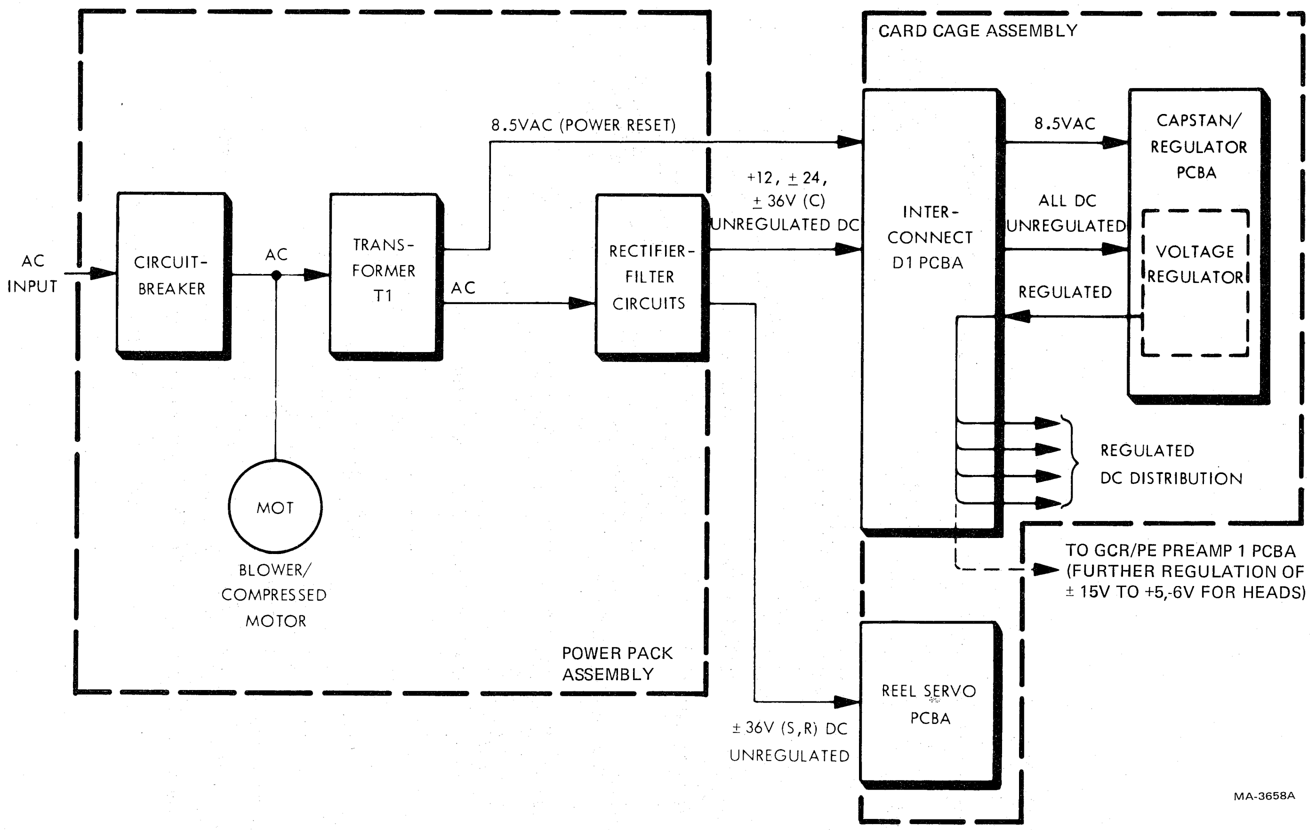


Figure 5-6 Power Supply Simplified Block Diagram

5.4 POWER SUPPLY AND DISTRIBUTION (Refer to Figure 2 in Volume 1 of the Technical Manual)

The transport derives all power from a single ac input (shown in simplified form in Figure 5-6). Primary ac power is used for the motor which drives the blower and compressor. A transformer T1 secondary winding output 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 GCR/PE preamp 1 PCBA.

The following paragraphs describe in detail the power supply and distribution circuits for a TU78 transport operating on 210 V 60 Hz power. For equipment using voltages and frequencies other than 210 V 60 Hz, you must determine that the input receptacle is properly connected to the primary winding taps. Various connections are listed in Table 3-1. These are detailed further in the following paragraphs. For clarity, 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

5.4.1 Primary Power Connections and Controls

The transport derives all necessary 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 transformer's primary winding taps. These taps are available at power supply terminal board A1TB1 (Figure 5-7). The transport can also be prepared for either 50 or 60 Hz power. This requires a different ac motor pulley and a different blower drive belt. Figure 5-7 shows that ac power is available to the transport when circuit breaker CB1 is closed.

5.4.2 Blower/Compressor Motor Power

The blower/compressor ac motor operates directly on ac input as shown in Figure 5-8. It is turned on automatically when solid-state switch S3 closes the circuit between A1TB1-1 and A1TB1-2. 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 transformer T1 secondary winding 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 when the temperature is too high. The switch contacts close when the motor temperature returns to normal.

5.4.3 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 power supply rectifiers and power-on reset logic (Paragraph 5.4.7). The voltage applied to the motor is 210 V, as long as the input taps on the transformer match the applied voltage.

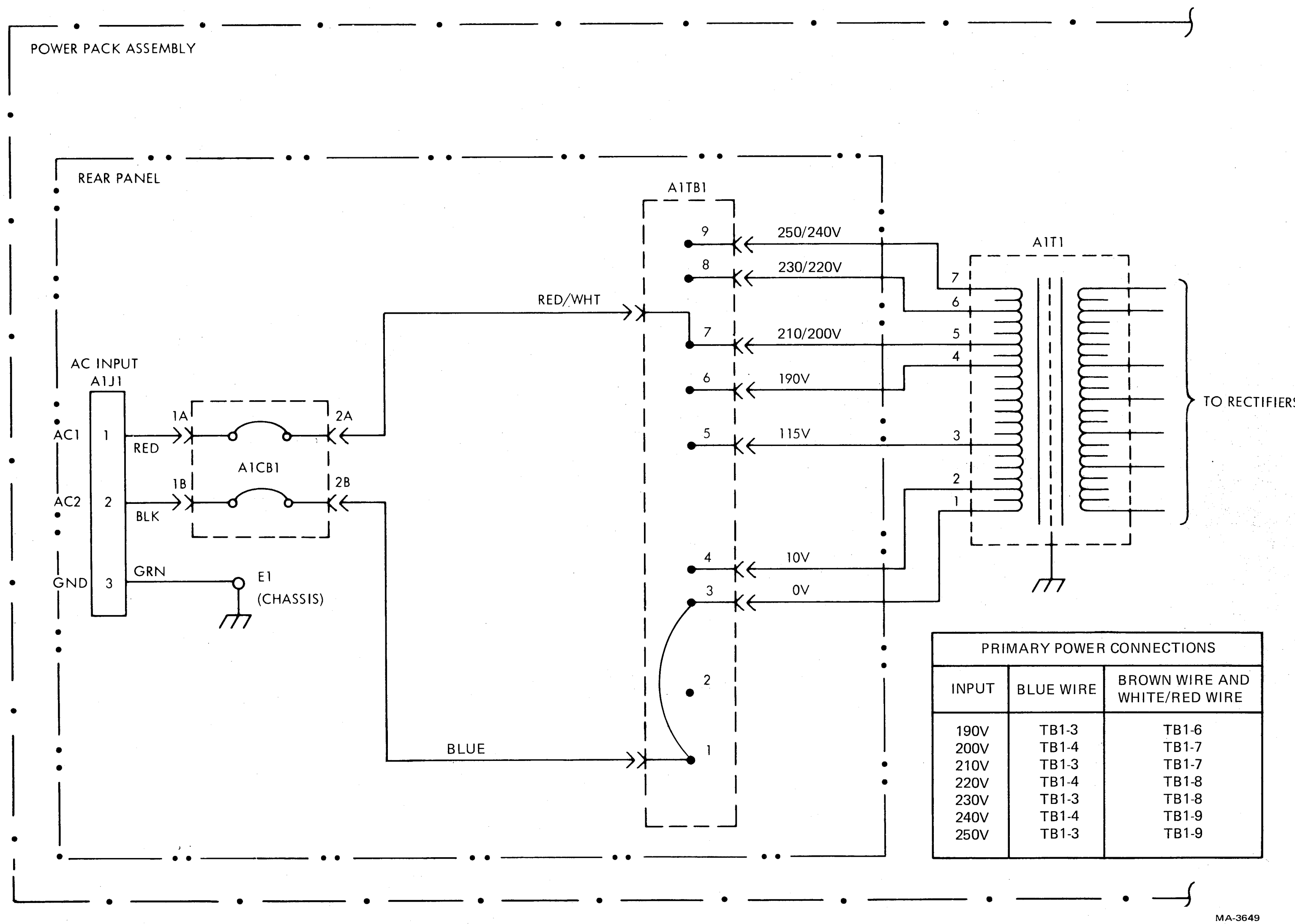
The power-on reset requirement is 8.5 Vac derived directly from the transformer T1 secondary winding. The connection to the secondary tap is physically made at the input to rectifier CR2, which is connected to A2TB1-10. A2TB1 is located at the rear of the card cage and provides direct inputs to vertically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

5.4.4 Unregulated DC Power Supplies

Power for the dc circuits is derived from various taps of the transformer T1 secondary winding (Figure 5-9). 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 listed 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



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 5-7 Primary Power Hookup and Control

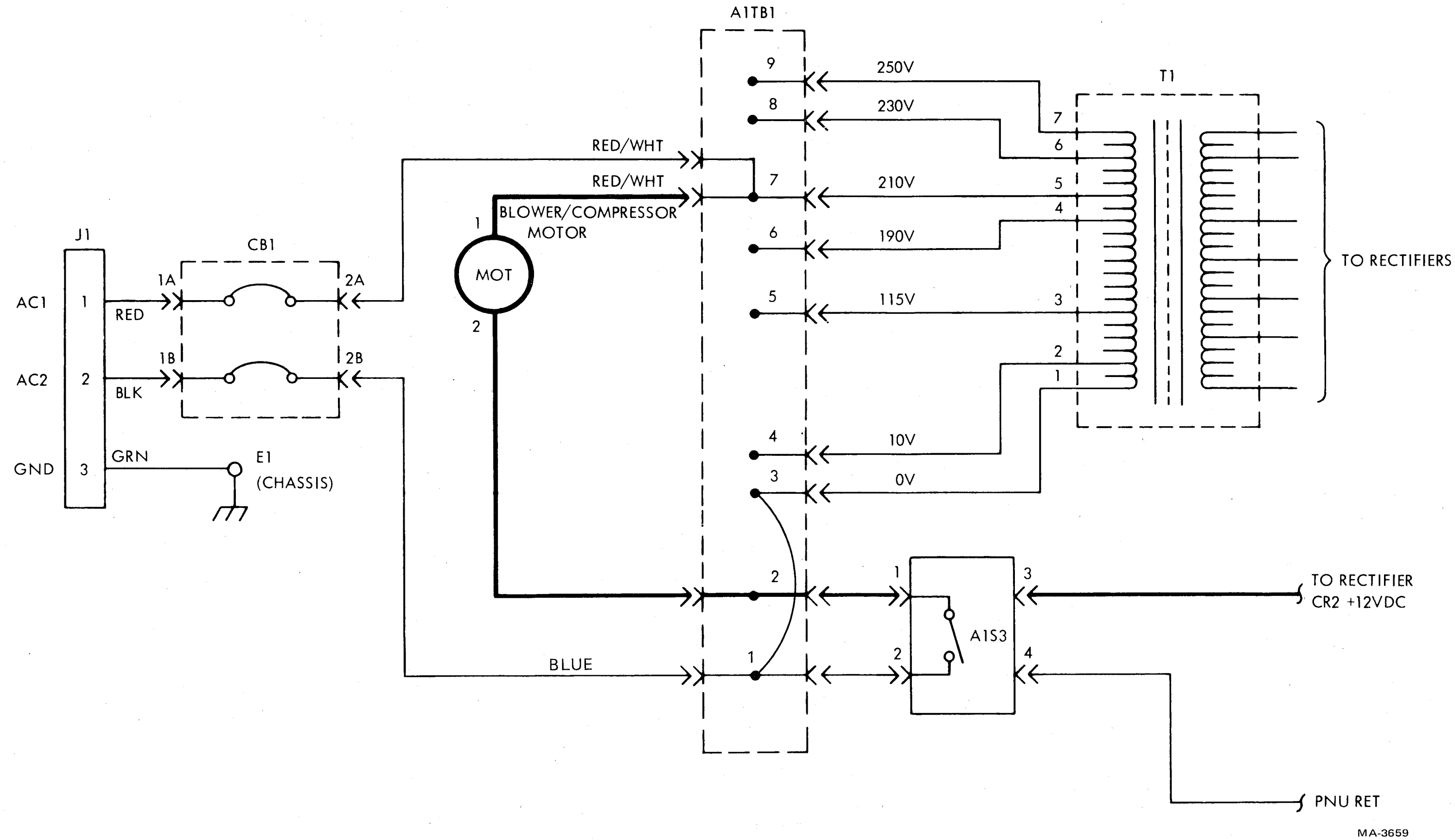


Figure 5-8 Blower/Compressor Motor Power and Control

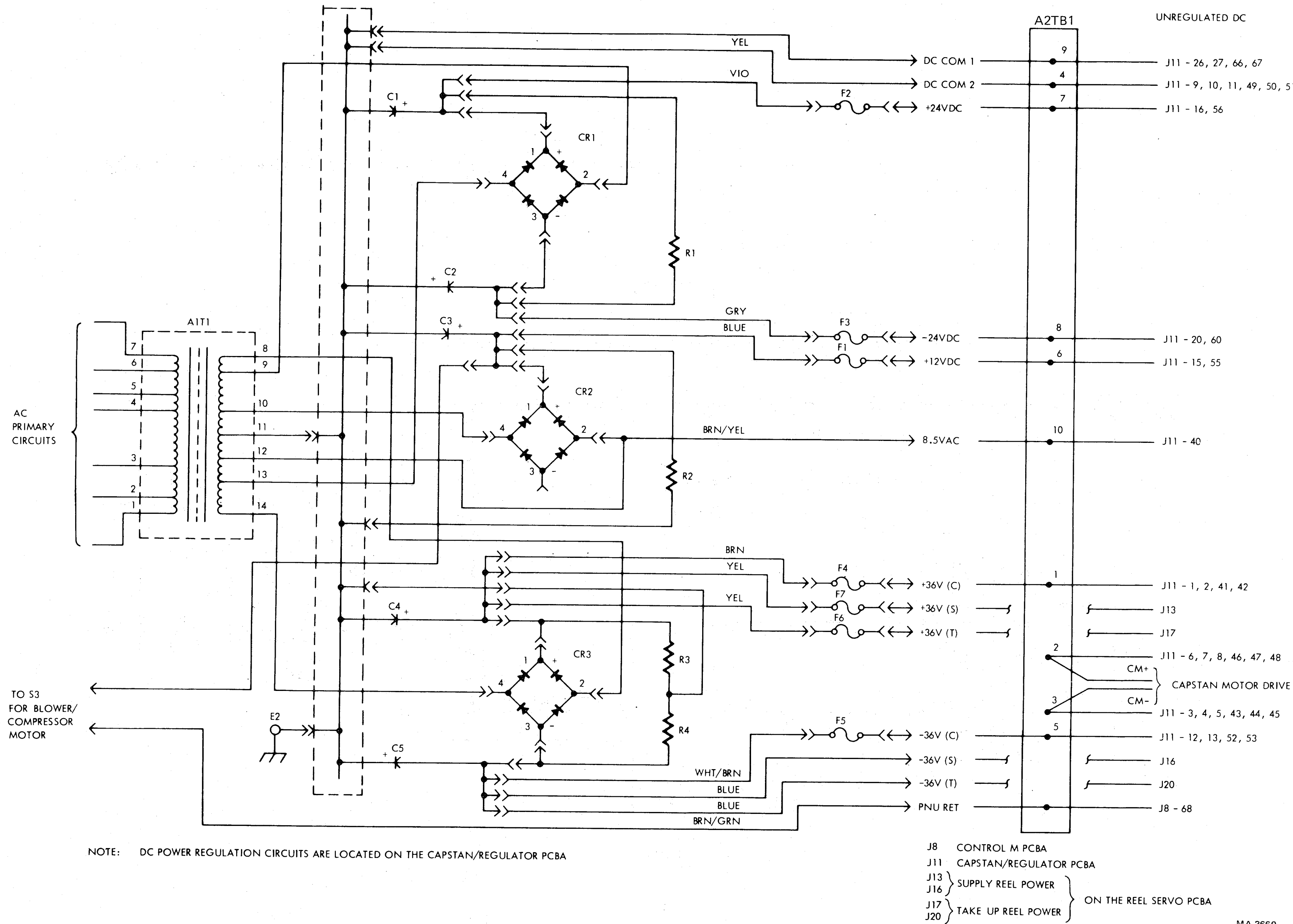


Figure 5-9 Unregulated Power Distribution Circuits

Rectifier outputs are routed through the respective fuses to terminal A2TB1, attached to the rear of interconnect D1 PCBA (Figure 5-9). They are connected through interconnect D1 PCBA conductors to the capstan/regulator PCBA for regulation and further distribution. However, the PNU RET line is routed to the control M2 PCBA.

Supply reel and takeup reel +36 Vdc unregulated power is routed directly from the respective fuse to the reel servo PCBA. It does not go 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.

5.4.5 DC Power Regulation

The +12 and ±24 Vdc unregulated power outputs are later regulated to provide the required +5, ±15, and +5/−6 Vdc power (Figure 5-10). This is described in the following paragraphs.

5.4.5.1 +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 an 8 A full load capacity. TP11 (on capstan/regulator PCBA) is used to monitor the regulated +5 Vdc output.

The +5 V is used primarily in the logic and lamp drive circuitry. Current is limited in the +5 V supply by current foldback techniques. This provides 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 circuits and amplifier circuits, +5 Vdc (S) and +5 Vdc (A) respectively.

The MIA interface logic uses +5 V (L) from the transport via P3-11, 12, 13, 28, 29, and 30. Write, read, and control M2 modules are made compatible with MIA 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, and 63 to J5-7, 43; J7-21, 57; and J8-37. After the interconnection the signal source name changes to +5 V (T).

5.4.5.2 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 2.5 A full load capacity. TP15 is used to monitor regulated +15 Vdc output, and TP18 to monitor regulated −15 Vdc.

5.4.5.3 +5/−6 Vdc – The +5 V and −6 Vdc used in preamp circuitry are derived from the +15 V and −15 Vdc by voltage regulators U13 and U14 on the GCR/PE Preamp 1 PCBA. The GCRE preamp 1 is mounted on back of the transport drive base assembly behind the read/write head area. The regulated ±15 Vdc used for this purpose is supplied through the read PCBA.

5.4.5.4 ±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 from fuse F5 in the same way.

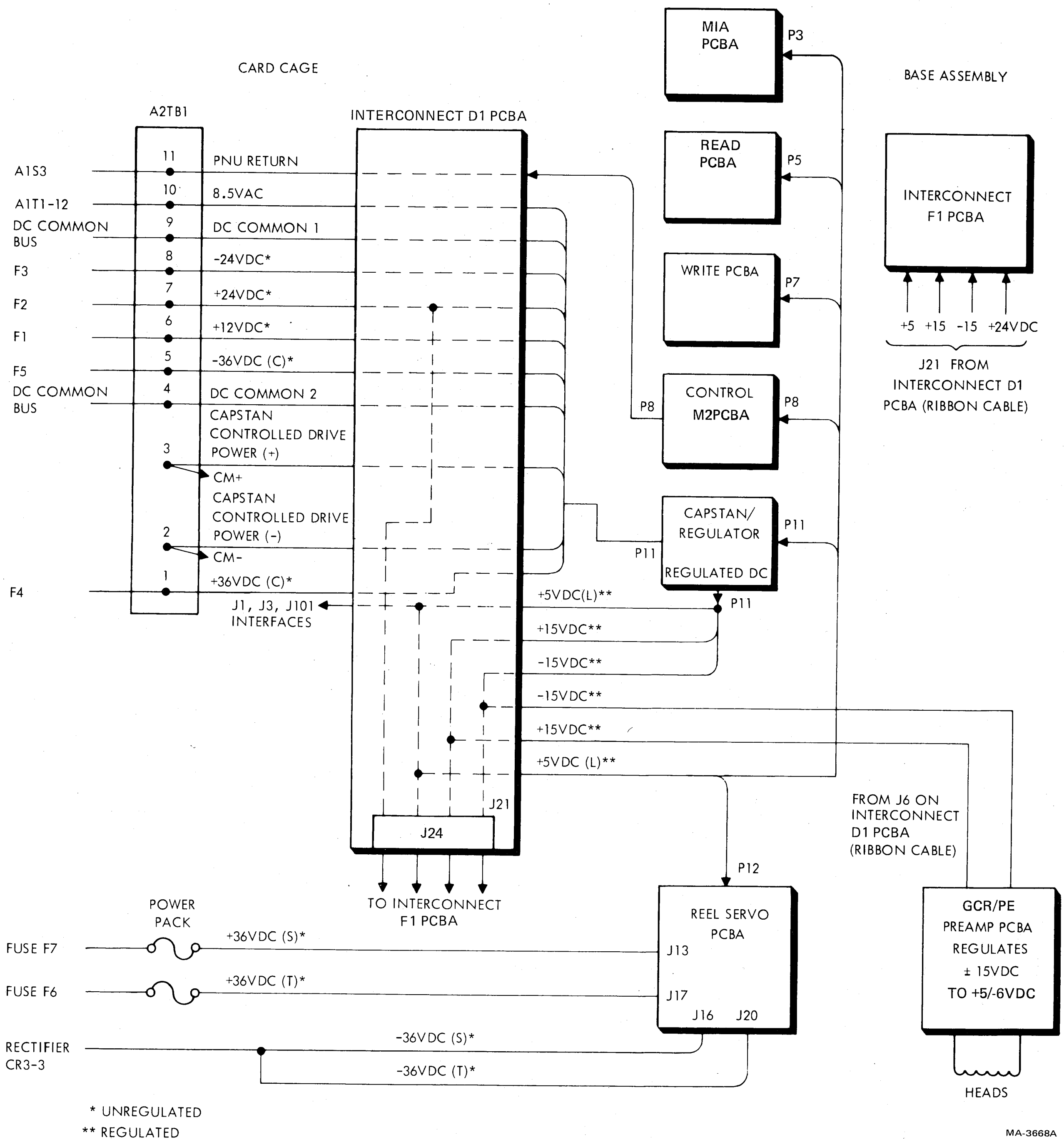


Figure 5-10 DC Power Regulation and Distribution

NOTE

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

5.4.5.5 ±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. Interconnect D1 PCBA circuits are not used. Unregulated −36 Vdc (S) is connected from rectifier CR3-3, without fusing, to J16 on the reel servo PCBA.

5.4.5.6 ±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.

5.4.6 Regulated Power Distribution

All 5 Vdc and 15 Vdc power is regulated on the capstan/regulator PCBA and distributed to other boards via J11 and conductors on the interconnect D1 PCBA. Internal connections of the interconnect D1 PCBA are listed in Appendix D. Regulated power distribution is shown in Figure 5-10.

The reel servo PCBA contains voltage regulators on the same board for the +5 Vdc (L) and +5 Vdc (A) used in the logic and amplifier circuits, respectively. Similarly, the +5/−6 Vdc used by the preamp circuitry is regulated internally on the GCR/PE preamp 1 PCBA.

5.4.7 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., before starting operation. The following unregulated power at inputs to the capstan/regulator PCBA is 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 5-10 shows the source of the power, and Schematic Number 104757 shows 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 −5 Vdc. However, this point is regulated by VR4 (zone 3-6E), inverted to nominal +5 Vdc 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 pulses, the previously described false conditions are sustained as long as the 8.5 Vdc, 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 Vdc is disconnected. This allows the input to VR2 (zone 3-4G) to bleed through CR9 and R110, disabling the above circuits. The 8.5 Vac feature protects circuits from damage by rapidly discharging the power pack capacitors whenever power is switched off or disconnected.

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. Therefore, all the power pack outputs except ±36 Vdc contribute to the reset/enable (NPORST/ENBL) network. These supplies must be in operating order to provide appropriate reset/enable signals, which effectively check supplies before transport operation. ENBL is used on the capstan/regulator PCBA to enable the cartridge motor drive circuits (zone 3-8C).

NPORST is gated with NINTLK (zone 2-8H) to produce CAPSTAN ENABLE. It is delivered through J11-37 and J11-77, via the interconnect D1 PCBA to the write PCBA (J7-11), control M2 PCBA (J8-61), reel servo PCBA (J12-9, 26), and as MIA PCBA (J1-1). 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 M2 PCBA (Schematic No. 106875, zone 4-8C, D).

5.4.8 Power Indicator

The Power indicator is lit by lamp driver U15 when power is on. This is one of the indicator drivers on the control M2 PCBA which are enabled and, in this case, switched on by NPORST from the capstan/regulator PCBA.

5.5 INTERFACING AND THE MULTIPLE INTERFACE ADAPTOR (MIA) PCBA

5.5.1 General

Interfacing between the TM78 formatter and TU78 transport circuitry is accomplished through the multiple interface adaptor (MIA). The MIA translates signals between the formatter interface (TU bus) and the transport interface. Figure 5-11 shows a basic functional block diagram of the MIA. The formatter interface (TU bus) is shown entering at the left and the transport interface is shown entering at the right.

5.5.2 Physical Description

The TU bus connects to the MIA via two jacks, J2 and J3. The MIA plugs into J1, J2, and J3 on the interconnect D1 PCBA. A separate cable connects the MIA to the transport's write PCBA (refer to Figure 5-5). Three sets of eight miniature DIP switches are mounted on the MIA. Two of these sets are used for setting a hardware serial number, which is used as a signature in status reporting. The third set is used for creating a special off-line test data pattern for maintenance purposes. Four toggle switches used in manual (maintenance) mode, set the density, tape direction, and read or write. Two LEDs indicate manual mode and wrong parity on the incoming command word.

5.5.3 Interface Connections

This section contains a summary of the interface connections (formatter and transport) for the MIA. A brief description accompanies each signal name.

5.5.3.1 Formatter to MIA Interface (TU Bus) Signals – The TU bus signals are listed in Table 5-1. A signal line is true when low ($<$1.0 V) and false when high ($>$2.8 V) except for the present line. The present line is true when HI. TU bus timing is explained in detail in Paragraph 4.4.1.2 of the TM78 Magnetic Tape Formatter Technical Manual EK-0TM78-TM. The TU bus signals are listed by cable and pin number in Appendix D.

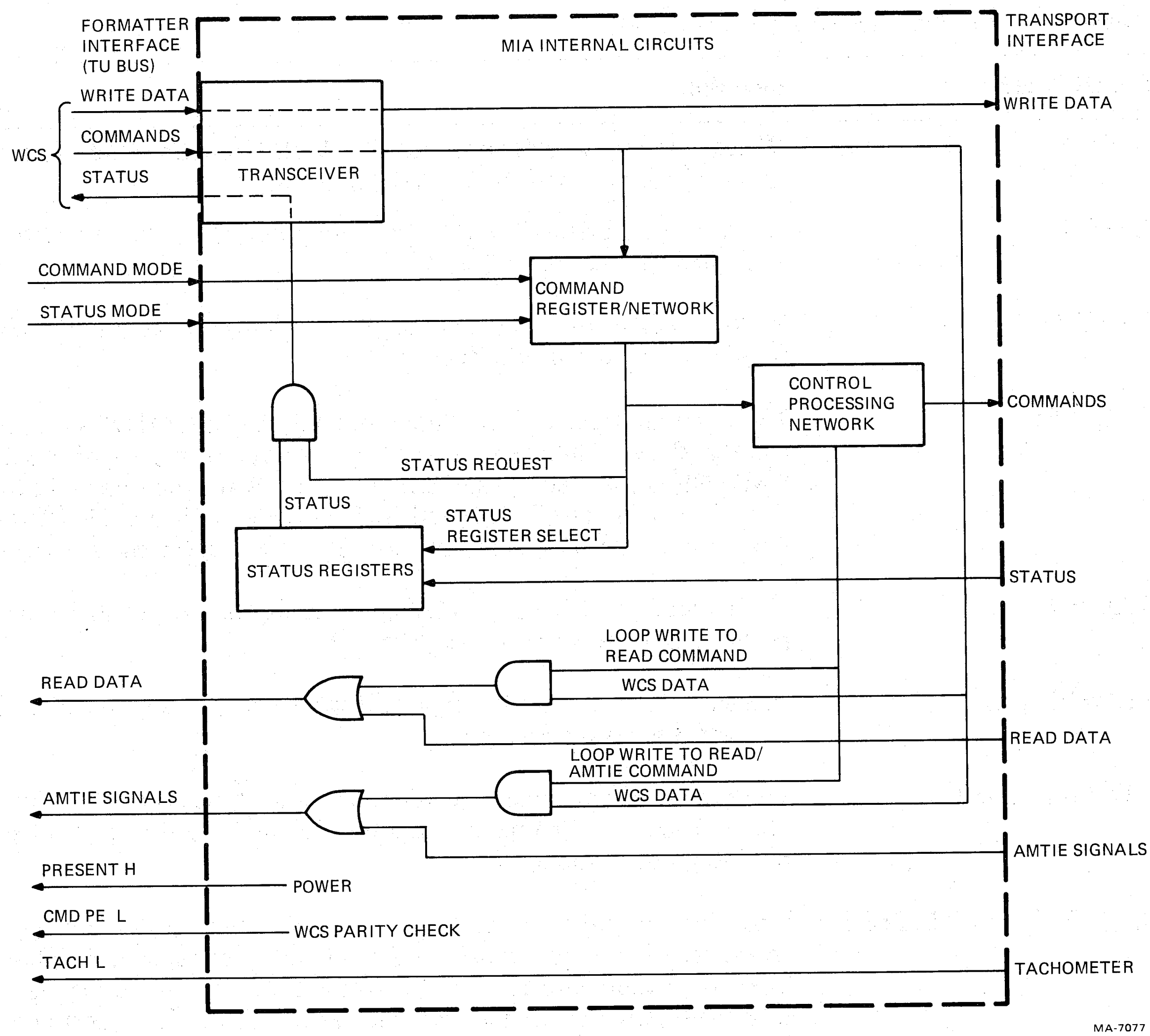


Figure 5-11 MIA Basic Block Diagram

Table 5-1 TU Bus Signal Summary

Signal Name	Function
WCS 7:0 L	Eight write/command/status lines are bi-directional and multiplexed for the three different functions. Information on the WCS lines is determined by the assertion of the WDS, CMD or STAT control lines. The WCS lines are asserted by the formatter during a write data or command transfer and asserted by the tape transport during a status transfer.
WCS P L	A single bi-directional, multiplexed WCS line – It carries the odd parity bit for command/status transfers, and the parity channel for a write data transfer. WCS P is asserted by the formatter during command or write data transfers and by the tape transport during status transfers.

Table 5-1 TU Bus Signal Summary (Cont)

Signal Name	Function
WDS L	Write data strobe indicates that the WCS lines contain data to be written on tape. WDS is asserted by the formatter.*
CMD L	Command indicates that the WCS lines contain a command byte. CMD is asserted by the formatter.*
STAT L	Status enables the tape unit to place a status byte on the WCS lines. STAT is asserted by the formatter.*
CMD PE L	The command parity error line indicates that a CMD/STAT address or command byte has been received by the tape transport with even parity. CMD PE is asserted by the tape transport. This line remains asserted until a clear command is received with odd parity. While CMD PE L is set, motion and density signals are not released to the tape transport.
TACH L	Tachometer is a line which reflects the digital output of the tape transports capstan servo motor tachometer.
PRESENT H	Present is asserted by the tape transport when it is connected to the TU bus and has power applied.
RD 7:0 L, RD P L	The nine read data lines are asserted by the tape transport when read enabled. They can also be asserted during the tape transport loop-write-to-read diagnostic mode.
AMTIE 7:0 L, AMTIE P L	The nine amplitude track in error signals can be asserted by the tape transport when read enabled. They indicate, independently, that the read back amplitude, on the track for which they are named, has not come up to a predetermined threshold value. They can also be asserted during the tape transport "loop-write-to-read" diagnostic mode.

*The WDS, CMD and STAT lines are mutually exclusive. That is, only one of the three (indicating one of three types of information on the WCS lines) can be logically true at any time.

5.5.3.2 Transport to MIA Interface Signals – The transport interface signals are listed in Table 5-2. A signal line is true when low (<0.8 V) and false when high (>3.0 V) unless indicated otherwise The transport interface signals are listed by plug/pin number in Appendix D.

5.5.4 Command/Status Register Descriptions

The formatter sends commands to the MIA PCBA in order to control the tape transport and acquire status information. It sends commands over the WCS lines. Because of bidirectional and multiplexed traffic on these lines, command and status information is handled by specifically addressable registers. Instantaneous status information is constantly updated at the registers and available upon request by the formatter. The MIA registers and bit descriptions are listed in Appendix C.

Table 5-2 Transport to MIA Interface Signal Summary

Signal Name	Description
	Signals from the transport to the MIA.
ISLT0	ISLT0 is a signal which, when low, indicates that the operator panel port select switch is in the 0 position.*
ISLT1	Same as ISLT0 except switch position 1*
ISLT2	Same as ISLT0 except switch position 2*
IONL	IONL is a level which is low when the on-line flip-flop is set. When low, the transport is under remote control; when high, the transport is under local control.
ILDP	ILDP is a level which is low when the transport is ready and on-line and tape is at rest with the BOT tab under the photosensor. The signal goes high after the tab leaves the photosensor area.
IFPT	IFPT is a level which is low when tape is loaded and under tension in the vacuum column, and the supply reel has the write enable ring removed.
IEOT	IEOT is a level which, when low and the transport is ready and on-line, indicates that the EOT reflective tab is positioned under the photosensor.
IRWD	IRWD is a level which is low when the transport is engaged in any rewind operation.
IRDY	IRDY is a level which is low when the transport is ready to accept any external command, i.e., when: 1. Tape is under tension in the vacuum column. 2. A load or rewind command has been completed. 3. There is no unload command in progress. 4. The transport is on-line.
IDDI	IDDI is a level which is low when the PE density mode is selected.
ITACH	ITACH is a pulse (1 μs) which is triggered by the positive and negative transitions of the capstan optical tachometer. The tape movement between alternate pulses is 0.254 mm (0.01 in).

*In order for ISLT0, 1, 2 to reflect their true levels, MIA command register 3, bits 3, 4, and 5 must be loaded with 1s by the formatter.

Table 5-2 Transport to MIA Interface Signal Summary (Cont)

Signal Name	Description
IARA ERR	The IARA ERR signal is generated on the read PCBA and sent through the write PCBA to the MIA via cable. It is effective in write mode only and notifies the system that the automatic read amplifier burst expected at the transport for recording has failed to record properly within the allotted time.
WRT STAT H	Write status is indicated by a high = true WRT STAT signal to the MIA via cable from the write PCBA.
MOTION H	The MOTION high = true signal via cable from the write PCBA to the MIA indicates that the tape transport is in motion.
WRT BIN H	WRT BIN indicates that the tape transport is writing binary data. It is routed from the write PCBA to the MIA via cable. This information is arbitrarily derived from the WD4 channel.
NPORST	NPORST initiates resetting and presetting of circuits when power is applied.
IAMTIE 7:0, P	An AMTIE signal is generated for each of the nine tracks on the basis of the amplitude of the data as received from the GCR/PE preamp 1 PCBA. An unsatisfactory channel output causes the Write PCBA AMTIE circuits to issue a low = true IAMTIE signal to the MIA via cable. IAMTIEP is not generated as a parity bit for the other eight channels, but reflects the amplitude status of the IAMTIEP track.
IRD 7:0, P	The nine IRD channels provide the MIA with data read from the tape.
	Signals from the MIA to the transport
IDDS	IDDS is a level which, when low, conditions the read electronics to operate in the 63 c/mm (1600 cpi) density mode. In addition, the Data density line (IDDI) to the controller/formatter goes low and the 1600 indicator becomes illuminated. Conversely, when IDDS is high, the read electronics operate in the 246 c/mm (6250 cpi) density mode, the 6250 indicator becomes illuminated, and IDDI goes high.
ISFC	ISFC is a level which, when low and the transport is ready and on-line, causes tape to move forward. When the level goes high, tape motion ceases.
ISRC	ISRC is a level which, when low and the transport is ready and on-line, causes tape to move in reverse. When the level goes high, tape motion ceases. An SRC is terminated upon encountering the BOT tab, or ignored if given when tape is at load point.

Table 5-2 **Transport to MIA Interface Signal Summary (Cont)**

Signal Name	Description
ISWS	ISWS is a level which is low for a minimum period of 20 μs after the front edge of an ISFC when the write mode of operation is required. The front edge of the delayed ISFC is used to sample the ISWS signal and sets the write/read flip-flop in the transport to the write state. If read mode is required, the ISWS signal is high for a minimum period of 20 μs after the front edge of an ISFC (or ISRC), in which case the write/read flip-flop will be set to the read state.
IRWU	IRWU is a level which resets the on-line flip-flop and initiates a rewind operation. Upon completion of the rewind, an unload sequence is automatically executed.
IRWC	IRWC is a level which, if the transport is selected, ready, and on-line, causes tape to move in reverse, moving at rewind speed unless a low tape (LT) condition has been sensed. In this case, movement is at reverse speed until it comes to rest at BOT. An IRWC is ignored if tape is already at BOT.
IRTH2	Not used
NLTH STDTH	NLTH and STDTH form a field which establishes the threshold of the read electronics for the nine AMTIE signals as follows: **NLTH** / **STDTH** / **Threshold** / **Mode** low / low / 10% / IRG check low / high / 10% / IRG check high / low / 25% / write high / high / 20% / read
IWINH	IWINH is a level which, when low, prevents the write head from being energized, while allowing the erase head to operate normally.
IWD7:0, IWDP	IWD7:0, P are write data signals which, when low at IWDS time, result in a flux reversal being recorded on the corresponding tape track.
IWDS	This is the trailing edge of the IWDS signal strobes the write data lines to the write PCBA circuits.
NTSTR	Not used

5.5.5 Circuit Description

The MIA is essentially a switching and routing device for signals between the TM78 formatter and the tape transport, in which the MIA is installed. Generally, the MIA performs the following three groups of functions.

1. It accepts commands and write data from the formatter and relays them to the transport in a form compatible with transport circuits.

2. It accepts read data, amplitude track in error (AMTIE) signals, and status indications from the transport and relays them to the formatter in a form compatible with formatter circuits.

3. It participates in certain system-checking functions, such as looping WCS signals from the formatter into the read data lines or, through registers, into the AMTIE lines back to the formatter. These functions are called loop-write-to-read (LWR).

With reference to the transport interface, each signal uses a dedicated path. However, in dealing with the formatter interface (TU bus), some of the signals (i.e., write data and most of the command and status indications) use the same conductors on a time-sharing basis. The MIA's basic function is multiplexing/demultiplexing signals on the write/command/status lines.

Figure 5-12 shows a detailed functional view of the MIA PCBA. The various signal paths are described in the following paragraphs.

5.5.5.1 Commands and Command Timing – Two types of command formats may be sent over the WCS lines by the formatter, as shown in Appendix C. They are the command/status address specifier byte and the actual command byte. The address specifier byte always has bit 7 = 1 and the command byte always has bit 7 = 0. Both bytes are strobed to the MIA by the CMD L line. Figure 5-13 shows the MIA logic associated with command timing and Figure 5-14 shows the timing associated with both types of command formats.

The formatter places the command/status address specifier byte on the WCS lines during the trailing (rising) edge of CMD L. The rising edge of CMD L also triggers the 500 ns CMD one shot. When the CMD one shot times out, its Q output latches the byte into the CMD/ADR latch, whose outputs MTC 7:0 now become stable. The $\overline{Q}$ output strobes MTC 4:0 to the CMD/STA ADR register which is enabled by CMD 7=1. The CMD/STA ADR register now holds the lower five bits of the command/status address specifier byte. The four low bits of its output (ADR 3:0) input to the MIA register address decoder, which asserts a select line (SEL 0-5, 7) to the associated command and status register pair. The next step in the process is a formatter initiated command write into the addressed command register, or a status request from the addressed status register. The high bit output of the CMD/STA ADR register (ADR 4) is not an address bit, but rather the pattern generator enable (PGE) bit. The PGE bit enables the test data pattern, written prior into command register 7, to be placed on the transport interface IWD lines.

When the formatter writes a command byte to the MIA, the byte is latched into the CMD/ADR latch as described in the previous paragraph. However, because bit 7 = 0, the CMD/STA ADR register input is disabled and it retains its previous contents. Signal MTC 7 enables one input of the execute (EXEC) one shot. On the trailing edge of the CMD one shot, the EXEC one shot is fired. The one shot output (EXEC H) strobes MTC 6:0 into the addressed command register on the trailing edge of its 500 ns timeout. The output of the command register is routed to the transport interface or internally within the MIA, depending upon the register. Figure 5-12 shows the routing for each command register.

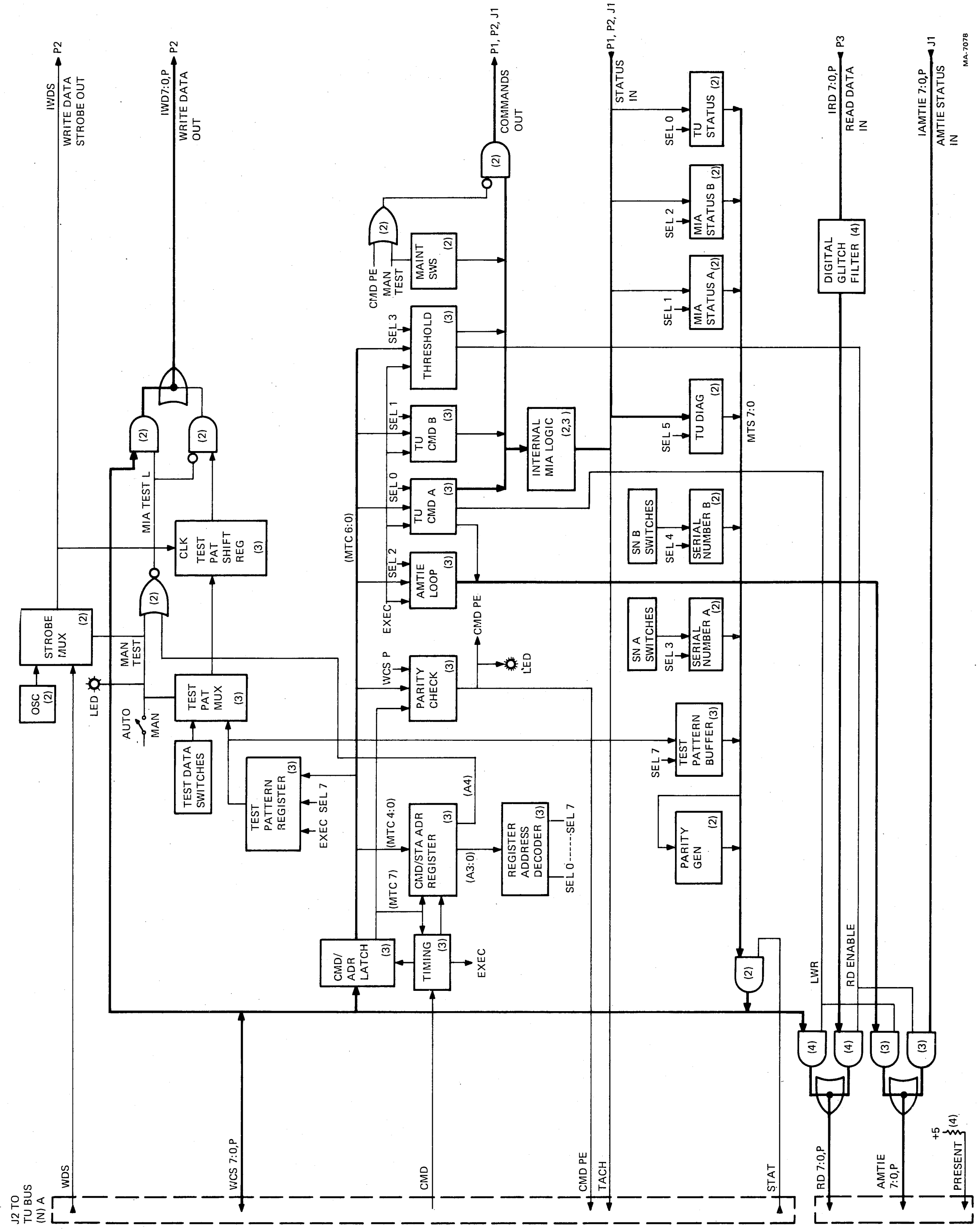


Figure 5-12 MIA Detailed Functional Diagram

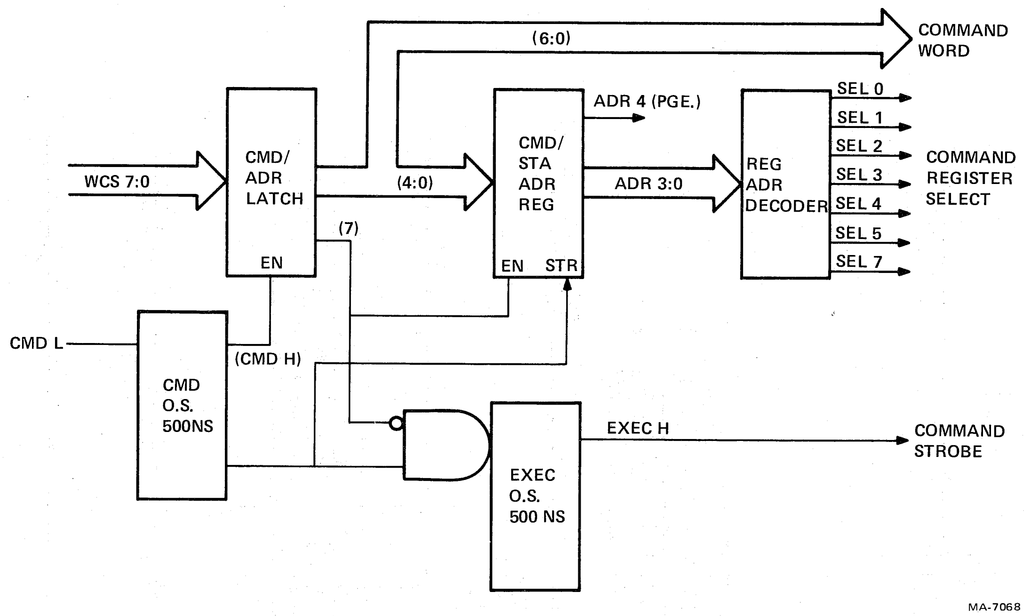


Figure 5-13 Command Timing Logic

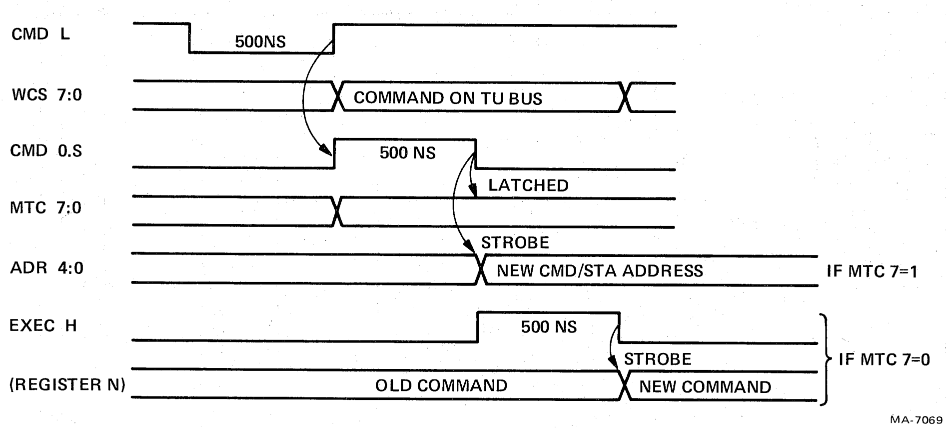


Figure 5-14 Command Timing

Command parity is checked in both command byte formats by inputting MTC 7:0 and WCSP into a parity checker. The checker is strobed on the trailing edge of the CMD one shot. If wrong (even) parity was received at the MIA, the CMD PE TU bus line is asserted back to the formatter, and the command is not gated to the transport interface. A command parity error also causes the CMD PE LED on the MIA to light.

5.5.5.2 Status – The formatter can examine the contents of any status register in the MIA, after it selects the desired register with an address specifier command (refer to Paragraph 5.5.5.1). Transport status, from the transport interface, is input to certain status registers while others receive inputs from sources on the MIA. The formatter requests status by asserting the TU bus STAT L line. Signal STAT L clocks the transport interface lines to the registers and enables the selected register outputs from the

MTS lines to the WCS lines. The trailing edge of STAT L clocks the status byte into the formatter circuitry. Status parity is generated by examining MTS 7:0 and asserting WCS P as required to maintain odd parity on the WCS lines. While the tachometer signal (TACH) is input to the TU DIAG register, it is also transferred from the transport interface to the TU bus with no gating. This is done so the formatter may examine it in real time during a data transfer operaton to guarantee constant tape velocity and ramp times within specification.

5.5.5.3 Write Data – Once the formatter has commanded the transport to move tape, and enabled the write circuitry, it asserts nine bits of write data on WCS 7:0, P along with the WDS strobe pulse. The data is gated through the MIA to the transport interface IWD 7:0, P lines, and the strobe pulse is gated to the IWDS line. Another source of write data is from within the MIA PCBA in test mode. This source is discussed in greater detail in Paragraph 5.5.5.8.

5.5.5.4 Read Data – Data from the transport's read electronics enters the MIA from the transport interface as IRD 7:0, P. The read data passes through nine independent digital filters that condition the waveforms, and is gated to the TU bus RD 7:0, P lines. Before, the data transfer, the formatter specified a read enable command by setting bit 6 of the threshold command register.

5.5.5.5 Amplitude Track In Error (AMTIE) Bits – AMTIE status information enters the MIA card from the transport interface (via cable from the write PCBA) as I AMTIE 7:0, P. AMTIE status is gated out to the TU bus as AMTIE 7:0, P, assuming the MIA is read enabled. Read enable is set and AMTIE bits are generated, in read and write mode, for both PE and GCR formats.

5.5.5.6 Diagnostic Loops – The formatter can configure MIA circuitry in loop write-to-read diagnostic mode to check the TU bus and portions of the MIA circuitry, independent of the transport. It does this by resetting the read enable bit (bit 6 of the Threshold command register), and setting the loop write-to-read (LWR) bit (bit 2 of the TU CMD A register). In this diagnostic loop mode, data can be sent from the formatter, looped around in the MIA, and sent back to the formatter in two ways. First, a data byte plus parity is sent out on the WCS lines and immediately looped around to the RD lines. In this case the WCS data is not accompanied by an enabling pulse on the CMD or STAT TU bus lines. Second, the formatter can loop data around from the WCS lines to the AMTIE lines. It does this by writing a full nine bits into the AMTIE loop command register (bits 6:0) and the TU CMD A register (bits P, 7). After writing data into these registers, the formatter can read it back on the nine AMTIE lines.

5.5.5.7 Switches and Indicators – Three sets of eight DIP switches, four toggle switches, and two light emitting diodes (LEDs) reside on the MIA PCBA. Two of the DIP switches set the four digit transport serial number in BCD format. The third DIP switch is used to create a write data pattern in off-line (manual) mode. One of the toggle switches functionally removes the transport from the formatter (auto), and places it in off-line test mode (manual). When the transport is in manual mode the remaining three toggle switches set tape direction (rev-off-fwd), data mode (read-write), and density (1600-6250). The two LEDs indicate manual mode and command byte parity error.

5.5.5.8 Test Pattern Generation – Test data patterns can be created and written to the transport over the transport IWD lines in any of three ways. First, the formatter can write test data through the MIA in the conventional manner any data is written to tape. That is, strobing data from the TU bus WCS lines to the IWD lines. Second, the formatter may write a pattern into MIA command register 7, the test pattern register. Then the pattern is shifted out to the IWD lines by formatter generated WDS strobe pulses. And third, a maintenance engineer place the transport in manual mode and create a test data pattern in the appropriate onboard DIP switches. In this case, data is strobed to tape by an oscillator on the MIA PCBA pulsing the transport interface IWDS line.

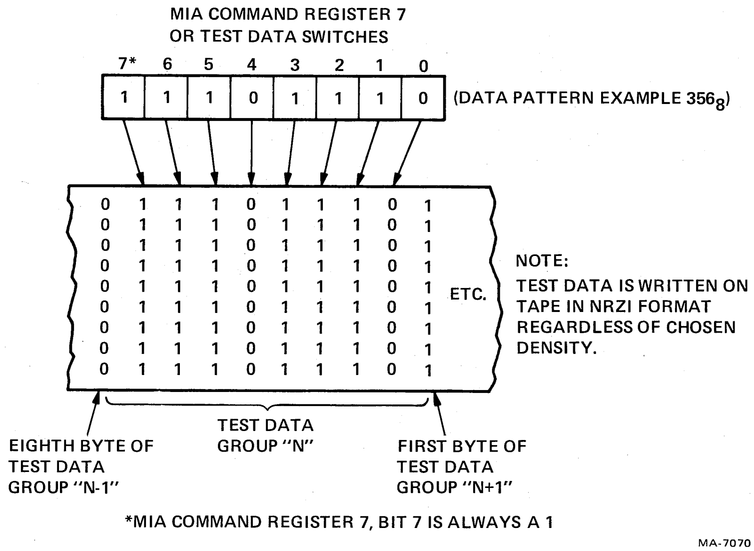


Figure 5-15 Test Data Tape Format

The manner in which the second and third methods actually write the test data is much different than the first, however. When register 7 or the switches are used, the pattern in the register or switches is not the pattern written to tape for each character. Rather, each bit of the 8-bit test pattern byte corresponds to a full 9-bit character on tape, for a total of eight tape characters. If a given bit in the test pattern is a 1, the corresponding 9-bit character is written to tape as a flux change in all tracks. Similarly, if the test pattern bit happens to be a 0, the tape character has no flux changes in all tracks. In this method of writing test data, parity and recording format on tape is not observed. The pattern of eight bytes is written repetitively on tape until commanded to stop. Figure 5-15 shows an example of the test data tape format.

5.6 SYSTEM CONTROL (Refer to Figure 3 in Volume 1 of the Technical Manual)

5.6.1 Control System Overview

The control logic circuitry manages transport operation through commands received from the host system and/or manual commands entered by means of switches provided on the transport. Figure 5-16 is a simplified block diagram of the control logic.

Most of the control circuits are mounted on the control M2 PCBA, which is plugged into connector J8 on the vertical interconnect D1 PCBA. The control M2 PCBA circuits are described in detail in Paragraph 5.6.6. The following text describes the control system in general.

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

Figure 5-17 shows the general routing of control signals throughout the transport assembly.

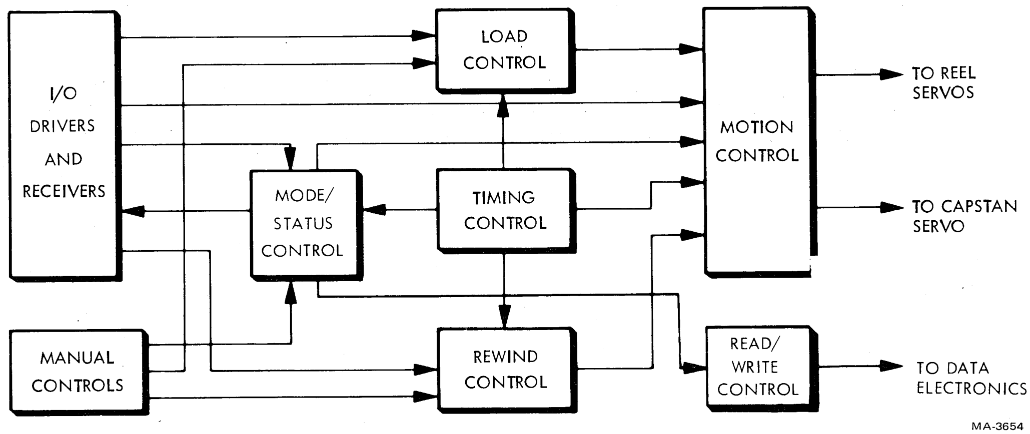


Figure 5-16 Control Logic Block Diagram

5.6.2 Manual Controls

Manual controls (Table 2-1) include the port select thumbwheel switch, LOAD/REW switch, ON LINE switch, UNLOAD switch, and RESET switch. Manual switching is shown in Figure 5-18. The power circuit breaker switch, mounted on the rear panel, is discussed in the power supply and distribution text.

In addition to the operating switches mentioned the following switches are provided for maintenance purposes.

- Tape motion switch (on control M2 .PCBA) Reel servo disabling switch (on reel servo PCBA).
- Test write switch (on the write PCBA).
- AGC exerciser switch (on the read PCBA).

The thumbwheel switch (S8) located next to the POWER indicator sets the MASSBUS port select code so the formatter may determine which MASSBUS (or both, or neither) to logically connect the transport to. Positions 0, 1, 2, and 3 are used. Contacts 0, 1, and 2 are connected to the MIA module via the control M2 module. SLT COM on P10-4 is connected to ground. The switch grounds one of the four select lines which connect to the MIA module via the control M2 module. Which select line is grounded depends on the MASSBUS port selected by the switch. SLT COM is grounded by jumper W3 on the control M2 module (Schematic Number 106875, zone 3-7C.) Jumper W3 also asserts SLT and SLTA which enables the various transport circuits involved in host system operation.

LOAD/REW, ON LINE, UNLOAD, and RESET switches S2 through S5 (Figure 5-18) 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 M2 PCBA, described in Paragraph 5.6.6.

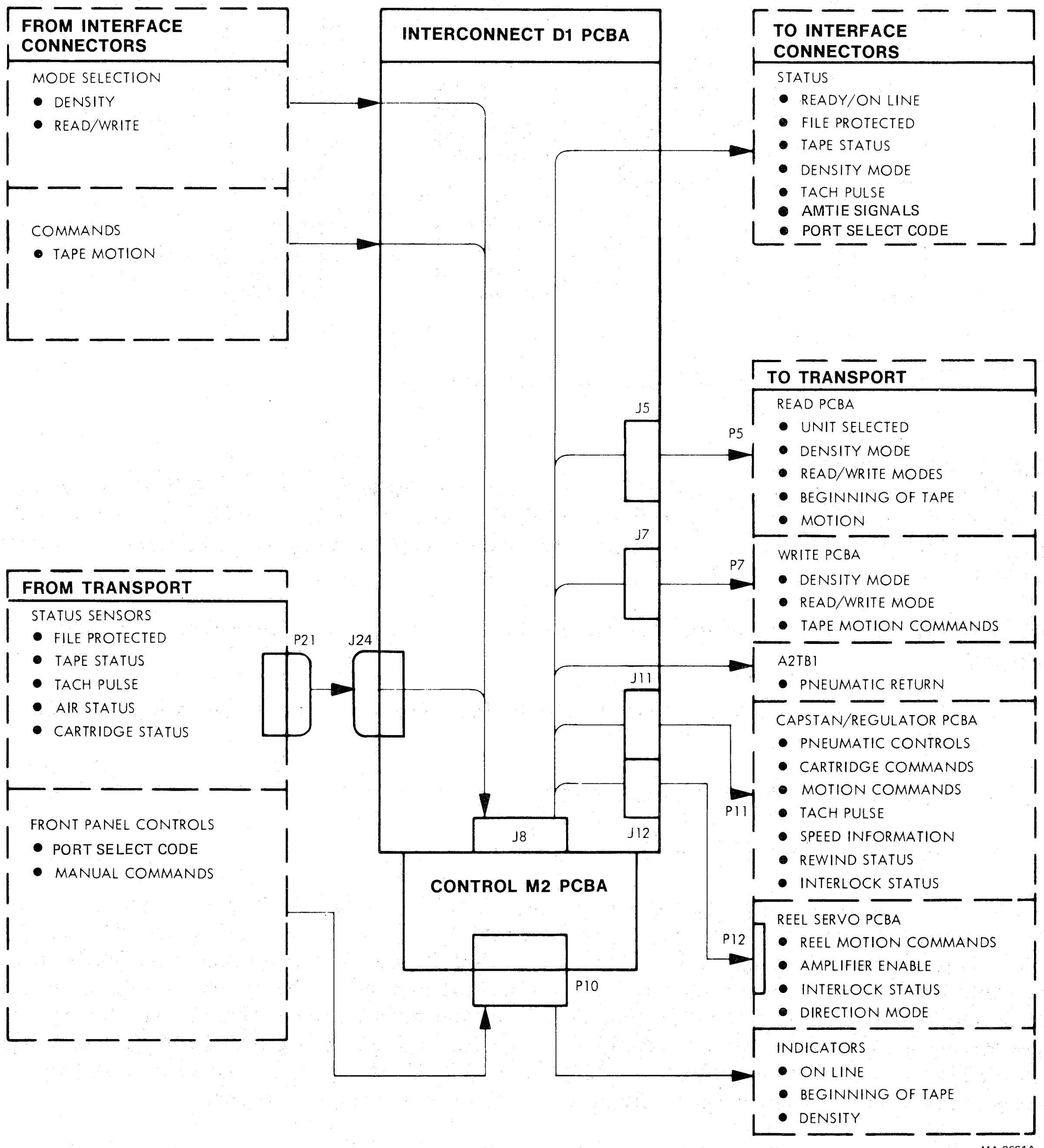


Figure 5-17 Control Signal General Routing

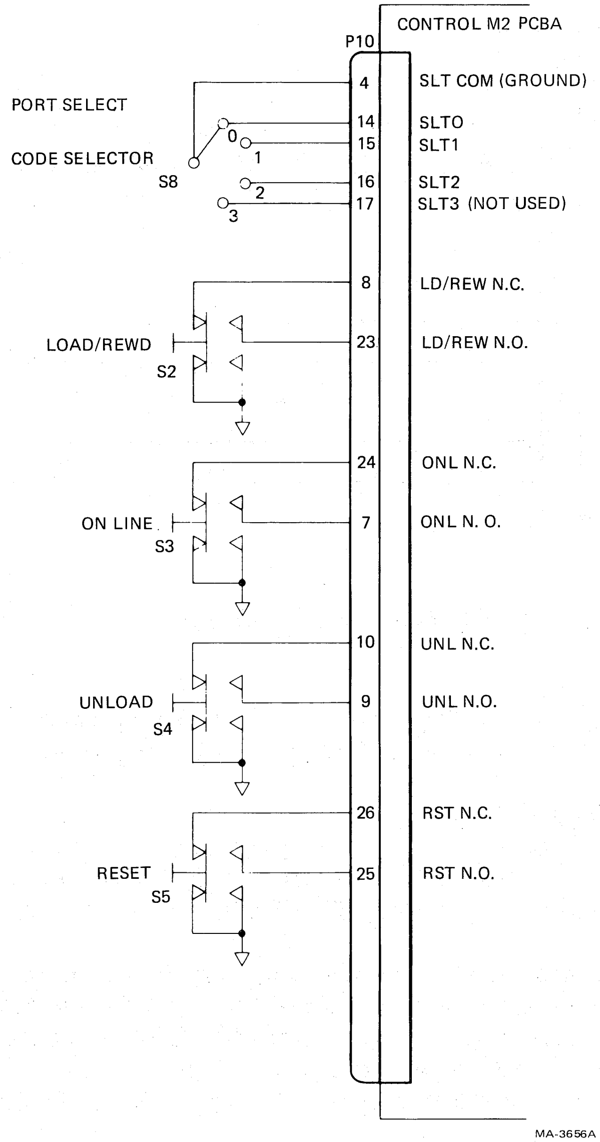


Figure 5-18 Manual Control Switching

5.6.3 LED Status Indicators

Panel LED indicators include power, bot (beginning of tape), online, file protect, load fault, 6250, and 1600. All indicators are connected to system circuitry through connector P10, which is mounted on the control M2 PCBA (Figure 5-19). The bot indicator lights to indicate that the BOT marker has been sensed and 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) lights to indicate that the write enable ring is not in place and the file is protected against writing. When illuminated, the Load fault (LDF) indicator cautions the operator that the tape failed to load. The 6250 indicator is illuminated when the system is set for high density (GCR) operation; the 1600 indicator lights when the system is set for low density (PE) operation.

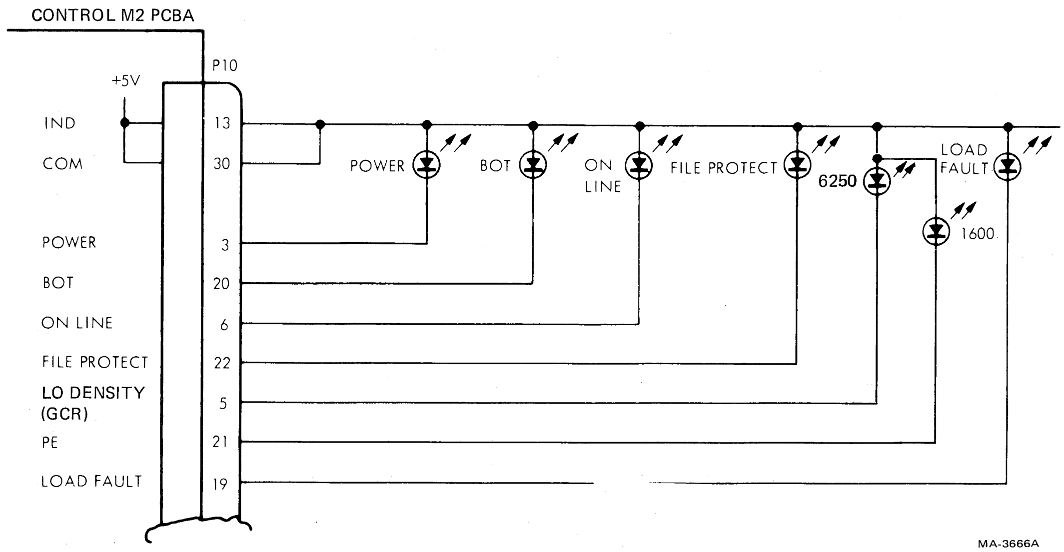


Figure 5-19 Front Panel Indicator Connections

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

5.6.4 Control System Inputs/Outputs

Inputs and outputs to the control system are generalized in Figure 5-17. Interface connectors are mounted directly on the interconnect D1 PCBA, which routes command/status signals between the MIA interface module and the control M2 PCBA edge connector, P8.

Manual control switches and associated LED indicators are connected directly to J10 on the control M2 PCBA. Status sensor information is connected through interconnect F1 PCBA J21 to J24 on interconnect D1 PCBA. It is then routed to the control M2 PCBA. Outputs from the control M2 PCBA to various other card cage PCBAs (read, write, capstan, reel, servo, etc.) are all routed via the interconnect D1 PCBA. This is shown in Figure 3 in Volume 1 of the Technical Manual.

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 using a manual switch (located on the control M2 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 MIA interface board.

On-line operation essentially includes read/write and motion procedures under host system control. Initiation of on-line operation requires the following conditions: tape has been loaded; all interlocks have been made; and the transport has provided the selected, ready, and on-line (SRO) signals (Schematic Number 106875, zone 3-3E).

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 M2 logic before receiving the manual load command (LD/REW N.O.). Until the tape is loaded and the necessary interlocks are made, the logic ignores all other commands except reset. Reset stops the load operation and prepares for another load command (in addition to its normal clearing and resetting functions).

After completing a successful load operation, the control logic accepts all other commands except a load command.

When the tape is loaded and positioned between the BOT and EOT (end of tape), a Rewind command may be initiated via the interface or manual operator control.

When the rewind control logic receives the rewind command, the following things occur.

1. A 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 the 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 BOT, a rewind is executed, then the unload operation is executed. If the tape is at BOT, only the unload operation is executed.

Jumper W3 on the control M2 module asserts SLT and provides SLTA to the output logic. The output logic provides NSLTA to the read function via J8-23. Jumper W3 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 MIA module via J10 and P8 of the control M2 module and the interconnect D1 PCBA.

Once power is on, the reset signal (NPORST), the input and output logic, and the front panel switches are enabled. These provide transport control provided system power is on (NPORST false). If system power is interrupted, NPORST goes low (true) causing 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 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 of the Technical Manual. 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.

When power is applied to the transport (NPORST false), IDDS on J8-19 of the control M2 PCBA generates a high 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 6250 or

*The control M2 PCBA is a multi-purpose PCBA and in this case the LO DENSITY signal indicates high density or 6250 mode.

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 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 M2 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) to the rewind generator, no more than one second after interlock is detected. Approximately one second after INTLK1, the delayed interlock signals (DINTLK and NDINTLK) and the interlock pulse (INTLKP1) are generated (control M2 PCBA). Signal 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. Signal NINTLKP2 disables the rewind generator.

The high DINTLK from the air load/control function to the rewind generator causes the generator to produce 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 M2 PCBA) is used to monitor the ready signal.

The ONL N.O. (normally open) and ONL N.C. (normally closed) 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 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 ready and on-line, the input logic provides the SRO signal to the output logic.

The status lines reflect the transport state. Because the transport is always selected (jumper W3 in), certain interface lines are always enabled. If the transport:

1. Is file protected, IFPT is low
2. Is rewinding, IRWD is low
3. Is on-line, IONL is low
4. Is in motion, ITACH is pulsing
5. Is in PE mode, IDDI is low.

If the transport is ready and on-line, the SRO signal enables the remaining three 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 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 low 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 U32-6 (TP21) 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 M2 PCBA) is enabled. This switch allows off-line testing of the transport. S1 moves tape in a forward and reverse direction. TP21 is used to monitor motion. TP22 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 M2 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 M2 PCBA

The control M2 PCBA integrates, develops, and applies commands received from the host system, manual control switches, or MIA test switches.*

External commands are delivered from the interface to the control M2 PCBA via the interconnect D1 PCBA, connector J8. Manual commands from the control panel are connected via J10 on the control M2 PCBA.

Internal signals used in the control process include feedbacks and status signals. These arrive at the control M2 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 M2 PCBA.

Inputs and outputs are detailed in Figure 5-20. The following text describes control M2 PCBA circuits that develop input signals into control outputs for 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 M2 PCBA. Refer to Figure 4 in Volume 1 of the Technical Manual for the source of sensor feedbacks.

5.6.6.1 Control System Timing – Control M2 PCBA clocks are derived from the 1 MHz oscillator circuits associated with crystal Y1 (Schematic Number 106875, zone 2-6H.) The 1 MHz prime frequency is referred to as clock A (CLKA), which may be monitored at TP20.

*The transport must be on-line to use MIA test switches.

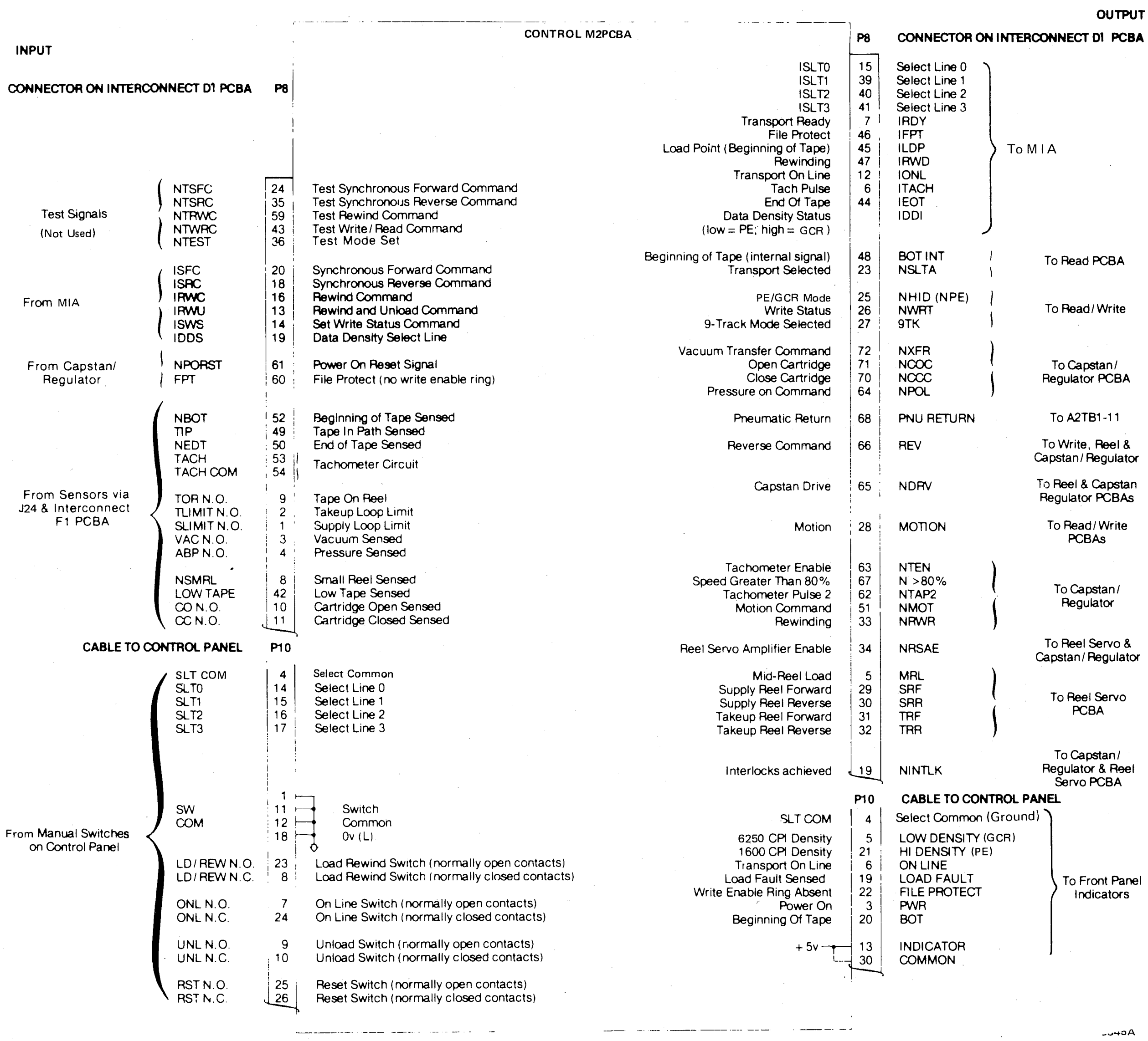


Figure 5-20 Control M2PCBA Inputs and Outputs

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 oscillator output, are listed in Table 5-3. Load/unload sequence counter outputs are described in Paragraph 5.8.2.

5.6.6.2 Transport/Massbus Port Selection – The common contact of the MASSBUS port selector switch (SLT COM) is grounded by jumper W3 on the control M2 PCBA (Schematic Number 106875, zone 3-7C). This ground supplies a low input to U102-9 (zone 3-6C), producing SLT and SLTA signals. SLT is applied to the motion command circuits (zone 3-5E) as one of the enabling inputs. SLTA is routed to U143-5 (zone 4-2H) to produce the NSLTA control signal at P8-23. NSLTA is applied to other transport circuits through interconnect D1 PCBA.

The selector switch ground common contract is returned to the MIA PCBA via P8-15, 39 and 40 as ISLT0:2. ISLT0 corresponds to switch position 0, ISLT1 to position 1 and ISLT2 to position 2. ISLT3 is not used in the MIA because it is assumed that if a ground is not present on ISLT0 (1 or 2) the switch must be in position 3. Table 2-1 lists port selector switch positions and functions.

Table 5-3 Basic Timing Frequencies (Refer to Schematic Number 106875)

Name Frequency	Test Point	Distribution	Sheet and Zone	Primary Use	Associated Signals
CLKA 1 MHz	TP20	U12-3, 11	6-4,5H	Tachometer pulse generation	TAPEN, TACHP, NTAP2, NTEN, NRWR, N>80%
		U52-3,11 U53-3,11	5-4G,H 5-3G,H	GO pulse generation	NGOP
CLKB 100 KHz	TP15	U35-11, U25-11	4-6D	Master reset generation	NMRSTP
		U35-3, U34-3,11 U61-3	4-3/6F	Load reset pulse, load pulse and rewind pulse generation	NLRSTP, NLDP NREWP
CLKC 10 KHz	TP39	U225-12,	5-6B	Stop pulse generation	NDRV
CLKD 100 Hz	TP17			Not used	
CLKE 10 Hz	TP19	U63-9	4-3B	Load fault indicator control	LOAD FAULT (LDFS)
		U54-13	5-7G	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
		U183-5	7-7C	Thread signal	THDS
		U216-11, U226-11	7-5,6B	Set tape loops command	STL
		U115-9	8-6A	Load fault 6	LDF6
CLKF 1 Hz		U184-11,3	7-3G	Interlock circuits	INTLK1, DINTLK, NDINTLK, INTLKPI
		U101-14	9-6F	Load fault 0	LDF0
CLKG 0.5 Hz		U64-13, U74-1	5-6,7F	Forward/ reverse motion	NGOP, MOT

5.6.6.3 Modes of Operation – The control M2 PCBA processes internal and external commands to establish the required modes of operation. The major modes, determined by the purposes for which the transport is to be used, are as follows.

Read Only, Forward
Read Only, Reverse
Write and Read Forward
Low Recording Density (PE)
High Recording Density (GCR)
Load Tape
Rewind Tape
Unload Tape

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

Reset/preset
Interlock
9-track
PE/GCR
Beginning of tape Interlock
Unit selected

These states are discussed in the following paragraphs.

Control M2 PCBA circuits which process 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. The operator can initiate it at other times by momentarily pressing RESET.

The circuits that check conditions (adequate power, etc.) and develop the reset/preset signals (NPORST, and ENBL) are located on the capstan/regulator PCBA. They are discussed on a system basis in Paragraph 5.4.7. The control M2 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 Number 106875, zone 4-8B.) NPORST is used to enable the front panel indicators (zone 4-3C). It is also applied to NOR gate U3 (zone 4-4C) as one of three inputs which will produce NMRSTP at the output of NAND gate (U13-11). NMRSTP is the low = true master reset pulse used in various circuits on the control M2 PCBA (as listed in zone 4-1C).

RST N.C. (J10-26) and RST N.O. (J10-25) inputs establish the state of flip-flop output U26-9. As the mnemonics imply, the RESET pushbutton switch contacts normally close the U26-13 clear (CL) inverted input circuit to signal ground (0 V), and Q output (U26-9) is low. The preset (PR) input (U26-10) is kept high by U6-10.

When the RESET switch is pressed, RST N.O. contacts are closed to ground and RST N.C. contacts are opened. The preset input U26-10 is pulled down momentarily, and the Q output (U26-9) 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 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 U13-11. 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 M2 PCBA.

Used in Producing	**Schematic Number 106875 (Sheet and Zone)**
NRST1	5-8E
PNU RETURN, UNL1	9-5G
NLDFS	9-7C
NLRST	7-5E
RST, NRST	8-8F
NCOC, NCCC	9-5A

NRST1 goes to U81-4 to preset the flip-flop (zone 5-7D) that controls rewind status, and to U83-5, to clear the flip-flop that initiates the on-line signals (DONL, NONL).

The PNU RETURN signal (9-1G) is used to turn on the compressor/blower motor. It is enabled by the application of NMRSTP to U156-1 (zone 9-5G).

The load fault status (NLDFS) flip-flop (zone 9-7C) is cleared by the application of NMRSTP to U166-13. This enables motion and other physical command outputs through P8 as shown in zones 9-2A through 9-2G. 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 7-4E) is produced either by NMRSTP at U194-9 or by the interlock (NINTLK) signal at U194-10, 11. NLRST resets the tape loading procedure flip-flops (zones 7-3A through 7-3E). RST and NRST (zone 8-3E) are initiated by NMRSTP at OR gate U64-5 or by other inputs to the same gate (zone 8-8F). RST resets the try counter (zone 8-6C) which issues a load command from U195-11, and the load sequence counter which produces the load counts (NC1,2; C1, etc.). Refer to zone 8-6H from where the count signals fan out to other areas of sheet eight.

The preceding paragraphs describe distribution of the master reset pulse NMRSTP and, in general, circuits on the control M2 PCBA where the signal used. Complete functions of the various circuits are described separately in the appropriate 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 Number 106875, zone 9-1F), and at NAND gate output U184-8 (zone 7-5F) where the signal originates. The NAND gate requires a high level at inputs 9, 10, 12, and 13 to produce a low = true NINTLK output level at U184-8. 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 7-8G and H. 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.

5.6.6.6 9-Track State – The 9-track signal is hardware-selected by means of jumper W1 (Schematic Number 106875, zone 4-3H). The jumper pulls down the inverted input to U201, causing it to produce a high = true 9TK signal at P8-27. This is connected via conductors on the interconnect D1 PCBA to J5-11 (read PCBA) for data reading circuits. Jumper W4 is always in.

5.6.6.7 PE/GCR State – Control M2 PCBA output NPE (low = true) at P8-25 (zone 4-1G) selects low density phase encoded (PE) operation. When NPE is high=false, the high density GCR mode is effective.

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 3-8B) is low. This applies a low at U65-9 (zone 4-4G), causing the OR gate to place the transport in PE mode (NPE low = true).

The other input to OR gate U65-10 is normally held high since jumper W4 (zone 4-6H) is removed. Therefore NAND gate U65-12 (zone 4-4H) is disabled. This circuit also initiates the DDI signal (zone 4-1G) which produces the interface IDDI signal through P8-17 (zone 3-1D). The interface driver (U161) is enabled by transport selection (SLTA) from U142-6 (zone 3-5B), which is always asserted by jumper W3. (The IDDI output on P8-17 is returned to the MIA as a density status signal.)

5.6.6.8 Beginning of Tape Interlock (BOT INT) State – The BOT INT output at P8-48 of the control M2 PCBA (Schematic No. 106875, zone 4-1H) 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 4-8B) via interconnect D1 and F1 PCBAs. The latched NBOT signal is also applied to various circuits on the control M2 PCBA as shown or referenced on the schematic (zone 4-4B).

5.6.6.9 Unit Selected State (NSLTA) – The NSLTA output at P8-23 of the control M2 PCBA (Schematic No. 106875, zone 4-1H) is always at a low = true level. This circuit is described in Paragraph 5.6.6.2.

5.7 AIR LOAD/CONTROL

The air load/control subsystem includes air and electronic provisions which control and monitor the tape path between the reels (Figure 4 in Volume 1 and Figure 5-21 in this volume).

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 take-up reels must vary according to the quantity of tape on the reels. For example, when the supply reel is full and the take-up reel nearly empty, the take-up 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 air load/control subsystem provides tape loop status signals to the reel servo circuits, which use the information to regulate 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 capstan. Energizing solenoid K3, on the vacuum valve, switches vacuum to the takeup reel hub to facilitate threading. A typical tape loop formation is shown in Figure 5-22. The complete tape path is shown in Figure 2-5.

Pressure (positive atmosphere) is developed by a pump located in the power pack/pneumatic assembly.

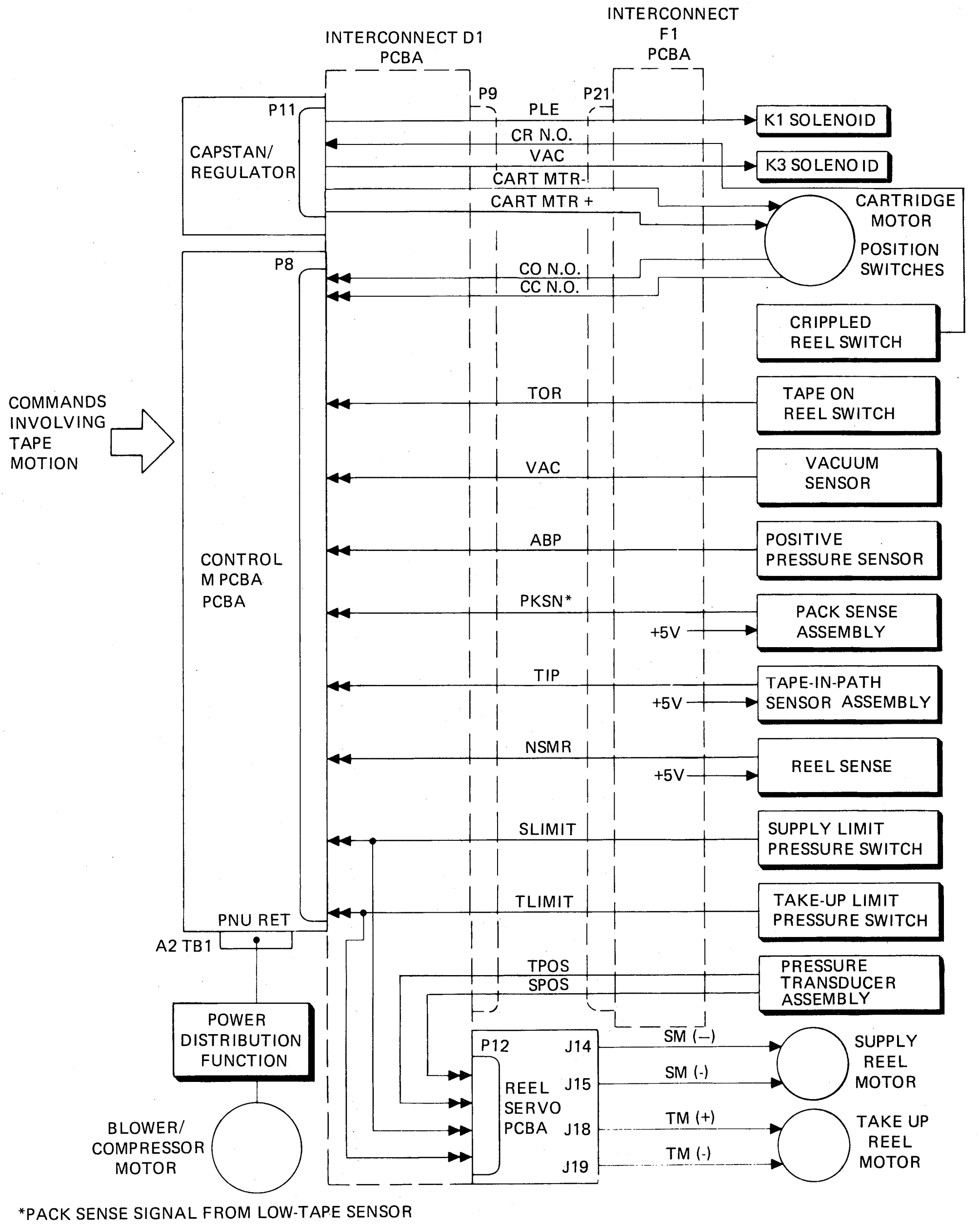


Figure 5-21 Air Load/Control Function

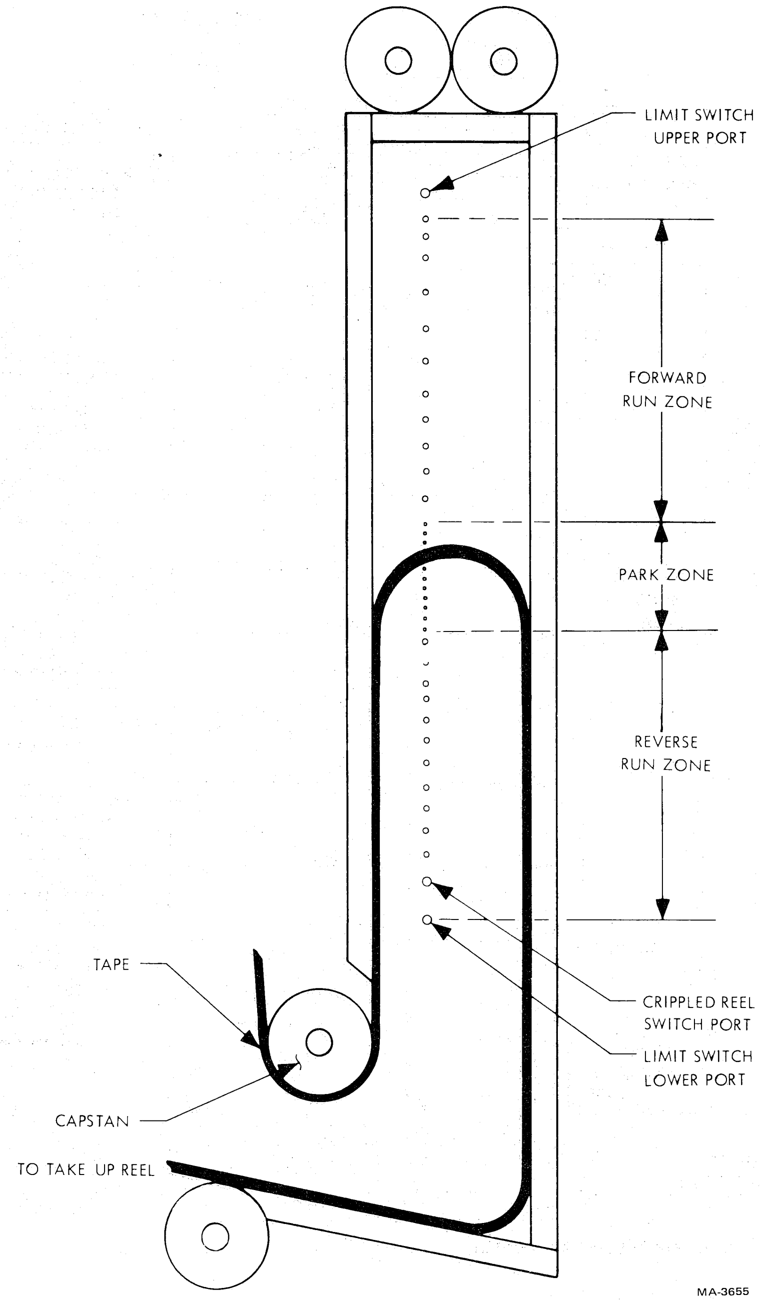


Figure 5-22 Tape Loop In Takeup Buffer Box

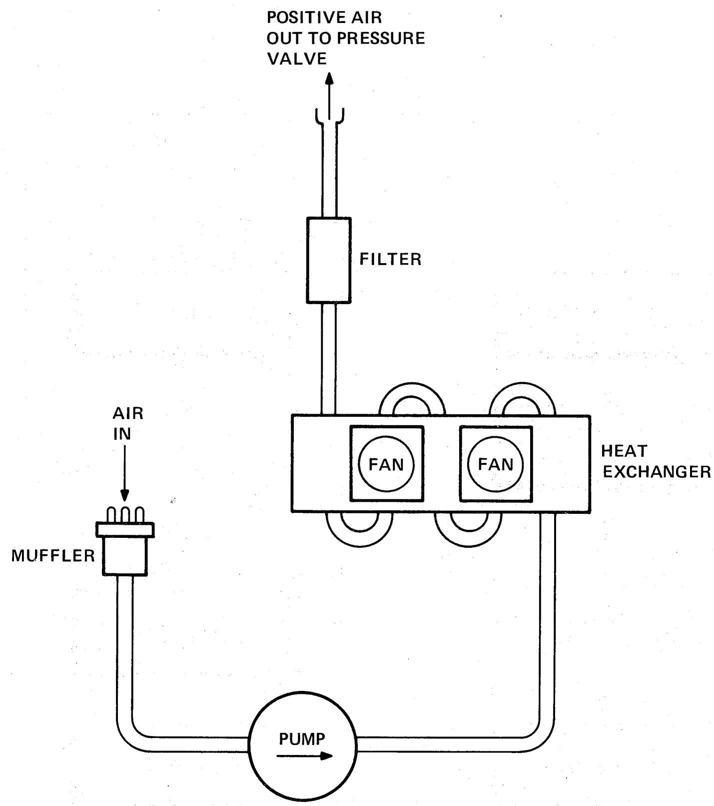


Figure 5-23 Positive Air Supply System

Air is drawn through an acoustic muffler by the pump and cooled in the forced air heat exchanger. The cooled air is filtered and delivered to the pressure valve located on the base assembly. Figure 5-23 shows a schematic of the positive air supply system.

5.8 TAPE LOAD, UNLOAD, AND REWIND OPERATION

5.8.1 Load/Unload Sequences

5.8.1.1 Tape Load – During a load operation, the following series of events occur (Figure 5-24).

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

2. If tape is in the tape path at this time, a midreel load situation is assumed, and the unit sets loops and starts towards BOT.

3. If tape was not in the tape path, the cartridge motor opens the cartridge, the take-up reel turns clockwise (CW), and a normal load is initiated.

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

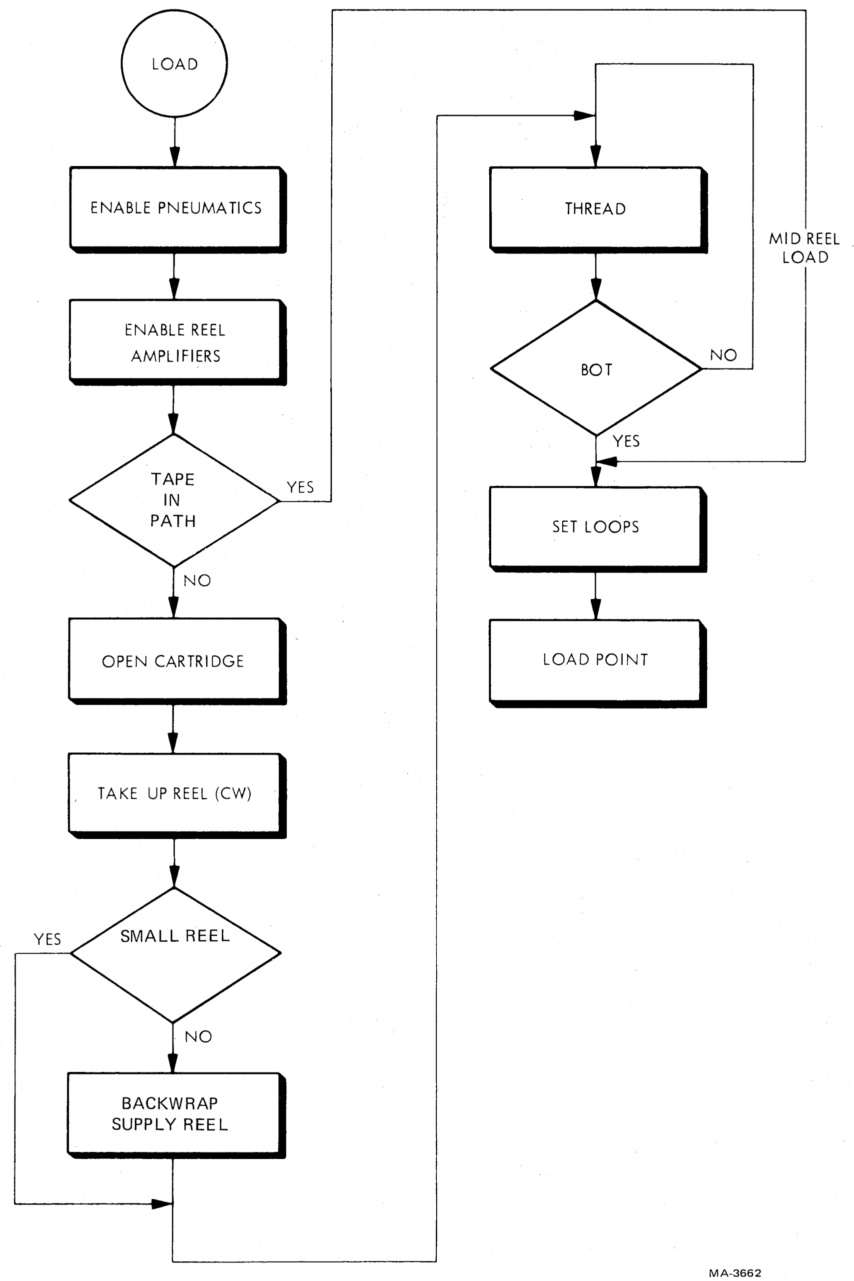


Figure 5-24 Load Sequence

NOTE

If the diameter of the outside turn of tape is too small, it is 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 auto-load (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 starts forward and tape threads through the tape path.

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

7. The transport is then ready for controller commands and data 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 sends a drive (NDRV) and direction (REV, true or false) signal to the capstan servo subsystem. This 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.

5.8.1.2 Tape Unload – The same auxiliary circuits employed to load tape into the vacuum chambers (load operation) are used during an unload operation (Figure 5-25). When the UNLOAD button is pressed 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

The unload procedure with tape at BOT is identical but without rewind operation.

5.8.2 Load/Unload/Rewind Circuit Operation

The tape loading procedure involves all steps that result in 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 tape reel is installed on the supply reel spindle, but sensors determine the tape has not been threaded through the guides to the take-up reel, normal load conditions exist. Pressing the LOAD/REW button initiates the automatic threading process, which connects the tape to the take-up 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 take-up reels when the LOAD/RE 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 of the Technical Manual.

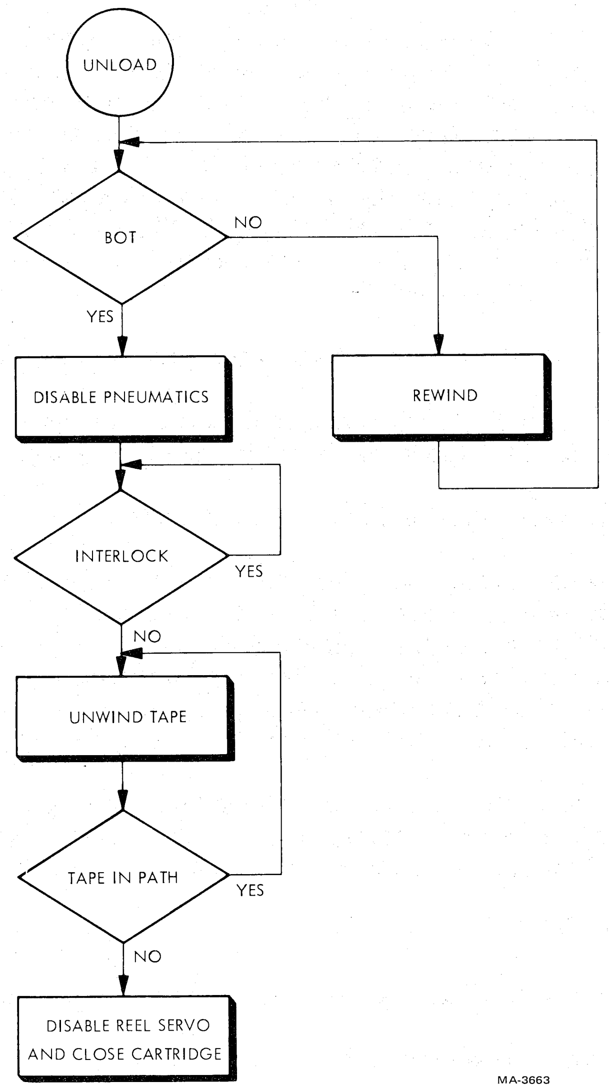


Figure 5-25 Unload Sequence

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

Schematic Number 106875, sheets 10 and 11, contain a flowchart for reel-motion logic by manual control. The flowchart includes motions commanded by means of the LOAD/REW and UNLOAD switches. The following text describes the preliminary power-on sequence and the load sequence with reference to the flowchart and various zones on other sheets of the same drawing. The power-on sequence is included here because it prepares the subject circuits for tape procedures.

5.8.2.1 Tape Control Presetting by Power-On Sequence – When power is applied (zone 11-8H), the power-on reset signal (NPORST) is produced (Paragraph 5.6.6.4). NPORST is applied to control M2 PCBA J8-61 (zone 4-8B). This is distributed as shown at zone 4-4B and gated with the manual reset circuits (zone 4-4C) to produce the master reset pulse (NMRSTP) at NAND gate output U13-11.

If the tape sensors find tape in the tape path, a high = true TIP signal is received at J8-49 (zone 4-8A). This signal informs the circuits that a load command, when received, will be under midreel load conditions. TIP and NTIP initiate midreel load signals MRL and NMRL (zone 7-1D). NTIP, from zone 4-4A, is applied to NAND gate U202-4 to inhibit a close cartridge command (NCCC). MRL goes to P12-28 of the reel servo PCBA, where, when high = true, it asserts NSRF2. This supplies additional torque to the supply reel servo. NMRL is applied to U124-10 (zone 7-2F) to turn pressure on (PSOL) and U125-10 to preset the air control flip-flop (zone 7-7F).

MRL (zone 7-1D) is also applied to NAND gate U194-2 as one of the conditions that preset the first delay flip-flop (U216-4, zone 7-6B). After a delay, U226-9 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, and NAND gate U202-4 (zone 9-5A) is enabled for a high output at U182-5 (zone 9-5A) of the cartridge control flip-flop. The other condition for issuing a close cartridge command is the input CC N.O. at U202-5 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 U194-3 (zone 9-8E) 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), and cartridge open (CO N.O.), unload number 1 (UNL1) depending on the mode of operation. SRR also is inhibited by the suppression of BKW when the set tape loops (STL) process is initiated. These signals are shown on the right side of sheet 9, zones 9-6G and 9-4E through 9-2C.

5.8.2.2 Circuits Involved in Tape Load/Rewind/Unload Procedures – Circuits involved in load, rewind, and unload control are shown in Schematic Number 106875 and are described as follows.

1. Clocks – Basic system clocks (zones 2-1A through 2-1H) are based on a crystal oscillator (Paragraph 5.6.6.1).

2. Load/Rewind Command Pulsing – Load/rewind command and pulsing circuits (zones 4-8F through 4-1F) are initiated by LOAD/REW momentary switch outputs.

Load reset pulse (NLRSTP)	U24-6, zone 4-4F
Load pulse (NLDP1)	U46-6, zone 4-1F
Rewind pulse (NREWP)	U46-12, zone 4-1F

3. Unload Commands – Unload command circuits (zones 4-8E through 4-1D) process either a manual command from the control panel UNLOAD switch or a logic command (IRWU at interface, zone 3-8E, NULC at U192-12, zone 3-5E). They produce unload command number 2 NUNLC2 at U56-12, zone 4-2E.

4. Reset Commands – Reset command circuits are located in zones 4-8D through 4-4C. This is the only command that interrupts a load procedure. 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 (U135-9, zone 7-1E) participates in setting the backwrap flip-flop (zone 7-2B), sets the thread-mode flip-flop (zone 7-2A), and the set-tape-loops flip-flop (zone 7-2B). These flip-flops then wait for their respective clock inputs. LDS also enables tape and reel motion command gates, etc. via U115-13 (zone 8-2G), U126-8 (zone 8-1D), and U166-8 (zone 9-7B) provided no load fault exists as decided at gate output U165-11 (zone 9-6B).

6. Load/Unload Counts – Load/Unload step sequence count control circuits are located in zones 8-6C through 8-6H, and 8-7H. Counter outputs (U215-12,9,8,11) are decoded and produce counts NC 0,1, 2, 3, 4, and 7, at outputs U205-1, 2, 3, 4, 5, and 9, respectively. The counter is incremented at input U215-14 by the output of U195-11 (zone 8-6C). This reflects the low tape sensor input pulses (P8-42, zone 8-8C) divided by five. The divided count is provided by U185-11 (zone 8-6C). Sensor pulse inputs at U185-1 are inhibited if a load fault exists (NLDFS at U136-2). The divider output is not applied to the load counter unless the transport is in load status (NLDS at U195-9, zone 8-6C). Or, if tape-in-path signal (NTIP) is high = false at U195-2 and unload command UNL1 is high = true at U195-1.

7. Load Fault Recovery – Load fault flip-flop (zone 9-7B) issues a high load fault status (LDFS) level at Q output U166-9 and a low load fault status level at Q output U166-8 whenever conditions warrant aborting the procedure. The flip-flop is cleared by master reset pulse NMRSTP at U166-13. In load status (LDS at U166-12) it is set to produce fault status by the input at U166-11 from fault NOR gate output U126-8 (zone 8-1D). Low inputs to the NOR gate which clock U166-11 are as follows.

U126-1 (TP41)	Load status terminated by end of count output to U186-11 (zone 8-2F)
U126-3 (TP42)	Try counter outputs U112-12, 9 are high indicating two attempts have already been made to load tape, these outputs cause NAND gate output U122-6 to produce a low
U126-6 (TP28)	System is at the set-tape-loop mode and tape loop timer outputs U123-9, 8, 11 are all high, indicating that time has run out for setting the loops.
U126-11 (TP14)	Failure to load count (NLDC from U195-11, zone 8-6C) at start count timer flip-flop input U125-3 (zone 9-7E) and timer inputs U101-2, 3 (zone 9-6F), causing U102-10 to send load fault zero (LDF0) to U126-11
U126-5 (TP32)	Failure of cartridge to open by count C3 as determined by NAND inputs U136-4 and 5 (zone 8-2E)
U126-4 (TP35)	Failure to get proper air pressure and vacuum condition by count C3 as determined by NAND inputs U136-12 and 13 (zone 8-2F), NAOK input at U136-13 is provided by output of U173-3 (zone 7-6F) on basis of Vac N.O. and ABP N.O. sensor inputs to P8-3 and P8-4
U126-12,2 (TP27)	Cartridge problem as determined by NAND output U132-6 when load pulse (NLDP2) is received at U131-5, these signals are inverted and applied to U132-4, 5 (zone 8-5B)

8. Tachometer Circuits – Capstan tachometer signal processing and application circuits shown on sheet 5, provide tape speed information feedbacks for optimum speed control. 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 6-2G). Then they are sent to the interface ITACH driver (zone 3-2E) provided the tachometer pulse circuits are enabled (TAPEN at U116-12, zone 6-3G). The tachometer pulses are also obtained from U13-8 (zone 6-4G) and applied to flip-flop clock inputs U95-11 and U93-11, and preset input U92-10 (zone 6-3B-D). They are also squared and applied to the velocity decoder and time constant circuits at U85-14 (zone 6-7E).

   After a 20 μs delay, the output U116-8 (zone 6-6D) clears the tachometer pulse number 2 flip-flop (zone 6-3B). This provides a squared pulse 20 μs long (NTAP2) at P8-62. After a 64 μs delay, the output at U104-10 (zone 6-6C) clears the rewind enabling flip-flop and produces a high at U93-6 (zone 6-2C). The inputs that produce U105-8 output (zone 6-5D) are all connected to pull-up resistors U96 which produce high inputs to U105 except those input lines with jumpers installed. The TU78 has jumpers W8 and W10 installed. Therefore, when time constant counter U86 has a high output on pins 11 and 9, all the U105 inputs are high and the U105-8 output goes low.

   The low output at U105-8 changes the state of outputs at U95-9 (zone 6-3D) and U92-5 (zone 6-2D). When the latter output is low, the rewind ramp is terminated (NRWR, zone 5-1B). When the N>80 percent 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 circuits on the capstan/regulator PCBA (Schematic Number 104757, zones 2-12C,D through 2-9C, D) convert the tachometer frequency pulses (NTAP2) to analog voltage signals used in the capstan servo summing amplifier.

9. Unload Control – Unload procedure control circuits are shown in zones 9-6G through 4-6B. NUNLC2 (refer to item 3) presets the first stage (rewind) unload command flip-flop (zone 9-6G). Output U146-5 (UNL1) is applied as a condition to various NAND gates, as shown in the schematic, and to enable the load counter (zone 8-7C). Q output U146-6 (NUNL1) provides the reel servo amplifier enable output at P8-34 by presetting flip-flop output U226-5.

   NUNL1 is also used in the mode circuits (zone 3-6C) and to initiate the rewind pulse circuits (4-7G). NULRW from U133-12 (zone 9-5H) is applied to U71-11 (zone 5-8E) to establish the state of the rewind status circuits. The output of U82-6 (zone 5-5D) is applied to the motion control circuits at U72-9 (zone 5-5E) to start tape motion.

   When BOT is sensed (BOT at U131-13, zone 9-5H), the rewind part of the process ends, but unload rewinding motion continues until interlock is broken (INTLK low = false at U133-1, zone 9-5H). BOT also is applied to the PNU RETURN flip-flop at its presetting input NAND gate (U145-10), and clock input U146-11 (zone 9-5H). At C4 count, flip-flop input U146-13 (zone 9-5G) clears the flip-flops disconnecting the PNU RETURN line, which turns off the blower/compressor motor. When interlock is broken (NINTLK high = false at U225-5, zone 9-3F), U226-9 changes state, disabling the reel servo amplifiers (NRSAE high = false).

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

The try counter provides an automatic second attempt at starting the loading sequence if the first attempt falls, but inhibits repetitious recycling. The try counter is cleared and reset by an input at U112-2 and 3 (zone 8-3D) from NOR gate output U164-6 (zone 8-8F). 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 U112-14 which primarily reflects the output of NAND gate U115-6 (zone 8-4D). 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, AND gate input U155-12 is low, U155-11 is low, and the try counter is incremented to T2. When counter outputs are high (at T3) at U112-12 and 9, the output at NAND gate U122-6 is low and reports a load fault 4 at load fault NOR gate U126-3. This prevents 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 U215-2, 3 (zone 8-7H). It is incremented by pulses from the low tape sensor P8-42 (zone 8-8C) after these pulse counts have been divided by five at divider output U185-11 (zone 8-6C). Application of the pulses are on the condition that no load fault has occurred. For example, the load fault status signal NLDFS at U136-2 (zone 8-7C) is high = false.

The pack sense assembly A4 located on the base assembly (Schematic Number 107307) contains an optical detector that senses a low-tape condition on the take-up reel. The pack sense assembly output are pulses (PKSN) coupled via TB2 and J21-30 to control M2 module J8-42 where they become low tape sensor. The optical detector senses two reflective tabs placed on the inside of the take-up 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 reel revolution, provided there is not enough tape on the reel to block the path between the detector and the tabs.

In rewind mode, when tape on the take-up reel is down to about 9.525 mm (0.375 in), the low tape sensor begins issuing pulses. The first pulse is used to slow tape motion so the reels can stop at BOT. In forward motion, the pulses are sent to the logic until tape on the take-up reel is sufficient to intercept the sensor path. These pulses, at the rate of two per turn, are sent through P8-42 to U136-1 (zone 8-7C).

During the load process, if no load fault exists, NLDFS is high = false at U136-2 and U136-3 applies the inverted pulses to U185-1. The output of U185-11 of the divider is one pulse per five inputs, or one per two and one half turns of the reel, at NAND gate input U195-12. If the transport is in load status (NLDS at NOR gate U195-9) then U195-11 issues low load count pulses. These are applied to the sequencing counter incrementing input U215-14.

The outputs of the sequencing counter are applied to decoder inputs U205-12, 13, 14, and 15. Decoder outputs are low at times corresponding to the count, which is the chip pin number minus one (For example, U205-1 is low at the zero count, U205-2 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. 106875)**

Decoder Pin (Zone 8-6H)	Count* (N = Low)	Distribution/ Zone	Mode	Effect
U205-1	NC0	U222-11/9-8E	Load	Opens cartridge if not open and no fault exists.
		U194-4/9-8E	Unload	Commands supply reel reverse if interlocks are not made (after BOT is reached)
U205-2	NC1	U222-10/9-8E	Load/ unload	Opens cartridge if not open, tape is in path, and no fault exists
		U125-11/7-7F	Load	If air pressure is correct, issues PSOL command
		U194-5/9-8E	Unload	Starts supply reel reverse if interlocks are not made (after BOT is reached)
	C1	U115-4/8-4D	Load	Increments try counter if a small reel has been sensed and if one try has not already been made
		U144-3/7-2B	Load	Starts backwrap if in load status, small reel has not been detected, and there is no tape in path (not a midreel load)
U205-3	NC2	U222-9/9-8E	Load/ unload	Opens cartridge if not open and no fault exists
		U144-11/7-2A	Load	Trailing edge starts threading process if in load status
U205-4	NC3	U155-4/7-3B	Load	Clears backwrap flip-flop
		U155-12/8-4D	Load	Increments try counter

*Counts are produced only under the following conditions (zone 8-6/7C)

Mode	**NLDFS (U136-2)**	**NLDS (U195-9)**	**NTIP (U195-2)**	**UNLI (U195-1)**
Load	high = false	low = true	N/A	N/A
Unload	high = false	N/A	high = false	high = true

Table 5-4 Load/Unload Sequence Control Count Applications (Schematic No. 106875) (Cont)

Decoder Pin (Zone 8-6H)	Count* (N = Low)	Distribution/ Zone	Mode	Effect
	C3	U136-12,4/8-2F	Load	Initiates load fault status if cartridge is not open or if air is not correct
		U145-13/9-6B	Unload	Closes cartridge if unload is complete, there is no tape in path, and cartridge is open
U205-5	C4	U156-13/9-6F	Unload	Terminates process if in unload status

Table 5-5 Try Counter Outputs (Schematic Number 106875, zone 8-3D)

Try No.	U112-12	U112-9	U122-6	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

Note that low tape counts at U215-12, 1 (zone 8-7H) are applied to U115-1 (zone 8-2G), as well as to the decoder. Similarly, counter output U215-11 is inverted and applied to clock flip-flop (U186-11, zone 8-2G). Flip-flop output U186-9 is applied to NAND gate input U115-2 (zone 8-2G). If BOT is reached, load status ends (LDS low), so U115-12 cannot issue a load fault 5 output. If counts stop before BOT is reached, U115-12 goes 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 so that output U186-9 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.

5.8.2.4 Automatic Tape Loading Sequence – When issuing the load command 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 that make decisions are shown in Schematic Number 106875, sheets 2 through 9. The logic flowchart for the procedure is in the same drawing, sheets 10 and 11. Sensor feedbacks are shown in Figure 4 in Volume 1 of the Technical Manual.

If tape is in the path and air status is satisfactory for operation after the LOAD/REW button is pressed, interlocks will have been made (Paragraph 5.6.6.5). NDINTLK is applied (zone 7-1G) and rewind mode is commanded by the resulting low = true rewind pulse NREWP (zone 4-1F). The tape stops at BOT, and the load is completed.

If interlocks are not made when the LOAD/REW command is processed, the automatic load sequence is initiated by the low = true load pulse NLDP1 (zone 4-1F).

Pulsing is developed by the series of flip-flops (zones 4-7F to 4-3G) activated by the LOAD/REW switch. While the momentary switch is pressed, J10-23 is connected to ground, which presets the first flip-flop in the series. The resulting Q output (U26-5) sets the next flip-flop (435-5) 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, U26-4 goes high, and U26-1 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 U145, inputs 2 or 1, 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 U164-4 (zone 8-8F) to reset the load sequence counters and control circuits. At clock B time, the output of U35-5 (zone 4-6F) causes the next flip-flop to change state. This terminates the NLRSTP pulse (U24-6) and applies its high Q output to NAND gate U54-2, which, while $\overline{Q}$ output at U34-8 is high, causes NAND output U54-3 to initiate a low load pulse (NLDP1) at U46-6 (TP18). This pulse is terminated when the $\overline{Q}$ output at U34-8 changes state at the next clock B time. NLDP1 is sent to U135-10 (zone 7-2E) to preset the load status (LDS) flip-flop and U134-10 (zone 7-2C) to preset the thread status (THDS) flip-flop. It is also inverted and used as a condition for output of NAND gate U133-6 (zone 8-3D).

If no cartridge is in place or, if the cartridge is sensed as neither open or closed, U132-6 (zone 8-5B) is low. This causes a load fault 1 signal at U126-2, 12 (zone 8-2D) and a load fault status level (NLDFS) at the $\overline{Q}$ output (U166-8) of the load fault flip-flop. NLDFS is applied to U136-2 (zone 8-7C) as one of the conditions in the network that issues the load count signal to U215-14 to increment the sequence counter U215 and decoder U205 (zone 8-6/7H). If NLDFS is true=low at U136-2, the reel-turning pulses from the low tape sensor are prevented from entering the divide-by-five chip at U185-1 (zone 8-6C).

If the cartridge is in place, U205-2 (zone 8-6H) issues count C1, which clocks backwrap (BKW) flip-flop U144-3 (zone 7-2B), and NC1, which clocks the air control flip-flop (U125-11) at zone 7-7F. Since, during normal load sequence, interlock is not made (NINTLK at U184-8, zone 7-5F, high = false), U124-8 (zone 7-2F) issues the pressure solenoid command (PSOL).

If no load fault exists, U166-8 (zone 9-7B) is high and U165-11 (zone 9-6B) is low, clearing the cartridge command flip-flop (zone 9-5A). This causes $\overline{Q}$ output U182-6 to initiate the NCOC command to open the cartridge.

At NC1, the backwrap flip-flop is enabled to be set (by the output of U143-8, zone 7-3C), provided the inputs (U133-9, 10, and 11) are high. This indicates that load status (LDS) mode is set (U135-9), a midreel load condition does not exist (U134-6), and the try counter output (U112-9, zone 8-3D) indicates no more than one previous try has been made (U112-9 high).

Load sequence count NC2 is applied to thread command flip-flop U144-11 (zone 7-2A). The NTHD output (U144-8) is sent to U154-9 (zone 9-7D) to initiate the supply reel forward (SRF) command and continue the take-up reel forward (TRF) command.

Load sequence count NC3 (zone 4-14D) applied to OR gate U155-4 (zone 7-3B) initiates clearing of the backwrap flip-flop. NC3 at U204-1 (zone 8-3H) is inverted to C3 and applied to NAND gate U136-4, which checks the cartridge open signal CO N.O. for a possible load fault. U136-11 (zone 8-2F) similarly checks for air system faults.

When tape appears in the path (BOT or NAOK), U196-12 (zone 7-5C) presets flip-flop U216-4 (zone 7-6B). The succeeding two flip-flops, clocked by CLKE, provide a delayed output at U226-9, which sets the tape loop command (STL) flip-flop. This delivers STL (zone 7-1B) to the reel servo motion commands at U222-13 (zone 9-4D). The take-up 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 U233-13, zone 9-6F), take-up reel reverse (TRR) and supply reel reverse (SRR) are commanded (zone 9-1C,D). When BOT is sensed, U131-13 (zone 9-5H) goes high and output U133-12 terminates motion.

5.9 REEL SERVOS (Refer to Figure 5 in Volume 1 of the Technical Manual)

5.9.1 Reel Servo Overview

The reel servo subsystem controls tape reel speed as required to maintain optimum tension on the tape between the supply and take-up reels. (The tension is interpreted from the positions of the tape loops.)

Figure 5-26 illustrates the basic signal flow as applied to each reel servo. 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, servo loop control 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.

If the supply reel is properly loaded, the air system in operation and interlock circuit status is acceptable, reel motion begins. The reel rotation speed is 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 take-up) and an offset input. The offset input pertains to adjusting reel motion to achieve a different loop configuration for different tape motion directions.

The supply and take-up reel servo networks are identical except for the polarity of the position transducer outputs. The crippled reel signal in the take-up reel servo system is applied to the capstan servo circuitry.

During load and unload operations, at which times the tape path has not stabilized, the reel speed is totally a function of voltage specified by the control electronics. Load and unload sequences are described in Paragraph 5.8.

5.9.2 Reel Servo PCBA

The reel servo PCBA, plugged into J12 on the interconnect D1 PCBA, contains the supply reel and take-up reel power amplifiers. These control the speed and direction of reel motion (Schematic Number 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 doing so the reel speeds 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 5-6 and 5-7. Power amplifiers and outputs to the reel motors are shown on sheet 4 of Schematic Number 106925.

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

Outputs to the reel motors are, respectively: supply reel motor positive, SM(+), J14; supply reel motor negative, SM(−), J15; take-up reel motor positive, TM(+), J18; take-up reel motor negative, TM(−), J19.

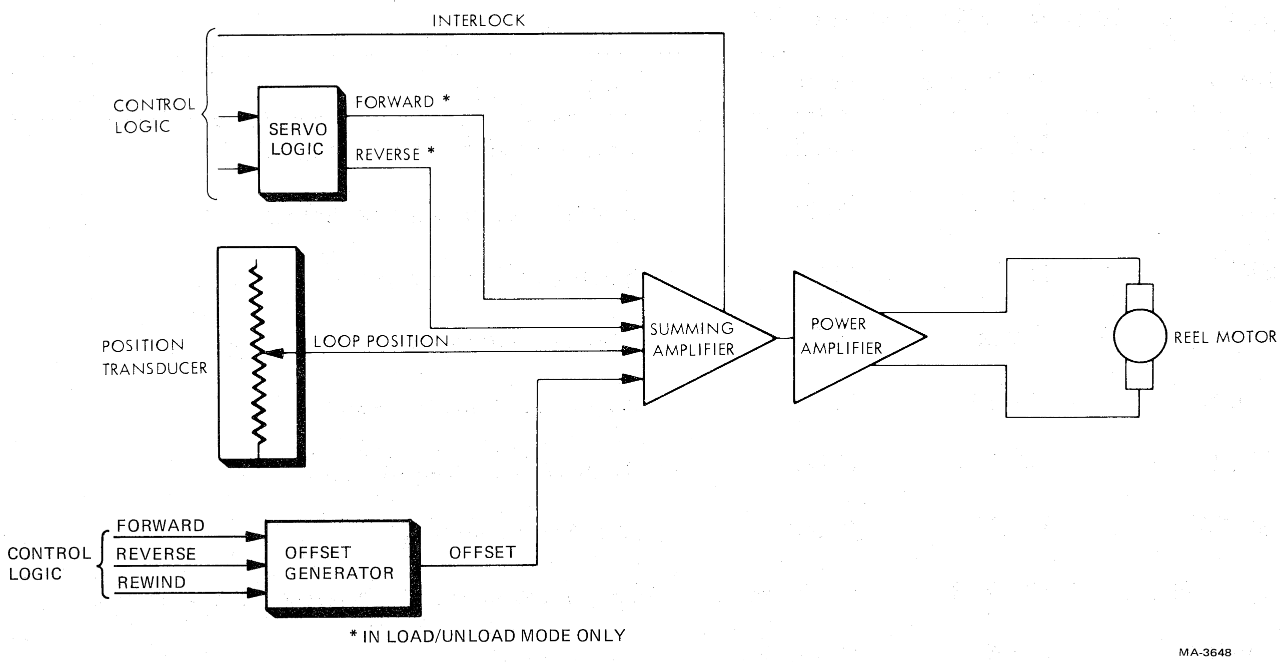


Figure 5-26 Reel Servo Block Diagram

Table 5-6 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	Take-up reel motor power
−36 V(T)	J20	C5(−)	Take-up 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	Take-up loop interlock (TLIMIT signal)
NSINTLK	J12-30	J21-6	Supply loop interlock (SLIMIT signal)
TRF	J12-15	J8-31	Take-up reel forward command

Table 5-6 Reel Servo PCBA Inputs (Cont)

Input	Connector	From	Purpose
TRR	J12-14	J8-32	Take-up 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	Take-up 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) 0 V(R)	J12-32 J12-34	Interconnect F1 PCBA	Power for position transducer

Table 5-7 Reel Servo PCBA Outputs

Output	Connector	To	Purpose
SM(+) SM(−)	J14 J15	Supply reel motor	Drive power
TM(+) TM(−)	J18 J19	Take-up reel motor	Drive power

Input signals to the reel servo PCBA are through interconnect D1 PCBA and J12, shown on the leftside of sheets 2 and 3 of Schematic Number 106925.

Both supply and take-up 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 take-up reel signals).

Mode control circuits are shown in zones 2-8E through 2-6C. They interpret supply reel (SR) and take-up reel (TR) motion commands (SRF, SRR, TRF, and 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). Take-up loop position signal feedback is applied to the corresponding take-up 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 take-up 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 M2 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 in zone 3-8E).

The reel servo inhibit switch (zone 2-6F) allows 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.

5.10 CAPSTAN SERVO (Figure 6 in Volume 1 of the Technical Manual)

5.10.1 Capstan Servo Overview

The capstan servo is a velocity management system. It 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 5-27.

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.

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.

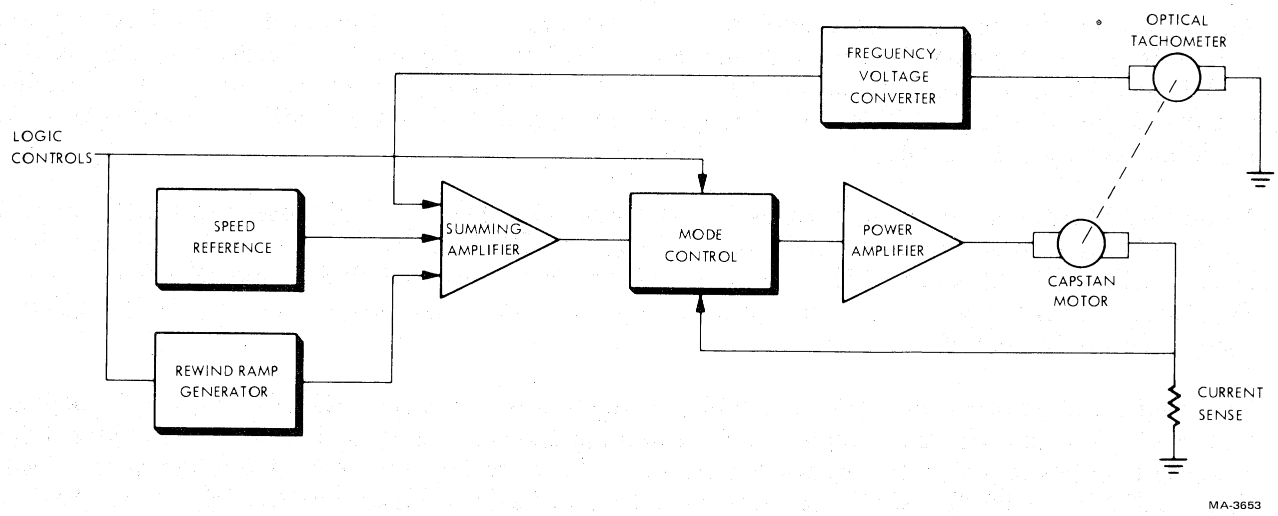


Figure 5-27 Capstan Servo Block Diagram

Figure 5-28 illustrates typical capstan servo waveforms. The following sequence of events describes normal capstan servo operation.

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, the 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 the direction and drive current is reversed.

Each time power is applied to the unit, the power distribution block generates a reset signal (NPORST) to the velocity decoder on the control M2 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.)

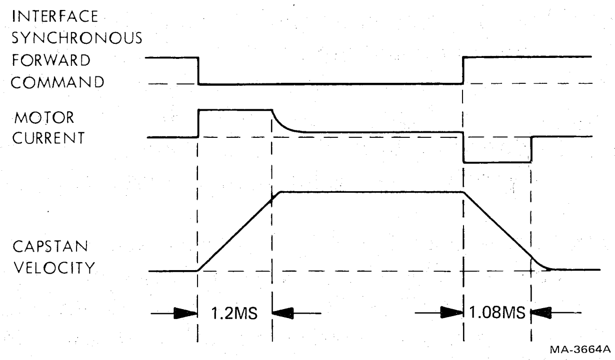


Figure 5-28 Capstan Servo Waveform for Forward Start and Stop

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 M2 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. There 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 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 Number 104757.

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, (shown at the left side of sheet 2. The amplifiers are enabled by the interlock signal (NINTLK) from the control M2 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 the application is determined by the forward-reverse switch (zone 2-7D) output 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 capstan speed reaches 80 percent of nominal tape speed. (N>80% input at P11-25 is 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. The crippled reel signal (CR N.O.) at P11-80 disables the rewind ramp generator if the tape loop excursion in the take-up reel buffer column becomes too short.

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). 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 positive 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 positive (+) 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 application of the vacuum source by controlling the vacuum valve solenoid. When NXFR is low = true, Q44 (zone 3-4C) is switched off. This causes Q45 base to be pulled down. This turns Q45 on, which connects the vacuum solenoid return (VAC SOL RET) to ground.

The 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 U11-2. 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. This causes 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 (covered in Paragraph 5.4.5).

5.11 DATA PATHS

This section outlines the data paths utilized in write operations, and traces the flow of data onto tape and back through the read recovery chain. For an understanding of the group code recording and phase encoded tape formats, refer to Paragraph 4.1, Recording Formats, in the TM78 Magnetic Tape Formatter Technical Manual (EK-0TM78-TM).

5.11.1 Introduction

Figure 5-29 shows an overview of the read/write data paths. Write data originates in the formatter and is placed on the TU bus. The MIA PCBA gates the write data through to the write PCBA where it is conditioned before going through the preamp PCBA to the write head.

Data picked up by the read head is amplified in the preamp PCBA and input to the read PCBA. The read PCBA further amplifies the read data and passes it on to the MIA PCBA where it is gated to the formatter over the TU bus. The read PCBA also establishes a gain control voltage for each track that is fed back to the preamp PCBA. Read data from the preamp PCBA passes through the read PCBA and is input to the write PCBA. The write PCBA generates an AMTIE signal if the read data amplitude falls below a predetermined threshold level. AMTIEs are gated through the MIA PCBA and sent to the formatter over the TU bus.

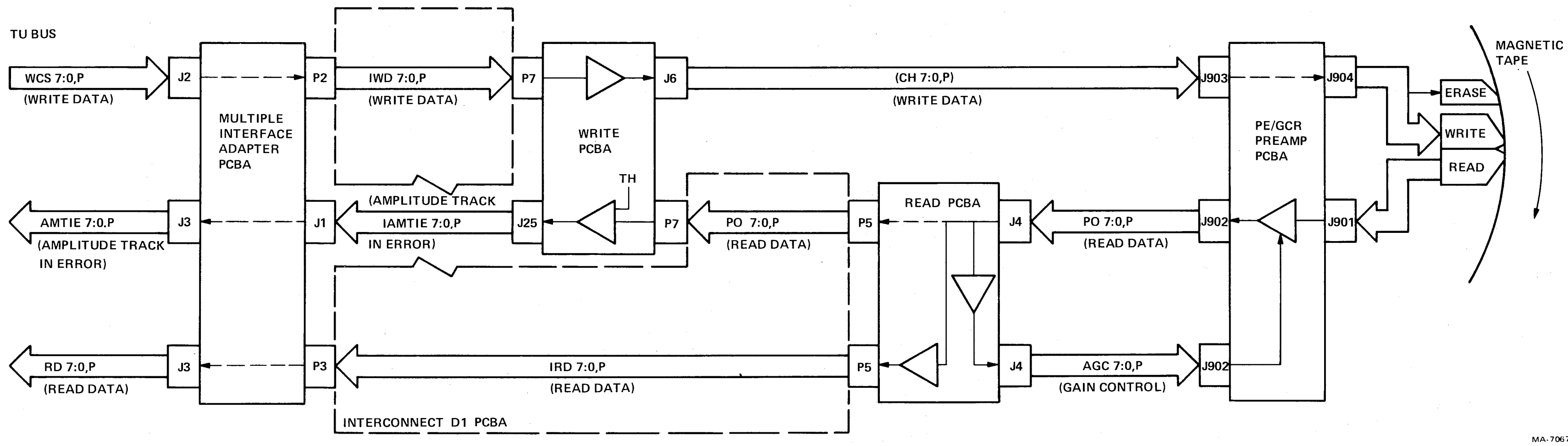


Figure 5-29 TU78 Data Paths

5.11.2 Write Function

The write function records formatted digital information on tape. The recording format and density are compatible with ANSI and IBM, 9-track PE or GCR. Figure 5-30 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 density signal (NPE) from the control M PCBA (J8-25) is input to the write control logic on the write PCBA at P7-61. The density command is received from the formatter via the MIA PCBA. Signal NPE is used to select either PE or GCR format (high = GCR, 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 lock out signal (W.P. SOL RET) to WLO solenoid, K2 via J11-33 and 73.

Signal 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 write control logic jacks J7-26 and J7-25, respectively.

The interface input data lines (IWDP, IWD0-IWD7) are routed to the write data buffers via J2 of the MIA PCBA. The MIA PCBA also provides the write data strobe (IWDS) to the write strobe logic via J7-47.

5.11.3 Read Function

The read function recovers digital information from magnetic tape in either the forward or reverse direction. The format is compatible with ANSI and IBM, 9-track GCR or PE. Figure 5-31 is a simplified block diagram of the read function.

The density signal (NPE) from the control M2 PCBA (J8-25) is applied to the read control logic on the read PCBA. The density command is received from the formatter via the MIA PCBA, Signal NPE is used to select either PE or GCR format (high = GCR, low = PE).

When the system control function detects a read command and an interface motion command, the control M2 PCBA provides a high motion signal (MOTION) via J8-28 and a high write signal (NWRT) via J8-26 to the read PCBA. NWRT is used to select either a read or write operation (high = read, low = write).

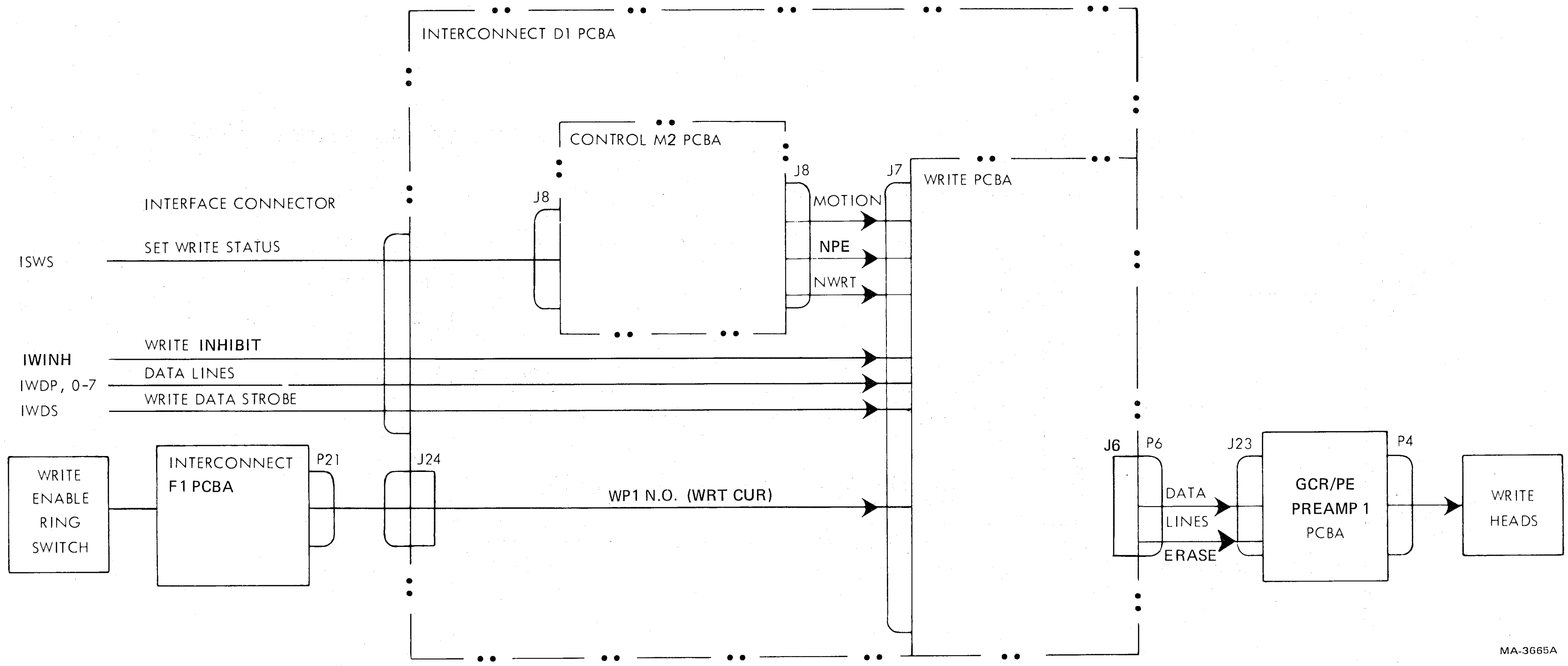


Figure 5-30 Write Function Block Diagram

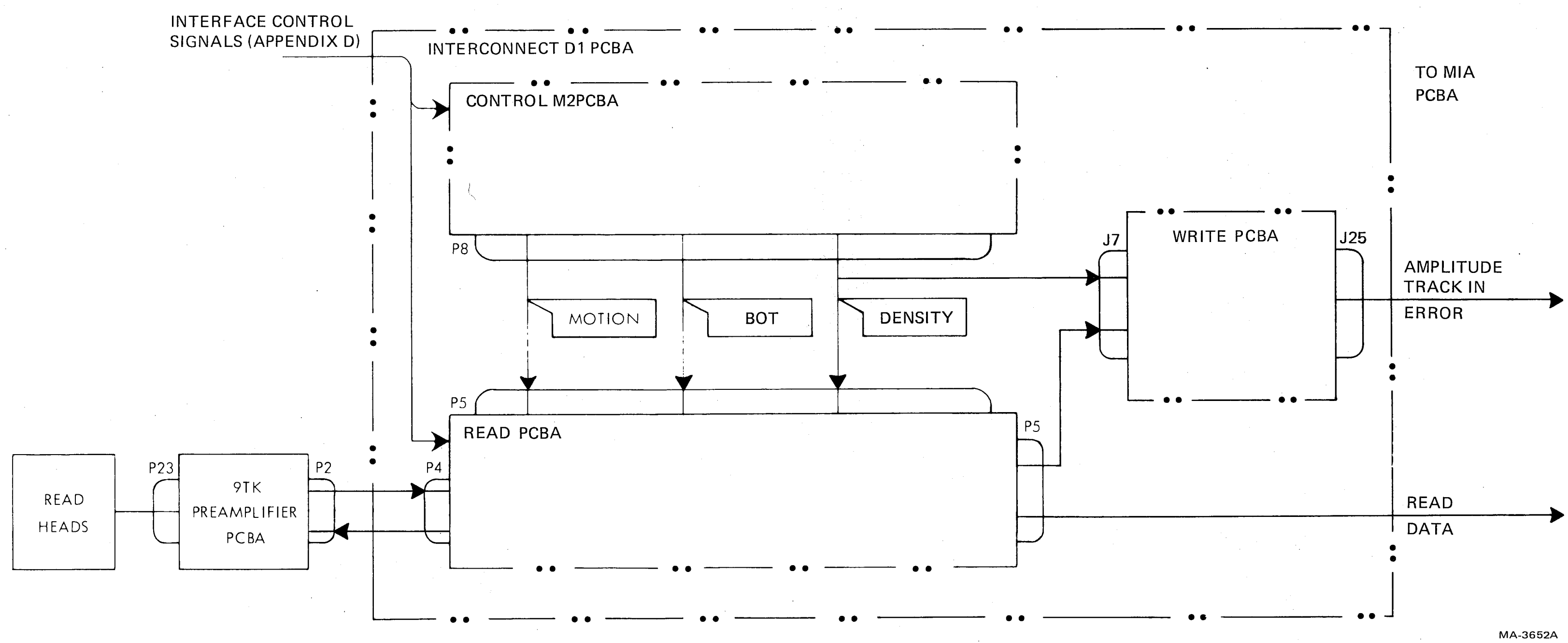


Figure 5-31 Read Function Block Diagram

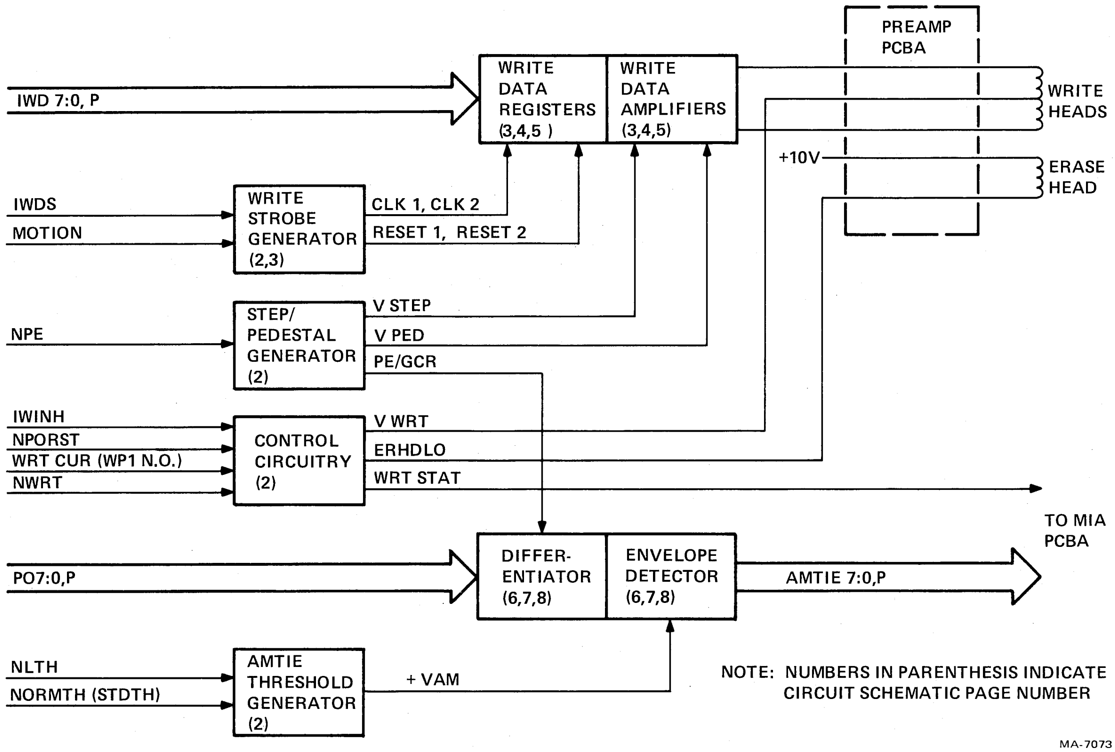


Figure 5-32 Write PCBA Block Diagram

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

Data retrieved by the read heads is preamplified on the preamp PCBA and routed directly to J4 on the read PCBA. There it is processed and presented to the interface in binary form as required by the formatter. The read data is also sent to the write PCBA as pointers (P07:O0, POP) for development of the AMTIE signals. Here the read data is examined for signal amplitude against a reference threshold.

5.11.4 Write PCBA

The write PCBA processes data received from the MIA PCBA, controls the write/erase heads, and checks the read data to provide the amplitude track-in-error (AMTIE) status signals.

The write PCBA plugs into J7 on the Interconnect D1 PCBA. Figure 5-32 is a block diagram of circuits on the write PCBA. Circuit details are provided in Schematic Number 107860. Write PCBA interface signals are listed in Tables 5-8 and 5-9.

Sheet 1 of Schematic Number 107860 shows hardware commonality and general notations. Sheet 2 shows the general mode control and power circuits, including the development of the pedestal-and-step waveforms used for greater recording efficiency. Sheet 3 shows the write data inputs, registers, and data strobe clock development (upper areas) with the parity bit channel and erase head circuits (lower areas).

Sheets 4 and 5 shows circuits for amplifying and preparing data for recording in channels 0 through 7. Sheets 6, 7, and 8 show amplitude track-in-error (AMTIE) signal development.

The following paragraphs provide more details on the circuit theory for each of these circuit groups.

Table 5-8 Write PCBA Inputs

Mnemonic	Connection	From	Purpose
WP1 N.O./ WRT CUR	J7-60,24	P21-29,32	Write power
NPE	J7-61	J8-25	Density select
NWRT	J7-25	J8-26	Write command
MOTION	J7-26	J8-28	Specifies that tape is rolling
IWINH	J25-4, J7-49	MIA J1-4	Write inhibit
NPORST	J7-11	J11-33,77	Power-on reset
NARA	J7-32	J5-17	ARA burst error
NTEST	J7-56	J1-22	Test mode (not used)
NTSTR	J7-20	J3-19	Test data strobe (not used)
IWDS	J7-47	J2-34	Write data strobe
IWD0	J7-44	J2-24	Write data
IWD1	J7-23	J2-23	↓
IWD2	J7-42	J2-22	↓
IWD3	J7-41	J2-21	↓
IWD4	J7-40	J2-20	↓
IWD5	J7-39	J2-19	↓
IWD6	J7-38	J2-18	↓
IWD7	J7-37	J2-1	↓
IWDP	J7-45	J2-25	↓
PO0	J7-65	J5-50	Read data bits used as pointers – used for developing AMTIE signals
PO1	J7-66	J5-51	↓
PO2	J7-67	J5-52	↓
PO3	J7-68	J5-53	↓
PO4	J7-69	J5-54	↓
PO5	J7-70	J5-55	↓
PO6	J7-71	J5-56	↓
PO7	J7-72	J5-57	↓
POP	J7-64	J5-49	↓
+5 V (T)	J7-21,57	INT. D1 W1-2,W2-2	Termination voltage (not used)
+5 V (L)	J7-18,19, 54,55	J11-22,23 62,63	Logic power
+15 V	J7-22,58	J11-21,61	Power for erase head amplifier
-15 V	J7-23,59	J11-14,54	Power for erase head amplifier
NLTH	J25-5	MIA J1-5	Establishes AMTIE threshold
STDTH	J25-15	MIA J1-15	Establishes AMTIE threshold

Table 5-9 Write PCBA Outputs

Mnemonic	Connection	To	Purpose
NARA (I ARA ERR)	J25-11	MIA J1-11	ARA burst error
MOTION	J25-16	MIA J1-16	Specifies tape is rolling
WRT STAT	J25-14	MIA J1-14	Transport in write mode
WRT BIN	J25-9	MIA J1-9	Status of write data bit 4
(CH0)*	J6-8,20	J23-8,17	Write head current
(CH1)*	J6-7,19	J23-7,16	↓
(CH2)*	J6-6,18	J23-6,15	↓
(CH3)*	J6-4,16	J23-4,13	↓
(CH4)*	J6-10,22	J23-10,19	↓
(CH5)*	J6-2,14	J23-2,11	↓
(CH6)*	J6-9,21	J23-9,18	↓
(CH7)*	J6-3,15	J23-3,12	↓
(CHP)*	J6-5,17	J23-5,14	↓
VWRT	J6-1,23	J23-1,20	Write head center tap
ERHD LO	J6-24	E2	Erase head current
WRT REG	J6-11	E1	Erase head current
AMTIE 0	J25-18	MIA J1-18	Amplitude track-in-error status
AMTIE 1	J25-19	MIA J1-19	↓
AMTIE 2	J25-20	MIA J1-20	↓
AMTIE 3	J25-12	MIA J1-12	↓
AMTIE 4	J25-3	MIA J1-3	↓
AMTIE 5	J25-2	MIA J1-2	↓
AMTIE 6	J25-13	MIA J1-13	↓
AMTIE 7	J25-1	MIA J1-1	↓
AMTIE P	J25-17	MIA J1-17	↓

*Mnemonic not shown on prints

5.11.4.1 Write Control and Power Circuits

- **Control Circuits**

  Control circuits are shown in the upper left area of Sheet 2, Schematic Number 107860. Inputs involved are IWINH, NWRT, NPORST, and WRT CUR (zones 2-8F,G,H). Signal WRT CUR originates on the base assembly as WP1 N.O.

  The control circuits are reset when the power-on reset signal (NPORST) is momentarily low = true. This opens Q1 (zone 2-7G) and Q3 (zone 2-8H). When Q1 is not conducting, Q2 and Q5 are also open. When Q3 is not conducting, Q4 and Q6 are similarly open. This terminates any previous mode until NPORST goes high = false.

  When the write command arrives (NWRT low = true), U112-12 (zone 2-8G) is high, U122-6 (zone 2-7G) is low and, through Q1, the base of Q2 is pulled down. This causes Q2 to conduct and apply a high to the base of Q5. Q5 then conducts, enabling write current (WRTCUR) circuits.

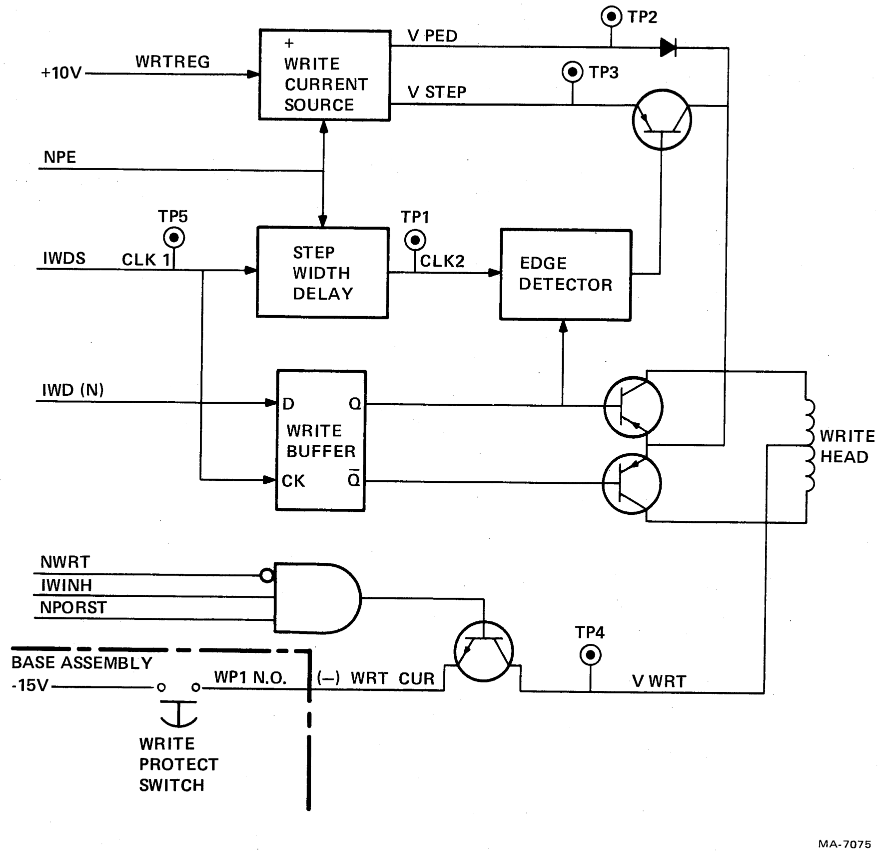


Figure 5-33 Write Amplifier Circuitry

- **PE/GCR Modes**
  Phase encoded (PE) mode is commanded when the NPE input to the write PCBA is low = true and group coded recording mode is commanded when NPE is high = false. This input is shown on Schematic Number 107860, zone 2-8E.

  When NPE is true, U112-10 (zone 2-8E) is high, producing the PE1 mode control signal, distributed as shown in zone 2-7E.

  When NPE is high = false, GCR mode is effective. GCR1 (zone 2-5E) and GCR3 (zone 2-5F) are distributed as shown to set up the circuits for GCR-formatted data.

- **Write Power**
  The +15 V dc input to the write PCBA for J7-58, 22 on the interconnect D1 PCBA (zone 2-8C, D), is reduced by diodes CR11 through CR14 (via jumper W4) and regulated by VR3 (zone 2-5C, 6C). The write power regulated (WRT REG) is applied to the voltage step (VSTEP) and voltage pedestal (VPED) circuits at zones 2-2H and 2-2E respectively.

5.11.4.2 Write Circuitry – The write circuitry comprising the current source, step delay, edge detector, write buffer, and amplifier is shown in simplified form in Figure 5-33. Refer to Figure 5-33 and Schematic Number 107860 while reading the following discussion.

- **Write Current Source (VPED/VSTEP) Circuits**
The terms voltage pedestal and voltage step refer to the shape of the write current waveform of a data bit. Theoretically, a series of 1s and 0s would involve a simple squarewave signal composed of square pedestal-like waves in alternating upright and inverted position. In practice, greater efficiency is achieved by overshooting the pedestal level at the beginning of each wave. This produces a waveform composed of squarewaves, with an added step more positive than the pedestal amplitude of positive waves and more negative than the pedestal amplitude of negative waves.

  In GCR mode, pedestal amplitude is adjusted by trimming R39 (zone 2-1D) and step amplitude is adjusted by trimming R22 (zone 2-1G).

  In PE mode, R36 (zone 2-1E) is used to trim pedestal amplitude and R19 (zone 2-1H) is used to trim step amplitude.

  Which PE and GCR adjustment described in the two preceding paragraphs is used, is determined by operational mode selection. In PE mode, the base of Q10 (zone 2-4E) is high, which turns Q10 off. This applies the low = true NPE2 signal to the various circuits listed in zone 2-3F, and also to CR8 (zone 2-3G) and CR10 (zone 2-3D). CR8 and CR10 then conduct, pulling down the gates of the FET Q14 (zone 2-3G) and Q15 (zone 2-3D), respectively. Q14 and Q15 then open the circuits adjusted by R22 (zone 2-1G) and R39 (zone 2-1D).

  In GCR mode, a low is applied to the base of Q10 (zone 2-4E). Q9 is then turned off, which selects the GCR adjustment circuits (R39 and R22). The circuits involved operate on the same theory discussed in the previous paragraph for PE mode VSTEP and VPED adjustments.

- **Write Data Buffers and Strobes**
Input data IWD7:0, P are input to the write PCBA through J7 of the interconnect D1 PCBA (zone 3-5D-5H). Data multiplexers U11, 31, and 41 always select the A inputs because the test mode is not employed. The write data strobe (IWDS, zone 3-7H) is made available through U41-11 and U41-9 as clock 1 (CLK1) to U99-2 (zone 3-3G) and U99-10 (zone 3-3E), where the signal is low when true. At the trailing edge, when the CLK1 signal goes high, it triggers either the GCR or PE one-shot, depending on the state of the GCR1 and PE1 mode inputs, to form the step width delay. If PE1 at U99-1 (zone 3-3G) is low = false, the GCR one-shot output at U99-4 is high for a period determined by the values of C11 and R48. Conversely, if GCR1 at U99-9 is low = false, the PE one-shot output at U99-12 is high for a period determined by the values of C12 and R50. These one-shot outputs are applied to NAND gate inputs U102-5 and 4 (zone 3-2G), respectively. The NAND acts as an OR function to produce a high if either of the inputs is low. This high is inverted at U92-10 to produce data strobe clock 2 (CLK2) at zone 3-1G.

  CLK1 (zone 3-3G), which is high = true (equivalent to the IWDS strobe) from U41-9 (zone 3-5G), is applied to the pedestal (VPED) flip-flop of all data channel and the parity channel amplifiers (e.g., U52-3, zone 3-7C). CLK2 (zone 3-1G) is applied similarly to the step (VSTEP) flip-flop (e.g., U52-11, zone 3-7C).

- **Write Current Driver Circuits**
All write current drivers and head control networks, including the parity bit channel network, operate on the same theory. In this discussion the parity bit circuits are referenced as an example. These circuits are in the lower part of Sheet 3, Schematic Number 107860.

Write voltage (VWRT) is applied to the center tap of the head winding (zone 3-2C and 3-3B). This is approximately -15 V dc. The direction of the magnetic flux then depends on whether the circuit through the coil is toward head connector pin 5 or pin 14. This is determined by the state of Q19 (zone 3-4B) and Q18 (zone 3-4C). If the data bit at U52-2 (zone 3-7C) is low at CLK1 time, U52-5 is low and Q18 conducts. If the data bit is high, U52-6 is low, and Q19 conducts.

Flip-flop U52-9 and EXCLUSIVE OR gate U53-6 together form the edge detector which determines the VSTEP pulse width. The VSTEP level is applied during part of the pulse time by the EXCLUSIVE OR gate output at U53-6 (zone 3-6B). This output is buffered and applied to the base of Q17 (zone 3-5G), which gates in the VSTEP level. The U53-6 output is low at all times unless one and only one of its two inputs (U53-4 or U53-5) is high. The output at U52-5 (zone 3-7C) is applied to U53-4 and also to adjacent U52-12. If U52-5 is high, U53-6 also is high until CLK2, when U52-9 and U53-5 go high, producing a low at EXCLUSIVE OR gate output U53-6. If U52-5 is low, at the next CLK2 time U52-9 and U53-6 is high until the succeeding CLK2 time. For each bit, 1 or 0, there is consequently a discrete time when EXCLUSIVE OR gate output U53-6 applies a high to the base of Q17 (zone 3-5D) to gate in the VSTEP voltage level.

Each of the other input data bits, IWD0–7, are processed in the same manner as the parity bit, IWDP, discussed in the previous paragraph, provided also that the write inhibit (IWINH) signal is not low = true.

When IWINH is true, a low applied at J7-49 (zone 2-8H) causes U51-8 to go high, U122-10 to go low, and U122-8 to go high. If Q3 is conducting, this applies a high to the base of Q4, turning off Q4 and consequently, Q6. This enables the write status (WRT STAT) signal to go high if Q5 is off, and prevents writing regardless of the previously mentioned write command and power inputs by removing the negative voltage to the center tap of the heads (VWRT).

The MOTION input to the write PCBA (zone 2-8E) is also required to establish the write mode. When MOTION is low = false, RESET1 and RESET2 (zones 2-1C,B) are also low = false. They are applied to the write buffers, such as U52-4 (zone 3-7C) and the edge detectors, such as U52-10 (zone 3-7B) for the parity channel. When the motion input is high = true, it provides the motion status output to the MIA PCBA at J2 (J25)-16 (zone 2-4G).

- **Erase Head Circuits**
  The erase head circuits are shown on Schematic Number 107860, zones 3-2A,B through 3-4A, B. The regulated write voltage (WRTREG) is available at diode CR25 (zone 3-3A) and passes through the erase head winding when the erase head low (ERHDLO) line is low. ERHDLO is developed in the write/write inhibit mode circuits (zone 2-4G) and is high during read only mode, to prevent erasing existing data unless new data is to be written.

5.11.4.3 Amplitude Track In Error (AMTIE) Circuits – Amplitude track in error (AMTIE) signals are generated on the write PCBA from read data. They are used to notify the error checking and correction circuits in the formatter of marginal data.

- **Threshold Selection**
  The threshold selection circuits are shown in zones 2-4B and 2-5B of Schematic Number 107860. These circuits regulate the + VAM to a level determined by the threshold selection (NLTH or NORMTH at J2-5 and J2-15, respectively). When NORMTH (normal threshold) is high = true, VR6 regulates the + VAM at approximately 6.0 V. When NLTH (low threshold) is low = true, VR5 regulates the + VAM at approximately 2.7 V. VR4 regulates VAM to assure approximately 7.5 V maximum. The regulated voltage is applied to the AMTIE circuits.

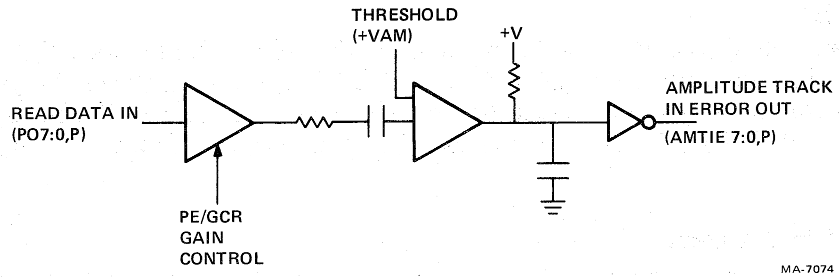


Figure 5-34 AMTIE Generator

- **AMTIE Generator Circuits**

Data received by the read PCBA for processing is also routed through the interconnect D1 PCBA to J7 into which the write PCBA is plugged. At the write PCBA inputs, the data from the channels are labeled as pointers (POP, PO0-7), as shown at the left side of Sheets 6, 7, and 8 of Schematic Number 107860. The following discussion uses the parity channel as an example, starting with POP (zone 6-8G). A simplified view of the AMTIE generator is also shown in Figure 5-34.

POP data bits are applied through C13 and R153 to differentiator input U132-1 (zone 6-7G). The differentiator operates in either GCR or PE mode, depending on the circuitry set up between U132-4 and U132-7. The circuit selection is made by mode selection signals NPE2 and NGC (zones 6-2F). When PE mode signal NPE2 is low = true, GCR mode signal NGC is high = false. These inputs cause Q44 (zone 6-6G) to stop conducting and turn Q45 (zone 6-6F) on. This electrically connects the PE gain determining components between differentiator pins U132-4 and U132-11. Similarly, when in GCR mode, signal NPE2 is high = false and NGC is low = true, allowing Q44 to conduct, therefore bringing in the GCR gain determining components.

Differentiator outputs U132-8 and U132-7 correspond to the voltage differential in time (DT/DV) of the input at pins 1 and 14. Positive (pin 8) and negative (pin 7) transitions are input to the threshold detector (U134) where they are compared with the threshold voltage (+ VAM). The output of the threshold detector is applied to the input of two open collector gates (U138-1 and U138-13). Each open collector gate forms the input to the envelope detector stage. Separate envelope detectors are provided for PE and GCR modes.

The peaks of each bit transition cause the threshold detector to produce an output, causing the open collector gate to conduct. Using the phase encoded threshold detector as an example, current would be conducted through gate U138-2 and resistor R171. During the time when a transition peak is not being detected, U138-2 is not conducting and capacitor C23 charges up through R171. In normal operation read data transitions occur at a frequency that does not allow capacitor C23 to charge up to a value equal to or greater than the input threshold of NAND gate U148-1. In other words, the NAND gate always is inhibited. However, should a signal dropout or incorrect data format appear on tape for a sufficient amount of time, C23 is not discharged and charges up to a value sufficient to enable the NAND gate. NAND gate output U148-3 disables NAND gate U148-5, whose output pin 6 enables the AMTIE driver U149-1. AMTIE driver U149-3 sends the low = true IAMTIEP to the MIA PCBA via J2 (J25) -17.

IAMTIE 7:0 signals are similarly generated in the appropriate circuits shown on Sheets 6, 7, and 8 of Schematic Number 107860.

5.11.5 Read PCBA

The read PCBA accepts signals from the read heads via the GCR/PE preamp 1 PCBA and decodes the signals to provide the formatter with read data in usable form. It also provides the preamp with a feedback gain control voltage. Finally, it routes the read signals to the write PCBA for use in generation of AMTIE signals. Table 5-10 lists inputs and Table 5-11 lists outputs for the read PCBA.

Table 5-10 Read PCBA Inputs

Mnemonic	Connection	From	Purpose
NPE	J5-10	J8-25	PE/GCR density select
NWRT	J5-47	J8-26	Write/read mode
BOT	J5-12	J8-48	Beginning of tape
PO0	J4-6,22	GCR/PE	Analog read data
PO1	J4-7,24	Preamp 1	↓
PO2	J4-9,25	PCBA, J902	↓
PO3	J4-42,28		↓
PO4	J4-3,19		↓
PO5	J4-31,32		↓
PO6	J4-4,21		↓
PO7	J4-13,30		↓
POP	J4-10,27		↓
+15	J5-5,41	J11-21,61	Regulated precision voltage
-15	J5-6,42	J11-14,54	Regulated precision voltage

The read PCBA plugs into J5 on the interconnect D1 PCBA. Read PCBA circuits are shown in Schematic Number 107855, which is referenced in the following paragraphs. Also, a simplified functional block diagram of the read PCBA is shown in Figure 5-35.

Sheet 1 of the schematic provides general hardware and commonality information. Sheet 2 covers mode control and power circuits. Sheets 3, 4, 5, and 6 show automatic gain control and AGC timing circuits for each of the nine channels. Sheets 7, 8, and 9 show the main decoding, amplifying, and processing circuits for each of the nine data channels.

The following text gives further details on the circuit theory for each of these circuit groups.

5.11.5.1 Read PCBA Control and Power Circuits – The following discussions of various read PCBA control and power circuits refer to zones of Schematic Number 107855.

- **Phase Encoded (PE) and Group Coded Recording (GCR) Mode Control**
  PE and GCR modes are applied to the read PCBA circuits as shown on Sheet 2 of Schematic Number 107855. The input command is NPE (zone 2-8G) from the control M2 PCBA. NPE is basically the PE mode command. When low = true, PE mode is selected. When high = false, GCR mode is selected.

  In PE mode, the inverted output at U15-2 (zone 2-7G) is high. This is applied to the base of Q5 (zone 2-2D). This turns off Q5 and produces the low = true NPE1. NPE1 is distributed to various parts of the read PCBA, listed in zone 2-1C, to set up the circuitry for PE mode.

Table 5-11 Read PCBA Outputs

Mnemonic	Connection	To	Purpose
+15	J4-16,33	GCR/PE preamp 1	Regulated voltage
-15	J4-15	PCBA, J902	
NARA (IARA ERR)	J5-17	J1-11	ARA burst error
Late AGC	J5-37	–	not used
AGC0	J4-5	GCR/PE preamp 1	Automatic gain voltage
AGC1	J4-23	PCBA, J902	
AGC2	J4-8		
AGC3	J4-11		
AGC4	J4-2		
AGC5	J4-14		
AGC6	J4-20		
AGC7	J4-29		
AGCP	J4-26		
PO0	J5-50	J7-65	Read data for AMTIES
PO1	J5-51	J7-66	
PO2	J5-52	J7-67	
PO3	J5-53	J7-68	
PO4	J5-54	J7-69	
PO5	J5-55	J7-70	
PO6	J5-56	J7-71	
PO7	J5-57	J7-72	
POP	J5-49	J7-64	
IRD0	J5-70	J3-32	Read data output
IRD1	J5-69	J3-31	
IRD2	J5-68	J3-27	
IRD3	J5-67	J3-26	
IRD4	J5-62	J3-21	
IRD5	J5-61	J3-20	
IRD6	J5-59	J3-18	
IRD7	J5-58	J3-1	
IRDP	J5-72	J3-34	

When NPE (zone 2-8G) is high = false, GCR mode is effective. The output of U15-12 is the high = true GCR4. This is applied to the base of Q6 (zone 2-2B), which closes to produce low = true NGCR, and also to the AGC timing circuits (zone 3-8D).

- **Read PCBA Power Circuits**
  Read PCBA power circuits are shown in the lower left corner of Sheet 2. The ±15 V inputs are reduced by diodes CR4 through CR13, and regulated by diodes VR1 through VR5 to produce voltages needed by the read analog circuitry. VR1 and VR3 (zone 2-7C) provide ±5.6 Vdc (±6 V) for the read differential amplifiers. VR2 provides +5.1 Vdc (+VR) for the AGC gain detect counter stages. VR4 provides -5.1 Vdc (-5 V) for the read zero crossing networks. VR5 provides +10 Vdc (+VGR) for the AGC digital to analog (D/A) converters.

5.11.5.2 Read Amplifier Circuits – The read track output amplifier circuits for the nine channels are shown on Sheets 7-9 of Schematic Number 107855. The following discussion of theory refers to the parity channel network, which is typical of the nine channels.

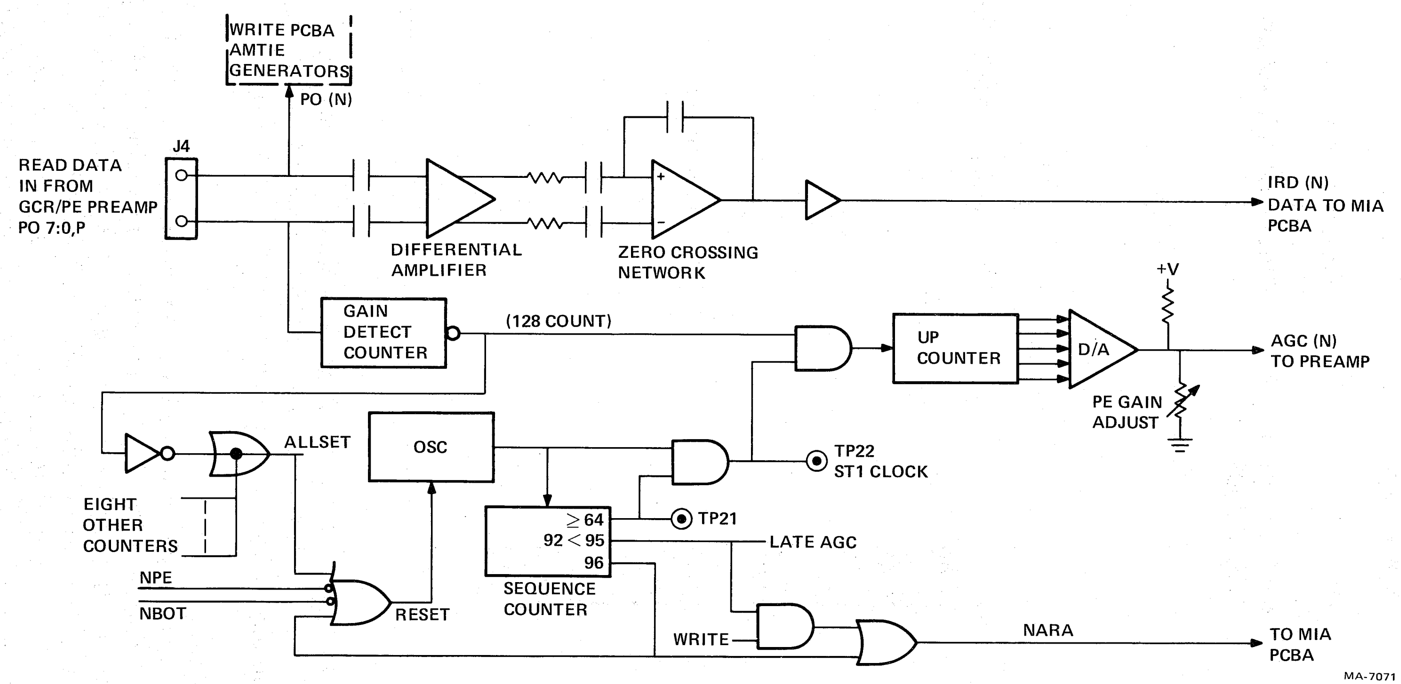


Figure 5-35 Read PCBA Functional Block Diagram

Connector pins J4-10 and J4-27 (zone 7-8G) are connected to the GCR/PE preamp 1 PCBA, which preamplifies the current flowing in the read head winding. The inputs at J4-10 and J4-27 are applied through C130 and C131 to differential amplifier inputs U101-14 and U101-1, respectively.

GCR or PE differentiation characteristics are determined by the circuits between preamplifier pins U101-4 and U101-11. These pins are connected through either Q131 (zone 7-5F) or Q130 (zone 7-6F), depending upon mode selection signals NGCR or NPE1 (zone 7-5F). If NGCR is low = true, Q131 is turned off and PE resistor R136 and capacitor C139 are effectively removed from the circuit between U101-4 and U101-11. If NPE is low = true, Q130 is turned off and GCR resistor R137 and capacitor C138 are ineffective.

The two amplifier outputs U101-8 and U101-7 (zone 7-6G), which are associated respectively with inputs U101-14 and U101-1, are input to U102 pins 1 and 2, the zero-crossing network comparator. The output of the comparator is current amplified and presented to read PCBA connector P5-72 as IRDP.

The same theory applies to the circuits for other data channels, shown on Sheets 7, 8, and 9 of Schematic Number 107855.

The resulting low = true IRD 7:0, P bits are sent to the MIA PCBA via the interconnect D1 PCBA. A low = true bit indicates a flux change away from the direction of the interrecord gap (IRG) magnetization. Similarly, a high = false bit indicates a flux change toward the direction of the interrecord gap magnetization. Whether a low = true or high = false bit should be interpreted as a 1 or a 0, is determined by the TM78 formatter.

5.11.5.3 Automatic Gain Control (AGC) Circuits – The read PCBA AGC function is initiated and controlled by circuits shown on Sheets 3 through 6 of Schematic Number 107855. Refer to Figure 5-35 for a simplified functional block diagram of the AGC circuitry. Figure 5-36 shows the timing sequence for AGC setup relative to information recorded at or near the BOT marker on a GCR tape. If unfamiliar with GCR recording formats, refer to Paragraph 4.1.2 of the TM78 Magnetic Tape Formatter Technical Manual (EK-OTM78-TM).

AGC, as an automatic gain setting function, is performed only in GCR mode. When in PE mode, the AGC voltages sent to the preamp PCBA are fixed by a pre-set potentiometer, one for each track.

Initiation of the sequencing logic is accomplished by gates at zone 3-7D. Beginning of tape status (NBOT is low = true) generates the preset (PRST) signal which holds all track D/A counters reset. Using the parity track as an example, PRST is applied to U106-2, 12 (zone 4-G, H 4) which outputs all low signals to the D/A converter. As the magnetic tape ramps up to speed, NBOT eventually goes high = false and the preset is removed. Gate U27-13 (zone 3-6D) also removes the reset from the sequencing oscillator, allowing it to produce clocks with an 800 μs period. These sequencing clocks are input to the sequencing counter U30 (zone 3-5D, E).

The sequencing counter and its associated decoding logic (zones 3-3C through 3-5D) express the number of counts in decimal terms. Three principal counts are produced by this network which represent discrete amounts of tape travel. These counts are as follows.

Count	Gate	Zone	Amount of Tape Travel
64	U30-9	3-5D	16.3 cm (6.4 in)
92	U32-8	3-3D	23.4 cm (9.2 in)
96	U32-3	3-5C	24.4 cm (9.6 in)

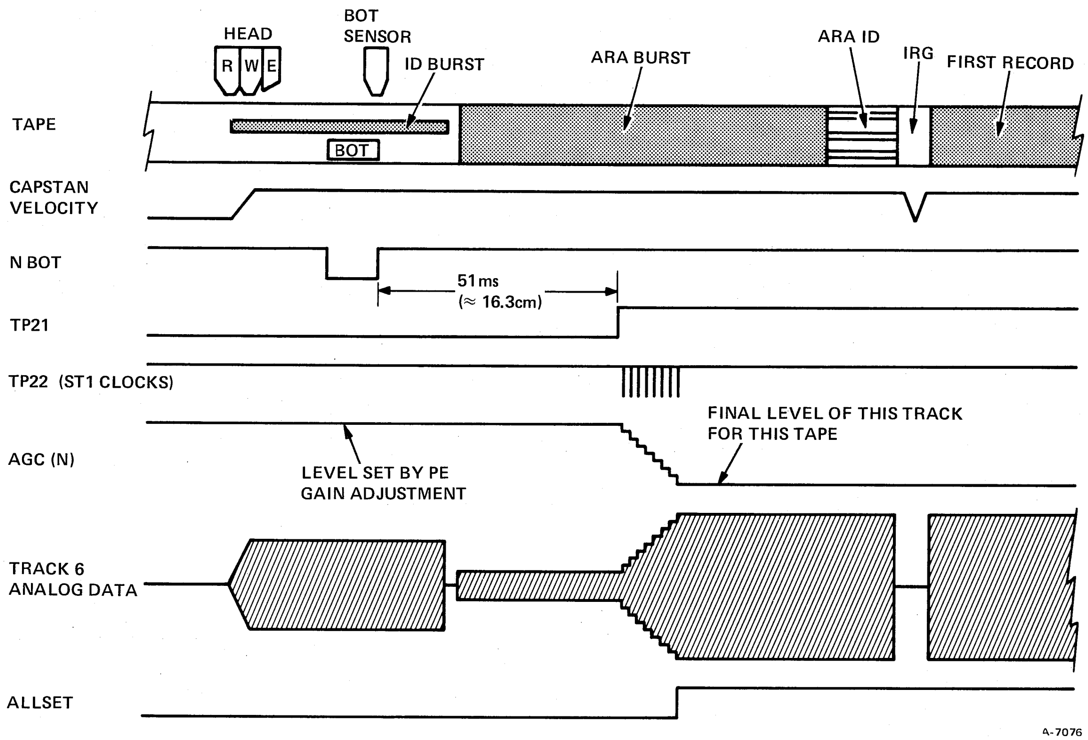


Figure 5-36 AGC Timing

The 64th count (TP21) enables NAND gate U29-2 (zone 3-5F) which outputs ST1 CLOCKs to the track D/A counters. The 64th count also allows the CLEAR signal at U31-2 (zone 3-4D) to go low = false. With CLEAR false, the gain detect counters, U105 (zone 4-6G, H) are allowed to count up. Read data (POP) enters the counter's threshold detector at U33-5 (zone 4-7G). If the amplitude of the read data ARA burst for this track is equal to, or greater than, 800 millivolts, the threshold detector outputs a pulse for each bit transition. The gain detect counter is configured to count 128 ARA transitions, then output a low logic signal from NAND gate U104-3 (zone 4-5F). If 128 transitions are not detected immediately following the first ST1 CLOCK pulse, the second pulse arrives 800 μs later and counts up the D/A counter stage U106-1 (zone 4-4H). This counter incrementally adjusts the AGC P output voltage via the D/A converter U107 and R107 through R111 (zone 4-3G, H) until the gain detect counter is able to count 128 transitions. The AGC P signal is driven toward ground in a maximum of 32 steps by the D/A converter, allowing the preamplifier stage (on the PE/GCR preamp 1 PCBA) to increase its gain.

When the gain detect counter reaches a count of 128, open collector gate U107-12 (zone 4-3F) turns off, releasing the low = false ALLSET signal. Also, NAND gate U104-3 (zone 4-5F) inhibits NAND gate U104-12 (zone 4-5H) and freezes the D/A counter.

When the gain detect counters for all nine tracks reach the 128 count, ALLSET is pulled up to high = true by R42 (zone 3-4B). This causes the sequencing oscillator to reset and stop the AGC sequencing cycle. Now the AGC voltages for each of the nine tracks are set and do not change for the tape duration.

If the sequencing counter reaches a count of 92 (D/A count of 28) before ALLSET is raised, the LATE AGC status signal goes high = true at U31-8 (zone 3-4C). Signal LATE AGC is sent out of connector P5-37, but is not used. If the transport was writing, LATE AGC enables NAND gate U26-3, 5 (zone 3-4C) and through U28-6 (zone 3-3C) and U23-3 (zone 3-26C) generates the status signal NARA at connector P5-17. Signal NARA is sent to the MIA PCBA via the write PCBA and interconnect D1 PCBA, where it becomes IARA ERR. In write mode, it signifies that the ARA burst failed to record properly within the allotted time. The formatter initiates a retry sequence and rewrites the burst.

If the sequence counter reaches a count of 96 (D/A count of 32) before ALLSET is raised, while the transport is reading, the other input of NOR gate U28-6 (zone 3-2C) is enabled and NARA is generated. This indicates to the formatter that at least one track counter has achieved maximum gain without recognizing 128 ARA burst transitions. Presumably the track(s) generates AMTIE pointers which aid in error correction when reading the upcoming data records on tape.

5.11.6 GCR/PE Preamp 1 PCBA

The GCR/PE preamp 1 PCBA, located at the rear of the transport base assembly, provides first stage amplification for read data, and acts as interconnection between the write and read PCBA and the heads. The GCR/PE preamp 1 PCBA circuits are shown on Schematic Number 107850.

The GCR/PE preamp 1 PCBA regulates the ±15 Vdc inputs from the capstan/regulator PCBA to obtain +5 and -6 Vdc for its differential amplifiers. The ±15 voltages are sent, via the interconnect D1 PCBA and the read PCBA, along the read cable, and enter the preamp PCBA at J902-16, 33 (+15) and J902-15 (-15) zone 2-7B, C.

Write data enters the preamp PCBA through header J903 (zone 2-7D through H) and is sent directly to the write head connector J23. Read data enters the preamp PCBA through read head connector J22 (zone 2-6A through H). The analog data signals are differentially amplified through two AGC controlled stages and output through connector J902 (zone 2-2A through H), where they are sent via cable to the read PCBA.

CHAPTER 6
MAINTENANCE AND TROUBLESHOOTING

6.1 SCOPE
This chapter provides procedures necessary to perform functional alignments, parts replacement, adjustments, and troubleshooting for the TU78 Magnetic Tape Transport assembly. Although TM 78 testing is included in some diagnostics, actual maintenance pertaining specifically to the TM78 is contained in the *TM78 Magnetic Tape Formatter Technical Manual (EK-0TM78-TM)*. The major TU78 assemblies referenced in this chapter are shown in Figures 1-3 and 1-4. Methods for gaining access to these assemblies are outlined in Chapter 3.

6.2 TU78 MAINTENANCE PHILOSOPHY
The TU78 Magnetic 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 TU78 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.

Corrective maintenance involves troubleshooting at the system level using system diagnostics, and at the subsystem level using TM78 microprogrammed maintenance routines and visual methods to localize the failure. System level diagnostics direct service personnel to the faulty functional area, not necessarily to the faulty module. Custom tailored read/write sequences may be created through the TM78 maintenance panel to further isolate the failure, or when the system is not available for maintenance. Unit level troubleshooting can be performed utilizing functional block diagrams, flow diagrams, timing diagrams, and engineering logic drawings, together with troubleshooting aids given in Paragraph 6.6. (Refer to the diagrams in Volume 1 of the Technical Manual 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.

6.4 PREVENTIVE MAINTENANCE
The recommended frequency for performing the PM tasks in this procedure are based on moderate equipment use. If use exceeds 2500 vacuum-on hours in six months, the PM frequency should be increased proportionally. Refer to Table 6-3 for preventive maintenance schedule.

6.4.1 Daily Preventive Maintenance
Preventive Maintenance for the TU78 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 should only be performed by trained, qualified service personnel. Table 6-3 outlines individual tasks and references the appropriate paragraph for individual procedures. Perform

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	DEC P/N	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_20)	29-11650	Dwyer #2040
Differential pressure gauge (0–5 PSI)	29-11636	Dwyer #2205
Portable accessory package for gauges (two 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 × 4 inch ballpoint hex driver	29-11630	Xcelite #99-25BP
#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	–

Table 6-3 Preventive Maintenance Schedule

Frequency	Procedure	Paragraph Number
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, and capstan.	4.3.4
	CAUTION **Observe warnings and notes in Paragraph 4.3.**	
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
	Remove tape cleaner and clean blades.	6.7.2
	Clean reel sense lenses and EOT/BOT cavities.	–
	Clean cartridge restraints.	–
	Clean and check supply reel locking hub friction ring. Check that reel does not slip on hub.	–
	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. 6-51
	Clean compressor intake muffler/filter element.	–
	Replace compressor in-line filter.	–

Table 6-3 Preventive Maintenance Schedule (Cont)

Frequency	Procedure	Paragraph Number
Semiannually or 2500 vacuum on hours	**NOTE** **If any of the following checks are out of tolerance, perform the associated adjustment.**	
	Check vacuums and pressures.	6.5.4
	Check supply reel load speed.	6.5.6.2
	Check take-up reel load speed.	6.5.6.3
	Check loop positions.	6.5.6.4
	Check cartridge limit switches.	6.7.8 (Steps 8, 9, 10)
	Check PE amplitudes.	6.5.7.3
	Check read skew (azimuth).	6.5.7.1

the tasks in the order listed in the table. It is not necessary to alter any adjustment on the TU78 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

This section provides adjustments and alignments relative to the TU78 transport. The adjustments and alignments are functionally grouped. Supporting illustrations are referenced where relative.

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

Acceptable limits are defined in each adjustment procedure, assuming the specified test equipment is accurate. When the measured value is within designated parameters, do not make an adjustment. Should the value fall outside specified limits, make adjustments according to the relevant procedure. Make the adjustment as close to the designated value as possible.

Some adjustments require using the TM78 maintenance panel. Procedures for operating the maintenance panel are provided in each alignment step that requires its use. For more information on the TM78 maintenance panel and its functions, refer to Paragraph 5.5 in the *TM78 Magnetic Tape Formatter Technical Manual (EK-0TM78-TM)*. A complete listing of interrupt/failure codes which may be shown in the maintenance panel's display, are included in Table 2-8 in the *TM78 Magnetic Tape Formatter User Guide (EK-0TM78-UG)* or the technical manual.

Table 6-4 Required Prerequisite/Corequisite Adjustments

Paragraph	Adjustment	Prerequisites Paragraph Number	Corequisites Paragraph Number
6.5.1	Power distribution	–	–
6.5.2	EOT/BOT adjustment	6.5.1	–
6.5.3	Pack sense adjustment	6.5.1	–
6.5.4	Vacuum and air pressure adjustments	–	–
6.5.4.1	System vacuum adjustment	–	6.5.4.2
6.5.4.2	Takeup reel vacuum adjustment	6.5.4.1	–
6.5.4.3	Air bearing pressure adjustment	–	–
6.5.4.4	Thread block and cartridge pressure adjustment	–	–
6.5.5	Capstan servo adjustments	6.5.1	6.5.7
6.5.6	Reel servo adjustments	6.5.1	–
6.5.6.1	Reel servo offset	–	–
6.5.6.2	Supply reel load speed adjustment	–	–
6.5.6.3	Takeup reel load speed adjustment	–	–
6.5.6.4	Tape loop position adjustment	6.5.4.1	
6.5.7	Read/write adjustments	4.3.4, 6.5.1 6.5.5	–

Some adjustments also require that the front door be open and the interlock switch be defeated. In order to defeat the interlock switch, first open the front door. Then with a spring hook, or other suitable hooked tool, push down on the switch actuator arm while pulling out. This allows the reel servos to operate normally. When the front door closes, the switch arm returns to its normal position.

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

6.5.1 Power Distribution

The +5 V logic supply voltage is adjustable. All other power supplies and regulators are not adjustable. The following procedure is given to direct service personnel to check, and adjust if necessary, the +5 V logic supply voltage, and to verify that all operating dc voltages are present.

WARNING
Dangerous voltages are present in the power supply.

1. Make sure 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 3-1 for proper jumper configuration.)

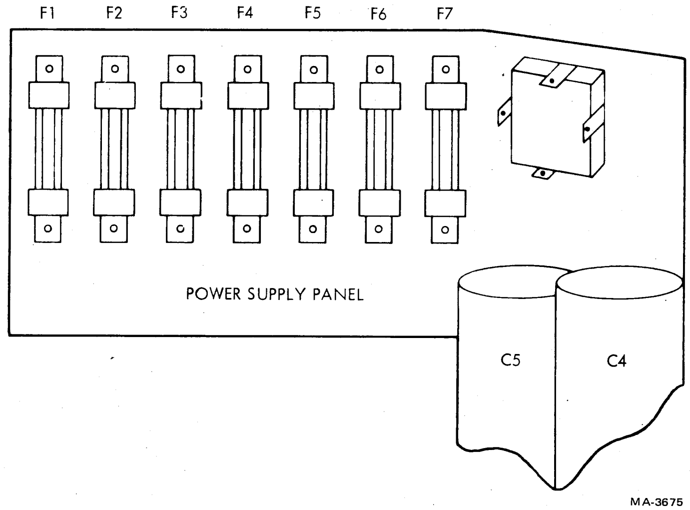


Figure 6-1 Power Supply Fuse Panel

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. Remove the four retaining screws from the left side of the TM78 logic gate and swing the gate out on its hinge (master TU78 only.)

4. Make sure the 874 power control circuit breaker (front) is on as well as the power supply circuit breaker (rear).

5. With a digital voltmeter (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 the readings are incorrect go to Section 6.6 for troubleshooting information.

Table 6-5 Power Supply Voltage Readings

Fuse	Circuit Function	Type	Measured Voltage (dc) Minimum	Nominal	Maximum
F1	+12 V	7 A FB	+09.5 V	+10.5 V	+11.5 V
F2	+24 V	5 A FB	+22.0 V	+24.0 V	+26.0 V
F3	−24 V	5 A FB	−22.0 V	−24.0 V	−26.0 V
F4	+36 V (C)	20 A FB	+35.0 V	+37.5 V	+40.0 V
F5	−36 V (C)	20 A FB	−35.0 V	−37.5 V	−40.0 V
F6	+36 V (T)	20 A FB	+38.0 V	+40.0 V	+42.0 V
F7	+36 V (S)	20 A FB	+38.0 V	+40.0 V	+42.0 V

6. 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 shows the locations of 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

7. If the voltage measured at TP11 is found to be outside specified limits, adjust potentiometer R179 on the capstan/regulator PCBA (Figure 6-2).

6.5.2 EOT/BOT Adjustment

The following procedure describes sensitivity adjustment of the EOT/BOT amplifier on the base assembly interconnect F1 PCBA.

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).

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.

5. Install the work tape reel on the supply hub. Thread the tape so 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 +0.1 Vdc (maximum) −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).

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.

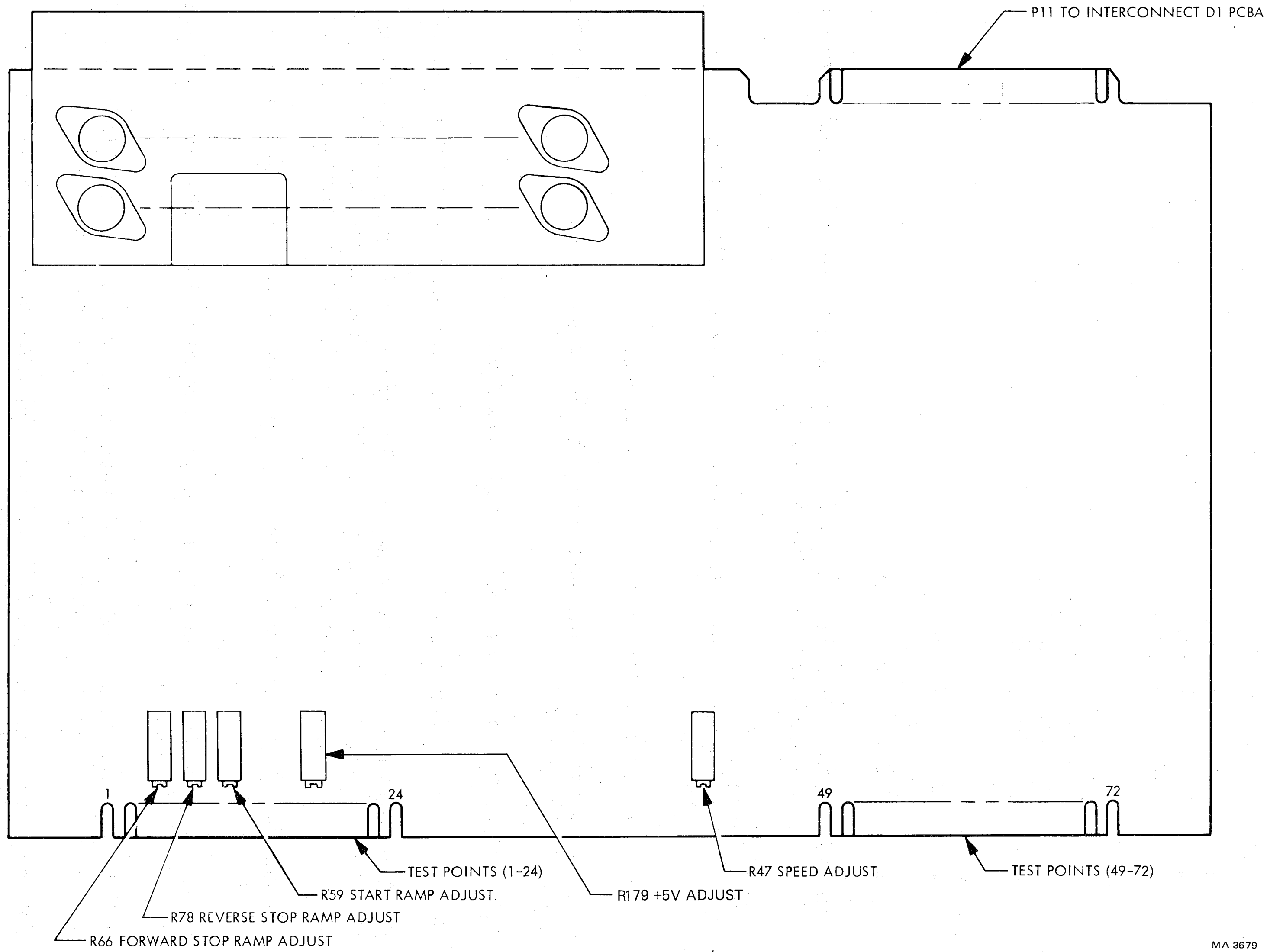
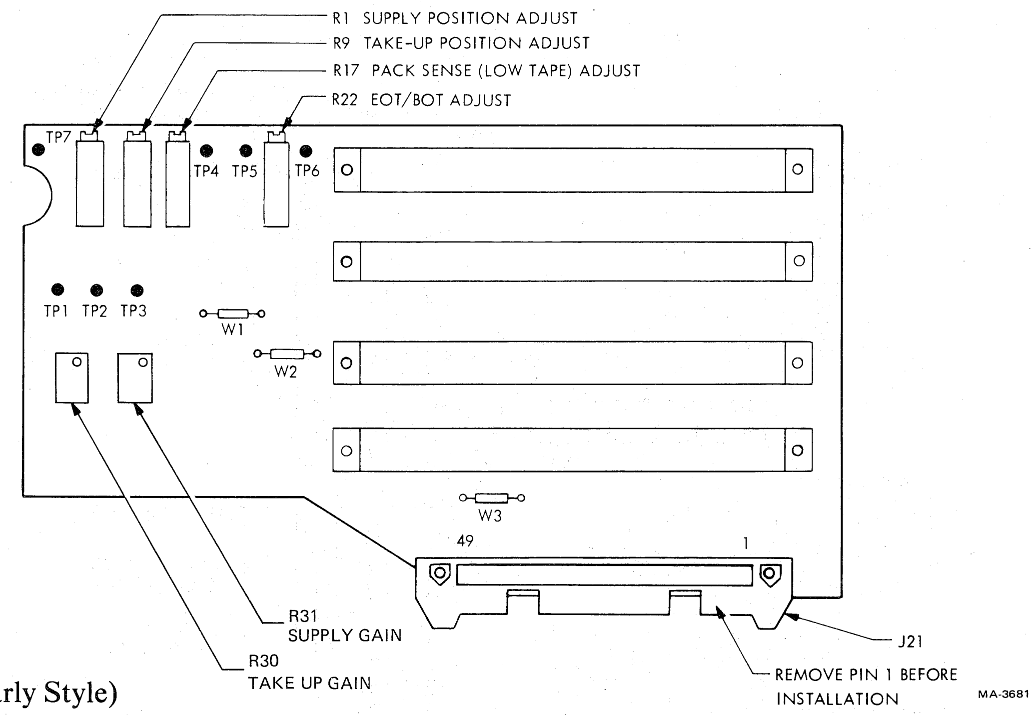


Figure 6-2 Capstan/Regulator PCBA Adjustments and Test Points



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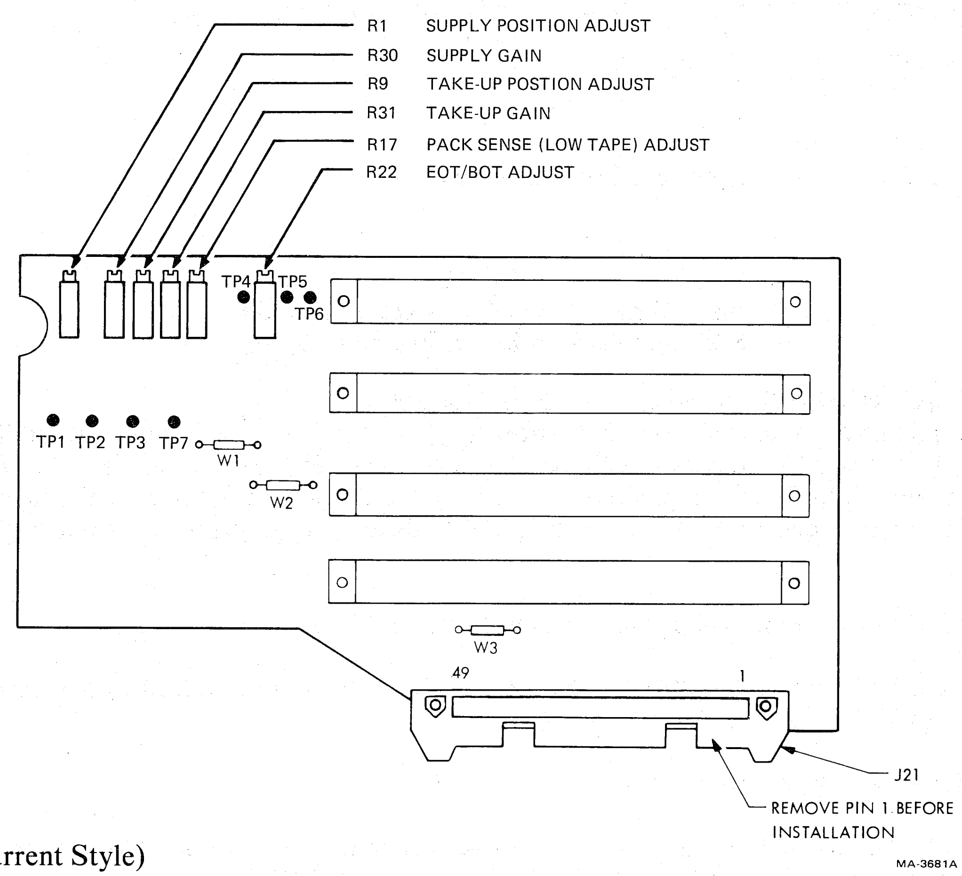


(Current Style)

Figure 6-3 Interconnect F1 PCBA Adjustments and Test Points

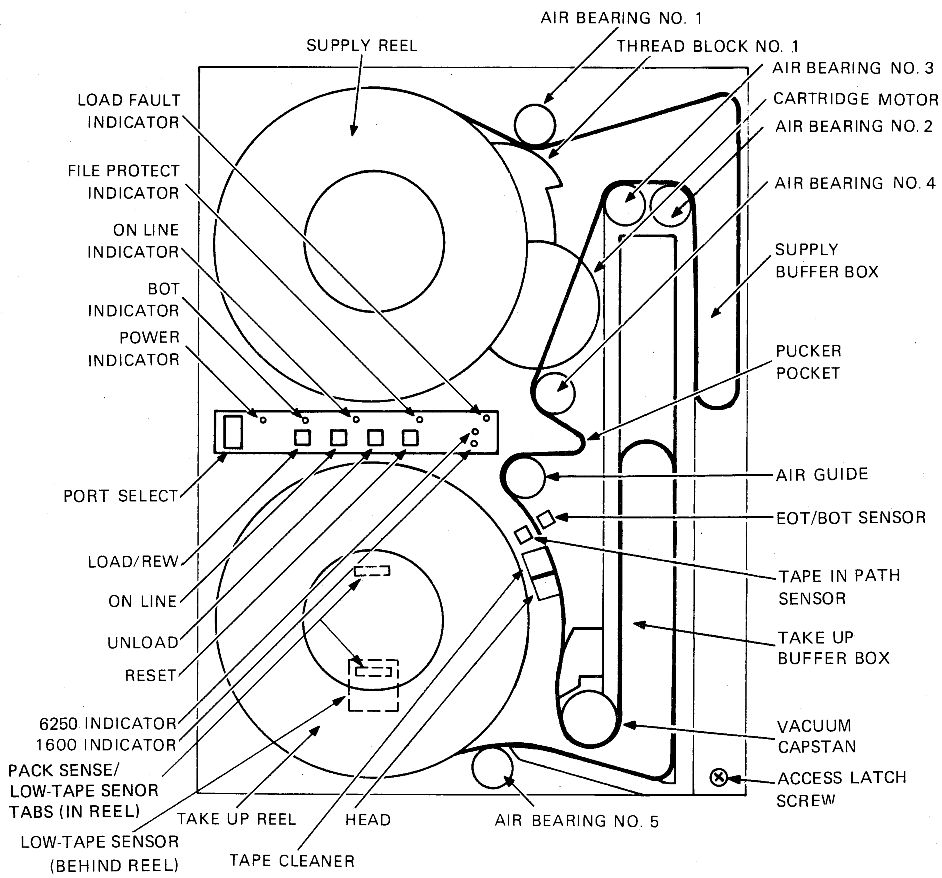


Figure 6-4 Base Assembly, Front Components

NOTE

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

6.5.3 Low-Tape Sensor Adjustment (Pack Sense Assembly)

The following procedure describes sensitivity adjustment of the low tape sensing circuit. The low tape sensor detects the amount of tape remaining on the take-up reel. If the remainder is 1.27 cm (1/2 in) or less (measured radially), the sensor produces an output. The output is used to slow the tape speed down during a rewind before sensing the BOT marker, and to develop sequencing counts during a tape loading operation.

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).

3. Open the transport front door.

4. Rotate the take-up reel until the sensor tab (located on the inside of the outer flange of the reel) is in line with the low tape sensor 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).

7. Rotate the take-up 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.

6.5.4 Vacuum and Air Pressure Adjustments

6.5.4.1 System Vacuum Adjustment – Refer to Figure 6-5 and Table 6-6 while performing this adjustment.

1. Turn transport power on.

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

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

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 M2 PCBA (Figure 6-6) 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 838 to 889 mm (33 to 35 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 864 mm (34 in) of water. While holding the screw, tighten the locknut 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 take-up reel vacuum as described in Paragraph 6.5.4.2.

6.5.4.2 Takeup Reel Vacuum Adjustment – Refer to Figure 6-5 and Table 6-6 while performing this adjustment.

1. Before attempting this adjustment, make sure system vacuum is within the specified limits outlined in Paragraph 6.5.4.1.

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

3. Place disable servo switch S1 on the reel servo PCBA (Figure 6-7) toward the rear of the transport.

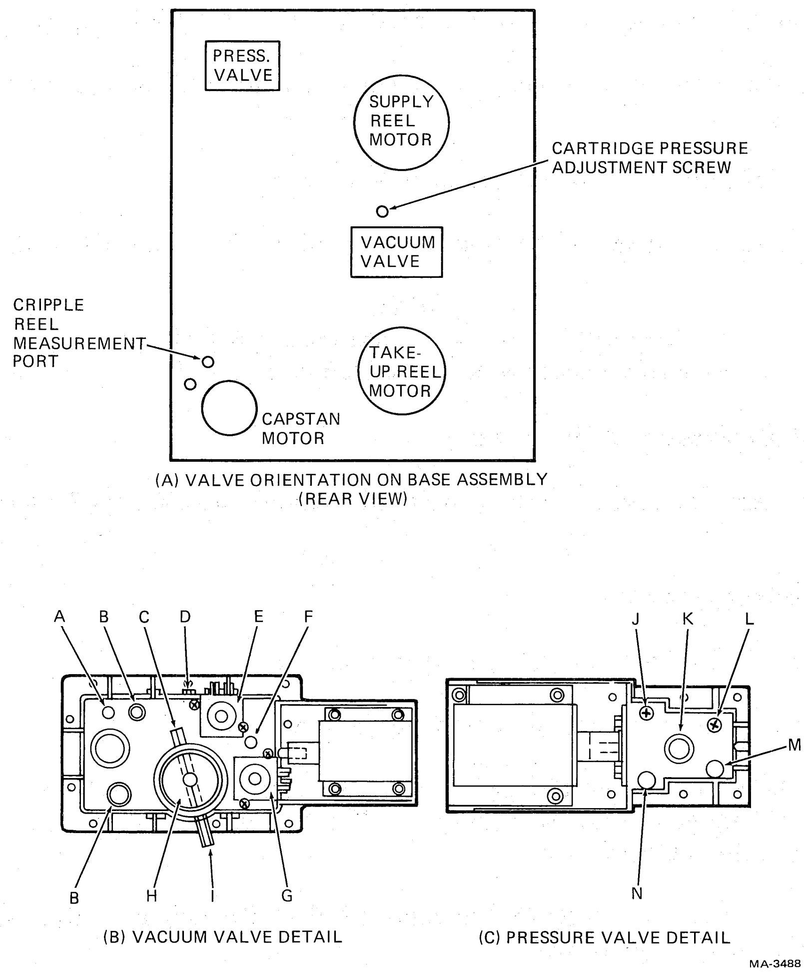


Figure 6-5 Vacuum Valve and Pressure Valve

4. Remove red cap from take-up reel vacuum port (F).

5. Connect a differential air gauge with a range of 0 to 1016 mm (0 to 40 in) of water to the take-up 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 take-up 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) and 457 mm (18 in) of water, (minimum).

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	Take-up 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

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 after which the coil should be allowed to cool for nine minutes.

10. If the reading is out of tolerance, loosen the take-up 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 make sure adjustment is not disturbed.
12. Press and release RESET button.
13. Remove air gauge and replace red cap. Place reel servo disable switch S1 forward (servo enable position).

NOTE

The two vacuum adjustments (Paragraphs 6.5.4.1 and 6.5.4.2) are interactive, and after performing one, the other should be rechecked.

6.5.4.3 Air Bearing Pressure Adjustment – Refer to Figure 6-5 and Table 6-6 while performing this adjustment.

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.

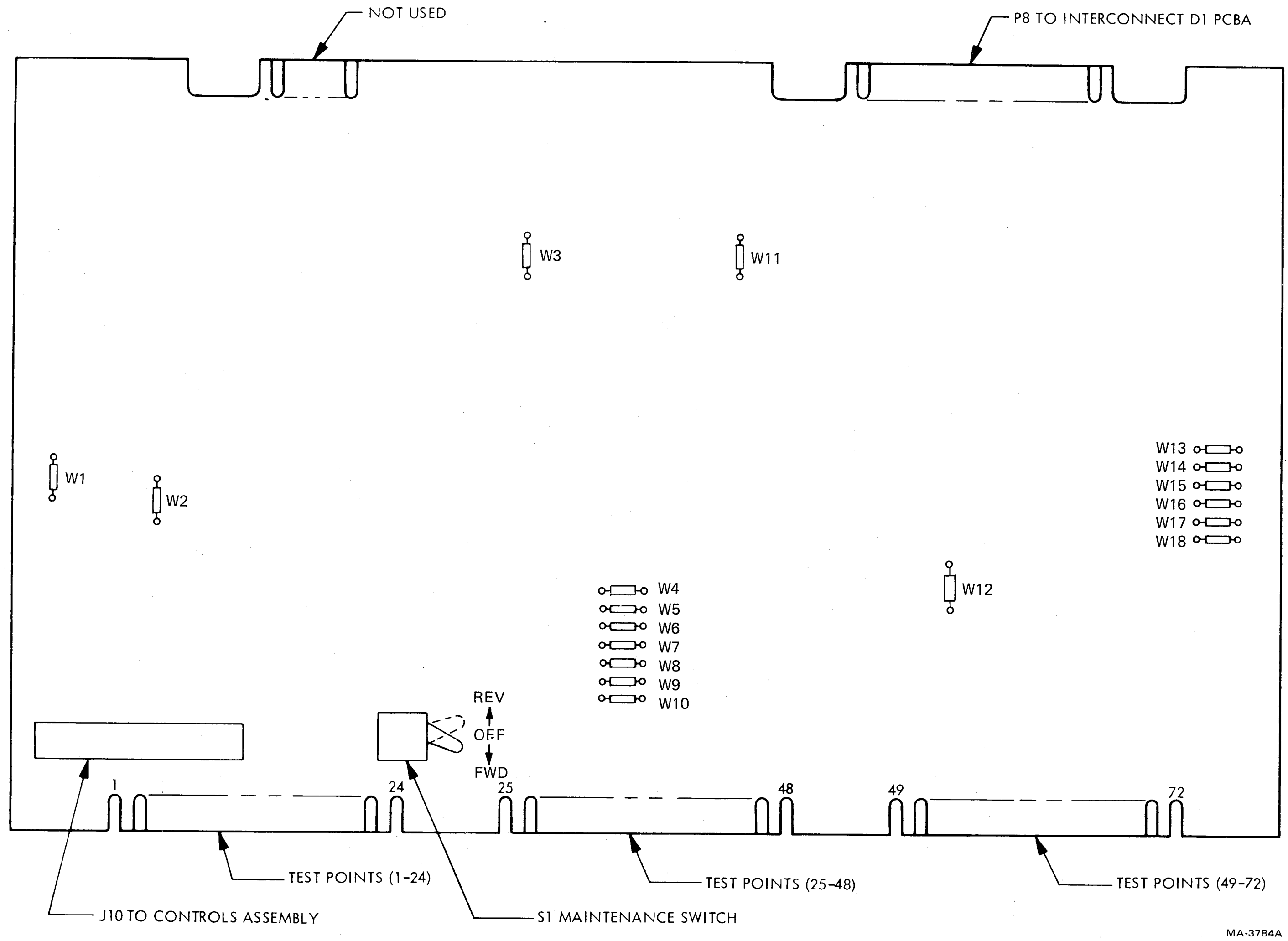


Figure 6-6 Control M2 PCBA Adjustments and Test Points

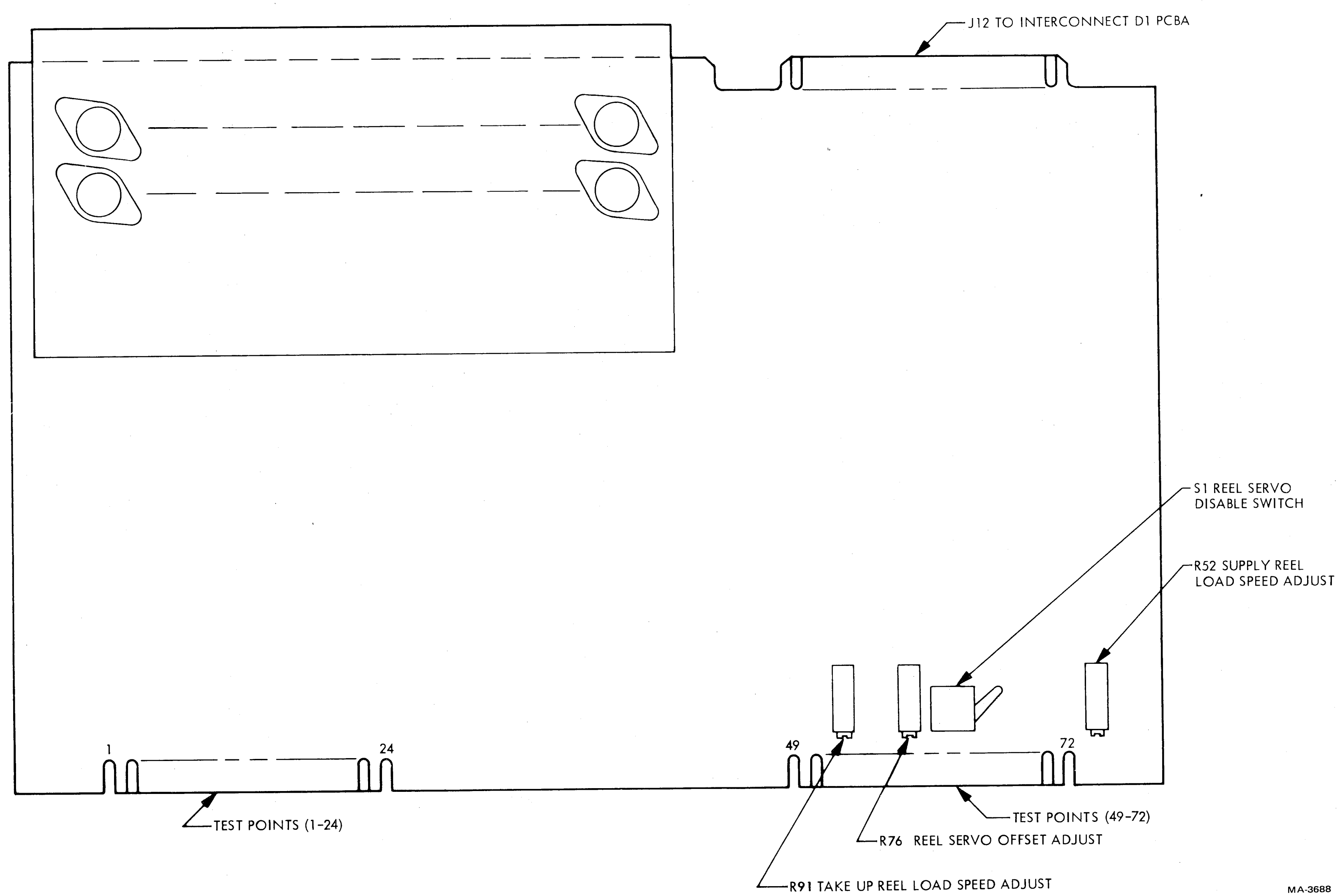


Figure 6-7 Reel Servo PCBA Adjustments and Test Points

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

5. Place maintenance switch S1 on control M2 PCBA (Figure 6-6) toward the front of the transport to drive tape forward.

6. Observe the air gauge while tape is running foward and check for an air bearing pressure reading between 27.6 kilopascals (4.0 psi) maximum and 24 kilopascals (3.5 psi) minimum.

7. If the reading is out of tolerance, loosen the locknut and adjust the air bearing pressure adjustment screw (J) for a 25.8 kilopascals (3.75 psi) reading.

8. Tighten the locknut while observing the air gauge to make sure adjustment is not disturbed.

CAUTION
Excessive torque on the lock nut damages port threads. Exercise extreme care.

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

10. Unload the tape.

6.5.4.4 Thread Block and Cartridge Pressure Adjustment – Refer to Figure 6-5 and Table 6-6 while performing this adjustment.

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 servo disable switch S1 on the reel servo PCBA (Figure 6-7) 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 the take-up reel six full turns by hand. This deactivates load fault zero 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, after which the coil should be allowed to cool for nine minutes.

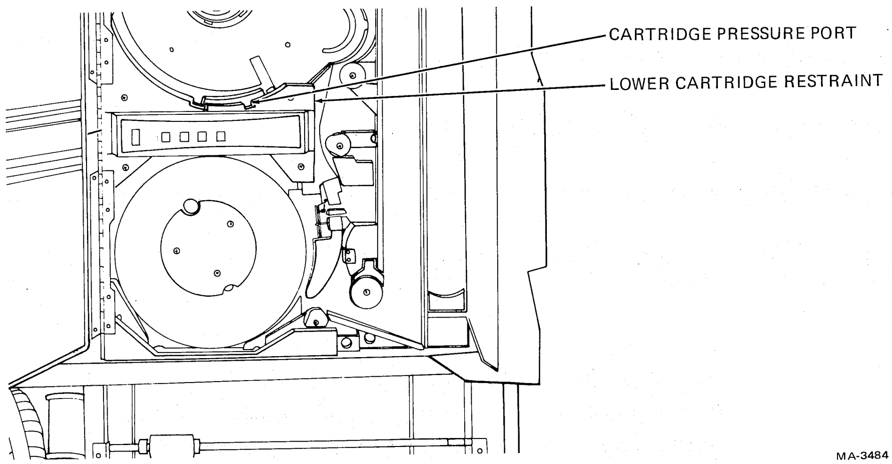


Figure 6-8 Cartridge Pressure Check Point

6. Observe air gauge and check for a reading between 660 mm (26 in) of water, maximum, and 559 mm (22 in) of water, minimum.

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

CAUTION
Excessive torque on the locknut damages the port threads. Exercise extreme care.

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 6-8), and install the tube fitting (DEC P/N 29-23228).

11. Connect the 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 the take-up reel six full turns by hand. This deactivates load fault zero 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, 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 6-5) 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 adjustment integration. Observe all cautions.

NOTE
An alternate method to the preceeding 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).

6.5.5 Capstan Servo Adjustments

The following are procedures for adjusting the capstan speed, start ramp, and forward and reverse stop ramps. Capstan speed adjustment affects tape speed as it moves past the read/write heads. Start ramp adjustment affects the amount of time it takes for the capstan servo to accelerate the tape from the rest position to full data handling velocity (125 in/s). Stop ramp adjustments affect the amount of time it takes for the capstan servo to decelerate the tape from full data handling velocity to rest position. You must perform the adjustments in the sequence given.

1. Verify power supply voltages according to Paragraph 6.5.1.

2. Load any write enabled 267 mm (10-1/2 in) tape to BOT.

3. Place the transport on-line and set the port switch to position 3 (maintenance).

4. Remove the lower front dress panel from the master TU78 to gain access to the TM78 maintenance panel. If the TU78 undergoing the adjustment procedure is not the master, remove the TM78 logic gate retaining screws and swing the gate out on its hinge so the maintenance display is visible to you.

5. Enable the TM78 maintenance panel by pressing **ENA**. The display responds with **HELLO**.

6. Enter the slave unit number in the following way.

   - Press **0** (parameter item zero)

   - Press **PAR**.
     The display flashes the parameter item location (**0**) then shows the contents of that location.

   - Enter the slave TU number by pressing **0, 1, 2** or **3**.

   - Press **DEP**.
     The display flashes the parameter item location again, then shows the new contents.

NOTE
Steps 7 through 11 describe the procedure for adjusting tape speed.

7. Execute the speed test command in the following way.

   - Enter **32**.

   - Press **EXE** (execute).
     The formatter executes one speed test command sequence, stops the transport, and responds with a termination status code in the display.

8. If the code is **01–00**, the capstan speed is within specification and you can proceed to step 12. However, a code of **77–01** indicates an error and an adjustment is required.

9. Adjust the capstan speed as follows in the following way.

   - Press **REP** (repeat).
     The maintenance display indicates the magnitude of the error in one of two ways. If the display shows **L EEEE**, there is a gross maladjustment and the TM78 cannot determine the direction in which to make the correction. If the display shows a number in the tens and hundreds position, a pointer adjacent to the number shows you which way to make the correction. The number may be any arbitrary value between **00** and **37**:**00** corresponding to correct speed, and **37** corresponding to maximum deviation.

   - Adjust potentiometer R47 on the capstan/regulator PCBA (Figure 6-2) while observing the display, until it indicates **L 00** . If the display shows **L** -nn (where nn = **01** through **37**) the capstan speed is too high and R47 must be turned counterclockwise. If the display shows **L** nn- the capstan speed is too low and R47 must be turned clockwise.

NOTE
If the tape reaches end of tape while making the adjustment, the TM78 initiates a rewind, places L EEEE in the display, and continues the test when beginning of tape is reached.

10. Press **CLR** (clear)
    The display should show a termination status code of **01–00** indicating done with no error.

NOTE
An alternate procedure for measuring capstan speed is to measure the frequency of the tach pulses. Connect a scope to control M2 PCBA, TP40 (Figure 6-6). The time period from trailing edge to trailing edge should be 80 μs $\pm$0.8 μs.

11. If it was necessary to adjust capstan speed, then the PE gains must be adjusted (Paragraph 6.5.7.3).

NOTE
Steps 12 through 16 describe the procedure for adjusting the forward start ramp.

12. Check the forward start ramp by executing a **34** command, as in step 7.

13. Again, if the termination status code is **01–00** no adjustment is required and you can proceed to step 17. Any other code indicates an error and an adjustment is necessary.

14. Press **REP**. The display indicates the magnitude of the error similar to that shown in step 9.

15. Adjust potentiometer R59 on the capstan/regulator PCBA (Figure 6-2) while observing the display, untill it indicates **L 00**. A pointer leading the displayed error value indicates the capstan is ramping up too quickly and R59 must be turned counterclockwise. A trailing pointer indicates the capstan is ramping up too slowly and R59 must be turned clockwise.

16. Press **CLR**.
The display should show a termination status code of **01–00** indicating done with no error.

NOTE
The following is an alternate procedure for measuring the forward start ramp.

- **Rewind the tape and place it on-line**
- **Create a 3200 FCI pattern on the tape by executing a 26 command through the maintenance keypad. (The TM78 must be off-line.) Rewind the tape.**
- **Connect an oscilloscope to the TU78.
Vertical CH1 to GCR/PE preamp 1 PCBA R14 top lead (Figure 6-9).**
- **Connect a jumper between the control M2 PCBA TP30 and TP25.**
- **Set control M2 PCBA maintenance switch S1 to the front (toward you). The tape alternately starts and stops.**
- **Refer to Figure 6-10a for a representative scope waveform and settings.**
- **The forward start ramp rise time (0 to 95%) should be in the 1.1 to 1.3 ms range.**
- **If it is out of adjustment, adjust capstan/regulator PCBA R59 for 1.2 ms.**
- **Return control M2 PCBA S1 to the center position.**
- **Although there is no adjustment, you may want to look at the reverse start ramp profile. The start ramp may measure from 1.1 to 1.3 ms ex-**

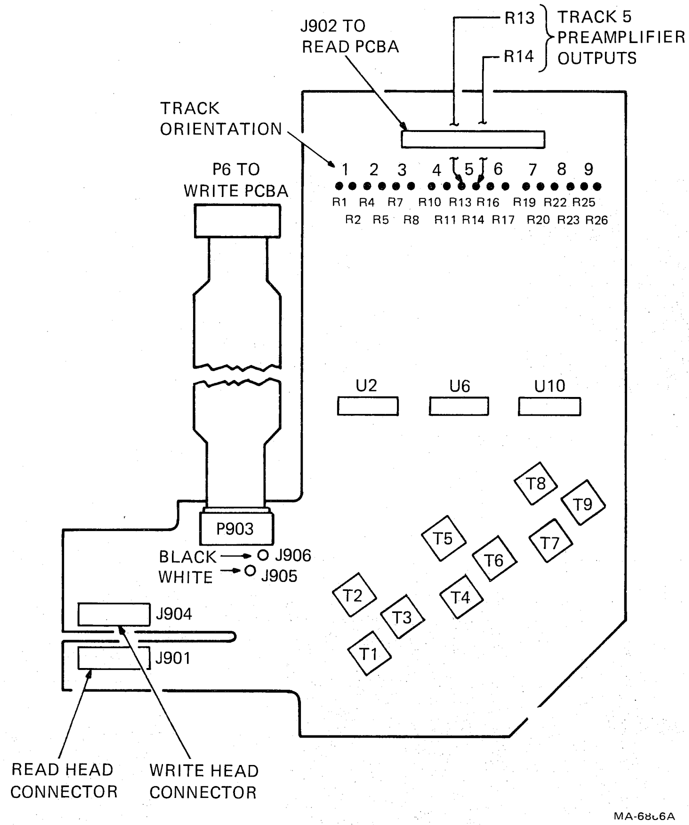


Figure 6-9 GCR/PE Preamp 1 PCBA Test Points

cept there may be a small "forward hitch" envelope for a 1.7 ms duration preceding the ramp. This forward hitch envelope is normal if there has been no tape motion for approximately 10 to 20 ms or more before a reverse motion command. Refer to Figure 6-10b for a representative scope waveform and settings.

NOTE

Steps 17 through 21 describe the procedure for adjusting the forward stop ramp.

17. Check the forward stop ramp by executing a **36** command as in step 7.

18. If the termination status code is **01–00**, no adjustment is required and you may proceed to step 22. Any other code indicates an error and an adjustment is necessary.

19. Press **REP**. The display indicates the magnitude of the error similar to that shown in step 9.

20. Adjust potentiometer R66 on the capstan/regulator PCBA (Figure 6-2) while observing the display, until it indicates **L 00**. A pointer leading the displayed error value indicates the capstan is ramping down too quickly and R66 must be turned counterclockwise. A trailing pointer indicates the capstan is ramping down too slowly and R66 must be turned clockwise.

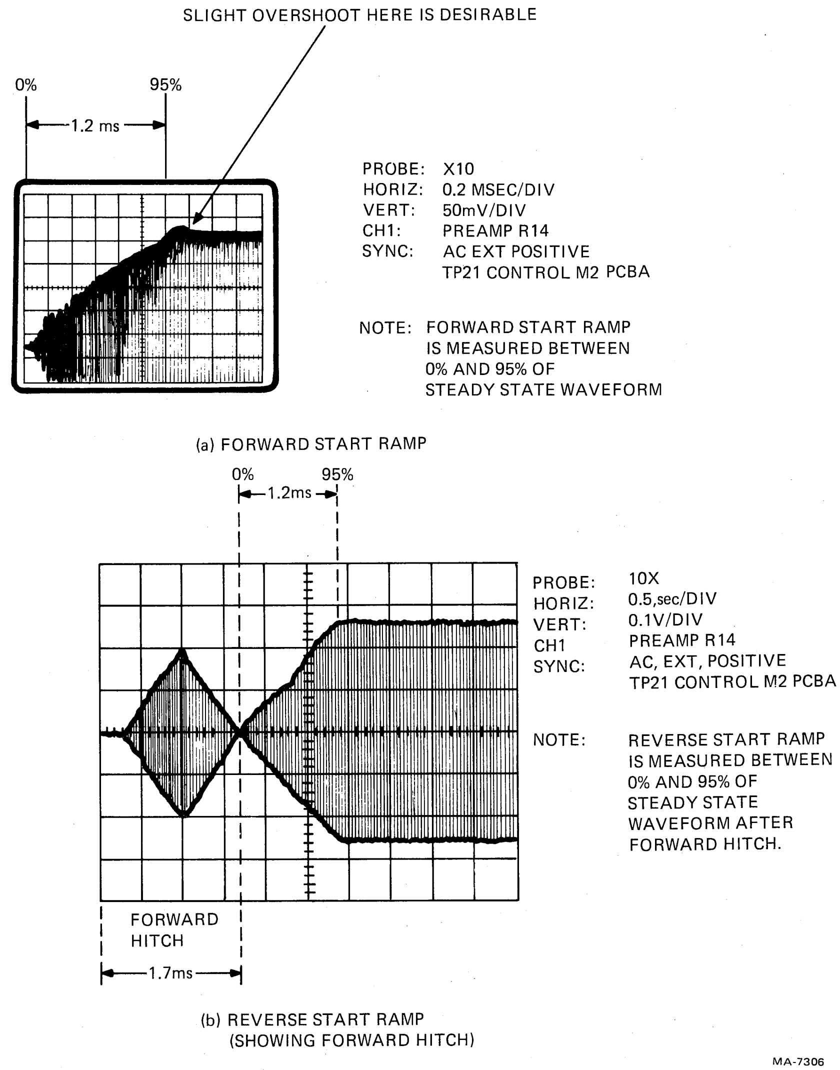


Figure 6-10 Forward Start Ramp

21. Press **CLR**.
The display should show a termination status code of **01–00** indicating done with no error.

NOTE

The following is an alternate procedure for measuring the forward stop ramp.

- **Rewind the tape and place it on-line**
- **Create a 3200 FCI pattern on the tape by executing a 26 command through the maintenance keypad. (The TM78 must be off-line.) Rewind the tape.**

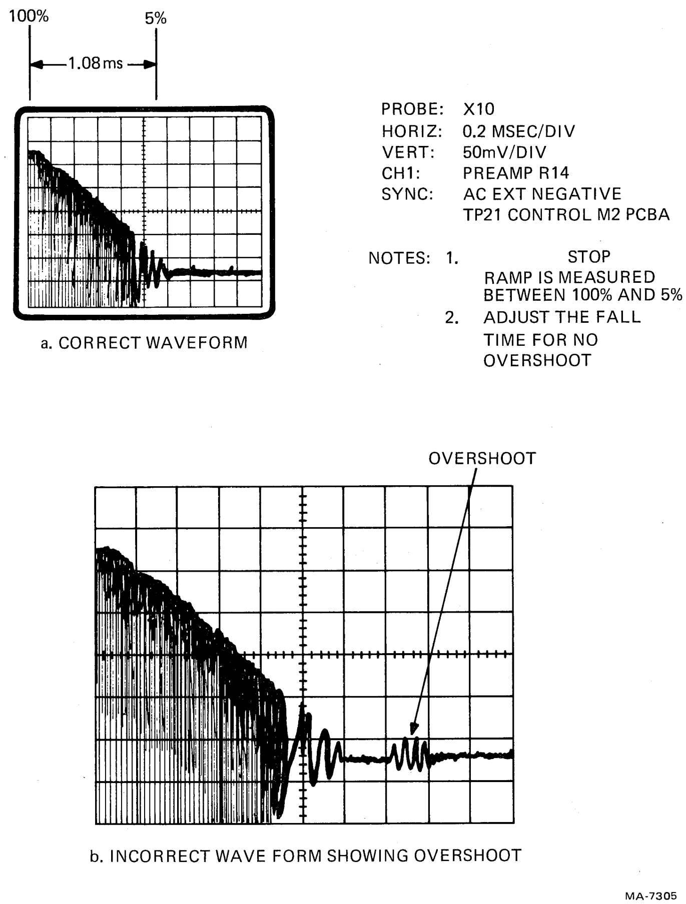


Figure 6-11 Stop Ramp

- **Connect an oscilloscope to the TU78. Vertical CH1 to GCR/PE Preamp 1 PCBA R14 top lead (Figure 6-9). External sync to control M2 PCBA TP21 (Figure 6-6).**

- **Connect a jumper between control M2 PCBA TP30 and TP25.**

- **Set control M2 PCBA maintenance switch S1 to the front (toward you). The tape alternately starts and stops.**

- **Refer to Figure 6-11 for a representative scope waveform and settings.**

- **The forward stop ramp fall time (100 to 5%) should be in the 1.02 to 1.13 ms range.**

- **If it is out of adjustment, adjust capstan/regulator PCBA R66 for 1.08 ms.**

- **Return control M2 PCBA S1 to the center position.**

NOTE

Steps 22 through 26 describe the procedure for adjusting the reverse stop ramp.

22. Check the reverse stop ramp by executing a **40** command as in step 7.

23. If the termination status code is **01–00**, no adjustment is required and you may exit the capstan adjustment procedures. Any other code indicates an error and an adjustment is necessary.

24. Press **REP**. The display indicates the magnitude of the error similar to that shown in step 9.

25. Adjust potentiometer R78 on the capstan/regular PCBA (Figure 6-2) while observing the display, until it indicates **L 00**. A pointer leading the displayed error value indicates the capstan is ramping down too quickly and R78 must be turned counterclockwise. A trailing pointer indicates the capstan is ramping down too slowly and R78 must be turned clockwise.

26. Press **CLR**.
The display should show a termination status code of **01−00** indicating done with no error.

NOTE

The following is an alternate procedure for measuring the forward stop ramp.

- **Rewind the tape and place it on-line**

- **Create a 3200 FCI pattern on the tape by executing a 26 command through the maintenance keypad. (The TM78 must be off-line.) Rewind the tape.**

- **Connect an oscilloscope to the TU78. Vertical CH1 to GCR/PE Preamp 1 PCBA R14 top lead (Figure 6-9). External sync to control M2 PCBA TP21 (Figure 6-6).**

- **Connect a jumper between control M2 PCBA TP30 and TP25.**

- **Set control M2 PCBA maintenance switch S1 to the rear (away from you). The tape alternately starts and stops.**

- **Refer to Figure 6-11 for a representative scope waveform and settings.**

- **The reverse stop ramp fall time (100 to 5%) should be in the 1.02 to 1.13 ms range.**

- **If it is out of adjustment, adjust capstan/regulator PCBA R78 for 1.08 ms.**

- **Return control M2 PCBA S1 to the center position.**

27. Unload the tape.

6.5.6 Reel Servo Adjustments

Reel servo adjustments provide for adjusting the reel servo offset, supply and take-up reel load speeds, and tape loop position. The adjustments are interactive. Therefore they all should be performed together (Paragraph 6.5.6 must be performed in its entirety). Refer to Figure 6-7 for reel servo adjustment and test point locations.

6.5.6.1 Reel Servo Offset Adjustment – The reel servo offset adjustment sets the dc reference level of the triangle wave generator output. This maintains balanced currents through the reel motors when they are not commanded to turn.

1. Verify power supply voltages according to Paragraph 6.5.1.

2. Turn transport power off.

3. Disconnect the take-up reel servo motor leads at the motor.

4. Turn transport power back on.

5. Open the transport front door, disable the door interlock switch, and remove the supply reel tape.

6. Press and release the LOAD/REW switch. Immediately turn the take-up reel three full turns by hand. This defeats 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, 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 supply reel hub motion.

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 take-up reel motor leads.

12. Turn transport power back on.

6.5.6.2 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). Make sure 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 50 to 60 rpm range.

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 seconds maximum (50 rpm) and 10.0 seconds minimum (60 rpm).

9. If the time displayed is out of tolerance (step 8), adjust potentiometer R52 on the reel servo PCBA for an 11 seconds (55 rpm) elapsed while performing steps 7 and 8.

10. Turn transport power off.

11. Remove grounds from the reel servo PCBA and remove the masking tape.

6.5.6.3 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 take-up reel should be rotating in a clockwise direction.

4. Measure the take-up reel speed directly in rpm with the hand held tachometer (DEC P/N 29-11635). Make sure the tachometer is fitted with the rubber cone type adapter. To measure the take-up reel speed, place the tip of the tachometer cone into the small dimple at the rear of the take-up reel servo motor shaft, and read the rpm directly from the tachometer LEDs. The reading should be in the 162 to 198 rpm range.

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 take-up 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 take-up reel should rotate in the clockwise direction.

4. Connect an oscilloscope input lead to TP43 (low tape sensor input) of the control M2 PCBA (Figure 6-6).

5. Observe the oscilloscope. The time between leading edges of two consecutive pulses should be between 183.7 ms maximum (162 rpm) and 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 the grounds and scope leads.

6.5.6.4 Tape Loop Position Adjustment

NOTES

1. **Check, and adjust if necessary, all vacuum and pressure readings outlined in Paragraph 6.5.4 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 transport power off.

2. Set control M2 PCBA maintenance switch S1 in the center position (Figure 6-6).

3. Set reel servo disable switch S1, located on the reel servo PCBA (Figure 6-7) toward the rear (disable).

4. Connect control M2 PCBA test points TP62 (NINTLK) and TP71 (PNU 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 take-up reel. Close the buffer box door.

7. Turn transport power back on. Vacuum and pressure comes on.

8. Manually rotate the supply reel clockwise to put tape into the supply buffer column. Rotate the reel so the tape forms a loop and 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, shown in Figure 6-12. 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 Number 4 (Figure 6-4) with your finger and manually rotate the take-up reel counterclockwise to form a loop in the take-up buffer column. Continue rotating the take-up 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 Number 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 and −0.2 Vdc minimum.

14. If the voltage is out of tolerance, adjust potentiometer R9 on the interconnect F1 PCBA for 0 Vdc (Figure 6-3).

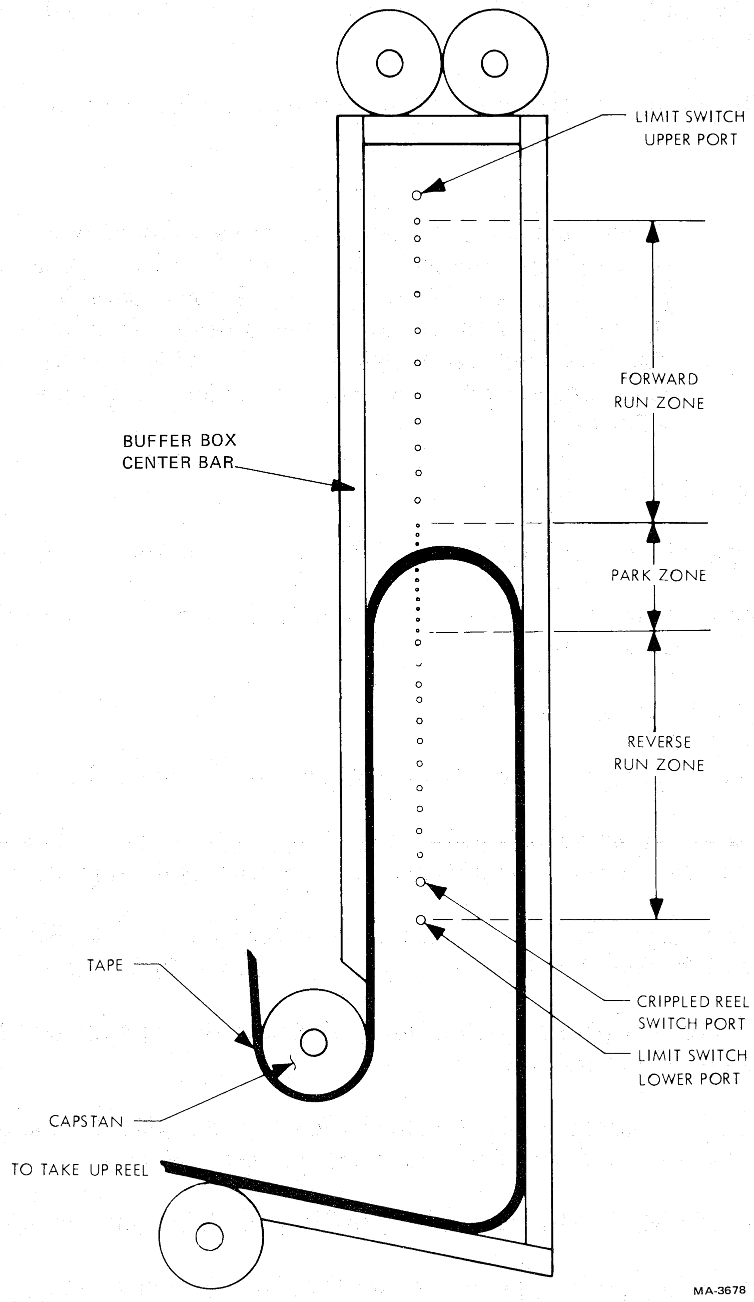


Figure 6-12 Buffer Column Park Zone (Take-up column shown)

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 and -0.2 Vdc minimum.

17. If the voltage is out of tolerance, adjust potentiometer R1 on the interconnect F1 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 (refer to Note 1 under Paragraph 6.5.6.4).

18. Turn transport power off.

19. Remove ground wires from TP62 and TP71 on the control M2 PCBA.

20. Enable the reel servos by placing reel servo PCBA switch S1 toward the front. Disable the front door interlock switch.

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. If the tape fails to load, refer to the reel servo troubleshooting procedures (Paragraph 6.6.6).

24. Set gain potentiometers R30 and R31 on the interconnect F1 PCBA (Figure 6-3) fully clockwise. (The potentiometers have a range of approximately 28 turns.)

25. Adjust the position potentiometers R1 and R9 on the interconnect F1 PCBA so that both tape loops are within the park zones.

26. Move the tape approximately 9 meters (30 ft) from BOT by placing control M2 PCBA switch S1 toward the front of the transport for three seconds.

27. Ground control M2 PCBA test point 31 to test point 25 to initiate a forward/reverse shuttle.

28. Adjust the take-up position potentiometer R9 on the interconnect F1 PCBA so the loop travel is equal above and below the take-up column park zone.

29. Remove the ground from control M2 PCBA TP31.

30. Record the park position of the tape loop in the take-up column. You need this in step 32.

31. Adjust take-up gain potentiometer R31 on the interconnect F1 PCBA approximately ten turns counterclockwise.

32. Adjust the take-up position potentiometer R9 so the take-up loop park position is identical to that recorded in step 30.

33. Ground control M2 PCBA TP31 again to obtain a forward/reverse shuttle.

34. Fine tune the position (R9) and gain (R31) potentiometers so the take-up loop matches the boundaries shown in Figure 6-13. The position potentiometer moves the loop excursion up and down in the column.

    The gain potentiometer increases and decreases the length of the excursion. Rotating the gain potentiometer counterclockwise decreases the servo loop gain and allows a longer loop excursion. Rotating it clockwise increases the gain and allows a shorter loop excursion. Do not allow the take-up loop excursion to extend beyond 24 cm (9-1/2 in).

    NOTE
    Because the gain and position potentiometers are interactive, it is necessary to alternate adjustments in the fine tuning process.

35. Remove the ground from TP31 on the control M2 PCBA.

36. Place control M2 PCBA switch S1 toward the front of the transport and allow the tape to move to the EOT point. When EOT is reached, move switch S1 to the rear for three seconds and allow the tape to move 9 meters (30 ft) from the EOT point.

37. Repeat steps 27 through 35 for the supply reel servo loop position. Use position potentiometer R1 and gain potentiometer R30 on the interconnect F1 PCBA. Do not allow the supply loop excursion to extend beyond 25.4 cm (10 in) in step 34.

38. When completed with the supply reel loop position, rewind the tape to BOT. Move the tape to EOT and rewind to BOT two more times. If interlock is broken, readjust the position and gain potentiometers until an optimum point is reached.

6.5.7 Read/Write Adjustments

The read/write adjustment paragraph gives, in the proper order, adjustment procedures for the functions needed to ensure data integrity.

NOTE

Before starting the read/write adjustments make sure 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 following order.

1. Read skew adjustment (azimuth)
2. Write current adjustments
3. PE gain adjustments

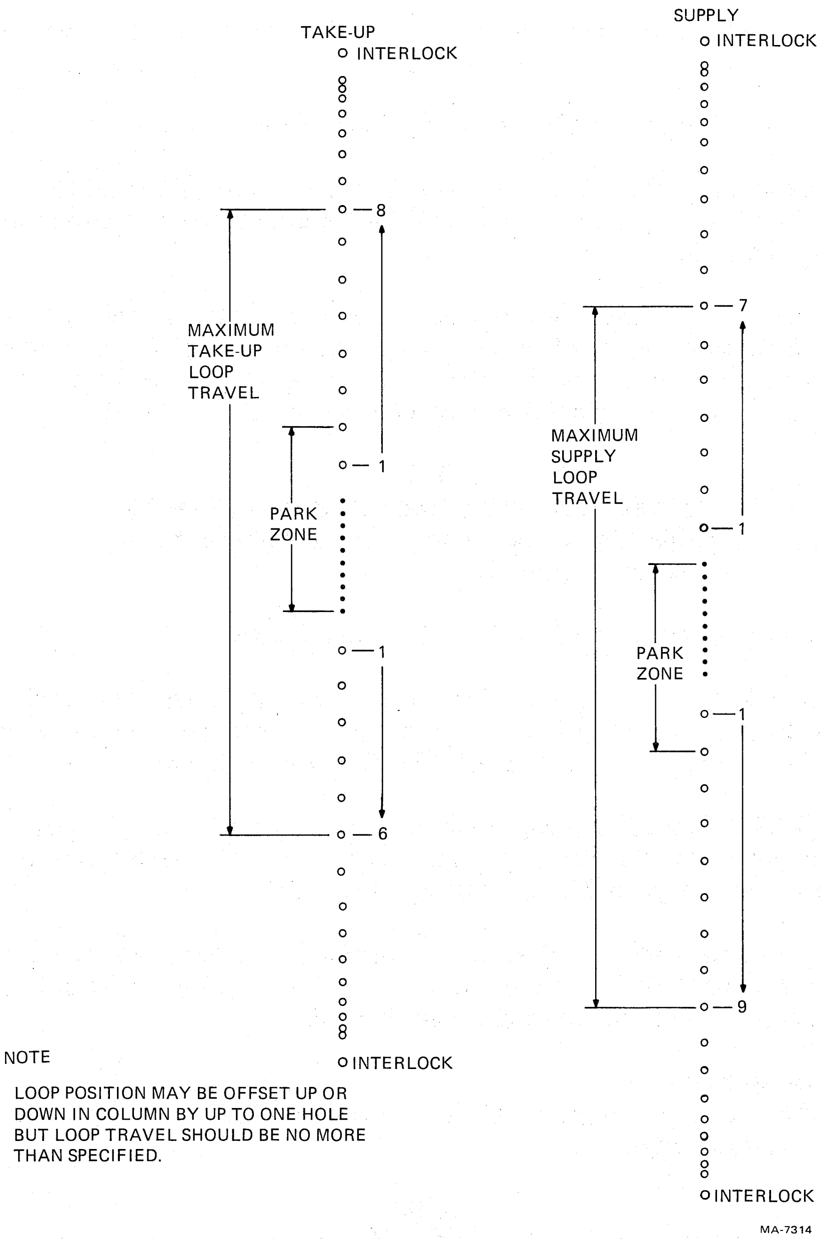


Figure 6-13 Loop Travel Limits

6.5.7.1 Read Skew Adjustment (Azimuth)

1. Mount and load a write protected master skew tape to BOT. Place the transport on-line. Defeat the front door interlock switch.

2. Set MIA PCBA maintenance switches (Fig. 6-14) as follows:

   S2 Left Read
   S3 Left 1600
   S4 Right Manual

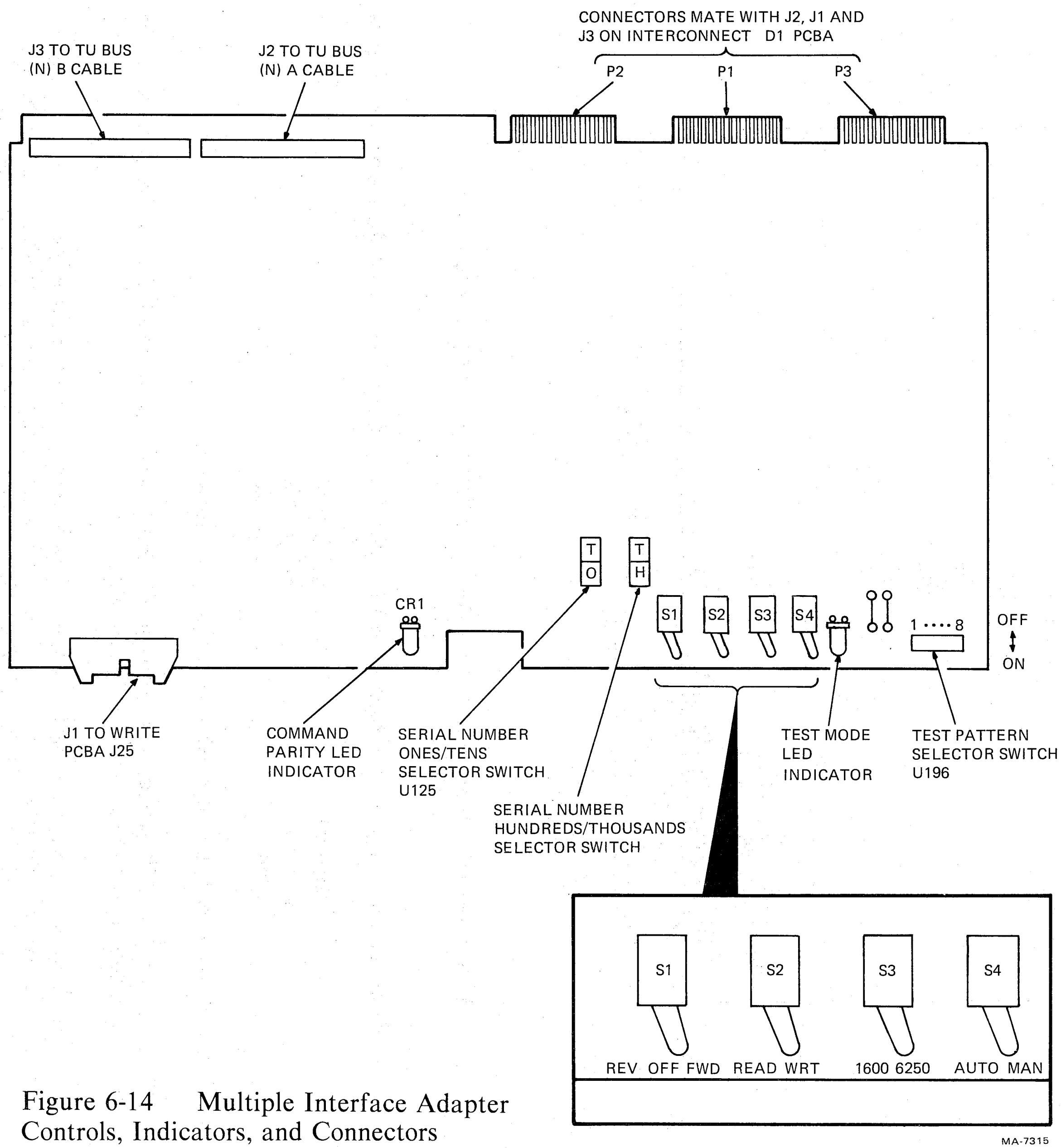


Figure 6-14 Multiple Interface Adapter Controls, Indicators, and Connectors

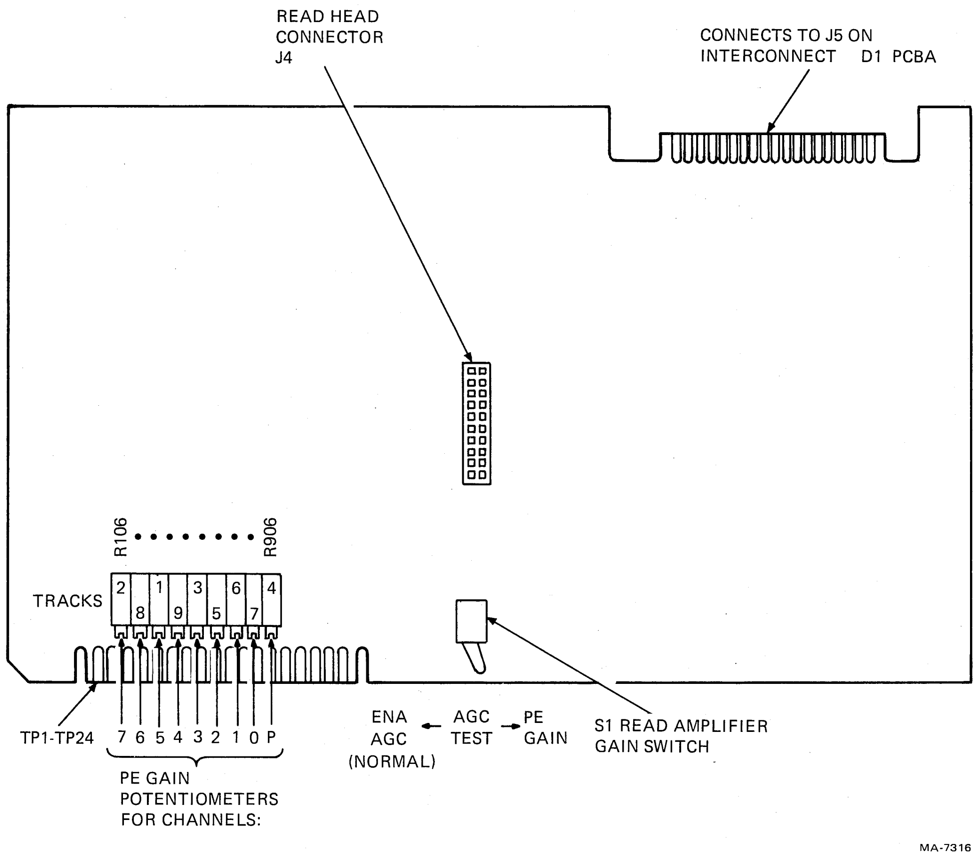


Figure 6-15 Read PCBA Test Points, Adjustments, and Connectors

3. Connect an oscilloscope to read PCBA (Figure 6-15) test point 11. Set the scope to as follows.

Vertical	=	0.2 V/div
Horizontal	=	0.5 μs/div
Sync	=	+, int, dc

4. Set MIA PCBA switch S1 to the right (run forward).

5. Watch the oscilloscope. The overlapping step should not exceed 1.2 μs (corresponding to 150 μ inches of skew) as shown in Figure 6-16.

6. If the skew is out of tolerance, adjust the azimuth angle of the read/write head to obtain a skew within the proper value. Adjust the head for minimum step width. The head can be adjusted by inserting a 1/8-inch allen driver through the buffer box door and into the tape cleaner cap-clip housing (Figure 6-17).

7. Set MIA switch S1 to the left (run reverse). The step width must not exceed 1.2 μs. If it does, the capstan motor tracking may have to be fine tuned (Paragraph 6.7.5).

8. Allow the master skew tape to continue in reverse to BOT, then remove it.

9. Set MIA PCBA switch S1 to the center (stop), and S4 to the left (auto).

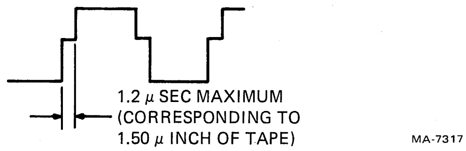


Figure 6-16 Read Skew Adjustment Waveforms

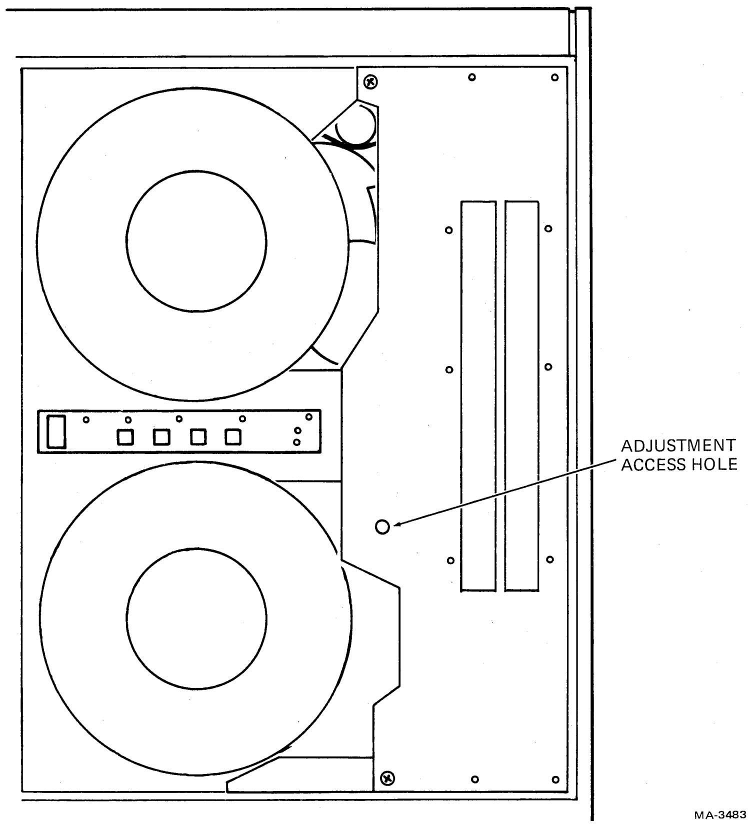


Figure 6-17 Location of Read Skew Azimuth Adjustment

6.5.7.2 Write Current Adjustments

1. Verify power supply voltages according to Paragraph 6.5.1.

2. Load any write enabled 267 mm (10-1/2 in) tape to BOT. Leave the transport off-line.

3. Set the MIA switches as follows.

   S1 = FWD (right)
   S2 = WRT (right)
   S3 = 1600 (left)
   S4 = MAN (right)

   Data pattern (U196) equals all ones (all switches forward)

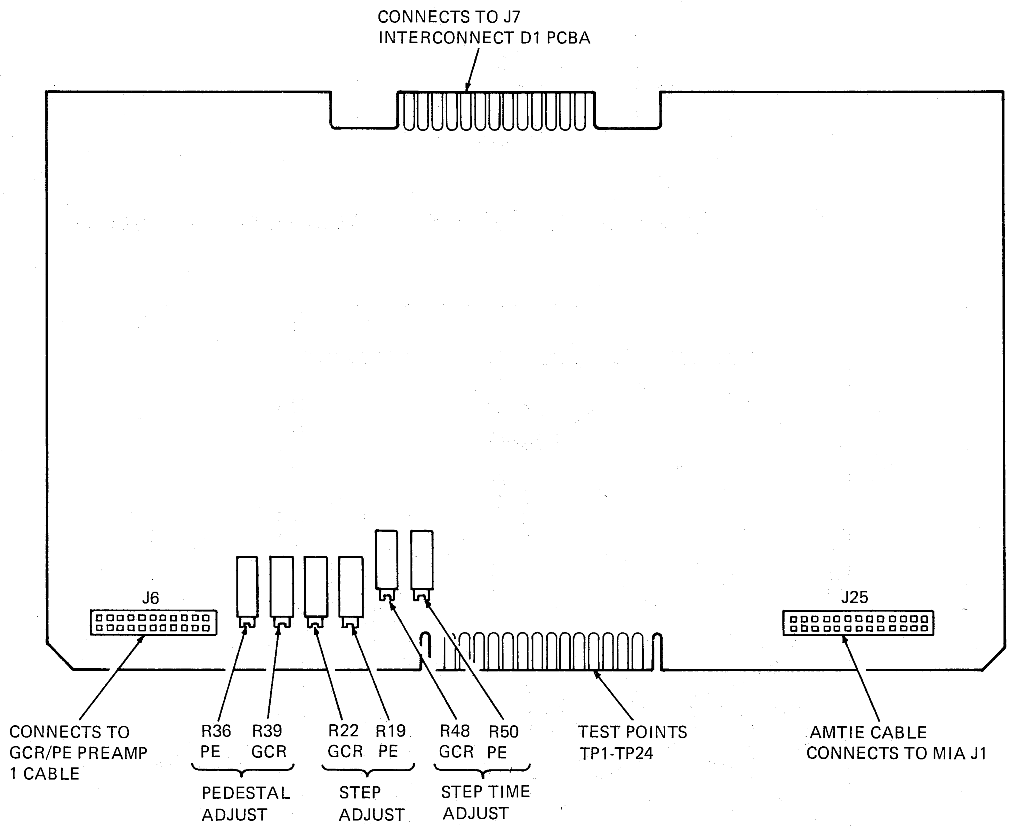


Figure 6-18 Write PCBA Test Points, Adjustments, and Connectors

A. Phase Encoded Write Current Adjustments

1. Connect an oscilloscope to write PCBA (Figure 6-18) test point 6. Set the scope as follows.

Vertical ch1	=	1.0 V/div, ac (X10 probe)
Horizontal	=	0.2 μs/div
Sync	=	+, Ch 1, dc

2. Place transport on-line. The tape starts moving forward.

3. Adjust write PCBA potentiometer R50 (PE step time) for a 1.25 μs $\pm$.1 μs positive pulse width.

4. Place transport off-line. The tape stops moving.

5. Move the scope probe to write PCBA TP3. Change the vertical setting to 2.0 V/div, dc.

6. Place transport on-line.

7. Adjust write PCBA potentiometer R19 (PE step voltage) for a +8.75 Vdc $\pm$0 Vdc level.

8. Move the scope probe to write PCBA TP2.

9. Adjust write PCBA potentiometer R36 (PE pedestal) for a +6.2 Vdc ±0 Vdc level.

10. Place the transport off-line and rewind the tape to BOT.

B. Group Coded Write Current Adjustments (Transport Off-line Loaded, at BOT)

Coarse Adjustments

1. Connect an oscilloscope probe to write PCBA test point 6. Set the scope as follows.

Vertical Ch 1	=	1.0 V/div, ac (X10 probe)
Horizontal	=	.05 μs/div
Sync	=	Auto, +Ch 1, dc

2. Set the MIA switches as follows

S1 = FWD (right)
S2 = WRT (right)
S3 = 6250 (right)
S4 = MAN (right)

Data pattern (U196) equals all ones (all switches forward)

3. Place transport on-line. The tape starts moving forward, writing all ones.

4. Adjust write PCBA potentiometer R48 (GCR step time) for a 350 ns ± 10 ns positive pulse width.

5. Place the transport off-line. The tape stops moving.

6. Move the scope probe to write PCBA TP3. Leave the scope settings as is, but place the vertical amplifier coupling switch to GND and position trace to the bottom of scope graticule, then place the coupling switch to dc.

7. Adjust write PCBA potentiometer R22 (GCR step voltage) for a +7.0 Vdc, ±0 Vdc level.

8. Move the scope probe to the write PCBA TP2.

9. Adjust write PCBA potentiometer R39 (GCR pedestal) for a +4.0 Vdc ±0 Vdc level.

Fine Adjustment

1. Move the scope probe to GCR/PE preamp 1 PCBA R13 (upper lead). This is signal PO5.

2. Set the scope to the following settings.

Vertical Ch 1	=	0.2 V/div, ac (X10 probe)
Horizontal	=	1.0 μs/div
Sync	=	auto, +Ch 1, ac

3. Place the transport on-line. Tape moves forward and writes all ones.

4. Adjust R22 (GCR step voltage) on the write PCBA clockwise until the peak-to-peak amplitude of the sine wave displayed on the scope just begins to drop.

5. Place the transport off-line. The tape stops moving.

6. Check TP3 with the scope. It should be less than 7.0 Vdc and in the 6.7 – 6.9 Vdc range.

7. Move the scope probe back to R13 (step 1).

8. Change the scope sync coupling from AC to HF REJ.

9. Set the MIA data pattern switches to a 10010011 pattern. (U196 switches 1, 4, 7, and 8 forward, 2, 3, 5, and 6 rear.)

10. Place the transport on-line. The tape moves forward and the transport writes the 10010011 pattern serially on each track.

11. Adjust write PCBA R39 (GCR pedestal) to obtain a waveform as shown in Figure 6-19A. Note the symmetrical shoulders for both sets of double zeros. Figure 6-19B and 6-19C show examples of unsymmetrical waveforms.

12. Place the transport off-line.

6.5.7.3 Phase Encoded Gain Adjustments

NOTE

The capstan servo adjustments (Paragraph 6.5.5) affect PE gain. Make sure that these adjustments are within tolerance before doing the PE gain adjustment.

1. Mount and load a write enabled master output tape (DEC P/N 29-11691). Place the transport off-line.

2. Connect an oscilloscope to GCR/PE preamp 1 PCBA R1 upper lead (Figure 6-9). Set the oscilloscope as follows.

Vertical Ch 1	=	.02 V/div, ac (X10 probe)
Horizontal	=	1.0 ms/div
Sync	=	auto, + Ch 1, ac

3. Set the MIA switches as follows.

   S1 = FWD (right)
   S2 = WRT (right)
   S3 = 1600 (left)
   S4 = MAN (right)

   Data pattern (U196) equals all ones (all switches forward).

4. Place the transport on-line. The tape moves forward.

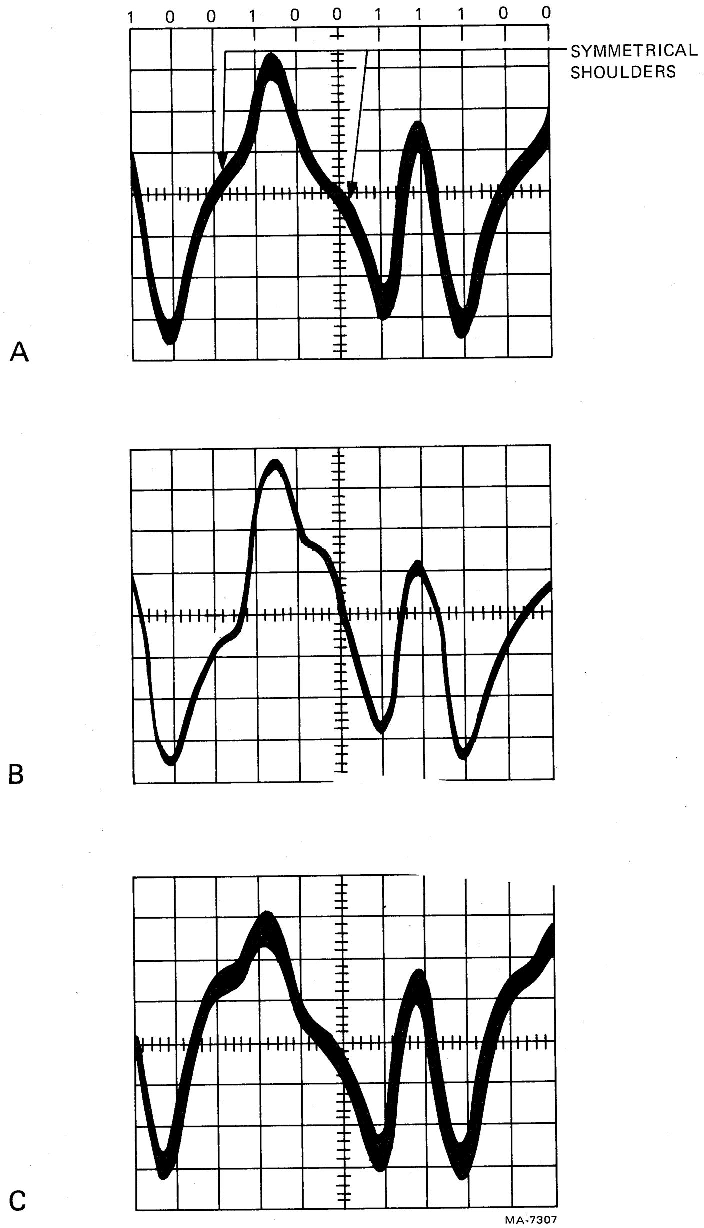


Figure 6-19 Pedestal Voltage Adjustment

5. Adjust the track 1 read PCBA potentiometer R706 (Figure 6-15) so the read data envelope measures 1.25 V peak-to-peak ±0 V.

6. Refer to Table 6-7 for test points and adjustments and adjust the other eight tracks as done in step 5.

NOTE

If the tape reaches EOT before you complete the adjustments, the MIA rewinds the tape automatically. Upon reaching BOT, the write operation resumes.

Table 6-7 PE Gain Test Points and Adjustments

Physical Track	Preamp Test Point	Read PCBA Adjustment
1	R1	R706
2	R4	R906
3	R7	R506
4	R10	R106
5	R13	R406
6	R16	R306
7	R19	R206
8	R22	R806
9	R25	R606

7. When finished adjusting all nine tracks, place the transport off-line, unload, and remove the master output tape.

8. Place MIA switch S4 to AUTO (left).

9. Verify proper transport operation by running the keypad or host CPU data reliability diagnostic.

6.6 TROUBLESHOOTING

Troubleshooting the TU78 transport consists of using this section as a guide in conjunction with system software on-line diagnostics, standalone diagnostics, and off-line maintenance features found within the transport and formatter. Aids to the troubleshooting process include the following things.

- System software device error log reports
- The theory discussion found in Chapter 5
- TM78 maintenance instruction/status codes found in the pocket service guide
- Transport functional block diagrams and logic/schematic diagrams found in Volume 1

6.6.1 Using the Multiple Interface Adapter (MIA) PCBA

This section describes how the MIA PCBA is used as an aid in performing certain transport adjustments, alignments, and troubleshooting.

6.6.1.1 Functional Description – The MIA PCBA is the interface between the TM78 formatter and the TU78 transport logic. It handles read/write data, command/status information and amplitude track in error (AMTIE) information. It also provides one of the points where field maintenance personnel can issue commands to the transport. This is in case the formatter and its maintenance features are not available due to failure or heavy customer usage.

The MIA PCBA has four toggle type command switches, eight DIP switches and two LEDs for troubleshooting purposes. Figure 6-14 shows where these components are and Tables 6-8 and 6-9 list their functions. A more detailed description of MIA theory is found in Paragraph 5.5.

Table 6-8 MIA LEDs

CR Number	Function
CR1	Command parity error
CR2	Manual mode

Table 6-9 MIA Switch Functions

Switch	Function	
Number	Left Position	Right Position
S1	reverse	forward
S2	read	write
S3	1600 mode	6250 mode
S4	auto (on-line)	manual (test)

6.6.1.2 Use Procedure – When the MIA PCBA is in manual mode (switch number 4 to the right), all data, command, AMTIE and status information is inhibited from crossing the TU bus interface. The other maintenance switches on the MIA 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 receive the MIA commands. Also, when in manual mode, the port select switch on the control panel has no effect and can be placed in any position.

The eight test pattern DIP switches (Figure 6-14, DIP U196) can be set to write a repeating eight character pattern to tape. Switch number 1 of U196 determines whether character 1, 9, 17, etc. is all 1s or all 0s. Switch number 2 corresponds to characters 2, 10, 18, etc. and so forth to switch eight for characters 8, 16, 24, etc. Refer to Paragraph 5.5.5.8 for a detailed description of test write data generation.

The right LED (CR2) is illuminated when in manual mode. The left LED (CR1) is illuminated when the MIA detects a command byte parity error from the formatter.

NOTES

1. **When in test write mode, a tape must have a write enable ring or the write/erase heads will be disabled.**

2. **All MIA switches are dynamic; that is the user may change densities, write/read, whether tape is moving or not.**

3. **When creating a tape in manual mode, upon reaching EOT, switch number 2 should be returned to the read (left) position. If not, when performing a reverse/rewind to return to BOT, the tape will be overwritten.**

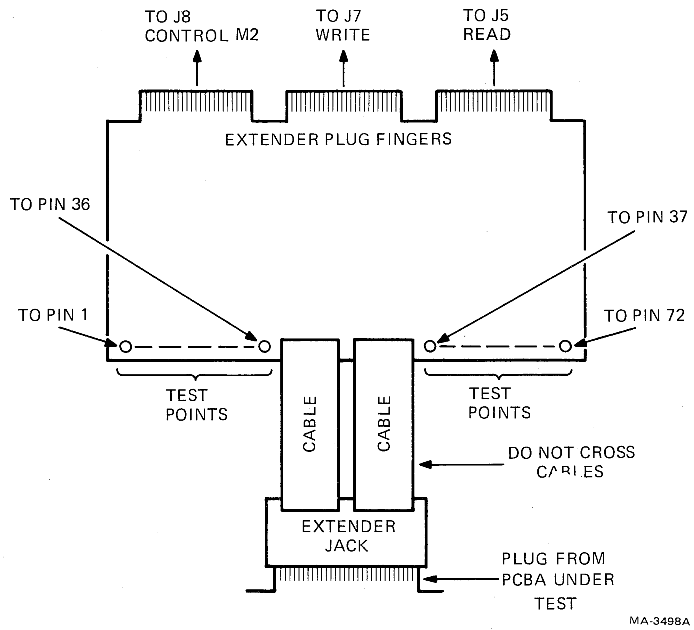


Figure 6-20 PCBA Extender

4. **Switch number 4 must be placed in the auto (left) position before returning the transport to operating system on-line usage.**

6.6.2 Using the PCBA Extender (DEC P/N 29-23218)

The PCBA extender is used as an aid in troubleshooting the TU78 transport. The read, write, and control M2 PCBAs can be extended for access one at a time. The MIA can not be extended, but is accessible by removing the cabinet top cover. The capstan/regulator and reel servo PCBAs can not be extended due to heat sinking requirements. Refer to Figure 6-20 for an illustration of the PCBA extender.

To extend a PCBA, first remove the PCBA retainer clip (Figure 3-6), 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 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). Therefore, if the read PCBA is to be extended, the extender must be inserted into the card cage with the READ (TOP) etch pointing up. If the control M2 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 onto the extended PCBA's plug fingers.

Note that the extender jack is connected to the extender with two flat cables. Place the extender jack with the two cables flat as shown in Figure 6-20. The jack must not be rotated 180 degrees (indicated by twisted cables). This would not make proper connections between the extended PCBA and the interconnect D1 PCBA.

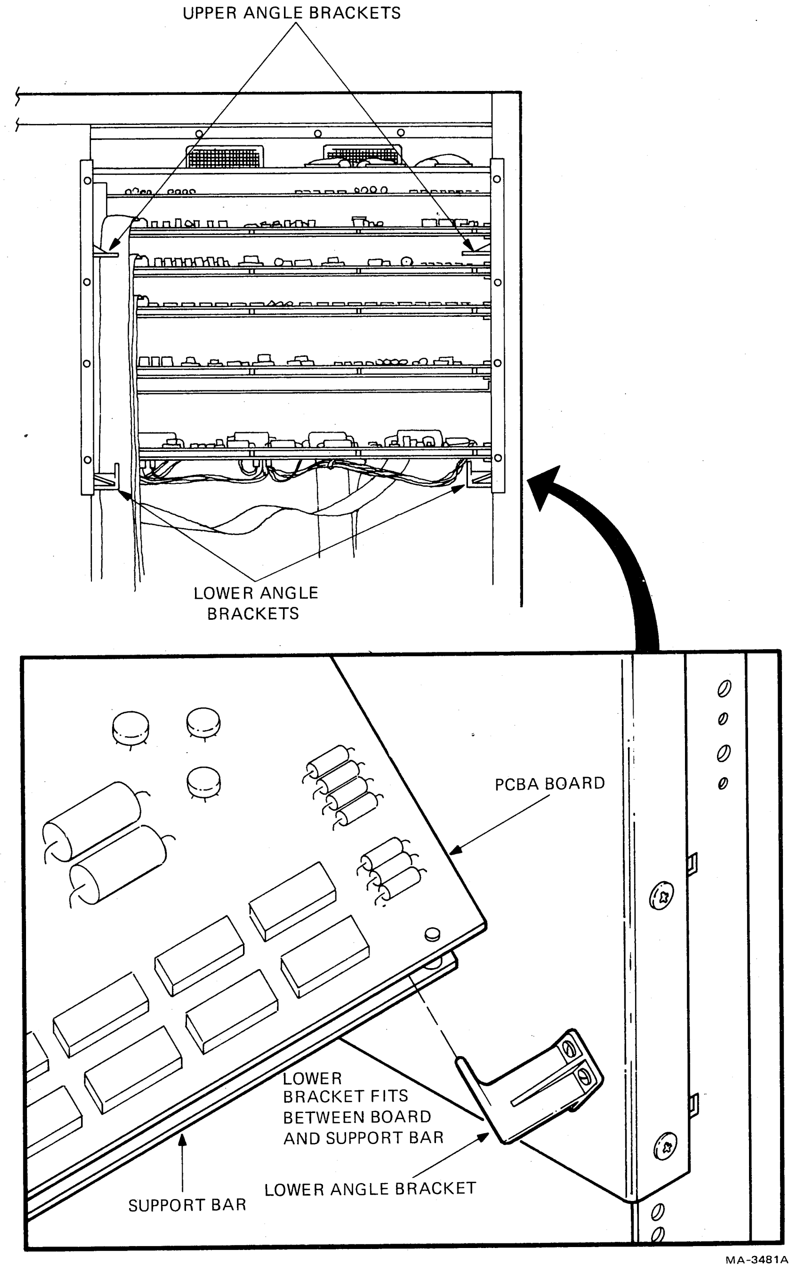


Figure 6-21 PCBA in Extended Position

The extended PCBA is supported at an angle within the card cage assembly by four nylon brackets protruding from the side, so 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 6-21 for an illustration of a PCBA in the extended position.

The 72 test points on the edge of the extender connect to the 72 pins on the interconnect D1 jack. Therefore, 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 connects 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 6-20).

6.6.3 Power Supply Troubleshooting

This section contains a failure analysis of the power supply and power distribution. Refer to Paragraph 5.4 for theory, and Figures 5-6 through 5-10, and Figure 2 in Volume 1 of the Technical Manual for functional block diagrams. With the exception of +5 V (L) individual power supply voltages are not adjustable. And, if a particular voltage is found to be out of acceptable range, a subassembly component has 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 following rules.

1. Make sure that power is off and the transport is unplugged before replacing any defective components in the power supply/pneumatic assembly.

2. The capstan/regulator PCBA cannot be extended from the card cage for troubleshooting with power applied since it requires heat sinking. If this PCBA is suspected, substitute a new PCBA.

6.6.3.2 Troubleshooting Hints

1. Examine the circuitry for burnt printed circuit board etch/components/wiring, oil leakage from capacitors, and loose connections. A good visual check can quickly determine the cause of a malfunction.

2. The +5 V, +15 V 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 transport power off then back on usually releases the crowbar.

6.6.3.3 Troubleshooting Charts – In checking the various areas of the power supply/distribution system, refer to the following troubleshooting chart (Table 6-10). Refer to Figure 6-1 for fuse locations.

6.6.4 Load Cycle Troubleshooting

When a load fault occurs, specific test points can be checked for clues 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 in Volume 1 (control M2 logic Schematic Number 106875, sheets 10 and 11 of 11).

The autoload cycle requires all vacuums and pressures to be within specification, and all power supply, control, capstan servo, and reel servo functional circuitry be operating. Before pursuing a path through these troubleshooting flows, the loading flowcharts and suggested corrections (Figures 2-4, 2-6, 3-18,

Table 6-10 Power Supply Troubleshooting Chart

Problem	Check	Result	Cause
No operator panel lights/no functions	Fans and blower at rear operating	no	Problem is in 874 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 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 or out of adjustment 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
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

Table 6-10 Power Supply Troubleshooting Chart (Cont)

Problem	Check	Result	Cause
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 no	Fuse F5 blown Bridge rectifier CR3 open Capacitor C5 shorted

and 3-19) should be followed. Also refer to Schematic Number 106875 (control M2 PCBA), sheets 10 and 11 of 11, for a functional loading flowchart and Figure 6-22 for an autoload timing diagram. Figure 4 in Volume 1 of the Technical Manual shows 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 the control panel) it can be categorized into one of seven possible load fault areas. In order to determine what area caused the fault, and therefore correct the source of this problem, you must scope test points on the control M2 PCBA. Table 6-11 lists the load fault numbers and their associated test points. During a normal load cycle the signal level at the test points remains 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 6-23 through 6-29 are the load fault flow diagrams.

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.

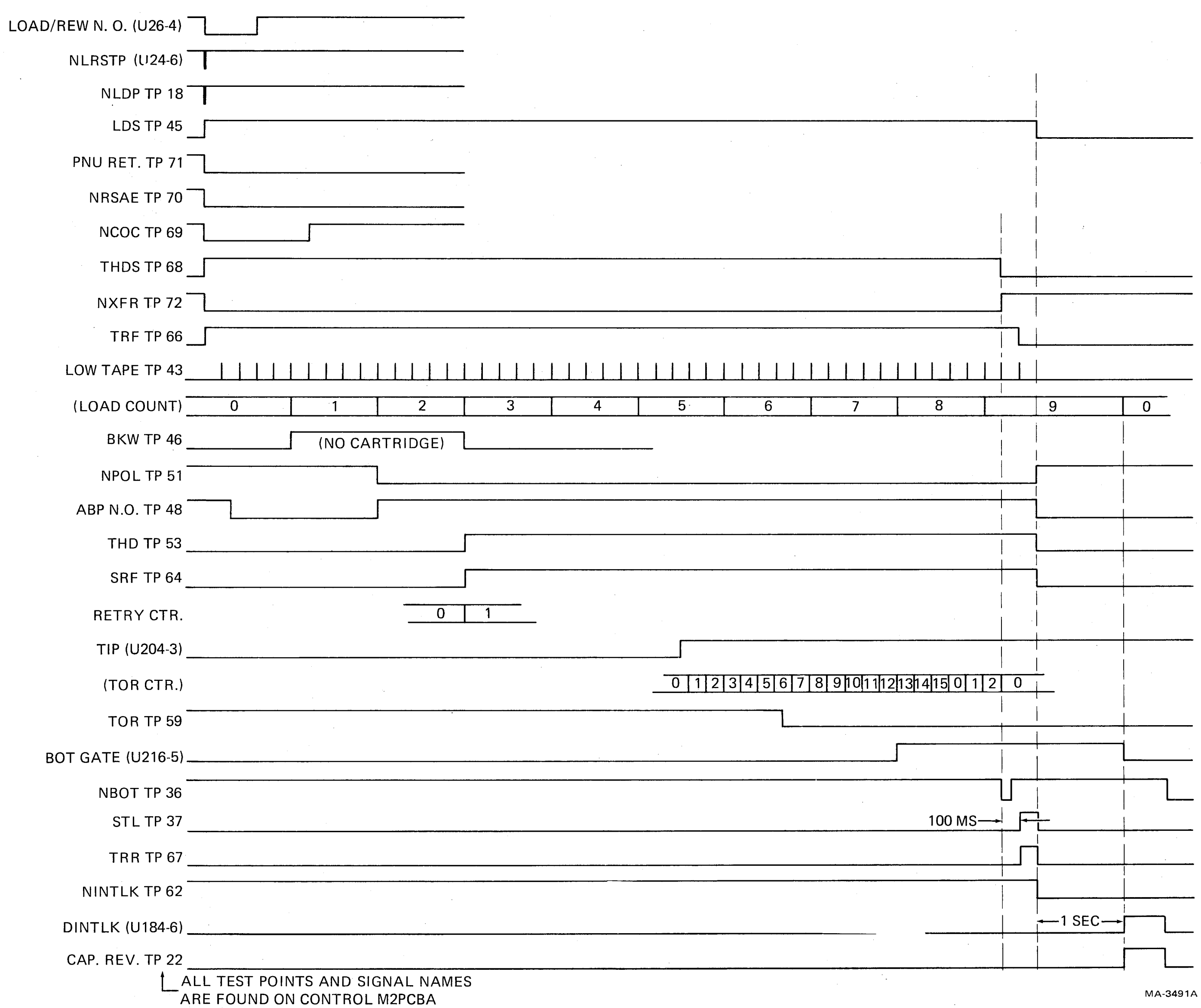


Figure 6-22 Autoload Timing Diagram

Table 6-11 Load Fault Categories

Load Fault Number	Control M2 PCBA Test Point	Category Description
0	TP14	No load count sequencing pulses from take-up 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

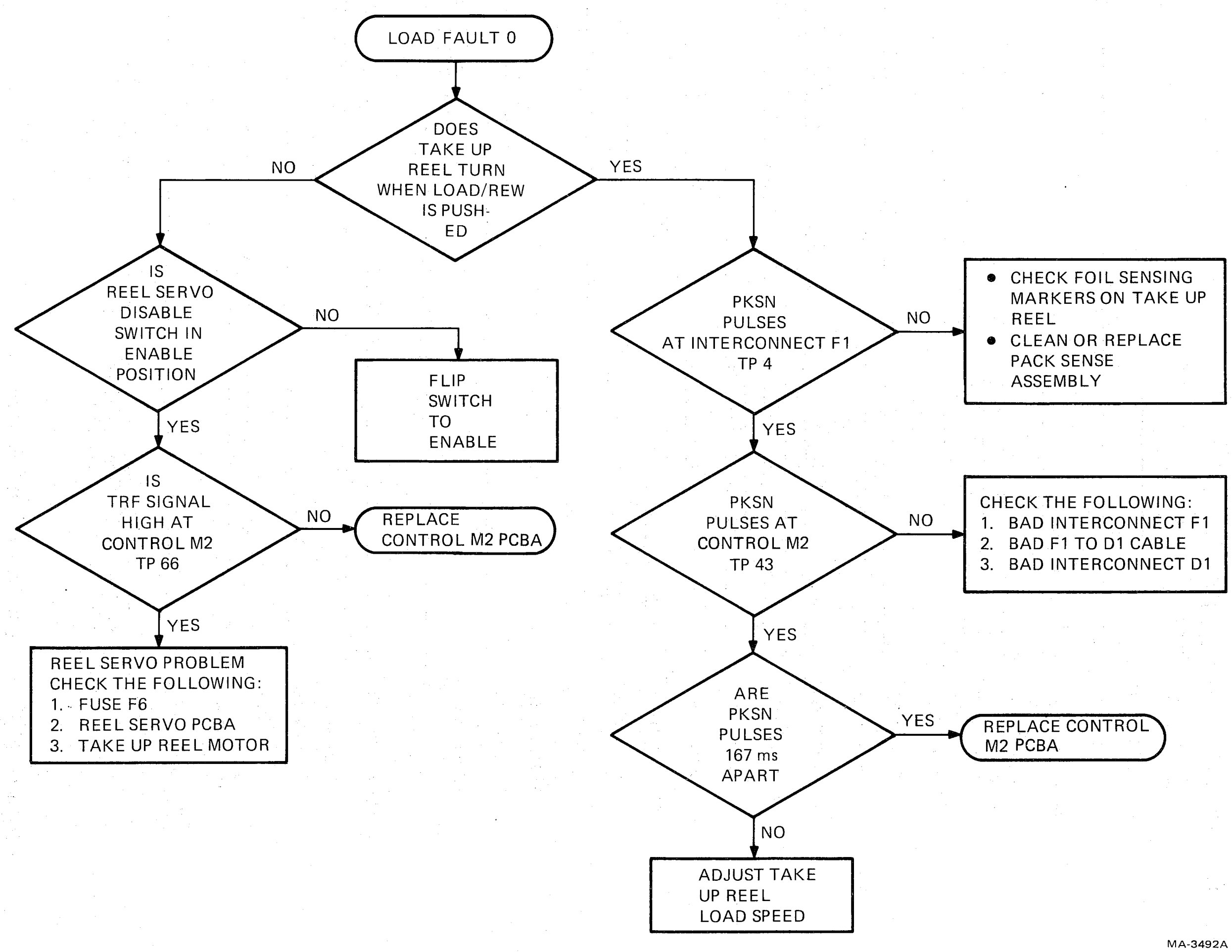


Figure 6-23 Load Fault 0 Flow Diagram

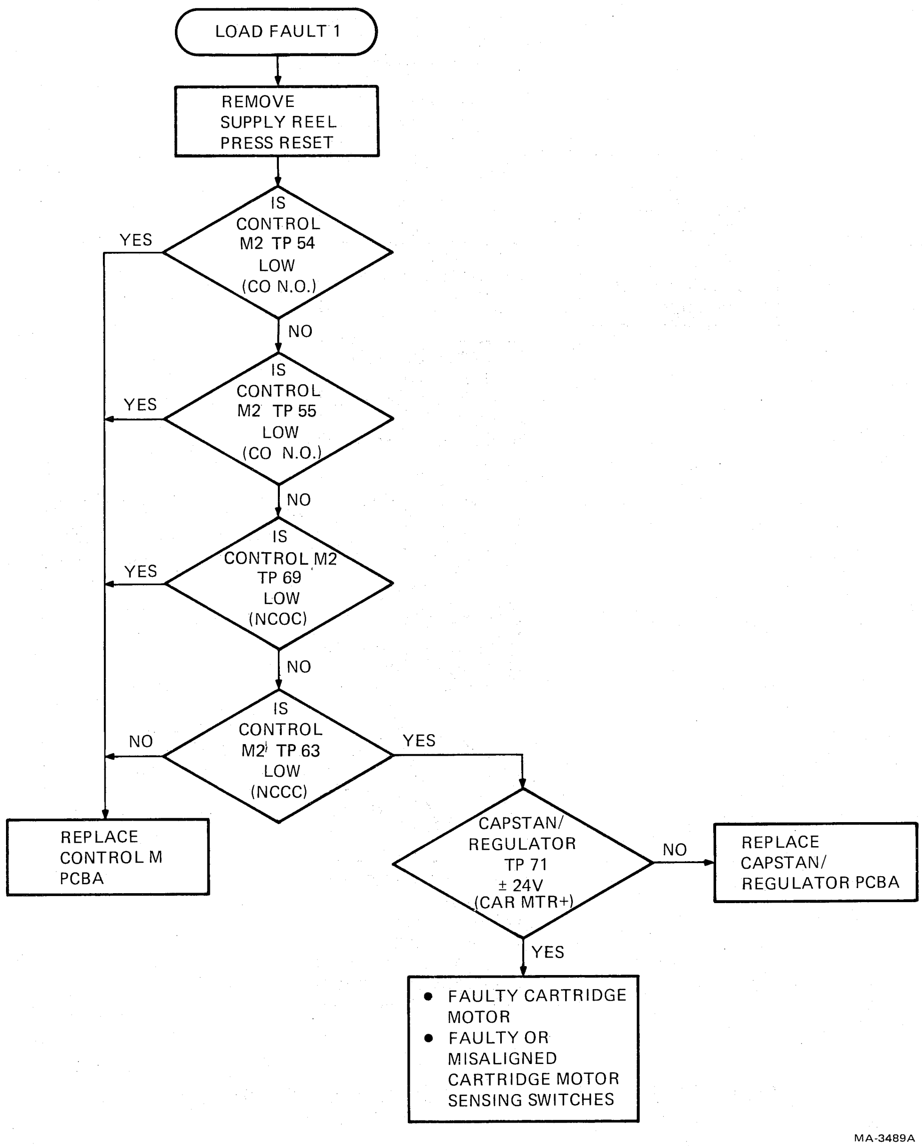


Figure 6-24 Load Fault 1 Flow Diagram

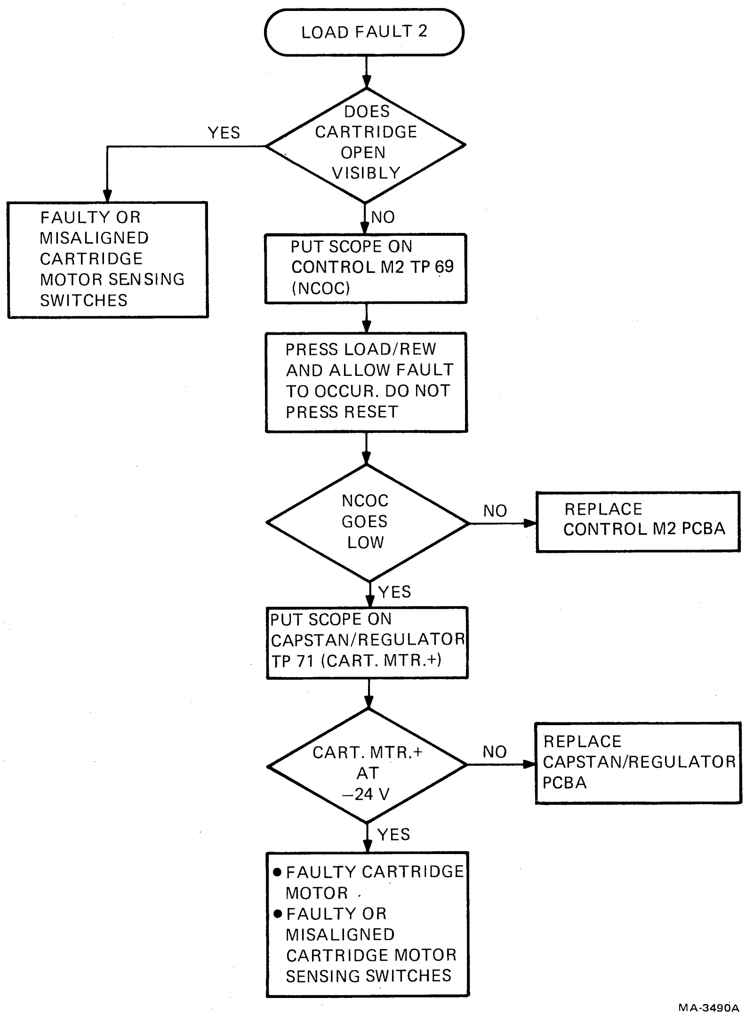


Figure 6-25 Load Fault 2 Flow Diagram

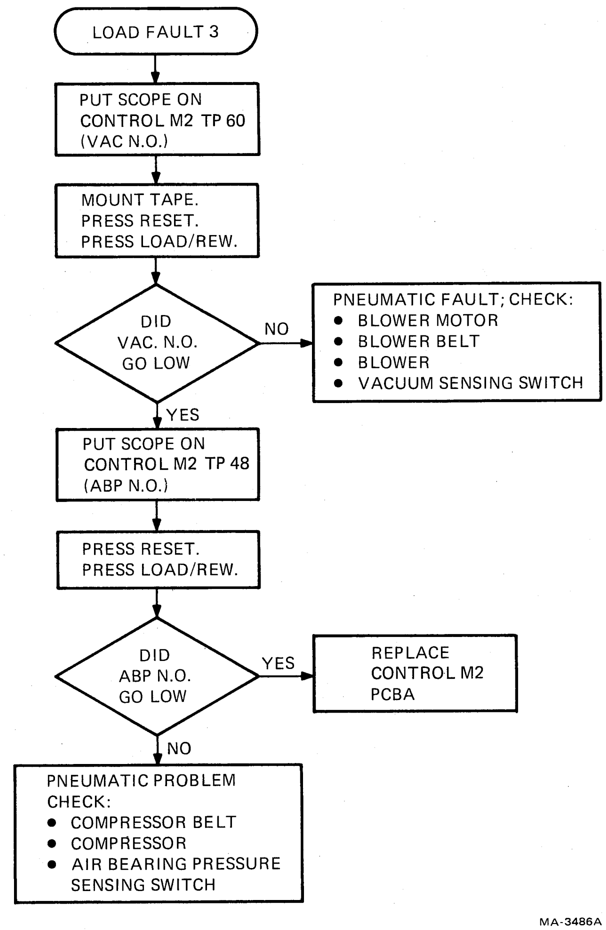


Figure 6-26 Load Fault 3 Flow Diagram

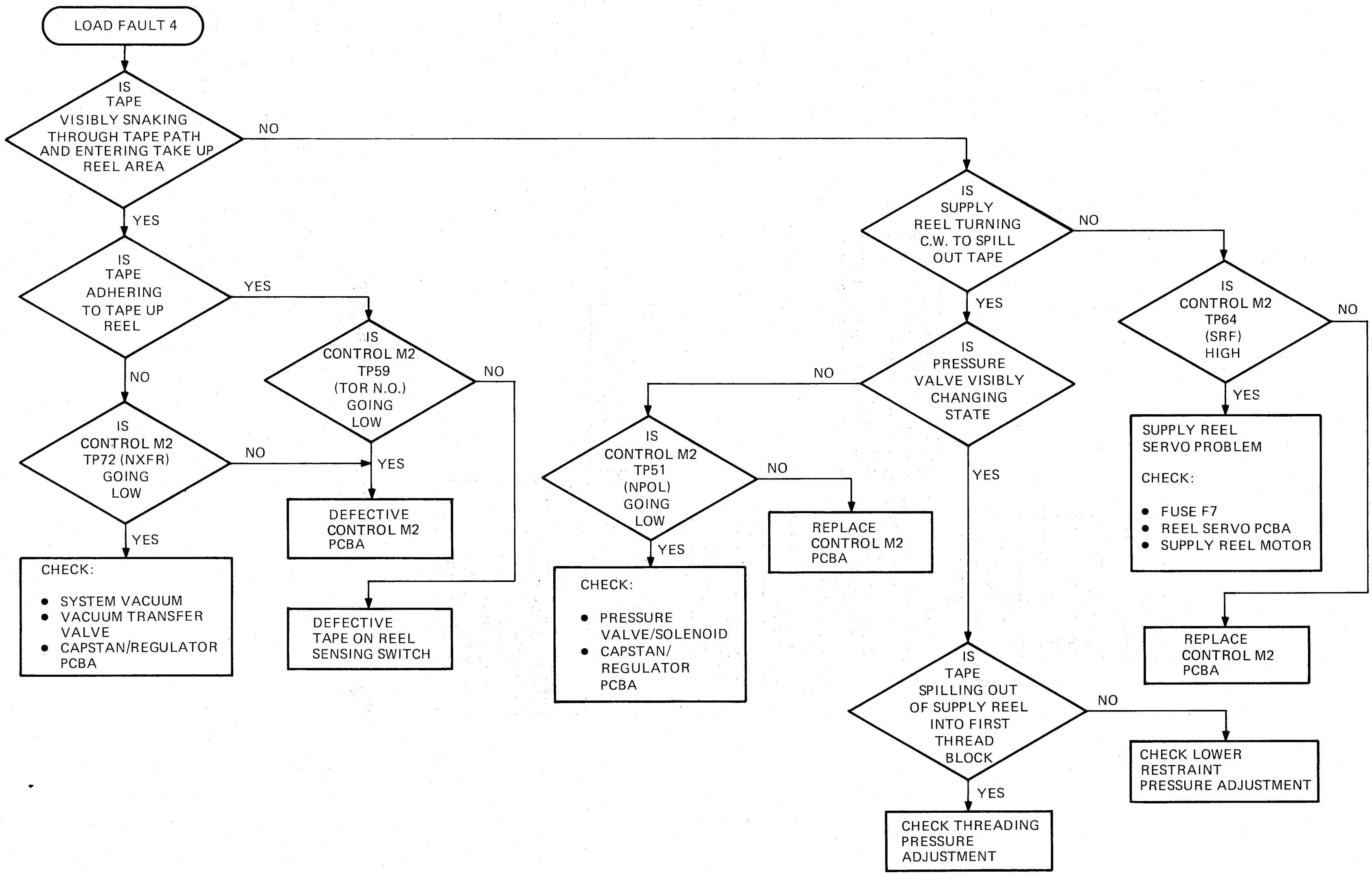
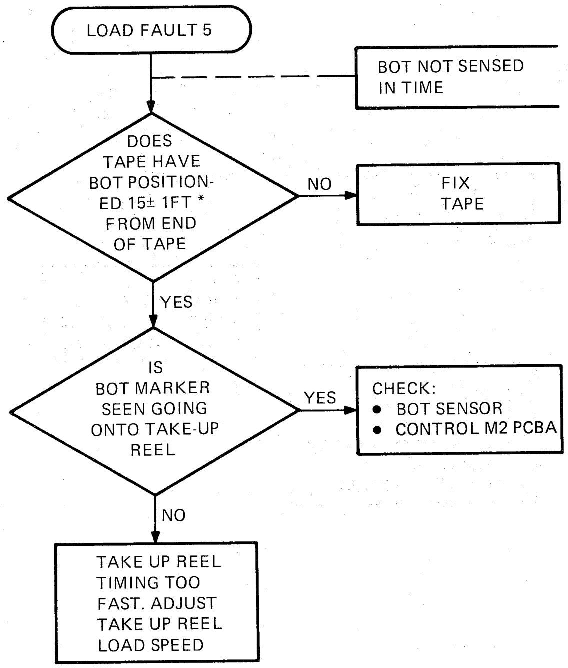


Figure 6-27 Load Fault 4 Flow Diagram



*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-3493A

Figure 6-28 Load Fault 5 Flow Diagram

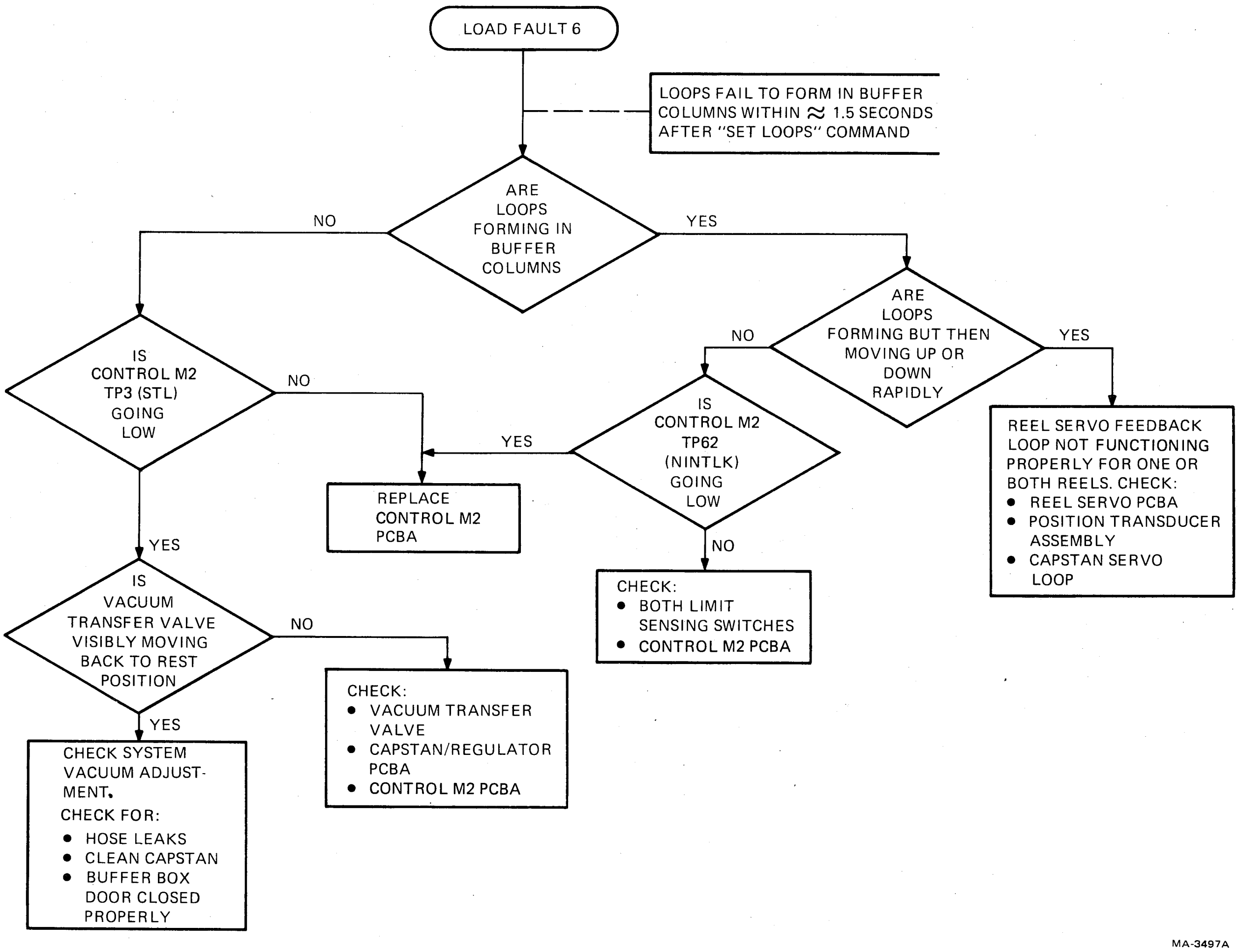


Figure 6-29 Load Fault 6 Flow Diagram

The accompanying flowchart (Figure 6-30) is used to troubleshoot a major pneumatic system failure. In order to track down more subtle failures, first inspect the system. Check for holes, cracks, or pinches in any of the hoses or tubing. Check the condition and tension of both drive belts. Check all positive and negative air values as outlined in Paragraph 6.5.4. 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 should be suspected. Also refer to the air/load control functional block diagram, Figure 4 in Volume 1 of the Technical Manual, for a schematic of the air system.

6.6.6 Reel Servo Troubleshooting

All circuitry used to drive both the take-up 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 of the Technical Manual for a reel servo functional block diagram. Also refer to Figure 6-31 for a simplified schematic diagram of the supply reel servo.)

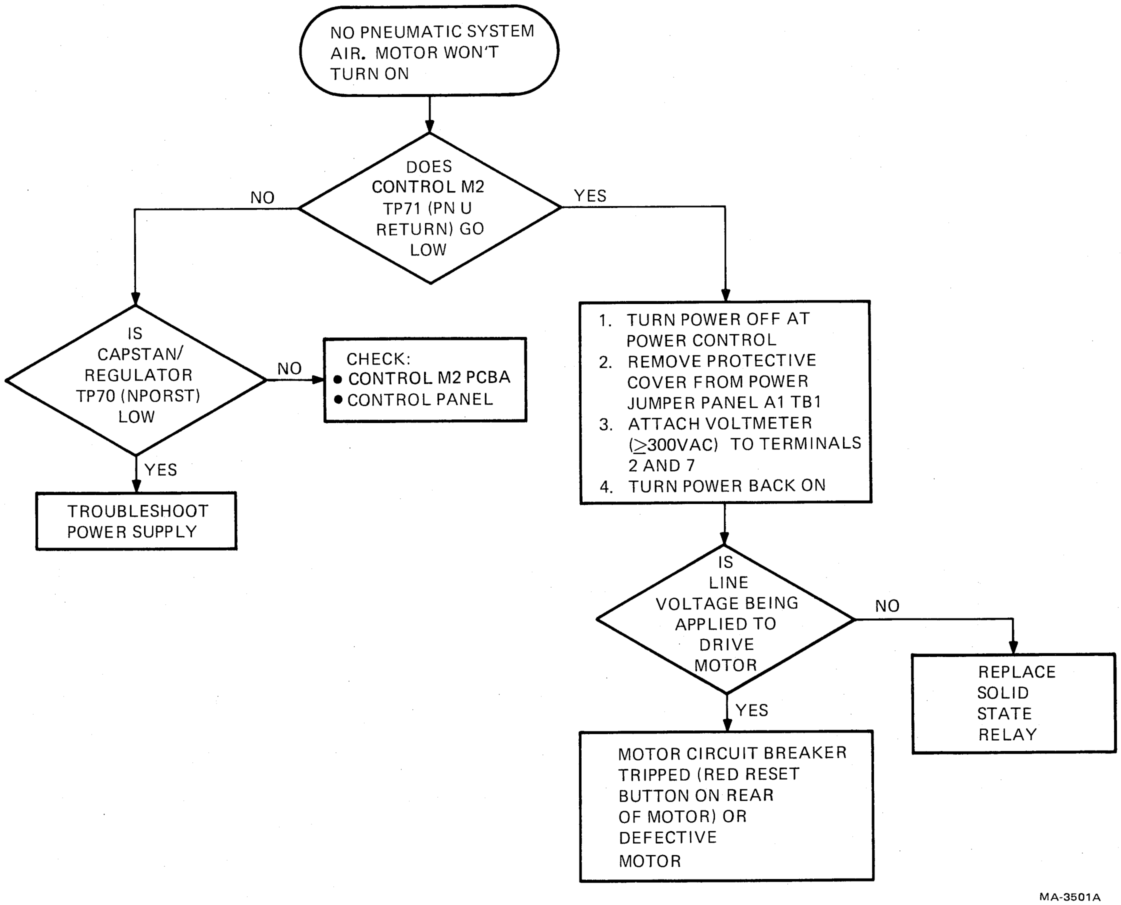


Figure 6-30 Pneumatic Troubleshooting Flow Diagram

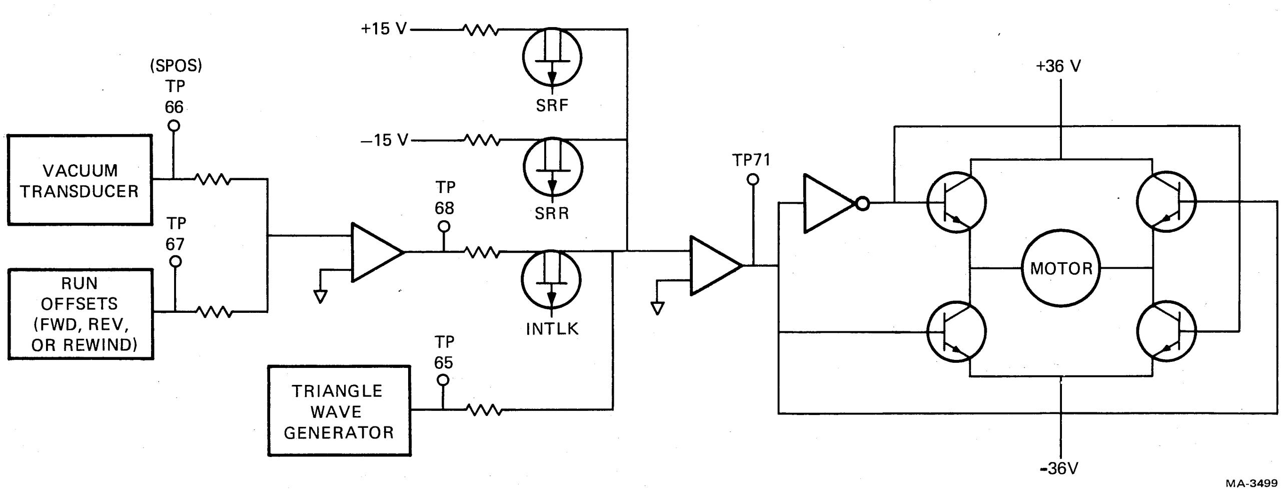


Figure 6-31 Supply Reel Simplified Schematic Diagram

Table 6-12 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	
TP18	−36 V(s)	−40 ±2	Power supply/pneumatic assembly
TP4	+36 V(t)	+40 ±2	
TP10	−36 V(t)	−40 ±2	
TP53	+5 V(s)	5.3 ±.3	Reel servo PCBA

Check all input power sources and voltages developed on the reel servo PCBA. Table 6-12 lists the test points, voltage names, and proper readings with allowable tolerances. Check the test points with a DVM using test point 49 as a ground reference.

A servomechanism is more difficult to troubleshoot in a dynamic condition than a quiescent condition. The TU78 reel servo consists of the reel servo PCBA, reel servo motor, loop position transducer, and loose coupling (feedback) provided by the tape loop in the buffer column. (For a block diagram refer to Figure 5-26.) Therefore, when encountering a reel servo problem, with no indication of what element of the loop is causing the problem, it is advantageous to initially replace the reel servo PCBA 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 (take-up reel only).

Use the following procedure to check reel servo loop feedback elements. Refer to Figure 6-12 for an illustration of the take-up buffer column, its zones, and sensing switches. The supply buffer column is similar but without the crippled reel switch port.

1. Check all system vacuum measurements (Paragraph 6.5.4).

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 M2 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).

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 take-up 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 number 4 (Figure 6-4) with your finger and manually rotate the take-up reel counterclockwise to allow a loop to form. Position the loop in the park zone and release your finger. Tape the take-up reel to prevent movement.

11. Press **RESET** on the control panel.

12. With a scope, monitor control M2 test points TP57 (supply limit N.O.) and TP61 (takeup 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 division 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 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 the loop extends to the upper limit switch and observe the voltage on the scope. Note the reading and the unsigned value of the readings together. The result should be in the 3.6 V to 4.2 V range.

NOTE

The 0.6 V tolerance is due to the system vacuum setting, the position adjustment setting on the interconnect F1 PCBA, and individual position transducer characteristics.

15. Retape the supply reel and remove the tape from the take-up reel. Repeat step 14 for the take-up reel and the take-up 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 ground probe on TB1-14. With the take-up 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 the capstan motor lead and set the reel servo disable switch to front. If, after eliminating the reel servo PCBA and the feedback element, the problem still exists, replace the reel motor.*

---

*Motors can develop shored windings due to overheating. Also, they have a life span associated with the brushes/commutator.

6.6.6.1 Dynamic Brake Check – This procedure must 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 M2 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

6.6.7.1 Introduction and Prechecks – It is assumed you have localized the fault to the TU78 data paths before entering this section. That is, no fatal error codes are displayed in the formatter maintenance panel and the basic integrity of the MASSBUS controller and formatter has been established by running the appropriate control logic diagnostic.

If the data reliability diagnostic shows a hard error on one of the nine tape tracks, skip the following prechecks and go directly to the write/read troubleshooting paragraphs. Otherwise, perform the prechecks; especially if the system error log or the data reliability diagnostic shows more than an average of ten read errors per 2400 feet of tape.

Data Path Troubleshooting Prechecks

1. Clean the transport and try another tape (Paragraph 4.3.4).
2. Make sure the AGC test switch on the read PCBA is in the AGC enabled position (left).
3. Check all unregulated and regulated voltages (Paragraph 6.5.1).
4. Check all vacuums and pressures (Paragraph 6.5.4).
5. Check all capstan servo adjustments (Paragraph 6.5.5).

6. Check head wrap angle (forward/reverse differential) adjustment (Paragraph 6.7.1, steps 6 through 14).

7. Check tape tracking (Paragraph 6.7.5, steps 8 through 31).

8. Check that air bearings are not installed wrong (Paragraph 6.7.4).

9. Check read/write adjustments (Paragraph 6.5.7).

6.6.7.2 Write Path/Read Preamp Troubleshooting – The following troubleshooting procedure uses the PE (1600 BPI) mode. If you are experiencing problems related to the GCR (6250 BPI) mode, simply place the maintenance switch to 6250 instead of 1600 when directed. The waveforms look similar but naturally the frequency is different. A write path one function diagram (Figure 6-32) is provided so you may trace the flow of data completely through the transport, from the TU bus to the head, using channel 7. Figure 6-32 provides pin charts so you may scope other channels as well.

1. Mount and load a write enabled scratch tape to BOT. Flip the MASSBUS port select switch to position 3 (maintenance) and place the transport on-line.

2. Release the service lock, pull out the stabilizer arms and swing open the base assembly. Make sure all vacuum/pressure hoses and pressure port caps are in place. Check all cables for proper seating, particularly the AMTIE cable from the write to MIA PCBAs.

3. Set the maintenance switches on the MIA PCBA (Figure 6-14) as follows in the order given.

Pattern select	All ones. (all switches forward)
S1	Reverse (left)
S2	Write (right)
S3	1600 (left)
S4	Manual (right)

The test mode indicator on th MIA PCBA, and the 1600 density indicator on the control panel should both be lit. The transport should not be moving tape.

4. Place MIA switch S3 to the right (6250). The 1600 density indicator should go out and the 6250 density indicator should come on.

5. Change the MIA switch settings as follows, in the order given.

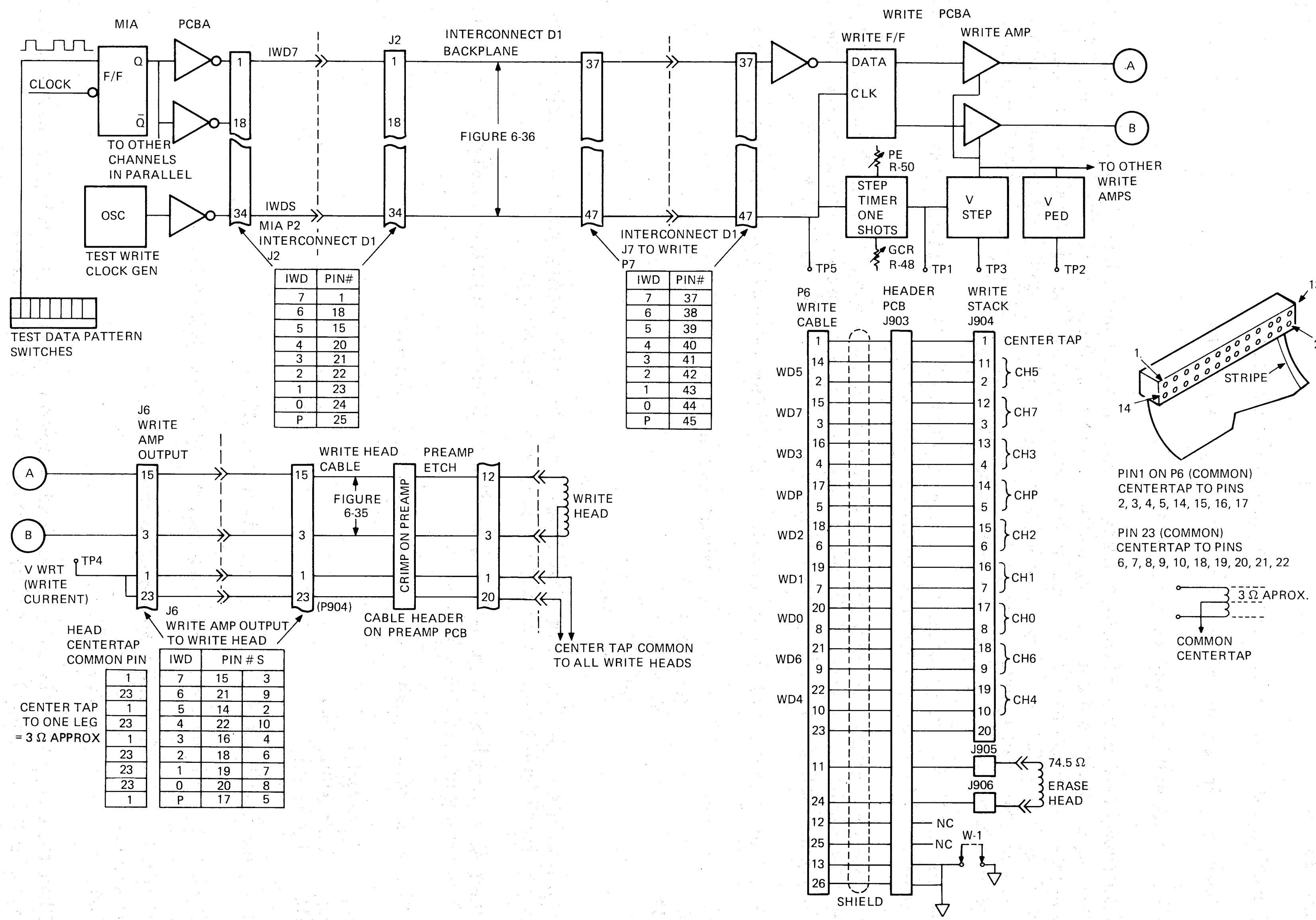
S4	Auto (left)
S1	Forward (right)
S3	1600 (left)

The tape should not move. If it does, return it to BOT.

6. Look at the output of the read preamplifiers. Set the scope as follows.

Vertical	= CH 1, 0.5 V/div, ac (using 10X probe)
Horizontal	= 2 μs/div,
Sync	= Norm, ac, Ch 1

7. Place the channel 1 probe on the upper lead of preamp output resistor R1. This resistor is one one of a pair for track 1 (channel 5). Refer to Figure 6-9 for location.



IWD	PIN#
7	1
6	18
5	15
4	20
3	21
2	22
1	23
0	24
P	25

IWD	PIN#
7	37
6	38
5	39
4	40
3	41
2	42
1	43
0	44
P	45

HEAD CENTERTAP COMMON PIN	IWD	PIN # S	
1	7	15	3
23	6	21	9
1	5	14	2
23	4	22	10
1	3	16	4
23	2	18	6
23	1	19	7
23	0	20	8
1	P	17	5

Figure 6-32 Write Path One Function Block Diagram

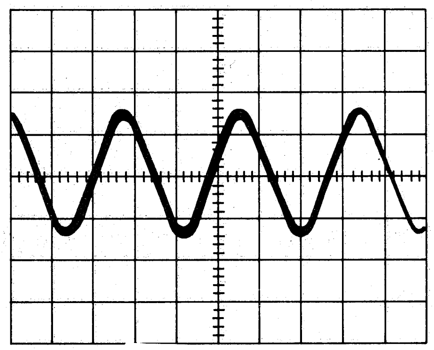


Figure 6-33 Read Preamplifier Output Waveform

8. Place MIA switch S4 to manual (right). The transport moves tape and attempts to write an all ones continuous record down tape. The tape can be started and stopped with the control panel ONLINE switch, and rewound with the REW/UNL switch when desired.

9. Look at the waveform on the scope. It should look exactly like the waveform shown in Figure 6-33. The sinusoidal waveshape should have a 5.4 μs period and have an amplitude of approximately 1.2 volts peak-to-peak.

   Amplitude varies according to the PE gain setting for each track and the type of tape being used.

10. Monitor each output resistor pair of each channel for a similar signal. Refer to Figure 6-9 to locate the resistors. If all signals from all channels are acceptable, assume the following and go on to read path troubleshooting (Paragraph 6.6.7.3).

    - Write path is ok
    - Write head is basically working
    - Read head is working
    - Preamp PCBA is working

11. If all channels are not working correctly (the waveshapes are very different from Figure 6-33), or are missing, the problem could be one of the following things.

    - Write PCBA
    - Preamplifier PCBA
    - MIA PCBA
    - Head

    Also check signal VWRT, the source for each write head center tap, by placing the scope probe on write PCBA TP4. During a write operation, TP4 should be +15 Vdc, ±1 Vdc.

    Go to step 13.

12. If most channels are working properly but one or more waveshapes are missing or distorted, proceed as follows.

a. Set the MIA switches as follows.

S1 Off (center)
S2 Read (left)
S3 1600 (left)
S4 Manual (right)

b. Load a master skew tape (write ring removed) and place the transport on-line.

c. Set the scope as follows.

Vertical Ch1	=	5 mV/div, ac (using X1 probe)
Vertical Ch2	=	5 mV/div, ac, invert (using X1 probe)
Vertical Mode	=	Add
Horizontal	=	10 μs/div
Sync	=	Normal trigger, HF rej, normal source

NOTE
X10 probes do not work for this measurement.

d. Place the Ch1 and Ch2 probes on each leg of a preamplifier compensation capacitor for a good track. Refer to Figure 6-9 in this manual, or Figure 23 in Vol 1 of the Technical Manual, for capacitor locations.

e. Place MIA switch S1 to the forward (right) position. The waveform on the scope should be sinusoidal, similar to that shown in Figure 6-34.

f. Now place the scope probes across the compensation capacitor for a suspected track. If the signal is missing or distorted, the head is at fault.

g. Stop the skew tape and unload it. The resistance of the head winding can be measured across the compensation capacitor.

NOTE
Use a VOM with a 20,000 ohm/volt rating or greater, or a DVM on low power ohms scale. The read head windings can be burned out by a high test current.

A good head winding measures approximately 8.2 ohms, while an open winding shows approximately 20,000 ohms (preamp input resistance).

h. If all read head outputs look okay when using a skew tape, mount the scratch tape again.

i. Look at the compensation capacitors again; this time while writing (MIA switch S2 right). You should see a sinusoidal waveform similar to the one shown in Figure 6-35.

j. If the waveforms observed at the read head are acceptable while reading a skew tape and while writing a scratch tape, but not at the preamp output (step 11), possible problem areas are as follows.

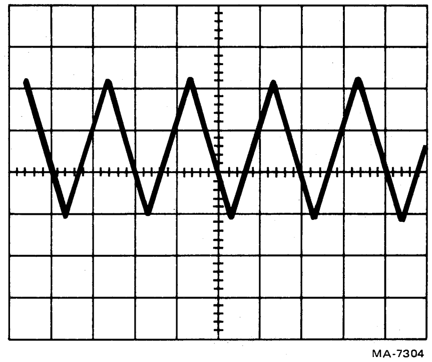


Figure 6-34 Normal Read Head Output While Reading

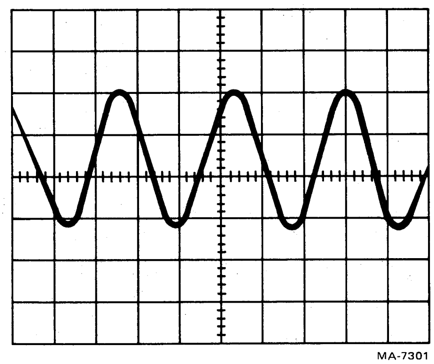


Figure 6-35 Normal Read Head Output While Writing

- Bad GCR/PE preamp 1 PCBA
- Bad read PCBA
- Bad cable from preamp to read PCBAs
  (preamp needs load from read PCBA to develop an output signal)

  Go on to read path troubleshooting (Paragraph 6.6.7.3).

k. If the waveforms observed at the read head are while reading a skew tape, but not while writing a scratch tape, possible problem areas are as follows.

   - Bad write PCBA
   - Bad MIA PCBA
   - Bad GCR/PE preamp 1 PCBA (write head cable)
   - Bad write head (worn or open/shorted windings)

     Go to step 13.

13. Remove power from the transport and place the write PCBA on an extender. Refer to Paragraph 6.6.2 for instructions on how to use the extender. Remove the write head cable from the write PCBA (J6).

14. Set the MIA switches as follows.

Pattern select	All ones (all switches forward)
S1	Off (center)
S2	Write (right)
S3	1600 (left)
S5	Manual (right)

15. Set the scope controls as follows.

Vertical Ch1	= 0.2 V/div, ac (X10 probe)
Horizontal	= 0.5 μs/div
Sync	= Norm, HF rej, Ch1

16. Flip MIA switch S1 to the right (FWD) and scope each of the write PCBA outputs at J6. Refer to Figure 6-32 for a pin diagram and signal table for J6. Figure 6-36 shows a write amplifier output waveshape with no load (P6 unplugged).

17. If any of the nine channels look significantly different, trace the signal back to the MIA PCBA using Figure 6-32 as a guide. Figure 6-37 shows the waveshape for write data and a write data strobe entering the write PCBA.

18. If all nine channels are acceptable, the write head is probably defective. To check, stop the tape and unload it and remove power from the transport. Measure the resistance of each write head winding using Figure 6-38 as a guide. Keep in mind that each write head winding is center tapped. Each half of the winding should measure approximately 3 ohms. If any winding shows open or shorted, replace the head assembly following the procedure in Paragraph 6.7.1.

19. If the write head continuity checks okay, and the head poles are not worn excessively (Paragraph 6.7.1), check the erase head continuity. The resistance between P6 pins 11 and 24 should be approximately 75 ohms with the write cable unplugged. In normal operation while writing, the erase head voltage (at the head) should be as follows.

P905 (White wire) = −10 volts
P906 (Black wire) = −15 volts

If the continuity check fails, the preamp PCBA or the head assembly has to be replaced. If the continuity check is correct but the voltage check is incorrect, the write PCBA has to be replaced. When replacing either of these components, make sure the black and white wires are put back correctly to observe correct erase head polarity.

6.6.7.3 Read Path Troubleshooting – The read path can be divided into the two basic sections; the data path and the AMTIE path. A read path one function diagram (Figure 6-39) is provided so you may trace the data flow completely through the transport, from the head to the TU bus, using channel 5. Figure 6-39 provides pin charts so you may scope other channels as well.

In order to check out the preamp PCBA and the read/write head, do check the write path first (Paragraph 6.6.7.2). If the write path checks did not localize a problem, proceed as follows to continue troubleshooting the read path.

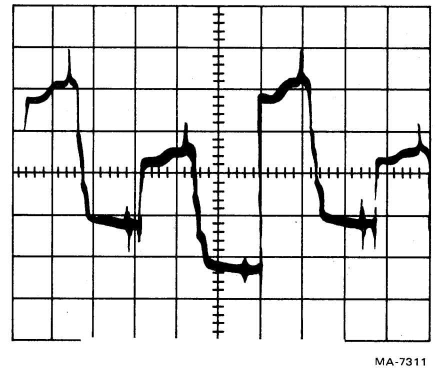


Figure 6-36 Write Amplifier Output With No Load

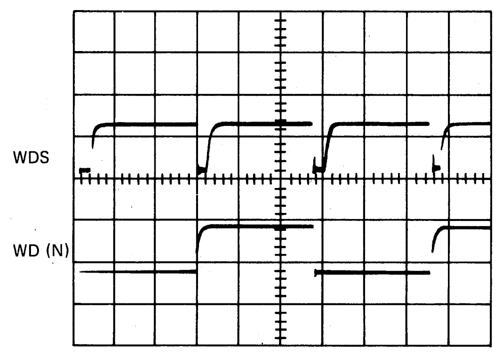


Figure 6-37 Write Data at Input to Write PCBA

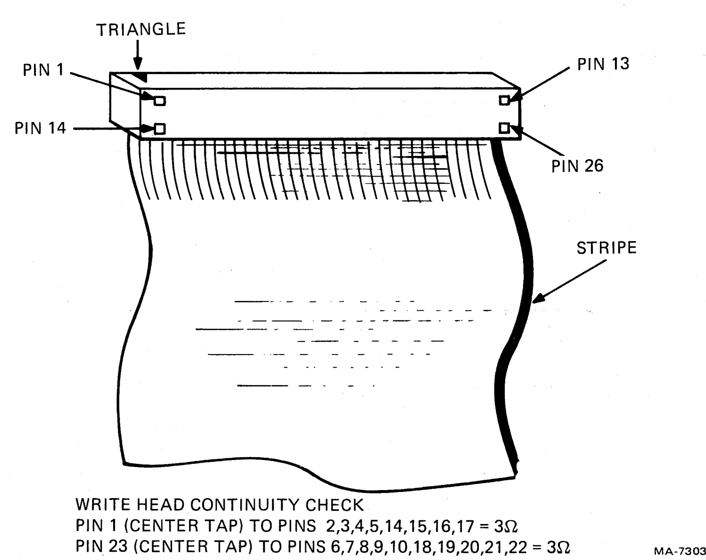
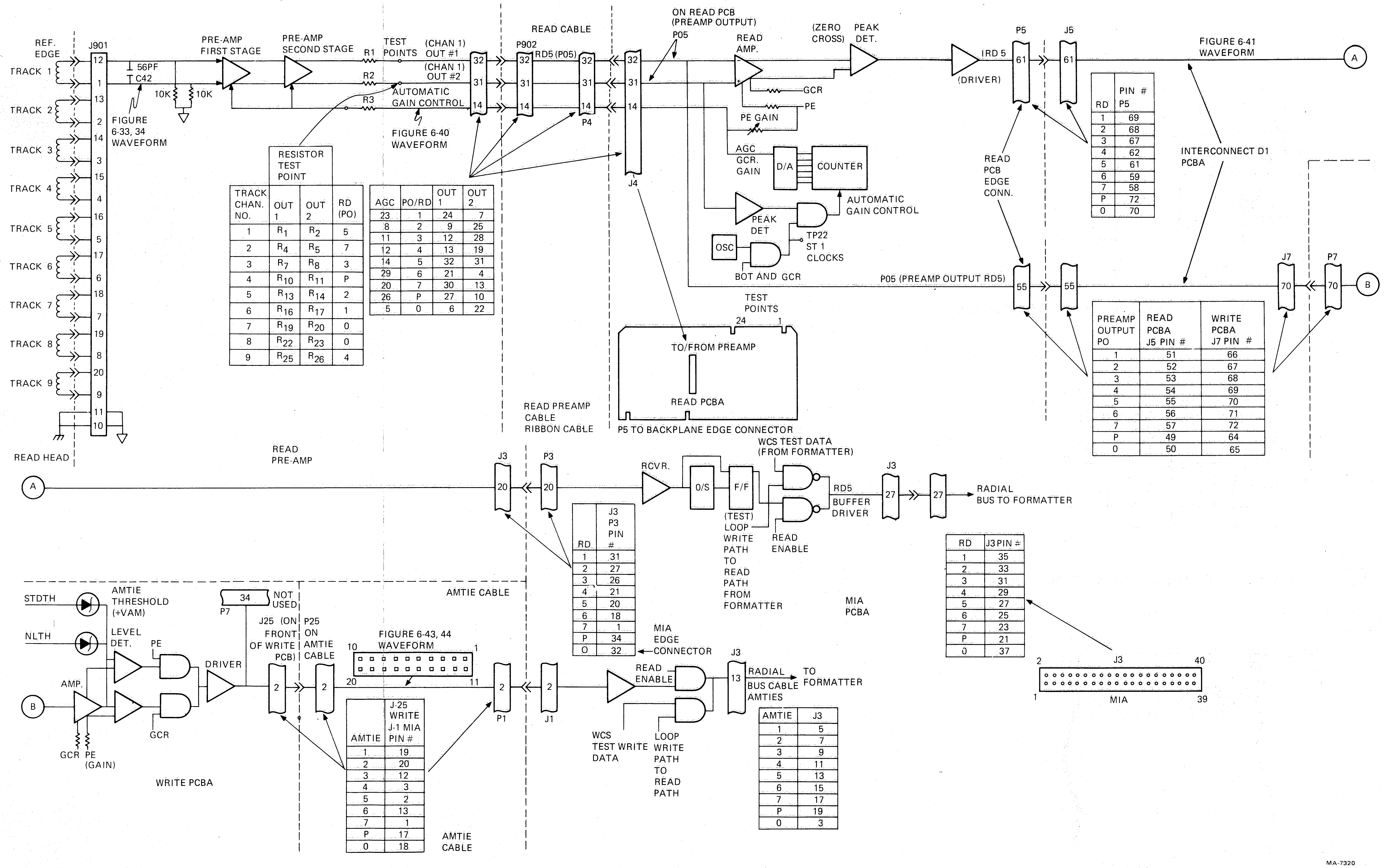


Figure 6-38 Write/Erase Head Plug (P6) Test Points



TRACK CHAN. NO.	OUT 1	OUT 2	RD (PO)
1	R_1	R_2	5
2	R_4	R_5	7
3	R_7	R_8	3
4	R_{10}	R_{11}	P
5	R_{13}	R_{14}	2
6	R_{16}	R_{17}	1
7	R_{19}	R_{20}	0
8	R_{22}	R_{23}	0
9	R_{25}	R_{26}	4

AGC	PO/RD	OUT 1	OUT 2
23	1	24	7
8	2	9	25
11	3	12	28
12	4	13	19
14	5	32	31
29	6	21	4
20	7	30	13
26	P	27	10
5	0	6	22

RD	PIN # P5
1	69
2	68
3	67
4	62
5	61
6	59
7	58
P	72
0	70

PREAMP OUTPUT PO	READ PCBA J5 PIN #	WRITE PCBA J7 PIN #
1	51	66
2	52	67
3	53	68
4	54	69
5	55	70
6	56	71
7	57	72
P	49	64
0	50	65

RD	J3 P3 PIN #
1	31
2	27
3	26
4	21
5	20
6	18
7	1
P	34
O	32

RD	J3 PIN #
1	35
2	33
3	31
4	29
5	27
6	25
7	23
P	21
0	37

AMTIE	J-25 WRITE J-1 MIA PIN #
1	19
2	20
3	12
4	3
5	2
6	13
7	1
P	17
0	18

AMTIE	J3
1	5
2	7
3	9
4	11
5	13
6	15
7	17
P	19
0	3

Figure 6-39 Read Path One Functional Block Diagram

6.6.7.3.1 Read Data Path – When writing or reading in GCR mode, the preamp gain is set automatically. Each track is set individually according to the playback signal received while reading the ARA burst. Refer to Paragraph 5.11.5.3 for an explanation of the AGC circuits. Gain in PE mode is a fixed level set by the read PCBA PE gain POT adjustments.

Check the GCR AGC circuits as follows.

1. Static tests

   a. Mount and load a write enabled scratch tape to BOT but do not place the transport on-line.

   b. Set the MIA PCBA test switches as follows.

Pattern Select	All ones (all switches forward)
S1	Forward (right)
S2	Write (right)
S3	6250 (right)
S4	Manual (right)

   c. Set the read PCBA AGC switch to the test AGC position (center).

   d. Set the scope controls as follows.

Vertical Ch1	= 0.5 V/div, ac (X10 probe)
Vertical Ch2	= 0.5 V/div, dc (X10 probe)
Vertical Mode	= Chop
Horizontal	= 5 ms/div
Sync	= Norm, AC, Ch1

   e. Place the Ch1 scope probe on read PCBA TP22 (ST1 CLOCKS).

   f. Press the ONLINE button and quickly press it again. This moves tape off the BOT marker and stops it.

   g. The trace on Ch1 should have a series of 32 positive going ST1 CLOCK pulses displayed, each with a period of 850 μs ± 85 μs. Refer to Figure 6-40. Position the Ch2 trace (straight line) on the bottom graticule of the screen.

   h. Now look at the nine AGC levels at the preamp by placing Ch2 probe on the following IC pins.

Track 1	U4-1
Track 2	U4-13
Track 3	U4-6
Track 4	U8-1
Track 5	U8-13
Track 6	U8-6
Track 7	U12-1
Track 8	U12-13
Track 9	U12-6

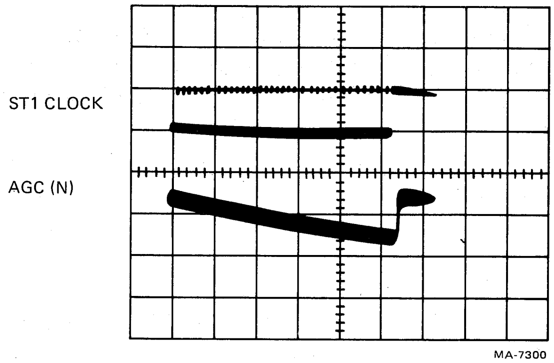


Figure 6-40   Automatic Gain Control (AGC) Waveform – GCR Mode

Make sure the scope probe is grounded to the preamp to eliminate unwanted noise. Refer to the lower trace shown on Figure 6-40. The waveform dc level should start at approximately +1.7 V (PE gain level) and ramp down, in a staircase pattern, to approximately +1.2 V.

i. If any of the AGC waveforms are incorrect, the likely cause is the read PCBA (AGC source). Replace it.

2. Dynamic tests

a. Use the same scope settings as in step 1d except for the following.

Vertical Ch2 = 0.1 V/div, ac (10X probe)

Reposition the Ch2 trace and observe the small staircase pattern on the decending ramp. Increase the time base (Horizontal) for a better view of the steps.

b. While looking at one of the AGC voltages, place the transport on-line. It begins writing and moving tape forward.

c. Observe the following things.

- The trace on Ch1 (ST1 CLOCK) shortens to approximately 9 clocks.
- The ST1 CLOCKS stop when all read channels lock up (all set).

d. Look at the other AGC voltages. Each one locks up at a different time depending upon that tracks amplitude. The last channel to lock up reaches a stable level at the last ST1 CLOCK.

e. To test full count, ground the upper lead of one of the right hand resistors of a resistor pair for one channel of the preamp. (For example, R2 for Ch5.) The ST1 CLOCKs go back out to 32 because this channel will not lock on.

f. If any of the AGC channels in this test remains at the lower voltage (approximately 1.2 Vdc), which is the maximum gain, it is probably bad and the read PCBA should be replaced.

g. If the ST1 CLOCKs fail to shorten up from 32 counts to something less, one or more channels are not getting set up. This may be due to a bad read PCBA or a reduced analog signal at its input.

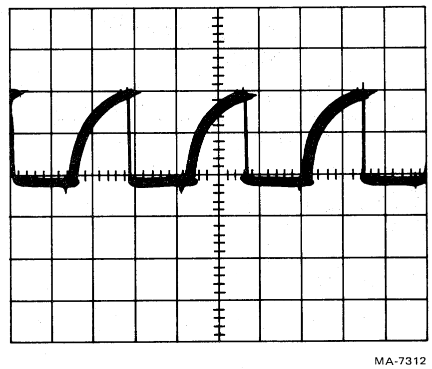


Figure 6-41 Read Data Output

h. If any AGC voltage fails to step down evenly, that is if some steps appear larger than others, part of the AGC DAC circuitry for that channel is not working properly. The transport can still function, but not as reliably as possible. Replace the read PCBA.

i. Return the read PCBA AGC switch to the normal (left) position.

3. Read data path
Use Figure 6-39 to trace the nine read data channels through the read PCBA and MIA PCBA. The TU78 does not generate a read data strobe pulse because all nine channels are deskewed in the formatter. Figure 6-41 shows the waveform for a read data bit at the output of the read PCBA [IRD (n)]. Read data bits are not latched in the TU78.

6.6.7.3.2 AMTIE Paths Troubleshooting – The TM78 uses AMTIES to detect active/inactive tracks. They determine the following things.

1. Which density ID track is written at BOT (PE = track 4, GCR = track 6)
2. ARA burst start
3. Preamble/postamble length and quality
4. Start/end of data envelope
5. File marks
6. A low amplitude track
7. Error correction pointers

Figure 6-42 shows a block diagram of the AMTIE generation circuitry.

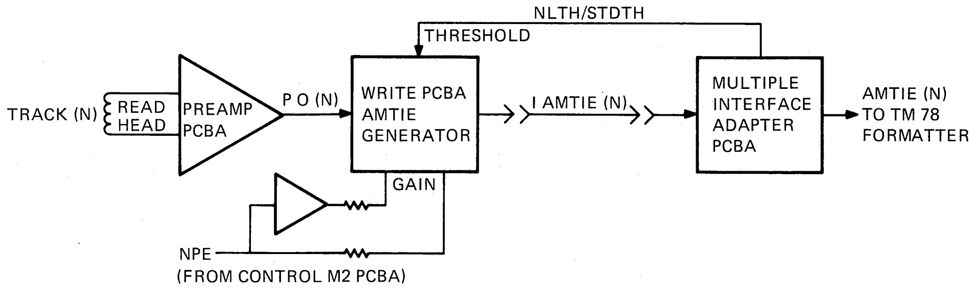


Figure 6-42 AMTIE Generation Circuitry

1. Troubleshooting +VAM AMTIE threshold voltage without TM78 formatter

   a. Set the scope controls as follows

      Vertical Ch1 = 1.0 V/div, dc (10X probe)
      Horizontal = 0.1 ms/div
      Sync = Auto, dc, Ch1

   b. Remove power from the tape transport. Place Ch1 probe on the front lead of write PCBA R324 (signal +VAM). Refer to Figure 6-43 for locations.

   c. Remove the AMTIE cable from the MIA PCBA. Reapply power to the transport and load a scratch tape to BOT.

   d. Take AMTIE threshold voltage measurements (+VAM) while grounding the following pins of the AMTIE cable connector (J25).

Ground Pin	Signal	+VAM Measurement
5	NLTH	+4.8 Vdc, ±0.5 Vdc
15	STDTH	+10.2 Vdc, ±0.5 Vdc

   If the results differ, replace the write PCBA or the AMTIE cable.

2. Troubleshooting +VAM AMTIE threshold voltage using TM78 fomatter

   a. Reinsert the AMTIE cable into the MIA PCBA Jack J1. The +VAM voltage should read +4.5 Vdc, ±0.5 Vdc.

   b. Load a scratch tape to BOT and set MIA switch S4 to auto (left).

   c. Set the scope controls as follows.

      Vertical Ch1 = 2.0 V/div, dc (10X probe)
      Horizontal = 1.0 ms/div
      Sync = Norm, Ch1, dc negative scope

   d. Place the Port Select switch to position 3 (maintenance), and the transport on-line.

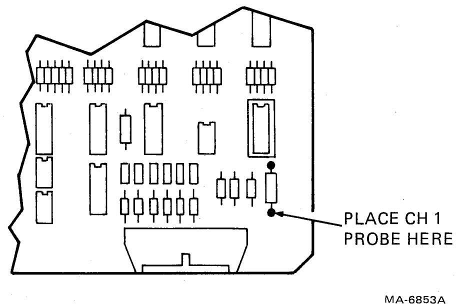


Figure 6-43 +VAM Test Point on Write PCBA

e. Enter the following commands into the TM78 maintenance keypad.

- **ENA** (enable)
- **63** (write GCR)
- **REP** (repeat instruction)

The display should indicate **LOOP** and the transport should write short records.

f. The +VAM AMTIE threshold signal shown on the scope should be similar to Figure 6-44. The voltage goes from +4.5 Vdc, ±0.5 Vdc to +10 Vdc, ±0.5 Vdc.

g. Press **CLR** on the keypad. Enter **7** and press **EXE** to rewind the tape.

h. If test "1" (without TM 78 formatter) works properly, but test "2" (with TM 78 formatter) does not, the likely cause is the MIA PCBA. If neither test works, the likely cause is the write PCBA.

3. AMTIE channel switching

a. Place the transport off-line and remove the AMTIE cable from the MIA PCBA (J1).

b. Use the same scope settings as in test 2, step 6, but change the horizontal setting to 1.0 μs/div.

c. Set the MIA switches as follows.

Pattern select	= SW1 forward, all others rear (10000000).
S1	= FWD (right)
S2	= WRT (right)
S3	= 1600 (left)
S4	= MAN (right)

d. Look at each AMTIE output at the cable connector with the scope. Refer to Figure 6-39 for pin numbers. Each output should be approximately 5.0 Vdc.

e. Place the transport on-line. The transport drives the tape forward and writes the 10000000 data pattern on each track down the tape. This pattern causes each track to produce an AMTIE. Each output goes to ground and returns to +5 V as shown in Figure 6-45.

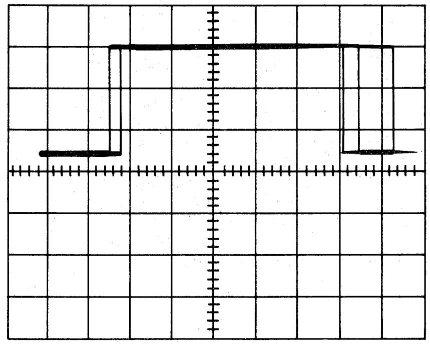


Figure 6-44 +VAM AMTIE Threshold Voltage

f. All AMTIE channels should look similar to Figure 6-45. If one or more do not, trace the signal back using Figure 6-39.

g. If an AMTIE channel is not acceptable and the preamp tests are all okay, replace the write PCBA.

h. If all AMTIE channels are acceptable but TM78 or diagnostics indicate an AMTIE problem, replace the MIA PCBA.

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 necessary by the procedures. References are 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 6-13.)

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 that 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 that do not have guttering, 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. That is the head has worn to a depth greater than 0.254 mm (0.010 in).

Head replacement is accomplished in the following way (Figure 6-46).

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 GCR/PE preamp 1 PCBA bracket to base assembly.

4. Grasp the head assembly and remove two socket-head screws holding the head against the head-mounting plate.

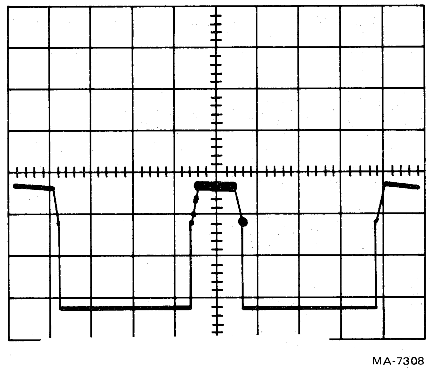


Figure 6-45 AMTIE Signal Switching

Table 6-13 Parts Replacement/Adjustment Cross Reference

Paragraph	Removal or Replacement Procedure	Corequisite Check/Adjustment
6.7.1	Head replacement procedure	6.5.7
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	6.5.7.1, 6.5.4.1, 6.5.4.2
6.7.6	Supply reel motor replacement	6.5.6.2, 6.5.6.4
6.7.7	Vacuum reel assembly replacement and takeup reel motor replacement	6.5.6.3, 6.5.6.4
6.7.8	Cartridge actuator motor replacement	—
6.7.9	Controls assembly removal and replacement	—
6.7.10	Blower/compressor ac motor replacement	6.5.4
6.7.11	Blower removal and replacement	6.5.4
6.7.12	Compressor removal and replacement	6.5.4

Table 6-13 Parts Replacement/Adjustment Cross Reference (Cont)

Paragraph	Removal or Replacement Procedure	Corequisite Check/Adjustment
6.7.13	Air valve solenoid replacement	—
6.7.14	PCBA removal/replacement	—
6.7.14.1	MIA PCBA	—
6.7.14.2	Read PCBA	6.5.7.3
6.7.14.3	Write PCBA	6.5.7.2, 6.5.7.3
6.7.14.4	Control M2 PCBA	—
6.7.14.5	Capstan servo PCBA	6.5.1, 6.5.5, 6.5.7.3
6.7.14.6	Reel servo PCBA	6.5.1, 6.5.6, 6.6.6.1
6.7.14.7	GCR/PE Preamp 1 PCBA	6.5.7.3
6.7.14.8	Interconnect F1	6.5.2, 6.5.3, 6.5.6.4
6.7.14.9	Interconnect D1	—

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 clean 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 the white lead to the erase head connects to J905 and the black lead to J905.

7. Initially align head by visually aligning lower edge of head with inclined edge of base metallic overlay. (Refer to Note 2 of Figure 6-46.) Bias head assembly by pressing it towards the right, into tape path, with finger pressure. Make sure the erase head contacts a sample section of magnetic tape. Lightly tighten the head-mounting screws. Connect erase head wires to the PCBA, making sure the white wire is closest to the operator.

8. Turn transport power on.

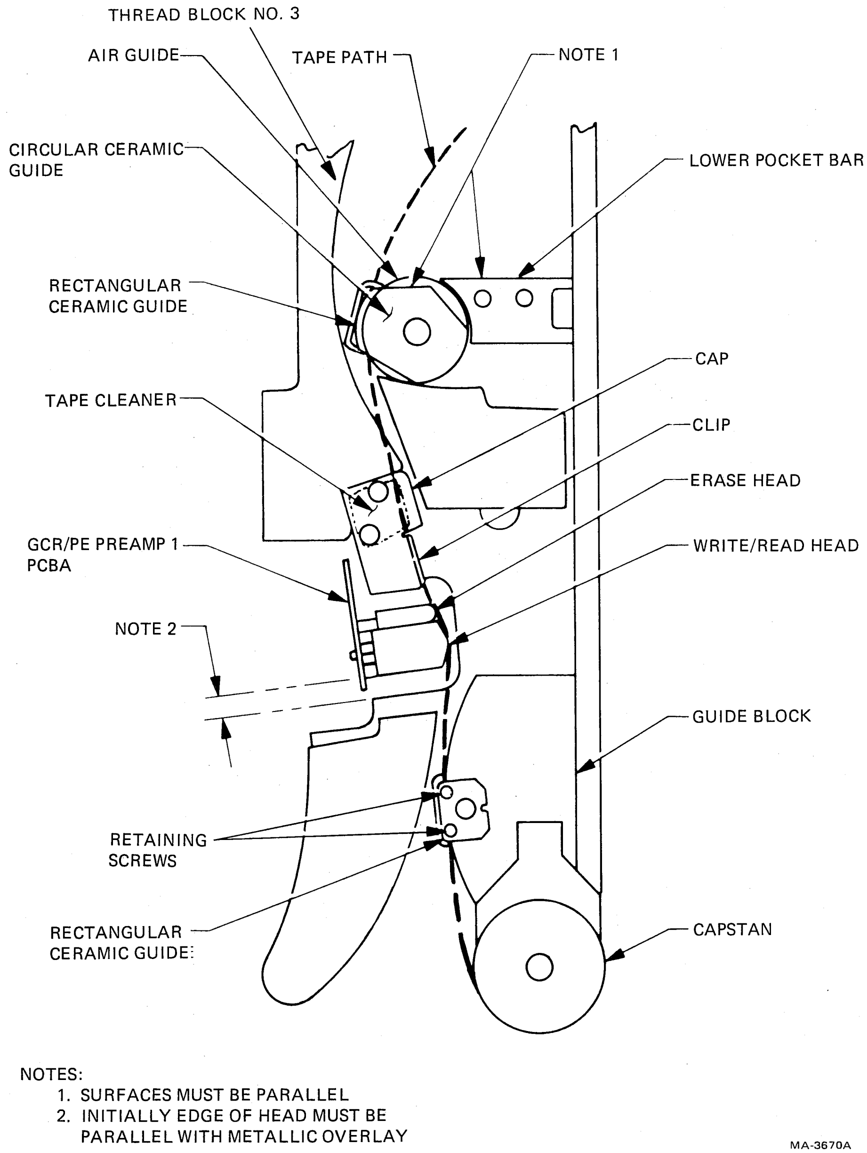


Figure 6-46 Read/Write Head, Tape Cleaner, and Air Guide Removal and Replacement

9. Load an all ones PE 64 c/mm (1600 cpi) tape on the transport and bring to load point.

10. Operate the transport in a shuttle mode (that is, forward then reverse) by grounding TP31 on control M2 PCBA (Figure 6-6).

11. Using an oscilloscope, observe waveform at the upper lead of R13 (track 5) of the GCR/PE preamp 1 PCBA (Figure 6-9).

12. While operating in the shuttle mode, mechanically rotate the GCR/PE preamp 1 PCBA until minimum amplitude difference between forward and reverse operation is achieved. The forward/reverse amplitudes must be in the 800 mV ± 100 mV range, peak-to-peak. The

lower amplitude must be equal to or greater than 90 percent of the higher amplitude. Grasp the GCR/PE preamp 1 PCBA on both the front and rear of base assembly to rotate it.

13. Open the buffer box door and make sure the erase head is in contact with tape. Repeat step 12 if necessary.

14. Tighten head mounting screws and PCBA mounting bracket screws.

15. Perform the following related adjustments:

    - Read/write adjustments Paragraph 6.5.7

6.7.2 Tape Cleaner Removal, Cleaning, and Alignment
The tape cleaner may be removed and reinstalled in the following way.

1. Open transport door and the buffer box door.

2. Remove two screws attaching the tape cleaner and its cap to the base casting (Figure 6-46).

3. Clean tape cleaner, cap, clip, and metal overlay on the 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 towards the right (towards the tape). Rotate cap so the formed clip is 1.524 mm (0.06 in) away from tape path. Slide clip against the 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 6-46), permitting it to hang by its leads.

5. Remove circular ceramic guide from air guide on front of base assembly (Figure 6-46).

NOTE
Do not remove air guide from base assembly.

6. Carefully insert penlight lens into the front of the air guide. Using a small mirror, make sure 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 the edge of lower pocket bar (refer to Note 1 in Figure 6-46).

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 6-46). 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 6-47). The air guide disassembly and cleaning procedure 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 Number 1 (Figure 6-47). 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 Number 1 to base assembly.

   NOTE
   The surface of the air bearing that has been milled out must be placed against the base plate.

   Rest cardboard against adjacent buffer box bar and 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). The shiny side of ceramic guide is mounted towards the magnetic tape. Align ceramic guide as shown in Figure 6-47.

5. Follow the same procedure for air bearings Number 2, 4, and 5. This procedure is also used for bearing Number 3 except that tangent point A is aligned with adjacent bearing Number 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.

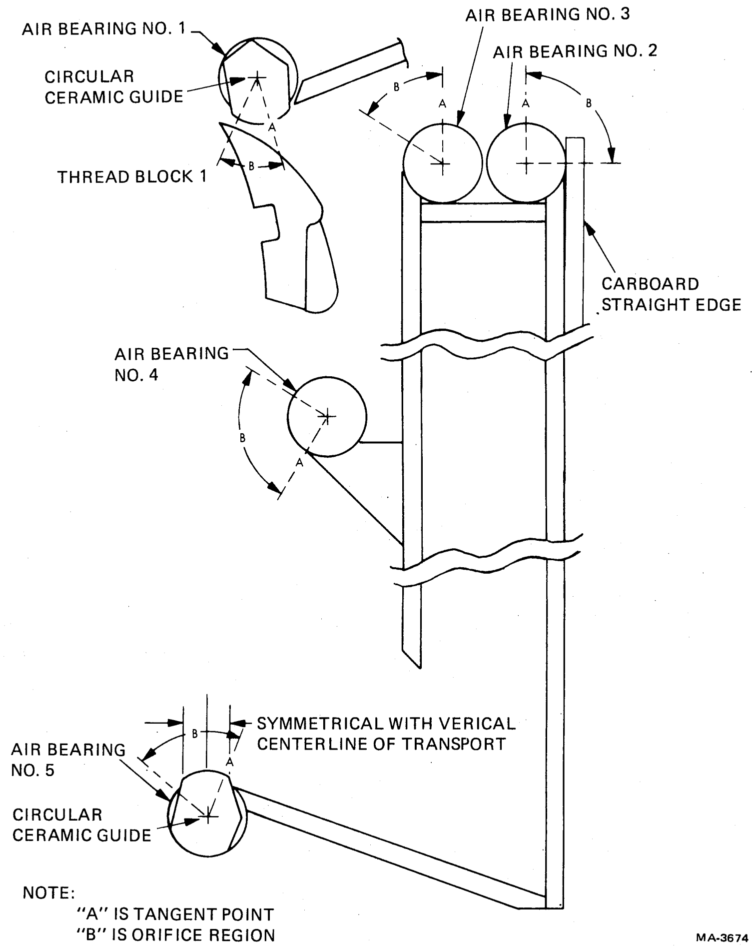


Figure 6-47 Air Bearing and Ceramic Guide Orientation

3. Remove the two hex nuts, lock washers, cups, and Belleville washers retaining motor plate to the base assembly at two locations (Figure 6-48A).

4. Cradle motor in your hand. At front of base assembly, remove socket-head cap screw (fixed point) (Figure 6-48B), containing Belleville washers and plain washer, freeing the motor.

5. Carefully slide motor off two adjusting studs. View the front of base assembly to make sure the capstan clears metal overlay and base casting.

6. Install the replacement motor, repeat steps 2 through 5 in reverse order.

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 21. A fine tuning of tape tracking is accomplished in steps 22 through 32.

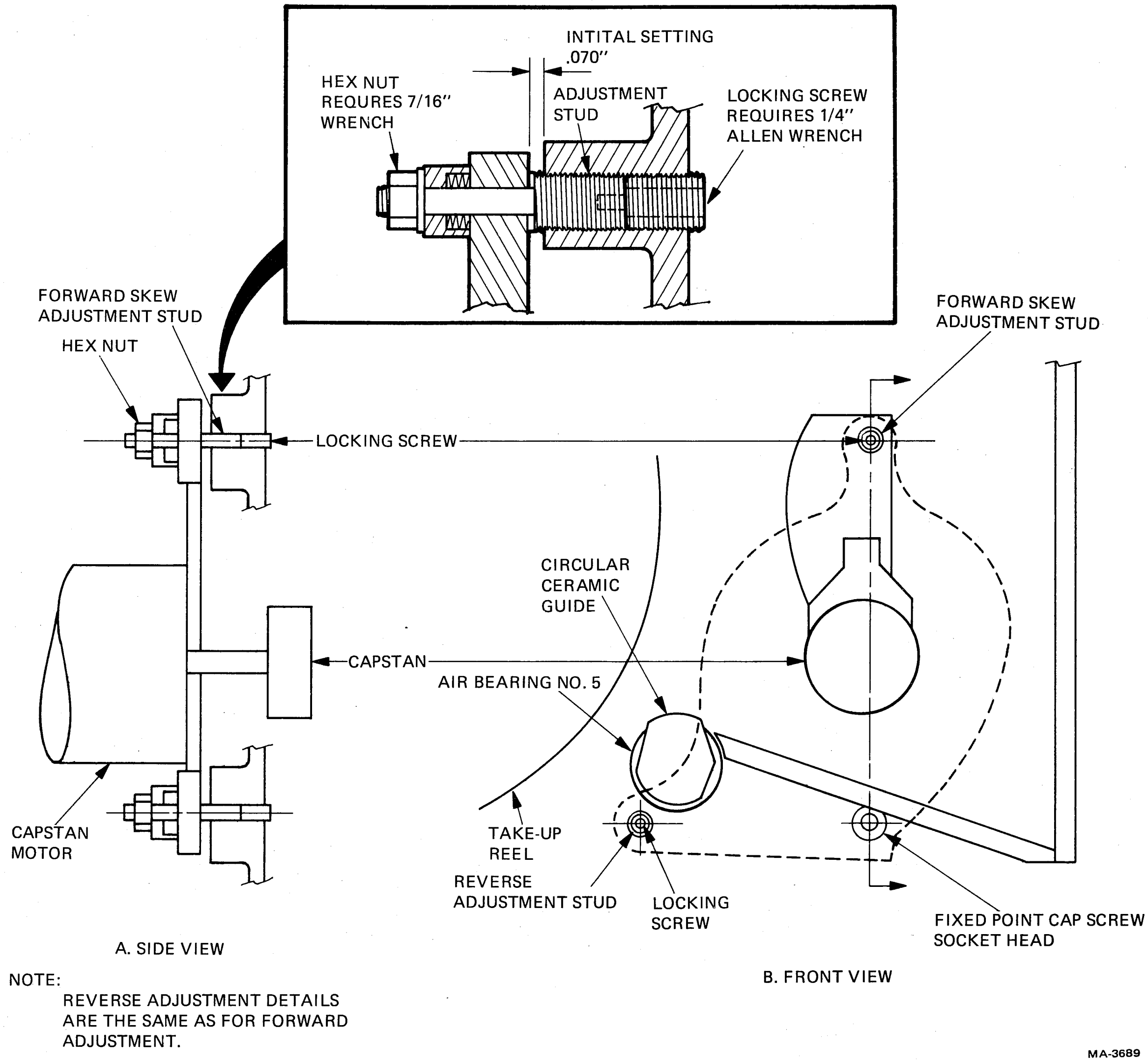


Figure 6-48   Capstan Motor Mounting

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 portion of tape used in the process and install a new BOT tab.

9. Place control M2 PCBA switch S1 (Figure 6-6) 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.

11. 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.

12. 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 6-48).

13. Loosen the capstan motor forward and reverse adjustment locking screws one full turn.

14. Remove the outside rectangular ceramic guide from the guide block by removing the two retaining screws and washers (Figure 6-46).

CAUTION
The thin ceramic guides are easily broken. Handle them with extreme care.

15. Gently retract the spring-loaded ceramic guides at both the guide block and the air guide so 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.

16. Close the buffer box door assembly.

17. Perform a systems vacuum check (Paragraphs 6.5.4.1 and 6.5.4.2).

18. Turn transport power on and perform a midreel load.

19. Run the drive forward using maintenance switch S1 on the control M2 PCBA. Adjust forward adjustment stud from the front of the base assembly (Figure 6-49) 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.

20. Run the drive in reverse using maintenance switch S1 on control M2 PCBA and adjust reverse adjustment stud from the front of the base assembly (Figure 6-49) so tape edge is aligned with the guide block.

21. 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 M2 PCBA can be grounded to TP25 to run the transport in shuttle mode.

22. Unload work tape and load a master skew tape to fine tune tape tracking.

23. Connect channel 1 of an oscilloscope to R1 (track 1) of the GCR/PE preamp 1 PCBA (Figure 6-9) and channel 2 to R25 (track 9). Ground oscilloscope probes. Sync internal positive on channel 1.

24. Run tape forward and reverse by grounding shuttle maintenance test point TP31 on control M2 PCBA.

25. Observe the oscilloscope and adjust the capstan tracking adjustment studs (Figure 6-49) for minimum differential between tracks 1 and 9 (outside two tracks of the read head).

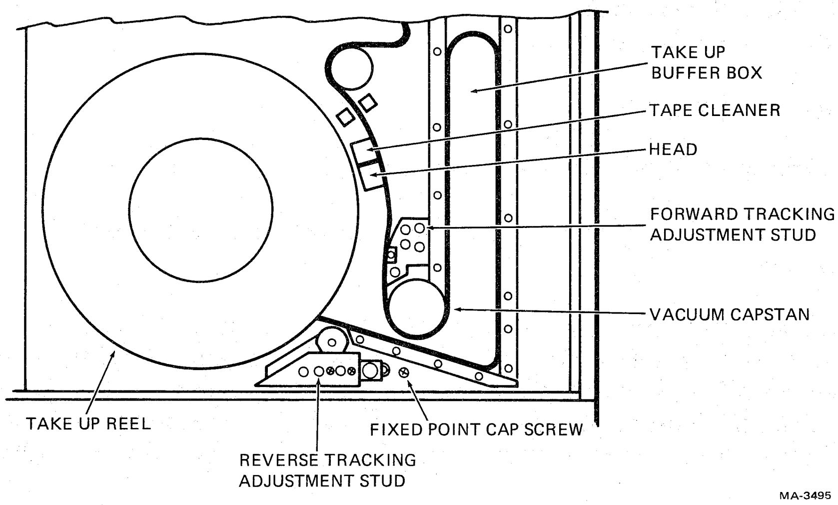


Figure 6-49 Capstan Tape Tracking Adjustment Studs

NOTE
Only very slight adjustments are required. Achieving no differential at this point may not be possible due to head azimuth plate misalignment.

Tape must be stopped and buffer box door opened each time the forward stud is adjusted.

26. If coincidence cannot be achieved, make sure the differential is minimal and equal, but opposite in the forward direction versus reverse direction. This indicates tape tracking is straight forward and reverse, and the head azimuth plate needs to be aligned (Paragraph 6.5.7.1).

27. Tighten locking screws, hex nuts, and socket-head cap screw, observing oscilloscope to make sure adjustments are not disturbed.

28. Remove jumper from TP31 on control M2 PCBA. Remove oscilloscope connection from GCR/PE preamp 1 PCBA.

29. 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.

30. Return spring-loaded ceramic guides to their operating position by pressing the guide on the corners with a cotton-tipped swab.

31. Install fixed ceramic guide. Being careful not to crack it.

32. Perform the read skew adjustment (Paragraph 6.5.7.1).

6.7.6 Supply Reel Motor Replacement

The supply reel motor can 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 front of the base casting by removing five small Phillips 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 for these screws from turning. A small open-end wrench can 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 the 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 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 it measures 11.4 to 11.7 mm (0.451 to 0.461 in) from the machined boss on the base casting. This machined boss is directly behind the flange at the two 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 the following related adjustments.

    Supply reel load speed (Paragraph 6.5.6.2)
    Tape loop position (Paragraph 6.5.6.4)

6.7.7 Vacuum Reel Assembly Replacement and Take-up Reel Motor Replacement

The vacuum reel assembly and the take-up reel motor are replaced using the following procedure. The vacuum reel assembly must be removed in order to remove the take-up reel motor.

1. Turn transport power off.

2. Open transport front door. Remove the seven trim assembly mounting screws and the entire trim assembly.

3. Open buffer box door and base assembly.

4. On back of base assembly below the take-up 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, go to step 10. If the take-up reel motor is to be replaced proceed with step 7.

7. At the 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 the replacement motor elbows can be properly placed. 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 back of base assembly, slip 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 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 and trim assembly.

13. Turn transport power on.

14. Perform the following related adjustments.

    Take-up reel load speed (Paragraph 6.5.6.3)
    Tape loop position adjustment (Paragraph 6.5.6.4).

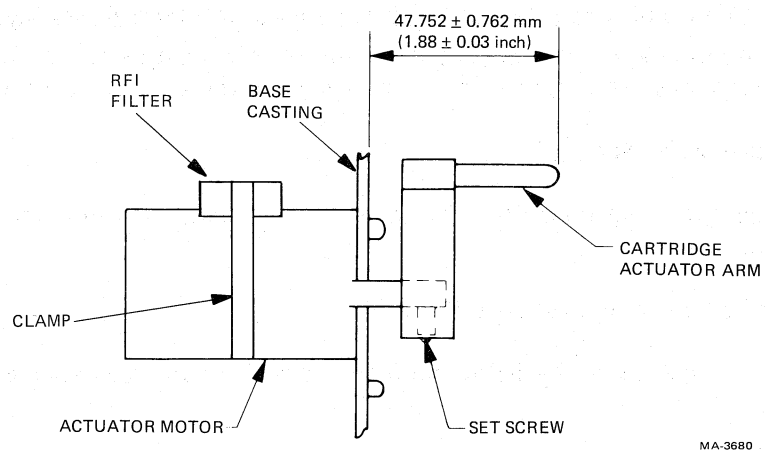


Figure 6-50 Cartridge Actuator Motor

6.7.8 Cartridge Actuator Motor Replacement

The cartridge actuator motor may be replaced as follows.

1. Turn transport power off.

2. Open transport front door and buffer box door.

3. Remove supply reel plastic overlay on front of the base casting by removing five small Phillips screws.

4. Remove arm from motor shaft by loosening set screw (Figure 6-50).

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 back of the base assembly, remove clamp from around motor and radio frequency interference (RFI) filter. Remove RFI filter from motor leads by sliding off filter top cover and lifting wires off the pins. Remove four motor mounting screws, and remove motor.

6. Install new motor with the four mounting screws. Set arm height shown in Figure 6-50 and tighten set screw.

7. Install a new RFI filter (DEC P/N 29-23279) by laying motor leads into the two filter body channels and pressing them onto the pins so pins puncture wire insulation. Slide filter top on. Install clamp around the motor and RFI filter and tighten it so the pin protruding from the filter bottom makes good contact with 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 stop driving. Adjust top limit switch if necessary.

11. Reassemble supply reel overlay.

6.7.9 Control Assembly Removal and Replacement

1. Turn transport power off at cabinet power control.

2. Open transport front door. Remove the seven trim assembly mounting screws and entire trim assembly.

3. Open the base assembly. Disconnect P10 from control M2 PCBA and free the flat cable from retaining clamps.

4. At front of the base assembly, remove the four control assembly mounting screws and slide the flat cable through base casting.

5. Install replacement assembly in reverse order.

6.7.10 Blower/Compressor AC Motor Replacement

The following procedure is used to remove and replace the blower/compressor ac motor.

WARNING

If the motor has stopped because of overheating, it restarts 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 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 then 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 is necessary for this operation.

5. Remove cover to motor leads and remove leads.

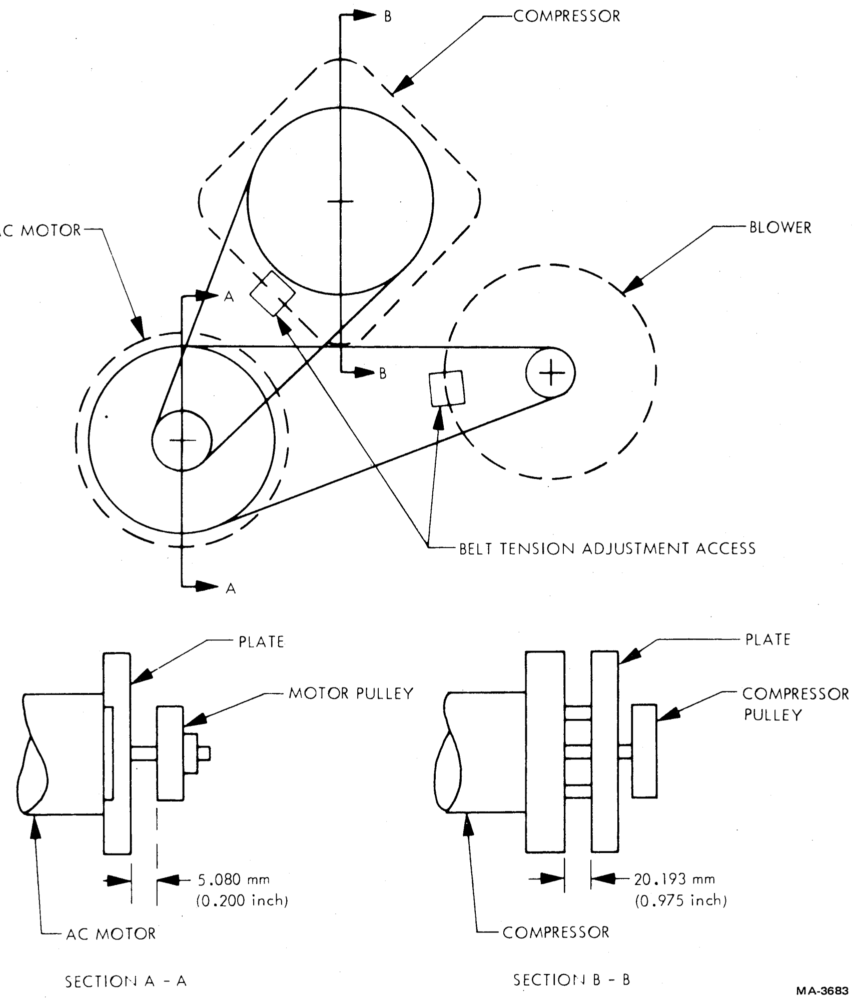


Figure 6-51 Blower and Compressor Pulley Alignment

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 6-51). Manually rotate motor clockwise and make sure 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 6.5.4).

6.7.11 Blower Removal and Replacement

1. Turn transport power off at the cabinet power control and disconnect power cord.

2. Remove belt guard. Remove hoses from top and rear of blower.

3. Loosen blower mounting screws. Slide blower left and slip belt off pulley (Figure 6-51).

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 blower mounting screws and remove blower.

6. Install replacement blower.

7. Reassemble in reverse order (steps 3 through 6).

8. Exert approximately 111.2 N (25 lb) of force on blower while tightening the three blower mounting screws to tension the belt. A slot is provided in the mounting plate to pivot a large screwdriver against the blower housing for tensioning the belt.

9. Attach hoses to top and rear of blower and assemble belt guard.

10. Connect the power cord and turn transport power on at the power control.

11. Perform vacuum and air pressure adjustments (Paragraph 6.5.4).

6.7.12 Compressor Removal and Replacement

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 6-51.

10. Exert approximately 111 N (25 lb) force on compressor while tightening the four compressor mounting screws to tension the belt. A slot is provided in the mounting plate to pivot a large screwdriver against the compressor housing for tensioning.

11. Attach tubes to the top of compressor. Manually rotate motor pulley clockwise and make sure compressor belt does not overhang pulleys; readjust compressor pulley if necessary.

12. Connect power cord and turn transport power on at the power control.

13. Perform vacuum and air pressure adjustments (Paragraph 6.5.4).

6.7.13 Air Valve Solenoid Replacement

When replacing the solenoid on either the vacuum or pressure transfer valve assembly, it must be adjusted according to the following procedure.

1. Loosen the solenoid mounting screws slightly to allow free movement.

2. Turn transport power off.

3. Ground the appropriate test point to TP49 to enable solenoid current:

Vacuum transfer valve	Control M2, TP72 (NXFR)
Pressure transfer valve	Control M2, TP51 (NPOL)

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

The procedures necessary to remove and replace all PCBAs are listed in the following nine paragraphs.

6.7.14.1 Multiple Interface Adapter PCBA (Slot 1)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 3-4).

3. Remove the three cables from jacks J1 through J3.

4. Grasp the edges of the PCBA and pull straight out of the interconnect D1 backplane.

5. Set the transport serial number for the new MIA PCBA by noting the position of the sixteen DIP switches (U125, U135) on the old MIA PCBA and sliding the new ones so they are identical (Figure 6-14).

6. Insert the new PCBA and reconnect the three cables. Make sure maintenance switch S4 is to the left (auto).

7. Install the PCBA retainer clip.

8. Turn transport power on.

9. Run the appropriate diagnostics to confirm transport operation.

6.7.14.2 Read PCBA (Slot 2)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 3-4).

3. Pull the read PCBA straight out of the interconnect D1 backplane.

4. Remove the read data cable from J4.

5. Plug the read data cable into J4 of the new read PCBA and insert it into the backplane.

6. Install the PCBA retainer clip.

7. Turn transport power on.

8. Perform the PE gain adjustment (Paragraph 6.5.7.3).

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 3-4).

3. Remove the write data cable from J6.

4. Remove the AMTIE cable from J25.

5. Pull the PCBA straight out of the interconnect D1 backplane and insert the replacement PCBA in its place.

6. Reconnect the write and AMTIE cables.

7. Install the PCBA retainer clip.

8. Turn transport power on.

9. Perform the following adjustments.

   Write current adjustments (Paragraph 6.5.7.2)
   PE gain adjustment (Paragraph 6.5.7.3)

10. Run the appropriate data reliability diagnostic.

6.7.14.4 Control M2 PCBA (Slot 4)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 3-4).

3. Remove the control cable from J10.

4. Pull the PCBA straight out of the interconnect D1 backplane.

5. Make sure jumpers W1 through W18, on the new PCBA, are configured according to the original PCBA. (Refer to Volume 1 of the Technical Manual, Figure 12, sheet 1, Schematic Number 106875, Table II, Version —12).

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.

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 screws securely.

5. Turn transport power on.

6. Perform the following checks/adjustment procedures.

   Power distribution (Paragraph 6.5.1)
   Capstan servo adjustments (Paragraph 6.5.5)
   PE gain adjustment (Paragraph 6.5.7.3).

7. Run appropriate diagnostics to confirm transport operation.

6.7.14.6 Reel Servo PCBA (Slot 6)

1. Turn transport power off.

2. Remove the eight 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 eight connecting wires.

7. Turn transport power on.

8. Perform the following checks/adjustment procedures.

   Power distribution (Paragraph 6.5.1)
   Reel servo adjustments (Paragraph 6.5.6)
   Dynamic brake check (Paragraph 6.6.6.1)

9. Run appropriate diagnostics to confirm transport operation.

6.7.14.7 GCR/PE Preamp 1 PCBA

1. Turn transport power off.

2. Open transport front door and buffer box door. Swing base assembly out.

3. Unplug the read data cable from J902 on the preamp PCBA.

4. Unplug the write data cable from J6 on the write PCBA.

5. Free the write data cable 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 erase head wires from pins J905 and J906.

7. Pull PCBA and cable out of base assembly.

8. Install the new PCBA in reverse order making sure the phenolic insulator is between PCBA and bracket. Note the white erase head lead connects to J905 and the black lead to J906.

9. Perform the following adjustment procedure.

   PE gain (Paragraph 6.5.7.3).

10. Run appropriate data reliability diagnostic to confirm transport operation.

6.7.14.8 Interconnect F1 PCBA

1. Turn transport power off.

2. Swing base assembly out.

3. Disconnect flat cable from J21 on interconnect F1.

4. Record wire color and connection point of all wires making connection at TB1, TB2, TB3, and TB4. Remove wires.

5. Remove PCBA from 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 completely removed, independent of the others, the PCBA undergoes a torsional strain which may fracture etched conductors.

6. Install 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 6.5.3)
   Tape loop position and gain (Paragraph 6.5.6.4).

8. Run 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 cabinet rear access door.

4. Remove the large metal plate below the exhaust fan assembly.

5. Remove plastic shield over terminal strip TB1 at the rear of interconnect D1 PCBA.

6. Record wire color of wires connecting to TB1. Remove wires.

7. Remove flat cable from J24 on interconnect D1.

8. Remove seven cap-head retaining screws and pull PCBA out of the front of the cabinet.

9. The new PCBA has two jumpers (W1 and W2) between J201 and J204. Cut jumper W2.

10. Install new PCBA in reverse order.

11. Reinstall all card cage PCBAs.

12. Run 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 the signal has been delayed with reference to the signal identified by the remainder of the term.

Mnemonic	Definition
ABP	Air bearing pressure
ACRC	Auxiliary cyclic redundancy check
AGC	Automatic gain control
AGC0–AGC7	Automatic gain control voltage for read Amplifier 0–7
AGCP	Automatic gain control voltage for the parity channel read amplifier
AMTIE	Amplitude track in error
AMTIE0–AMTIE7	Amplitude track in error interface signals for read channels 0–7 (low = true)
AMTIE P	Amplitude track in error interface signal for the parity read channel (low = true)
ANSI	American National Standards Institute
BKW	Backwrap
BOT	Beginning of tape
BPI	Bits per inch

C0 – C4	Load/unload sequence count 0 through 4 (high = true)
CART MTR ±	Cartridge motor supply voltage
CART N.O.	Cartridge normally open
CART PRESS N.O.	Cartridge pressure
CART SOL RET	Cartridge solenoid return
CC N.O.	Cartridge closed (low = true)
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
CM ±	Capstan motor voltage
CO N.O.	Cartridge open (low = true)
CPU	Central processor unit
CRC	Cyclic redundancy check
CRCC	Cyclic redundancy check character
CR N.O.	Crippled reel normally open (low = true)
DDI	Data density indicator signal
DINTLK	Delayed interlock pulse
DIP	Dual in-line package
DONL	Delayed on-line signal
DRV	Drive
DSE	Data security erase
DT	Drive type
ECC	Error correcting code
EOT	End of tape
ERHDLO	Erase head low
F	Frequency
FCI	Flux changes per inch
FF	Flip-flop
FPT	File protected (high = true)
FRPI	Flux reversals per inch
F/V	Frequency-to-voltage converter
FWD	Forward
GCR	Group code recording
HI DEN N.O.	High density normally open (not used)
I	I/O (see Note 1)
IBOT	Beginning of tape interface output (low = true)
ICMD L	Command strobe (low = true)
ICMD PE L	Command parity error (low = true)
ID	Identification
IDDI	Data density indicator signal output (low = PE, high = GCR)
IDDS	Data density select input

IDDSE	Data density select enable (always low)
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
INTLKP1	Pulsed interlock (occurs after INTLK before DINTLK)
IONL	On-line signal at interface (low = true)
IPS	Inches per second
IRD0—IRD7	Read data bit 0 through 7 output, respectively. Interface signal (low = true)
IRDP	Read data parity output. Interface signal (low = true)
IRDY	Tape transport ready output. Interface signal (low = true)
IRG	Inter-record gap
IRTH2	Read threshold level 2 (not used)
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)
ISLT0	Select port A input, interface signal (low = true)
ISLT1	Select port B input, interface signal (low = true)
ISLT2	Select ports A/B input, interface signal (low = true)
ISLT3	Select maintenance input, interface signal (not used)
ISRC	Synchronous reverse command input, Commands tape motion in reverse at reading speed.
ISTAT L	Status strobe (low = true)
ISWS	Set write status, interface signal (low = true)
ITACH	Tachometer output, interface signal (low = true)
IWCS0—IWCS7	Write/command/status bits 0—7
IWCSP	Write/command/status parity bit
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)
IWINH	Write inhibit (low = true)
LATE AGC	Late automatic gain control setup (not used)
LDF0	Load fault zero
LDFS	Load fault status
LD/REW	Load/rewind
LDS	Load status
LED	Light emitting diode
LO DENSITY	Low density (for 6250 indicator)
LOAD FAULT	Load fault warning signal
LWR	Loop write to read
MIA	Multiple interface adapter
MOT	Motion
MRL	Mid-reel load
ms	Millisecond
MUX	Multiplexer
N>80%	Capstan speed is greater than 80% (low = true)
NAE	Reel servo amplifier enable

NAOK	Air okay (low = true)
NARA	Automatic read amplification burst error (low = true)
NBOT	Beginning of tape (low = true)
NC0−4	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/reel servo drive (low = true)
NEOT	End of tape (low = true)
NGOP	Go pulse (low = true)
NLDC	Load clock (low = true)
NLDFS	Load fault status (low = true)
NLDP	Load pulse (low = true)
NLDS	Load status (low = true)
NLRSTP	Load reset pulse (low = true)
NLTH	Low AMTIE threshold
NLTP	Low tape pulse (low = true)
NMOT	Motion (low = true)
NMRL	Mid-reel load (low = true)
NMRSTP	Master reset pulse (low = true)
NORMTH	Normal (standard) AMTIE threshold
NPE	Phase encoded (low = true)
NPOL	Pressure on-low (low = true)
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)
NRWT	Write signal (low = true)
NRZI	Non-return to zero, inverted
NSFC	Synchronous forward command to move tape in forward direction at reading and writing speed (low = true)
NSMRL	Small reel sense signal (low = true)
NSRC	Synchronous reverse command for reverse motion at reading speed (low = true)
NTAP2	Tach pulse 2 (squared and set at 20 μs pulses) (low = tach mark sensed true)
NTEN	Tach enable (low = true)
NTEST(A)	Test signal (low = true) (not used)
NTHD	Thread command
NTIP	Tape in path (low = true)
NTSTR	Test write strobe (low = true) (not used)
NULRW	Rewind and unload command (low = true)
NULC	Unload command (low = true)
NUNLC2	Unload command 2 (low = true)
NXFR	Transfer, energize vacuum transfer solenoid (low = true)
ONL	On-line

P N.O.	Pressure normally open
PCB	Printed circuit board
PCBA	Printed circuit board assembly
PE	Phase encoded
PKSN	Pack sense
PLS	Pulse
PNU	Pneumatic (blower system on) command
PNU RETURN	Pneumatic system return signal
PO0—PO7	Preamplifier output analog data for read channels 0—7
POP	Preamplifier output analog data for the parity channel
PRES SOL RET	Pressure solenoid return
PRST	Preset
PSOL	Pressure solenoid command
PWR	Power okay
RD	Read data
RD0—RD7	Read data bit 0 through 7, respectively (high = true)
RDP	Read data parity bit
RDY	Ready
REC	Record
REV	Reverse or capstan reverse
REW	Rewind
RST	Reset
RWD	Rewind
RWND	Rewind
RWS	Rewind status
SEL	Select
SFBRK	Supply reel forward brake
SLIMIT	Supply tape - loop limit
SLT A	Transport selected
SLT COM	Select common (always low)
SM±	Supply reel motor voltage
SN	Serial number
SPOS	Supply (loop) position
SRBRK	Supply reel reverse brake
SRF	Supply reel forward
SRR	Supply reel reverse
STDTH	Standard (normal) threshold
STL	Set loops
TACH	Tachometer
TACHP	Tachometer output pulse to interface
TAPEN	Tachometer pulse enable
TSTDAT	Test data (not used)
TFBRK	Take-up reel forward brake
THDS	Thread status
TIP	Tape in path
TLIMIT	Take-up tape - loop limit
TM±	Take-up reel motor voltage
TOR	Tape on reel

TPOS	Take-up (loop) position
TRBRK	Take-up reel reverse brake
TRF	Take-up reel forward
TRR	Take-up reel reverse
TU BUS	Tape unit bus
TWDS	Test write data strobe
UNL	Unload
VAC	Vacuum applied
VAC SOL RET	Vacuum solenoid return
VPED	Pedestal voltage
VSTEP	Step voltage
VWRT	Write voltage
WCS	Write/command/status
WD	Write data
WP1NO	Write protect solenoid set
WP SOL RET	Write protect solenoid return
WRT	Write or write signal
WRT BIN	Write binary track 4
WRT CUR	Write current
WRT REG	Regulated write voltage
WRT STAT	Write status (high = true)
9TK	Nine track (always high)
9TK N.O.	9 track normally open (not used)

APPENDIX B
FLOWCHART GLOSSARY

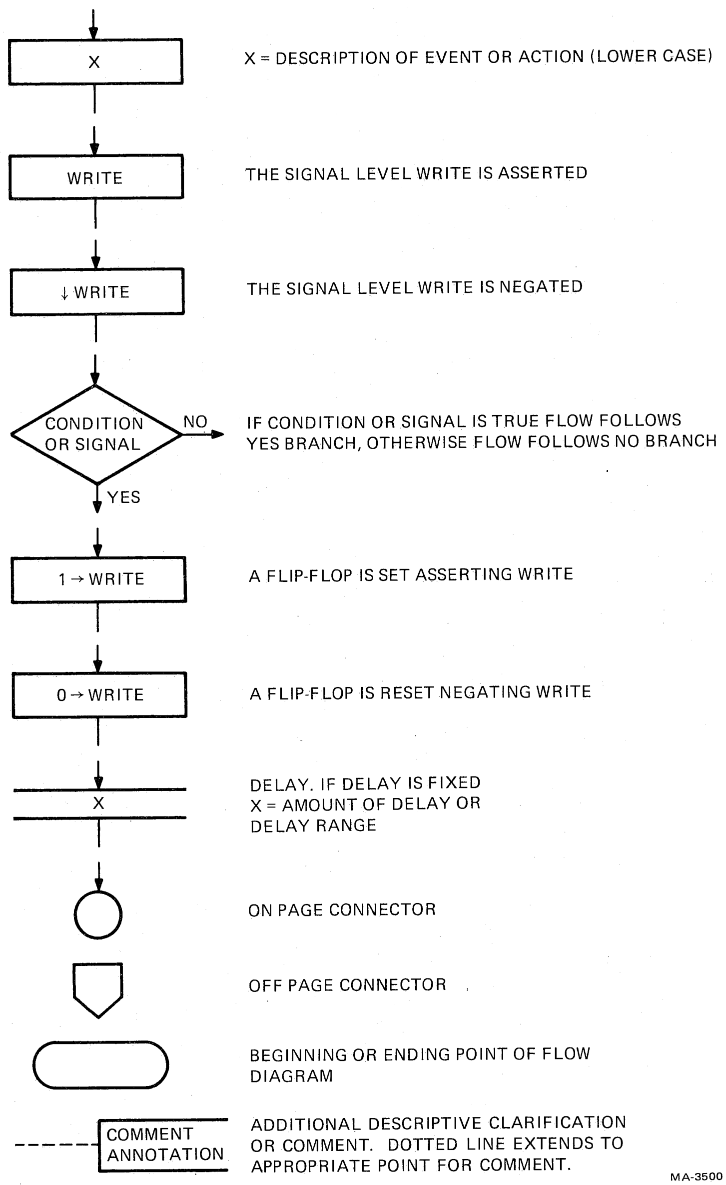


Figure B-1 Flowchart Glossary

APPENDIX C
TAPE UNIT MIA COMMAND/STATUS REGISTER BIT DESCRIPTIONS

The TM78 formatter controls the tape unit by writing into the TU command locations, and senses tape unit status by reading TU status locations. The formatter accomplishes this by writing and reading a unique internal register. This results in an eight bit parallel transfer across the TU bus WCS (write/command/status) lines.

The register address is determined by a special form of command write which has bit 7 = 1. All other commands have bit 7 = 0, using the other seven bits for command information. Once a command/status address has been specified, it remains in effect until the formatter sends a new address to the tape unit. Figure C-1 shows the format of the three types of command/status bytes. Figure C-2 is a summary of the tape unit command/status locations. Tables C-1 (Command) and C-2 (Status) provide a detailed description of each command/status register.

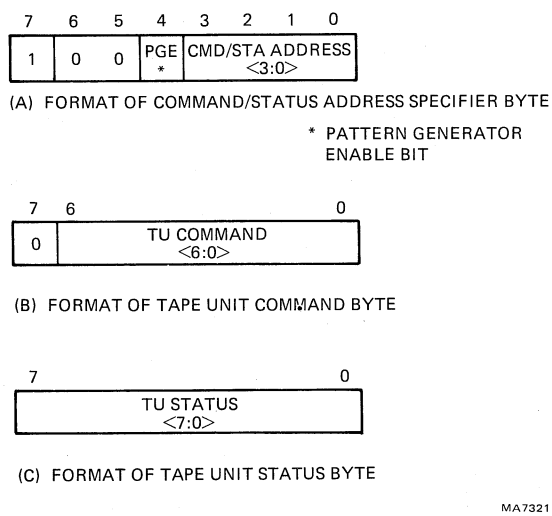


Figure C-1 Tape Unit Command/Status Byte Format

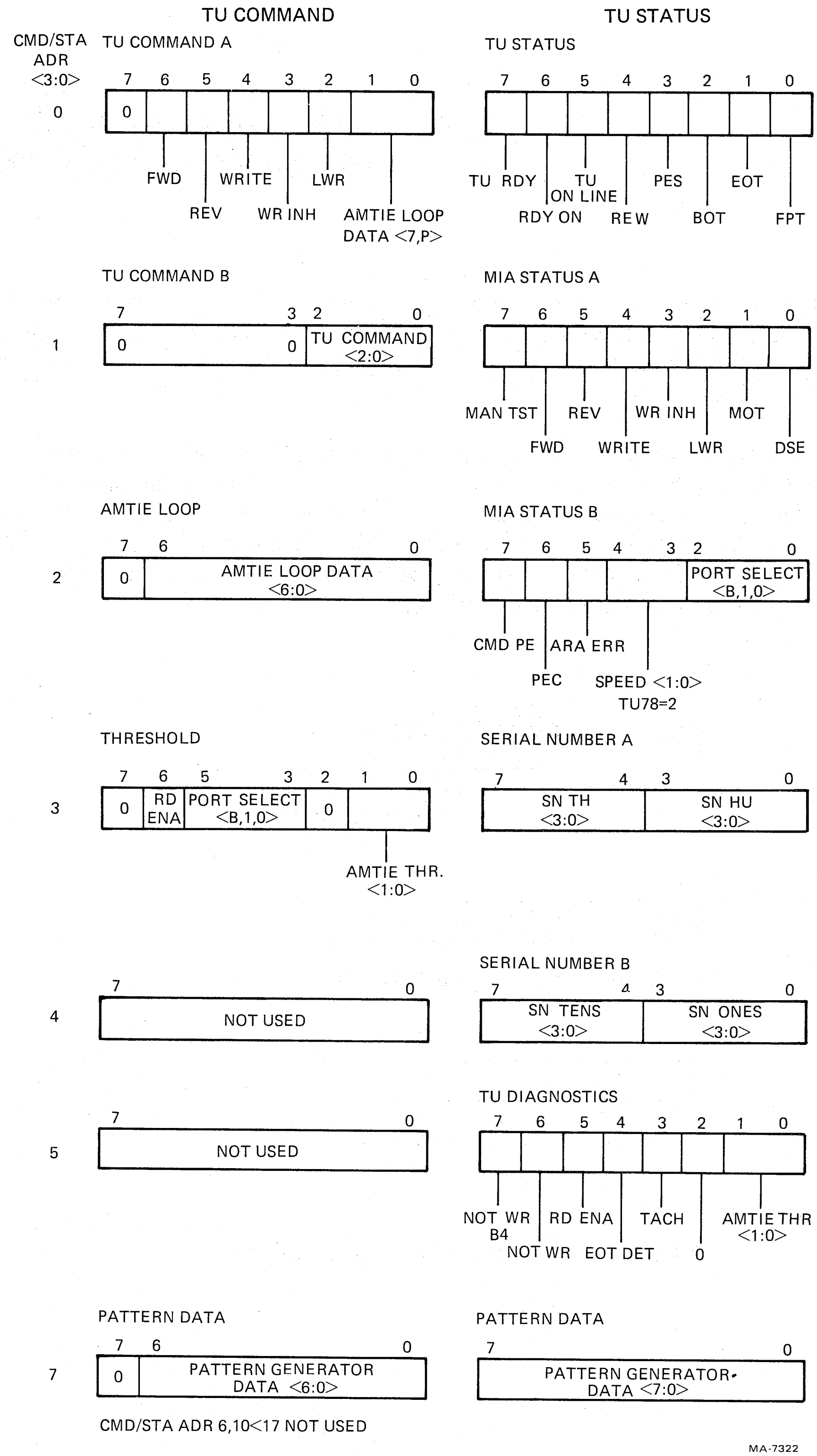


Figure C-2 TU Command/Status Summary

Table C-1 TU Command Register Descriptions

Bits	Name	Description
TU CMD/STA ADR = 0 (TU COMMAND A)		
7	–	Zero
6	Forward	This commands the tape unit (if ready and On-line) to move tape forward.
5	Reverse	This commands tape unit (if Ready and on-line) to move tape in reverse direction. Tape stops upon detection of BOT.
4	Write	The tape unit (if on-line and not file protected or rewinding) is enabled to erase tape. If not Write Inhibited, tape may also be written.
3	Write Inhibit	Prevents tape unit's write head from being energized, while allowing erase head to operate normally. This is meaningful only when write = 1.
2	LWR	Loop write-to-read – The tape unit drives nine read data (RD) lines from corresponding nine WCS lines, and nine AMTIE lines from corresponding nine AMTIE LOOP bits.
1,0	AMTIE Loop	These bits drive AMTIE (amplitude track in error) bus lines <7,P> respectively when (transport) LWR is set.
TU CMD/STA ADR = 1 (TU COMMAND B)		
7:3	–	Zero
2,1,0	TU command	Tape unit command function: 2:0

Octal Value	Function	Description
0	CLR TU	Clears FWD, REV, WRITE, WR INH, LWR, DSE, CMD PE, and RDY ON.
1	Set PE	Set TU to (PE) phase encoded recording format
2	Set GCR	Set TU to group code recording (GCR) format
3	CLR EOT	Clear EOT status
4	Rewind	If ready and on-line, tape is rewound to BOT – RDY = 0 until rewind sequence is completed

Table C-1 TU Command Register Descriptions (Cont)

Bits	Name	Description
		Octal Value / **Function** / **Description**
		5 — Unload — If ready and on-line, transport switched off-line, tape rewound and removed from tape path
		6 — DSE — Causes FWD to set until EOT sets or until a CLR TU command
		7 — TEST — Sets RDY ON and CMD PE, causing CMD PE TU bus line to be asserted
TU CMD/STA ADR = 2 (AMTIE LOOP)		
7	–	Zero
6:0	AMTIE loop 6:0	These bits drive AMTIE bus lines <6:0> respectively when LWR (transport) is set.
TU CMD/STA ADR = 3 (THRESHOLD)		
7	–	Zero
6	Read enable	This enables tape unit AMTIE signals to TU bus RD/AMTIE lines.
5,4,3	Port select <B,1,0>	The complement of these bits is logically ORed with tape unit's port select switch. They are normally set to allow position of the port select switch to be read via status address 2 MIA STATUS B.
2	–	Not used
1,0	AMTIE threshold 1:0	A two bit field which establishes threshold of the TU read electronics for nine AMTIE signals.
		Octal Value / **Threshold** / **Mode**
		0/1 — 10% — IBG check
		2 — 25% — Write
		3 — 20% — Read

Table C-1 TU Command Register Descriptions (Cont)

Bits	Name	Description
TU CMD/STA ADR = 7 (PATTERN DATA)		
7	–	Zero
6:0	Pattern Generator Data	Represents data field intended to be written to tape for maintenance purposes. This register is actually eight bits wide. On every write to this register, bit 7 is set to a 1. The loaded pattern is generated on all nine channels with bit 0 first, then bit 1, until all have been sent.

Table C-2 TU Status Register Descriptions

Bits	Name	Meaning When Set
TU CMD/STA ADR = 0 (TU STATUS)		
7	Ready	The tape unit is on-line, not rewinding, not loading or unloading, and all pneumatic interlocks are made.
6	Ready on	Ready has undergone a transition to set state. This is cleared by a CLR TU command.
5	On-line	The tape unit has been placed on-line, and if ready, responds to motion commands issued remotely from formatter.
4	Rewinding	The tape unit currently rewinding.
3	PES	The tape unit currently set to phase encoded recording format. If reset, the tape unit is set to group code recording format.
2	BOT	The BOT marker on the tape is positioned at the BOT sensor and ready is set.
1	EOT	The EOT marker on the tape is, or was, positioned at the EOT sensor during a forward operation with ready set. EOT status clears when: 1. The EOT marker is positioned at the EOT sensor during a reverse operation with ready set. 2. The tape unit is commanded to rewind tape. 3. A CLR EOT command is written into the TU CMD B location.
0	File protect	The tape reel currently loaded does not have the write enable ring in place.

Table C-2 TU Status Register Descriptions (Cont)

Bits	Name	Meaning When Set
TU CMD/STA ADR = 1 (MIA STATUS A)		
7	Manual Test	The MIA manual test switch is in the manual test position.
6	Forward	The forward command bit has been written with a 1, or a DSE command has been written into the TU CMD B location.
5	Reverse	This indicates the state of the reverse command bit.
4	Write	This indicates the state of the write command bit.
3	Write Inhibit	This indicates the state of the write inhibit command bit.
2	LWR	This indicates the state of the TU loop write to read command bit.
1	MOT	This indicates that the capstan servo motor is turning.
0	DSE	This indicates that a DSE command has been written into the TU CMD B location. It clears when EOT sets, or when a CLR TU command is written into TU CMD B.
TU CMD/STA ADR = 2 (MIA STATUS B)		
7	CMD PE	A command or CMD/STA address has been received by the tape unit with even parity, or a TEST command has been written into TU CMD B. This clears when a CLR TU command is received, whether parity is correct (odd) or not. This bit drives the TU bus CMD PE L line.
6	PEC	A SET PE command has been sent to TU CMD B. Assuming proper hardware operation, this bit is the same as PES in TU status.
5	ARA Error	During a GCR operation, from 24.1 cm (9.5) after BOT, the read amplifier gains failed to achieve the required value. This is valid only if READY is set.
4,3	Speed 1:0	This is a two bit field that indicates tape unit speed. TU78 = 2 (125 IPS)
2,1,0	Port Select B,1,0	This indicates the position of the multiposition port select switch on the tape unit operator panel. The bits are meaningful only when the port select bits in the threshold command location have been written to ones.

Table C-2 TU Status Register Descriptions (Cont)

Bits	Name	Meaning When Set
		B 1 0 Meaning 1 1 0 Position 0 (MASSBUS A) 1 0 1 Position 1 (MASSBUS B) 0 1 1 Position 2 or both (MASSBUS A or B) 1 1 1 Any other position (Select neither MASSBUS)
TU CMD/STA ADR = 3 (SERIAL NUMBER A)		
7:4	SN TH 3:0	Most significant (thousands) BCD digit of tape units serial number
3:0	SN HU 3:0	The hundreds BCD digit of tape units serial number
TU CMD/STA ADR = 4 (SERIAL NUMBER B)		
7:4	SN TENS 3:0	The tens BCD digit of tape units serial number
3:0	SN ONES 3:0	Least significant (ones) BCD digit of tape units serial number
TU CMD/STA ADR = 5 (TU DIAGNOSTICS)		
7	Not write Bit 4	This indicates the state (polarity) of the write driver for physical track four head.
6	Not write	There is no current flowing through the write or erase heads. (This is the same as MIA status A, bit 7.)
5	Read enable	This indicates the state of the read enable bit in the threshold command location.
4	EOT DET	The tape's EOT tab is positioned at the EOT sensor. This is not valid unless ready = 1.
3	Tach	This indicates the state of the output from the capstan motor digital tachometer.
2	–	Not used
1,0	AMTIE THR 1:0	This indicates the value of the AMTIE threshold field in the threshold command location.

Table C-2 TU Status Register Descriptions (Cont)

Bits	Name	Meaning When Set
TU CMD/STA ADR = 7 (PATTERN DATA)		
7:0	Pattern Generator Data	This indicates the data field currently in the pattern generator command location.

APPENDIX D
INTERFACE WIRE LIST AND TRANSPORT INTERCONNECTIONS

Table D-1 Major Plug/Jack Reference Designations

Item	Location	Description/Purpose
MIA J1	On MIA PCBA	Connects to write PCBA J25 via cable
MIA J2	On MIA PCBA	Connector for TU bus A
MIA J3	On MIA PCBA	Connector for TU bus B
J1–J3	Interconnect D1 PCBA	Connectors for P1–P3 on MIA PCBA
J4	On read PCBA	For ribbon cable to preamp PCBA on base assembly
J5	On interconnect D1 PCBA	Main connector for read PCBA P5
J6	On write PCBA	For ribbon cable to preamp PCBA
J7	On interconnect D1 PCBA	Main connector for write PCBA P7
J8	On interconnect D1 PCBA	Main connector for control M2 PCBA
J10	On control M2 PCBA	For ribbon cable to manual controls on transport front panel
J11	On interconnect D1 PCBA	Main connector for capstan/ regulator PCBA
J12	On interconnect D1 PCBA	Main connector for reel servo PCBA
J13	On reel servo PCBA	For +36 V to unregulated dc supply
J14	On reel servo PCBA	For supply reel motor drive power (+)
J15	On reel servo PCBA	For supply reel motor drive power (−)
J16	On reel servo PCBA	For −36 V to unregulated dc supply
J17	On reel servo PCBA	For +36 V from unregulated dc supply
J18	On reel servo PCBA	For take-up reel drive power (+)
J19	On reel servo PCBA	For take-up reel drive power (−)

Table D-1 Major Plug/Jack Reference Designations (Cont)

Item	Location	Description/Purpose
J20	On reel servo PCBA	For −36 V from unregulated dc supply
J21	Accommodates P21 of cable from J24 in card cage to interconnect F1 PCBA on base assembly	For connecting card cage circuits to base assembly sensor and control circuits
J22	On GCR/PE preamp 1 PCBA attached to rear of base assembly	Read head input to preamp PCBA
J23	On GCR/PE preamp 1 PCBA	Output from GCR/PE preamp 1 to write heads
J24	On interconnect D1 PCBA	For cable to interconnect F1 PCBA
J25	On write PCBA	Connects to MIA PCBA

Table D-2 TU Bus Interface Signals

Pin	TU Bus A MIA J2	TU Bus B MIA J3
1		
2	GND	GND
3	WCS0	AMTIE0
4	GND	GND
5	WCS1	AMTIE1
6	GND	GND
7	WCS2	AMTIE2
8	GND	GND
9	WCS3	AMTIE3
10	GND	GND
11	WCS4	AMTIE4
12	GND	GND
13	WCS5	AMTIE5
14	GND	GND
15	WCS6	AMTIE6
16	GND	GND
17	WCS7	AMTIE7
18	GND	GND
19	WCSP	AMTIEP
20	GND	GND
21	CMD	RDP
22	GND	GND
23	WDS	RD7
24	GND	GND
25	STAT	RD6
26	GND	GND
27	CMD PE	RD5

Table D-2 TU Bus Interface Signals (Cont)

Pin	TU Bus A MIA J2	TU Bus B MIA J3
28	GND	GND
29	TACH	RD4
30	GND	GND
31		RD3
32	GND	GND
33		RD2
34	GND	GND
35		RD1
36	GND	GND
37		RD0
38	GND	GND
39		PRESENT H
40	GND	GND

Table D-3 AMTIE Cable Signals

MIA J1/ Write J25 Pin	Signal
1	IAMTIE7
2	IAMTIE5
3	IAMTIE4
4	IWINH
5	NLTH
6	Ground
7	Ground
8	Ground
9	WRT BIN H
10	Not used
11	IARA ERR
12	IAMTIE3
13	IAMTIE6
14	WRT STAT H
15	STDTH
16	MOTION H
17	IAMTIEP
18	IAMTIE0
19	IAMTIE1
20	IAMTIE2

Table D-4 MIA PCBA to Transport Interface

Connector J1/P1		Connector J2/P2		Connector J3/P3	
Pin	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**
1	NPORST	1	IWD7	1	IRD7
2	IEOT	2	Ground	2	Ground
3	ILDP	3	Ground	3	Ground
4	IFPT	4	Ground	4	Ground
5	IRWD	5	Ground	5	Ground
6	IONL	6	Ground	6	Ground
7	IRWU	7	Ground	7	Ground
8	ISWS	8	Ground	8	Ground
9	ISLT0	9	Ground	9	Ground
10	IRWC	10	Ground	10	Ground
11	IDDI	11	Ground	11	+5
12	ISRC	12	Ground	12	+5
13	IDDS	13	Ground	13	+5
14	IFSC	14	Ground	14	Ground
15	Not used	15	Ground	15	Ground
16	Not used	16	Ground	16	Ground
17	Not used	17	Ground	17	Ground
18	Not used	18	IWD6	18	IRD6
19	IRDY	19	IWD5	19	NTSTR
20	Not used	20	IWD4	20	IRD5
21	Not used	21	IWD3	21	IRD4
22	Not used	22	IWD222	22	Not used
23	Ground	23	IWD1	23	Not used
24	Ground	24	IWD0	24	Not used
25	Ground	25	IWDP	25	Not used
26	Ground	26	ITACH	26	IRD3
27	Ground	27	Not used	27	IRD2
28	Ground	28	Not used28	28	+5
29	Ground	29	Not used	29	+5
30	Ground	30	Not used	30	+5
31	Ground	31	ISLT2	31	IRD1
32	Ground	32	Not used	32	IRD0
33	Ground	33	ISLT1	33	Not used
34	Ground	34	IWDS	34	IRDP

Table D-5 Power Distribution on Interconnect D1 PCBA

Level Signal	From	Termination 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		

Table D-5 Power Distribution on Interconnect D1 PCBA (Cont)

Level Signal	From	Termination To	To	To
+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		
DC COM 1	A2TB1-9	J11-26,27, 66,67		
8.5 Vac CM(+)	A2TB1-10 A2TB1-3	J11-40 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 J24-37,39,40 J8-22,58	J5-3,4, 39,40 J12-4,5, 21,22	J7-15, 16,17 51,52,53
0 V(1)	J11-26, 27,66,77	J1-23 – 34 J5-26 – 36, 38 J101-2 – 14, 16,17 J201-20 – 34 J204-2 – 17	J2-2 – 17 J7-1 – 10 J102-1 – 18 J202-2 17	J3-2 – 10 14 – 17 J8-38 J103-A,B,C, D,J – V J203-2 – 10, 14 – 17
+5 V(L)	J11-22,23, 62,63	P21-2,4 J24-47,49 J5-8,9,44,45 J12-1,2, 18,19	J7-18,19, 54,55 J101-S	J3-11,12,13, 28,29,30 J8-21,57 W1-1
+5 V(1)	J203-11, 12,13,28, 29,30	J201-18	W2-1	
+5 V(T)	W1-2,W2-2	J204-1,18	J7-21,57	J8-37
+15 V	J11-12,61	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

Table D-6 Deck Interface Ribbon to Interconnect D1 PCBA

Level Signal	From	Termination 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
0 V(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			
WP1 N.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		

*Also WRT CUR

Table D-7 **Internal Control Signals on Interconnect D1 PCBA**

Level Signal	From	Termination To	To	To	To	To
NPE	J8-25	J5-10	J7-61			J103-7
NWRT	J8-26	J5-47	J7-25			
MOTION	J8-28	J5-48	J7-26			
FPT	J8-60			J11-19		
BOT(INT)	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			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		
NPOL	J8-64			J11-59		
(SPARE A)						
NPORST	J11-37,77	J1-1 J12-9,26	J7-11 J201-1	J8-61		
PNU RET	J8-68	A2TB1-11				

Table D-8 Interface Control Signals on Interconnect D1 PCBA

Level Signal	From	Termination To	To	To
ISFC	J101-C	J1-14	J201-14	J8-20
IDDS	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
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
ISLT0	J101-J	J1-9	J201-9	J8-14
ISLT1	J102-B	J2-33	J202-33	J8-15
ISLT2	J102-D	J2-31	J202-31	J8-16
ITACH	J102-K	J2-26	J202-26	J8-6

Table D-9 Interface Read Signals on Interconnect D1 PCBA

Level Signal	From	Termination To	To	To
IRDP	J103-1	J3-34	J5-72	J203-34
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
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

Table D-10 Interface Write Signals on Interconnect D1 PCBA

Level Signal	From	Termination To	To	To
IWDS	J102-A	J2-34	J7-47	J202-34
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

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