TA78
Magnetic
Tape Drive

Service Manual

d i g i t a l

TA78
Magnetic
Tape Drive

Service Manual

digital	DECwriter	RSTS
DEC	DIBOL	RSX
DECsystem-10	MASSBUS	UNIBUS
DECSYSTEM-20	PDP	VAX
DECUS	P/OS	VMS
DECmate	Professional	VT
DECnet	Rainbow	Work Processor

CHAPTER 3   CHECKS AND ADJUSTMENTS

CHAPTER 4   TA78 TROUBLESHOOTING AIDS

CHAPTER 5   TU78 TROUBLESHOOTING PROCEDURES

CHAPTER 6   REMOVAL AND REPLACEMENT

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1.1   SCOPE

This manual provides information needed by trained, qualified service personnel to install and maintain TA78 hardware. Preventive maintenance information in this manual includes a list of periodic tasks that involve the transport only. Corrective maintenance information in this manual includes procedures for adjustments, troubleshooting, and parts replacement. Troubleshooting involves the use of certain aids that apply to the formatter and/or transport, and hands-on procedures that apply to the transport only.

1.2   HARDWARE CONFIGURATION

The TA78 tape drive includes a TS78 tape formatter and a TU78 tape transport (Figure 1-1). The TS78 formatter interfaces with up to four TU78 transports. Therefore, you can add up to three TU78 slave transports to a TA78. Each transport is independently cabled with a radial bus configuration. This configuration allows you to remove one or more transports while the others stay on-line.

The standard tape interface (STI) bus connects the TS78 formatter to a tape data channel (TDC) module in the hierarchical storage controller (HSC). A TDC module supports up to 4 TS78 formatters and therefore supports up to 16 TU78 transports. Separate STI bus cabling connects each TS78 directly to the TDC module. As with the transports, you can remove one or more formatters while the others stay on-line.

The TS78 formatter is available in only one version that has hardware for static dual-porting with two STI bus cables. Therefore, a TA78 can be driven by two HSCs (Figure 1-2).

The TA78 is available in two standard versions. They differ only in the input power required by the transport.

        TA78-BF   208 Vac at 60 Hz
        TA78-BJ   208 Vac at 50 Hz
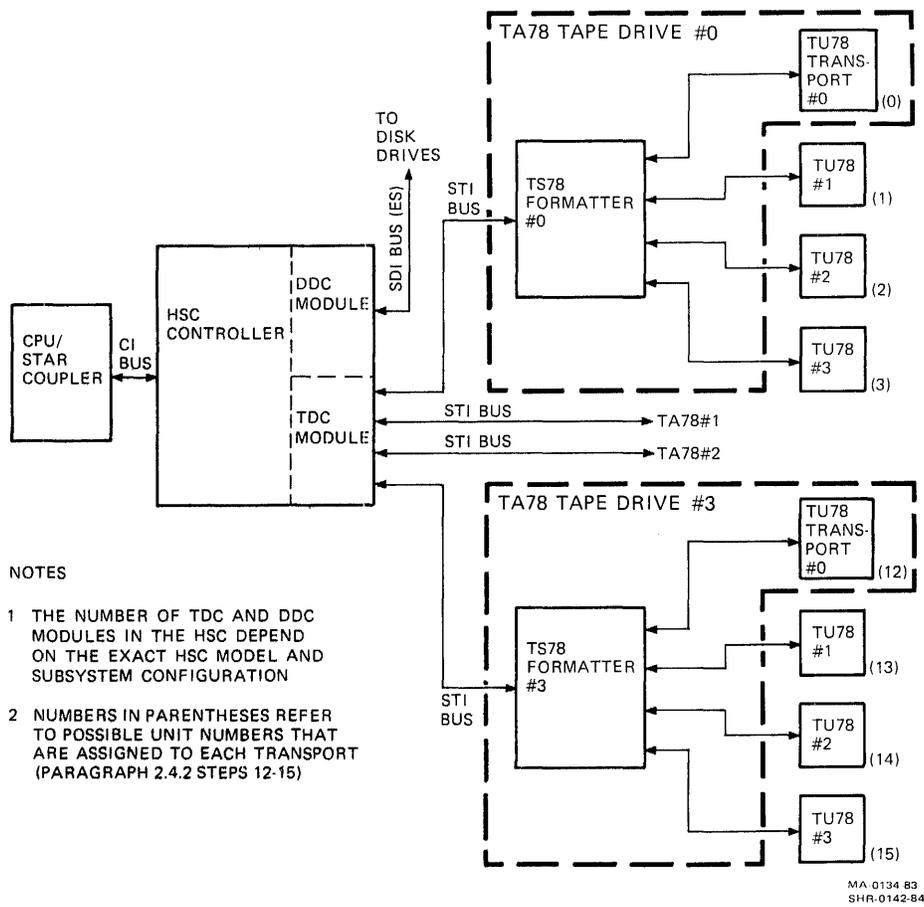
Figure 1-1   Basic Tape Subsystem Configuration
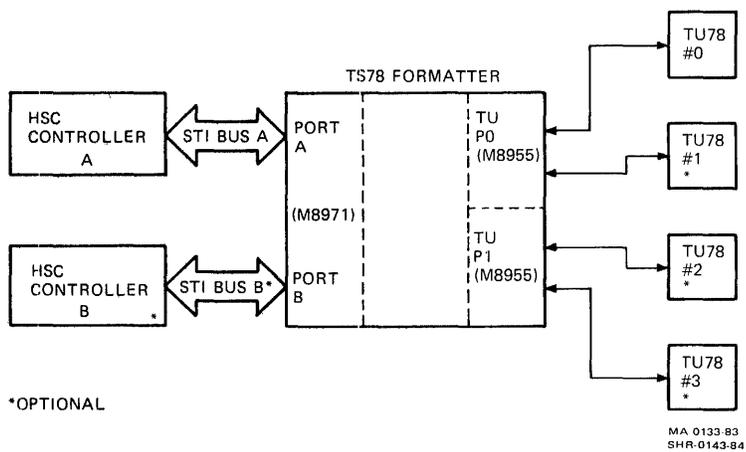
Figure 1-2   Possible TA78 Configurations

1.3   PHYSICAL DESCRIPTION

An H9602-KA cabinet houses the TA78. Figure 1-3 shows the major subassemblies of the TA78 listed below.

    TS78 tape formatter
    TS78 power supply
    872-E or 874-E power controller
    TU78 transport (base assembly, card cage area, and power pack assembly)
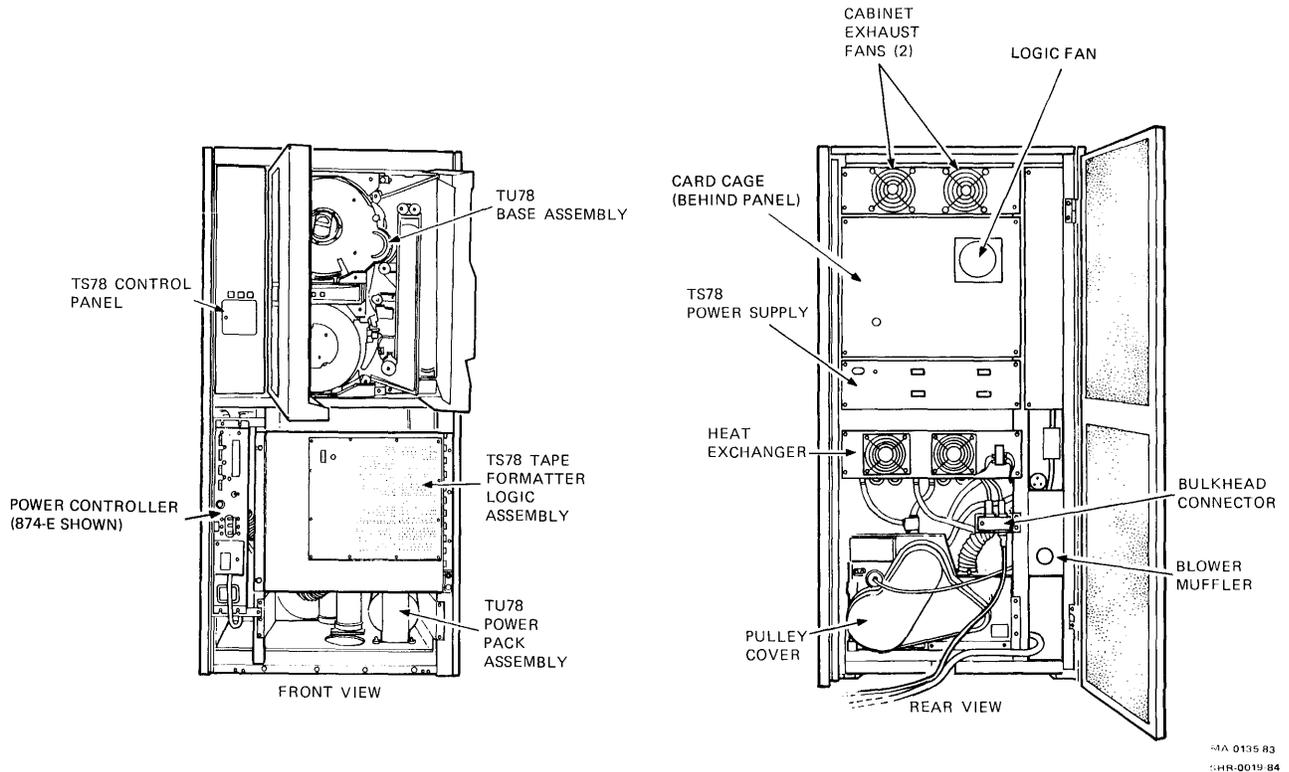
Figure 1-3   TA78 Tape Drive (Front and Rear View)

The TS78 tape formatter contains the formatter logic assembly, control panel, and bulkhead connector. The formatter logic assembly (Figure 1-4) includes the 20 modules in the following list. Figure 1-5 shows the backplane module layout.

FRONT VIEW

REAR VIEW

MA 0136 83
SHR-0144-84
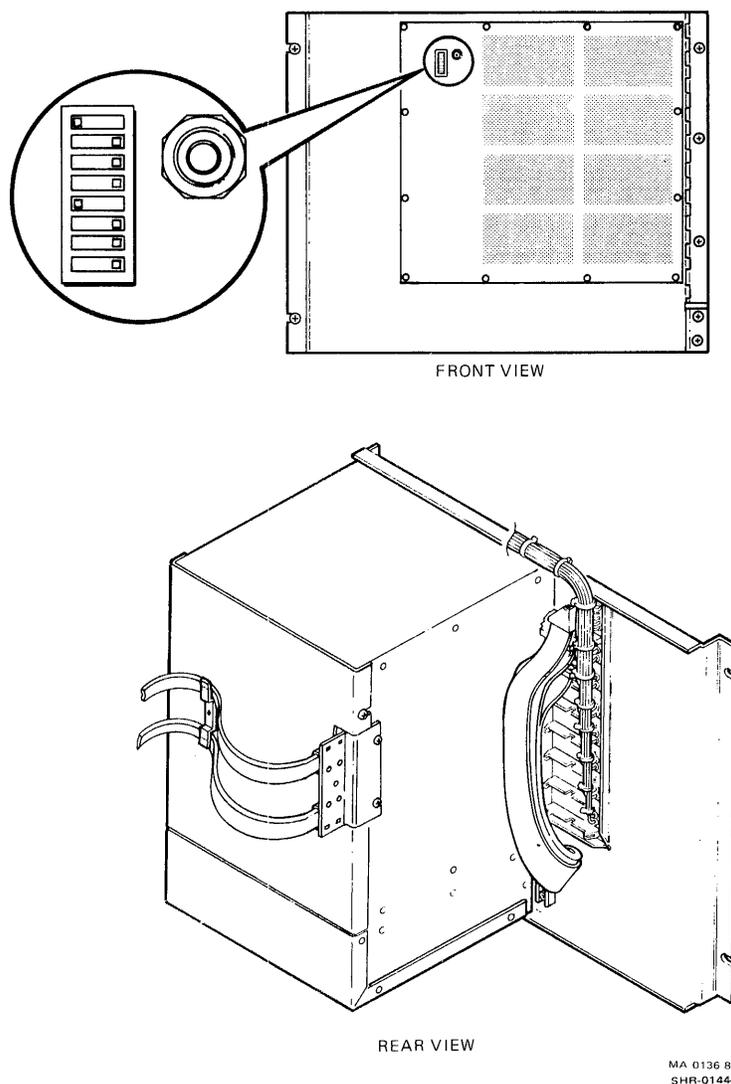
Figure 1-4   TS78 Formatter Logic Assembly
               (Front and Rear View)

M8950 read channel (9)
M8951 error correcting code (ECC) controller
M8952 cyclic redundancy checker (CRC)
M8953 read path controller
M8955 tape unit port (2)
M8958 translator
M8959 write microcontroller
M8970 STI protocol microcontroller
M8971 STI interface
M8972 microcomputer
M8973 extended memory

COLUMNS

16 15 14 13 12 11 10 9   8 7 6 5 4 3 2 1

ROWS

A

B

C

D

M8950 (RC 4)
M8950 (RC 3)
M8950 (RC 2)
M8950 (RC 1)
M8950 (RC 0)
M8951 (ECC)
M8953 (RMC)
M8955 (TU PORT)
(PORTS 2,3)

M8955 (TU PORT)
M8958 (XMC)
M8959 (WMC)
M8972 (BMC)
M8973 (MX)
BLANK
M8970 (PM)
M8971 (BI)
(PORTS 0,1)

M8950 (RC P)
M8950 (RC 7)
M8950 (RC 6)
M8950 (RC 5)
M8952 (CRC)

BLANK

BLANK

MA-6174D
SHR-0145-84

Figure 1-5   TS78 Module Layout (Rear View)

Figure 1-6 shows the TS78 power supply (70-17121), which includes the following items.

     H7422-AB power supply chassis
     H7441 +5 V regulator (2)
     H7490 -5 V regulator
     H7476 +15 V regulator
     54-14192 AC/DC LO module

Figure 1-7 shows 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)
     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
     Preamplifier PCB (PN 29-23766)
     Vacuum transducer assembly (PN 29-23246)
     Pressure switch (column limit) (4) (PN 29-23238)
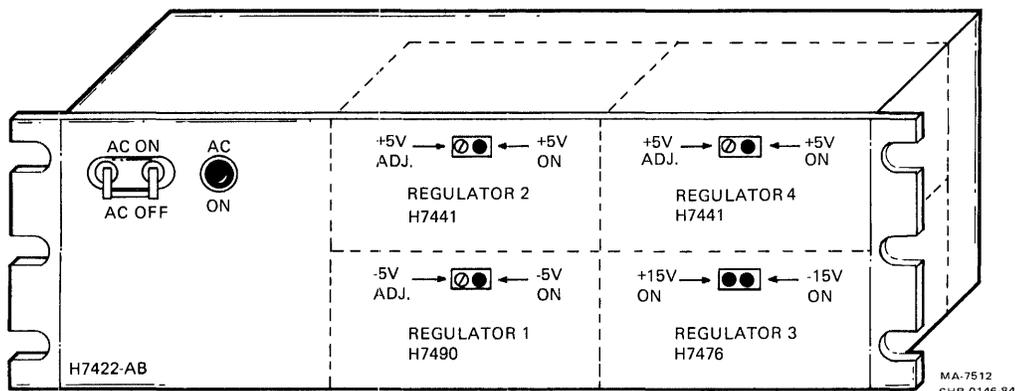
Figure 1-6   TS78 Power Supply

CARTRIDGE
UPPER RESTRAINT   INTERLOCK SWITCH
BUFFER BOX DOOR
ASSEMBLY

REEL SENSE
ASSEMBLY

BACKWRAP
DEFEAT SWITCH

LOWER RESTRAINT

CONTROL
ASSEMBLY

TA78

REEL HUB ASSEMBLY

TIP ASSEMBLY

EOT/BOT ASSEMBLY

HEAD

FRONT VIEW

PRESSURE SWITCH
(PNEUMATIC INTERLOCK)

PRESSURE VALVE
ASSEMBLY

INTERCONNECT F1
PCB

PRESSURE
SWITCH
(COLUMN LIMIT)

CARTRIDGE
MOTOR

VACUUM
TRANSDUCER
ASSEMBLY

VACUUM VALVE
ASSEMBLY

PREAMP PCB

SERVICE LOCK

CAPSTAN MOTOR
ASSEMBLY

PACK SENSE ASSEMBLY
(NOT SHOWN)

REEL MOTOR ASSEMBLY
(SUPPLY REEL)

WRITE PROTECT
ASSEMBLY

PRESSURE SWITCH (2)
(VACUUM)

REEL MOTOR ASSEMBLY
(TAKE UP REEL)

REAR VIEW

MA-0152-83
SHR-0016-84

Figure 1-7   Base Asssembly (Front and Rear View)

1-7

Figure 1-8 shows the card cage, which contains 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)
    Capstan/regulator PCB (PN 29-23765)
    Reel servo PCB (PN 29-23231)
    Cabinet exhaust fans (2) (PN 12-17916-02)
    Interconnect D1 PCB (not shown in Figure 1-8) (PN 29-23211)
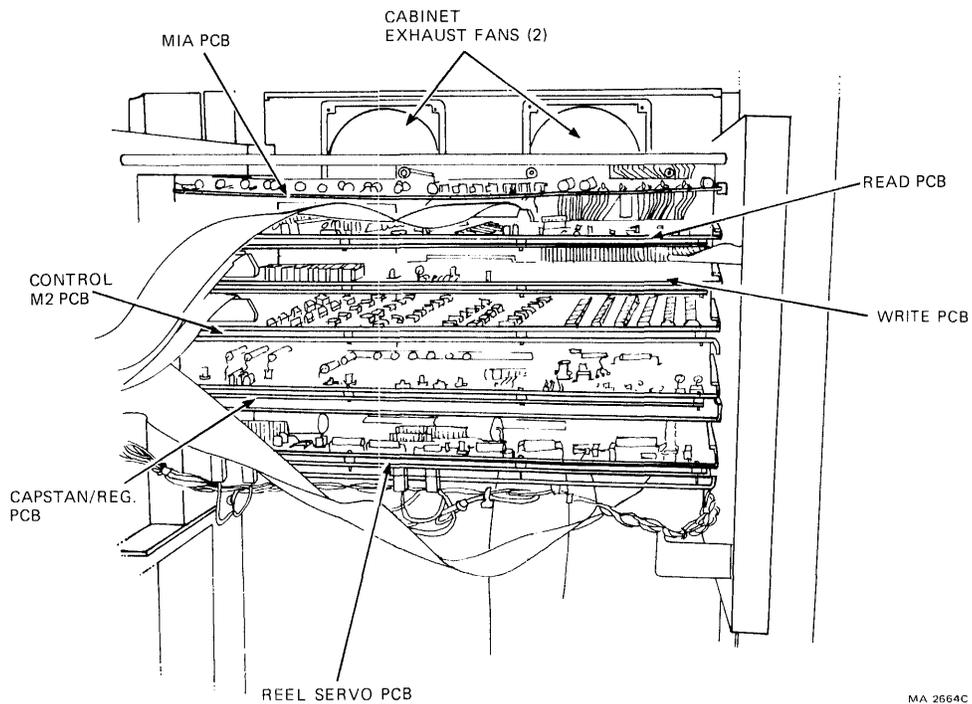
MA 2664C
SHR-0147-84

Figure 1-8   Card Cage Area

Figure 1-9 shows the power pack assembly, which contains the following items.

Rectifiers (3) (PN 29-23311, 29-23312)
Vacuum hose
Fuse panel
Air filter (PN 29-23259)
Blower (PN 29-24013)
Pulley cover
Power transformer terminal strip
Compressor (PN 29-23257)
Motor (PN 29-23236)
Transformer (PN 29-23258)
Muffler (PN 29-23220)
Heat exchanger fans (2)
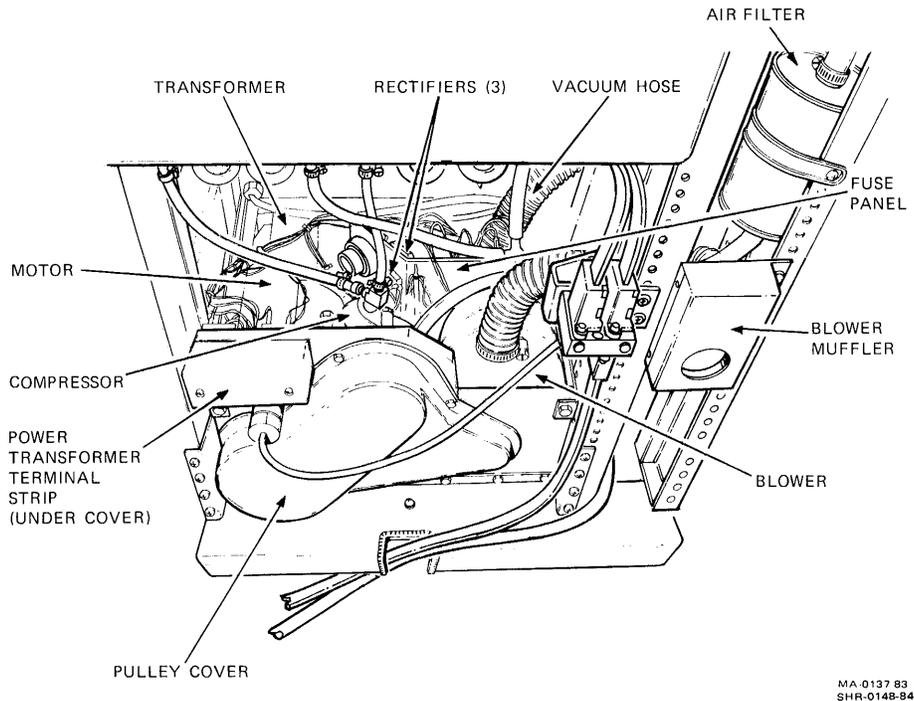
Figure 1-9   Power Pack Assembly (Rear View)

1.4 MAINTENANCE PHILOSOPHY

TA78 maintenance includes customer care, preventive maintenance, and corrective maintenance. Customer care involves daily cleaning of the transport as described in Paragraph 4.3 of the TA78 Magnetic Tape Drive User Guide. Preventive and corrective maintenance tasks should only be performed by trained, qualified service personnel.

Preventive maintenance (PM) is necessary only for the transport. Regular PM includes cleaning certain parts and checking certain adjustments.

The corrective maintenance philosophy is isolation of a failure to a single field replaceable unit (FRU) such as a module or mechanical assembly. Some transport failures may need only an adjustment as opposed to FRU replacement.

The TA78 offers several troubleshooting aids which apply to the formatter and/or transport. The primary troubleshooting aids are formatter-resident microdiagnostics. Other troubleshooting aids include: subsystem diagnostics, LED indicators, the error log, prewritten tape motion routines, and the ability for you to write and run your own tape motion routines.

You may need additional hands-on troubleshooting procedures to isolate a failure in the transport to a single FRU. In addition, troubleshooting can also be performed using functional block diagrams, flow diagrams, timing diagrams, and engineering logic drawings.

1.5 TOOLS

In addition to the standard Digital tool kit, you need the following tools to service the TA78. The third column of the list identifies tools that are in the TS78 control distribution (CD) kit (PN A2-W0617-10) or the TU78 CD kit (PN A2-W0341-10).

Description	Part Number	Included in a CD Kit
Dual-trace oscilloscope with two X10/X1 probes	—	No
Digital voltmeter	--	No
Two multilayer dual-height module extenders	W900	No
Reel motor centering tool	29-23206	Yes
Reel flange locating bar	29-23207	Yes
PCBA extender	29-23218	Yes

Description	Part Number	Included in a CD Kit
Lower restraint tube fitting	29-23228	Yes
Differential pressure gauge (0--40 inch H_2O)	29-11650	Yes
Differential pressure gauge (0--5 PSI)	29-11636	Yes
Portable accessory package for gauges (2 needed)	29-11647	Yes
Tachometer (decimal readout)	29-11635	Yes
Tape crimper	47-00038	Yes
Xcelite handle	29-10562	Yes
7-inch extension	29-11625	Yes
5/32 inch $\times$ 4 inch ballpoint hex driver	29-11630	Yes
Number 1 phillips screwdriver shaft	29-11001	Yes
Master skew tape (1200 ft)	29-19224	No
Magna-See tape developer	29-16871	No
50X microscope with graticule	29-20273	No
Heat sink compound	90-08268	Yes
Inspection mirror (dental type)	29-19663	No
Cleaning kit	TUC01	(comes with TA78)
Standard output tape	29-11691	No
Handheld terminal kit (or equivalent)	29-24195	Yes
STI loopback connector (2)	70-19074-01 (2)	Yes

1.6 RELATED DOCUMENTS

The following list describes documents related to the TA78.

Title	Order Number	Contents
TA78 Magnetic Tape Drive User Guide	EK-0TA78-UG	Description, operation, and installation of TA78
TA78 Magnetic Tape Drive Technical Description Manual	EK-0TA78-TD	Theory of operation of TU78 transport, TS78 formatter, and TS78 power supply
TA78 Magnetic Tape Drive Maintenance Guide	AA-P673A-TK	Summary of troubleshooting and maintenance procedures for TA78
TA78 Magnetic Tape Drive IPB	EK-0TA78-IP	Exploded views and parts lists of TU78 transport, TS78 formatter, and TS78 power supply
874 Power Controller IPB	EK-00874-IP	Exploded views and parts lists of 874
872 Power Controller IPB	EK-00872-IP	Exploded views and parts lists of 872
TU78 Magnetic Tape Transport Technical Manual, Volume 1	EK-1TU78-TM	Schematics and logic prints of TU78
HSC50 Service Manual	EK-HSC50-SV	Procedures for troubleshooting HSC50
TA78 Field Maintenance Print Set	MP-01614-00	Engineering drawings and parts lists for TS78 formatter mechanics and logic and TS78 power supply mechanics and circuitry

2.1   SITE PLANNING

Follow the requirements specified in this section to prepare a site for the TA78.

2.1.1   Space Requirements

Figure 2-1 shows the space and service clearances required for the TA78 cabinet. There must be enough space to swing the TS78 formatter out of the cabinet for servicing and open the front and rear doors on the TU78 tape transport.
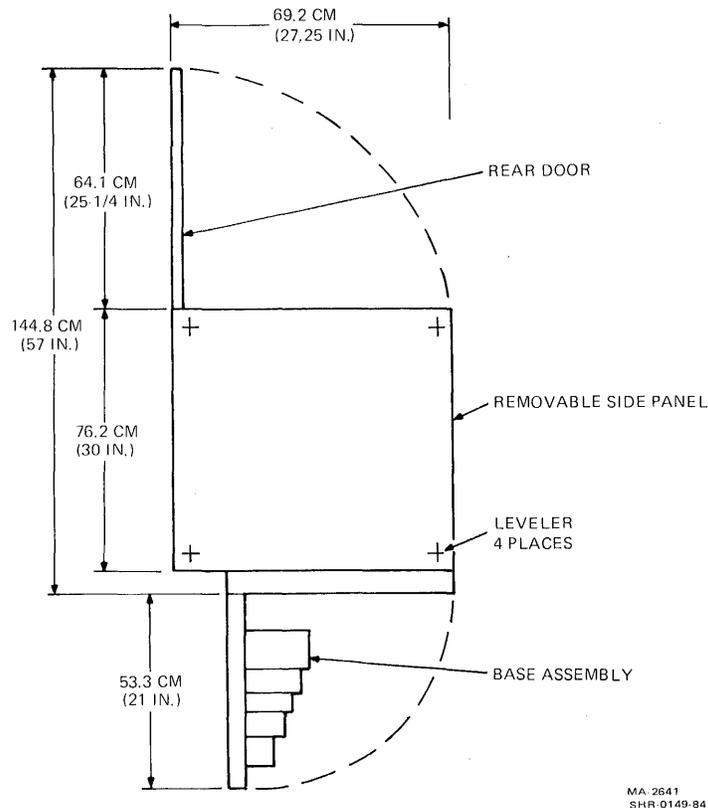
Figure 2-1   Space and Service Clearance (Top View)

PLUG	RECEPTACLE

BROWN

BLUE

GREEN/YELLOW

GREEN
EARTH
GROUND

PHASE OR
NEUTRAL

(NEUTRAL
PREFERRED)

PHASE OR
NEUTRAL

HUBBEL #2621

NEMA #L6-30P

DEC #12-16886-00

HUBBEL #2620

NEMA #L6-30R

DEC #12-16887-00
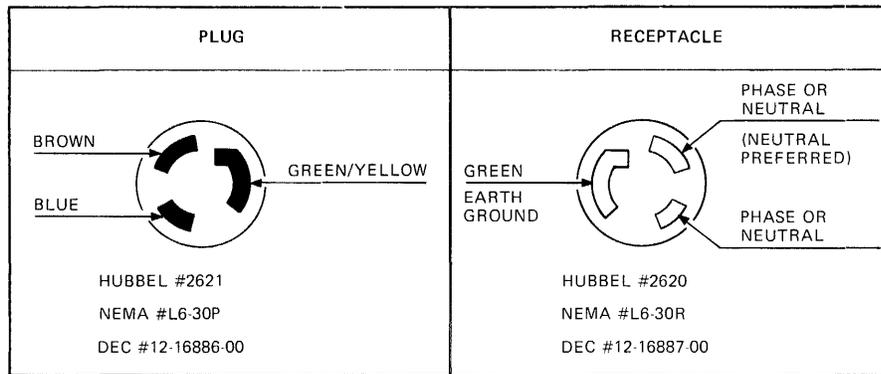
MA 0140 83
SHR-0150-84

Figure 2-2   TA78 Main Power Plug/Receptacle

2.1.2   Power Requirements

The TA78 tape drive can operate from 188 Vac to 256 Vac at 60 Hz, or 198 Vac to 256 Vac at 50 Hz, with proper connections on the power pack assembly. Line voltage should be maintained to within +10 percent of the nominal value. Frequency should not vary more than +1 Hz. Figure 2-2 shows the compatible power receptacle for the TA78.

2.1.3   Environmental Requirements

The TA78 tape drive should be 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 of 15° to 27° C (59° to 80° F) and relative humidity of 40 to 60 percent should be maintained.

2.2   UNPACKING AND INSPECTION

This section provides procedures for unpacking and inspecting the TA78.

2.2.1   Unpacking

The TA78 cabinet (H9602-KA) comes mounted to a wooden shipping skid that absorbs shock. The skid measures about 76 cm (30 in) wide, 107 cm (42 in) long, and 15 cm (5.75 in) high. The cabinet is packed in an extra strong corrugated cardboard container. The container measures about 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 panels of the container are bolted together.) Also mounted to the skid are two wooden ramps that you reposition during the unpacking procedure to roll the cabinet off the skid.

PLASTIC BANDS,
CUT, REMOVE, AND DISPOSE

CONTAINER,
REMOVE AND DISPOSE

PLASTIC BAG,
REMOVE AND DISPOSE

ANGLE BOARD,
REMOVE AND DISPOSE
(4 REQUIRED)

POLYESTER TAPE,
CUT

RAMPS, ATTACH TO
SKID DECK

MA-7015
SHR-0024-84
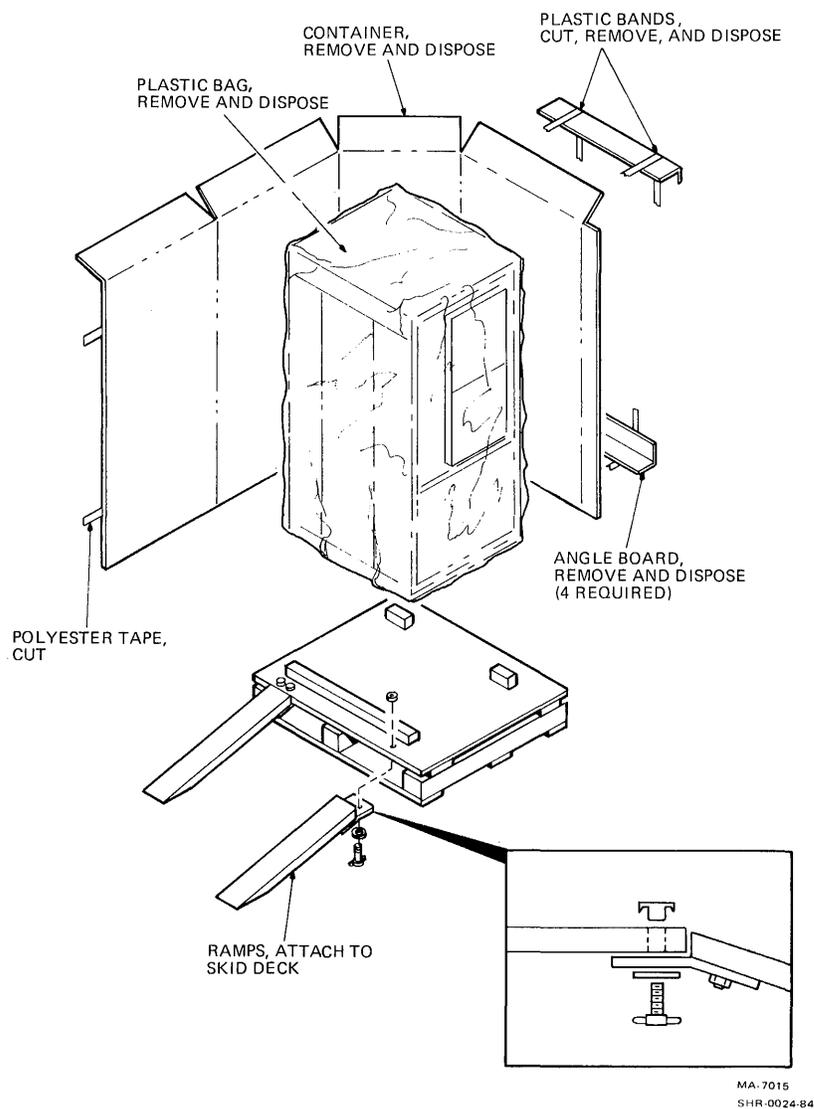
Figure 2-3   Unpacking the TA78

To unpack the TA78, perform the following procedure. (Refer to Figure 2-3.)

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

2-3

FRAME

TA78 CABINET

TEE NUT

BLOCK SPACERS

SKID DECK

SQUARE WASHER

HEX BOLT
(NYLOCK)

MA-7016
SHR-0017 84
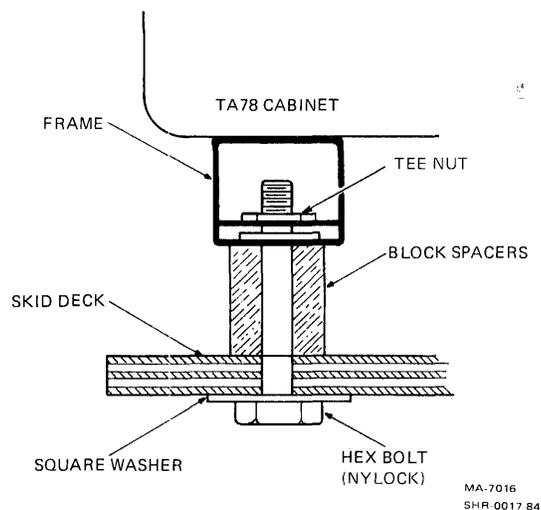
Figure 2-4   TA78 Mounting for Shipment

2.   Remove four hex bolts and square washers which hold unit
      to skid (Figure 2-4). Dispose of skid blocks and
      hardware.

3.   From the shipping kit, remove four thumb screws and two
      flat washers. Remove two 1/4-20 X 3/4 hex bolts from the
      shipping kit and secure the orange wheel locks to the
      cabinet. Make sure the wheels face from side to side of
      the unit and not from front to back.

4.   Remove the two skid ramps from the front of the skid.
      Save the two flat washers and dispose of the two hex
      bolts and external tooth washers.

                              NOTE
           You need four flat washers for this
           procedure.

5.   Attach both skid ramps and secure to the side of the skid
      as shown in Figure 2-3.

                            CAUTION
           The following step requires two people
           to roll the TA78 down the ramps. The
           majority of the transport's weight is in
           the upper-half of the cabinet, making it
           top-heavy. Do not try this procedure
           alone.

6.   With one person standing in front and one person standing in back of unit, guide unit down ramps until safely on floor.

7.   Dispose of ramps and hardware.

2.2.2   Inspection

After unpacking the TA78, inspect it, and report any damage to the responsible shipper and the local Digital sales office. Perform the inspection as follows.

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

2.   Open the transport front door. Press the upper and lower release buttons in all the way and open the buffer box door. Make sure the buffer box door is tightly secured to the cabinet. Inspect for foreign material, loose or damaged components, and glass damage.

3.   Check the transport for any foreign material 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 its
rubber surface or apply pressure to it.
Pressure causes it to deform.

6.   Check the tape path for any sharp edges.

7.   Close the buffer box door by pressing the two release buttons. Use moderate pressure; the buttons will not catch if pressed too hard.

8.   Close the transport front door.

2.3 SINGLE TRANSPORT INSTALLATION

This section provides information for installing a TA78 with a single transport.

2.3.1 Mechanical Installation

After unpacking and inspecting the TA78, roll it into position and proceed as follows.

> NOTE
> If the TA78 is placed next to another system cabinet, do not remove the adjoining side panels and bolt the cabinets together. Instead, leave the panels on and position the TA78 tightly against the other cabinet. This practice maintains proper air flow in both cabinets.

1. The vent in the cabinet front panel is an array of vertical slots. A quick-release latch is about 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 pulling the front panel forward to release one corner. In the same manner, while continuing to pull forward, release the latch at the other end of the array to free the panel. Remove the 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 and taped to the inside of the front panel.

3. Raise the interlock rods on each side of the cabinet. Remove the two stabilizer arms from the stabilizer sleeve assemblies (Figure 2-5).

4. Screw the leveler pads into the stabilizer arms.

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

6. Install the leveler feet in the lower corners of the cabinet frame (Figure 2-5).

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

8. Using a level, adjust the feet until the cabinet is level.
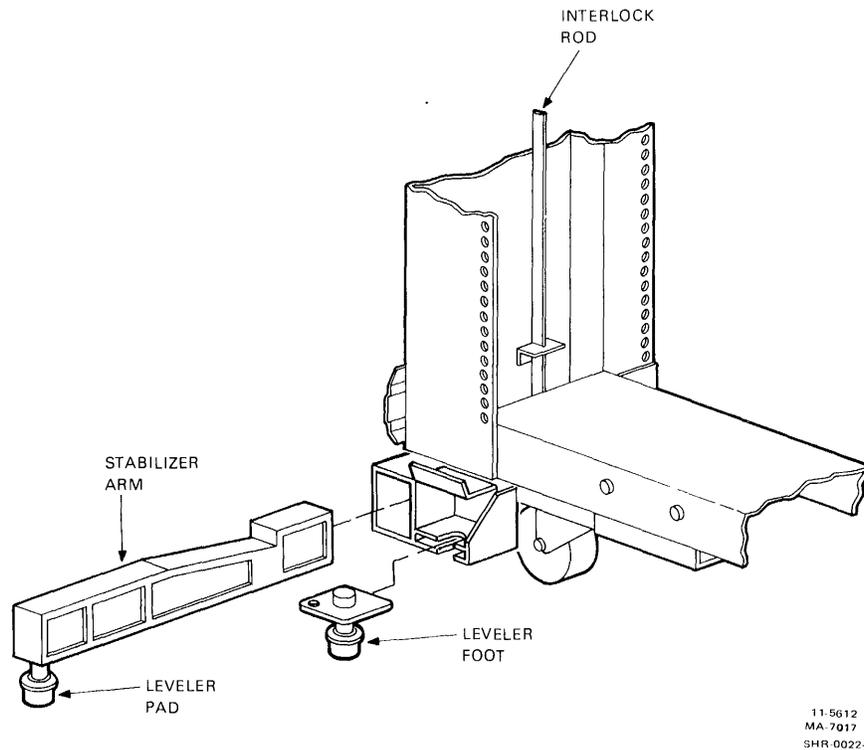
Figure 2-5   Location of Stabilizer Arm and Leveler Feet

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

10.   Insert a 5/32-inch allen wrench in the rear door latch.
      Turn the wrench one-quarter turn counterclockwise. Open
      the door.

11.   Open the transport front door and the buffer box door.
      Using a screwdriver, release the service lock 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).

PADDING

MIA PCB

READ PCB

WRITE PCB

CONTROL M2PCB

PUSH

PULL

CAPSTAN SERVO PCB

REEL SERVO PCB

MA-2645A
SHR-0151-84
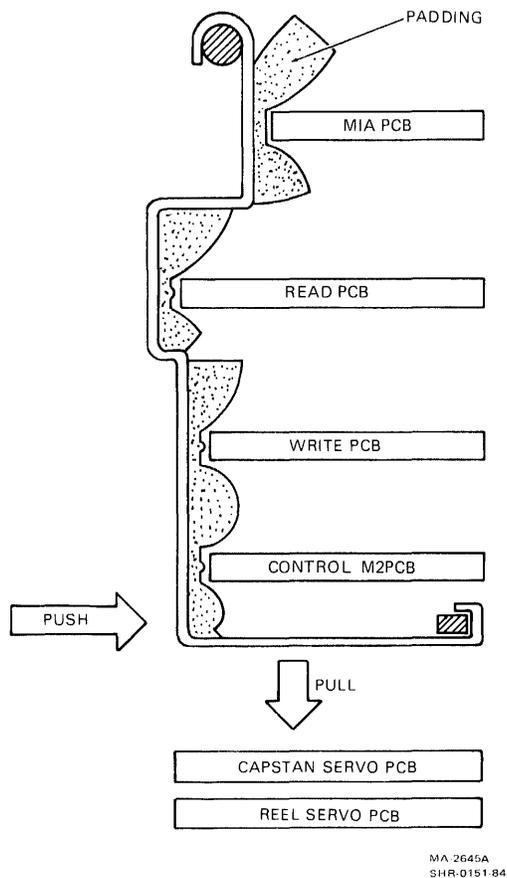
Figure 2-6   PCB Retainer Bracket (Side View)

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

13. Check seating of the PCBs in their sockets.

14. Replace the PCB retaining bracket.

15. Make sure the TS78 is securely mounted to the frame
     members inside the cabinet. Check for damage to the
     backplane (cracks, bent pins, etc.).

16. Remove the two 10-32 screws (Figure 2-7) securing the
     left side of the TS78 gate. Swing the gate out on its
     hinge. Loosen the two logic cover retaining screws
     (Figure 2-8) and remove the cover.

17. Make sure all circuit modules are firmly seated in their
     correct locations (Figure 1-5).

18. Replace the logic cover and tighten the retaining screws.

TS78
LOGIC GATE

REMOVE TWO
10-32
SCREWS

HINGE

MA-0141-83
SHR-0152-84
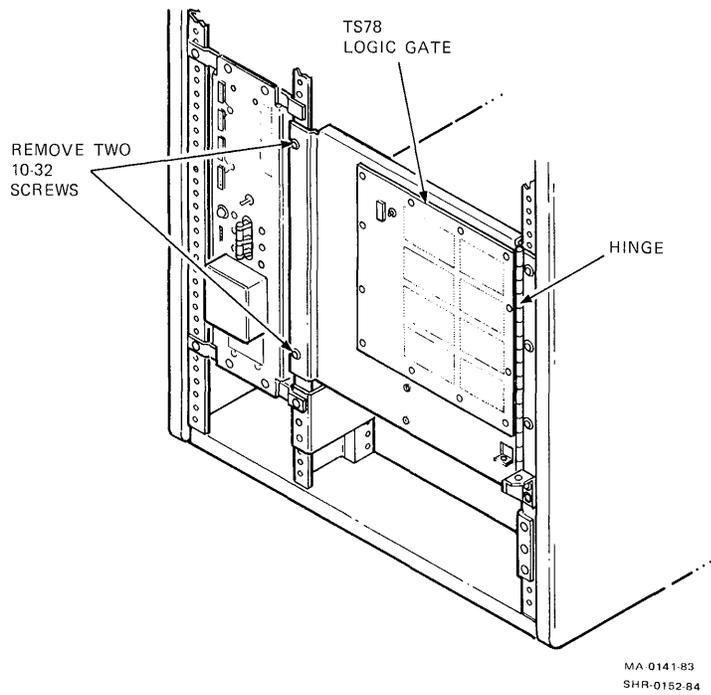
Figure 2-7   Releasing the TS78 Logic Gate

RELEASE
CABLES

LOOSEN
SCREWS
(2)

REMOVE
LOGIC
COVER

MA-0142-83
SHR-0153-84
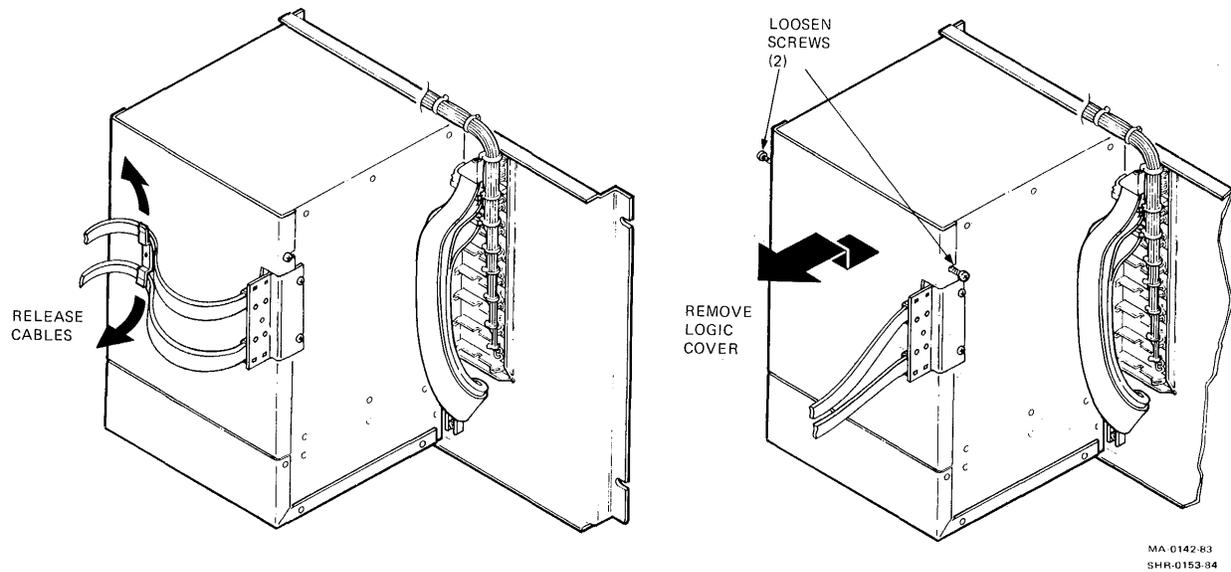
Figure 2-8   Removing the TS78 Logic Cover

2.3.2   Power and Cabling

Figure 2-9 shows the TA78 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/872-E power controller switched outlet to transport power pack

b.   Power cable from power controller switched outlet to cabinet exhaust blowers

c.   Power cable from power controller switched outlet to pneumatic system heat exchanger blowers

d.   Power cable from power controller switched outlet to TS78 power supply
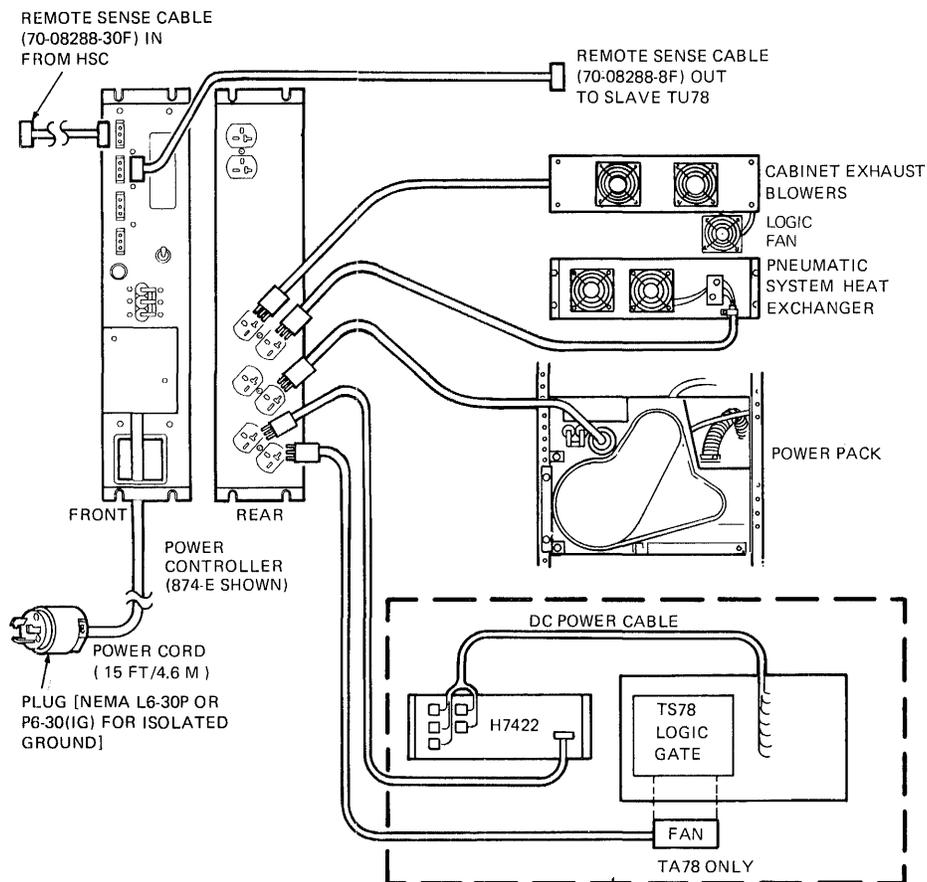
MA-7018
SHR-0018-84

Figure 2-9   TA78/TU78 Power Distribution

e. Power cable from power controller switched outlet to TS78 logic cage blower

f. DC power cable harness from TS78 power supply to TS78 logic gate

2. Make sure the power on/off circuit breaker on the power controller is on and the remote/local switch is set to REMOTE ON (Figure 2-10).

872-E FRONT PANEL

874-E FRONT PANEL
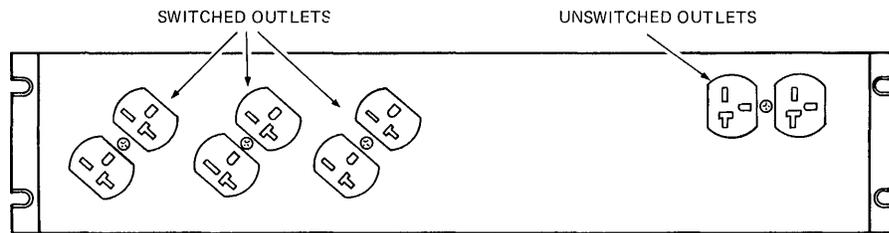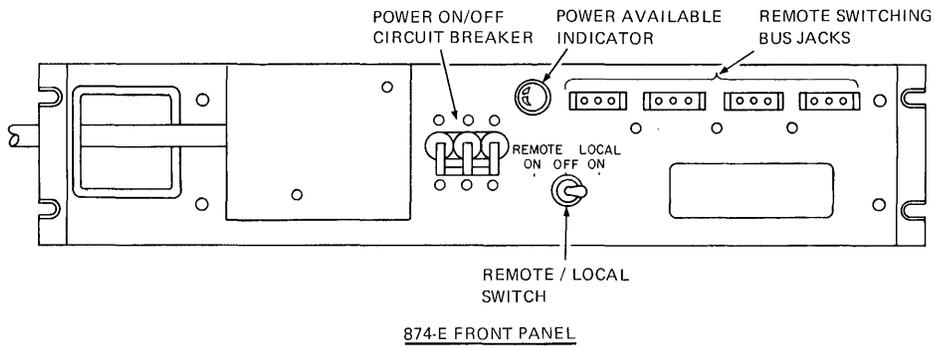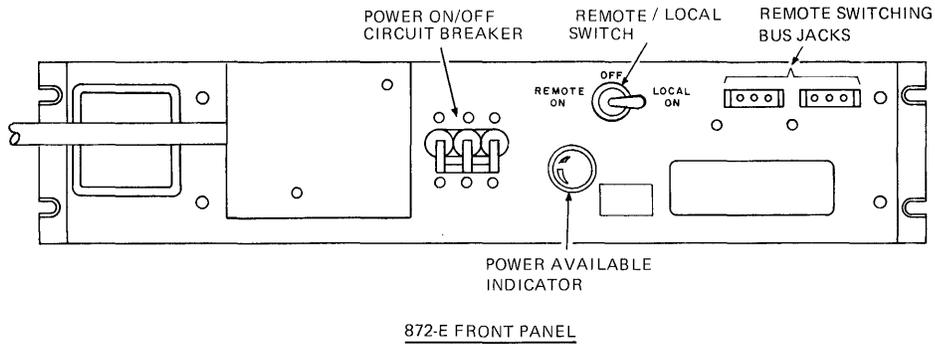
REAR PANEL (874-E and 872-E)

MA-0153-83
SHR-0015-84

Figure 2-10   874-E/872-E Power Controller

3. Check the fuses on the power pack fuse panel (Figure 1-9). Swing the TS78 logic gate out on its hinge to see the fuses from the front of the cabinet.

4. Remove the cover from the power transformer terminal strip (Figure 2-11). (Also remove the ac input plug on power pack.) Make sure the blue, brown, and white/red wires are connected according to Table 2-1. The terminals are numbered 1 through 9, from left to right. Replace the cover and connect the power pack connector.

Figure 2-11   Rear of Power Pack with Pulley Cover Removed

Table 2-1 Primary Power Connections

Input Voltage Taps	Blue Wire	Brown Wire and White/Red Wire
210	TB1-3	TB1-7
220	TB1-4	TB1-8
230	TB1-3	TB1-8

NOTE: All taps are ±10 percent.

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

NOTE

All TA78s are manufactured to operate at
an elevation of 0 to 610 m (0 to 2000
ft). If the drive you are installing is
to operate at a higher elevation,
install one of the optional high
altitude kits listed in Table 2-2. Table
2-3 lists the parts and their part
numbers for each kit.

Table 2-2   High Altitude Kits

Altitude	Frequency	Part Number
610 to 1220 m	60 Hz	A2W-0476-10 or 29-23985
(2000 to 4000 ft)	50 Hz	A2W-0476-11 or 29-23982
1220 to 1830 m	60 Hz	A2W-0477-10 or 29-23986
(4000 to 6000 ft)	50 Hz	A2W-0477-11 or 29-23983
1830 to 2438 m	60 Hz	A2W-0478-10 or 29-23987
(6000 to 8000 ft)	50 Hz	A2W-0478-11 or 29-23984

NOTE: High altitude kits with A2W-class part numbers contain
enough equipment to convert five TA78 tape drives. High altitude
kits with 29-class part numbers contain only enough equipment to
convert one drive.

Table 2-3   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	108478-12	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--2438 m	60 Hz	108479-11	108479-01	108478-08	102635-05
(6000--8000 ft)	50 Hz	108479-12	108479-01	108478-13	102635-05

NOTE: Vendor part numbers are shown.

6. If you need to install the kit, perform the following steps.

   a. Disconnect the ac line at the rear of the power pack by pulling the plug straight out.

   CAUTION
   Do not try this or any other removal or replacement procedure in the power pack assembly without first removing the 230 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 installation. 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 high altitude compressor pulley.

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

   f. Make sure both belts track completely on the pulleys. If not, try shifting the motor pulleys.

   g. Replace the belt guard and the power cord.

   h. Pack 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.

7. Connect the BC26V flat STI bus cable to the bulkhead connector (Figure 2-12). The bulkhead connector is a box at the rear of the cabinet. Cables from the HSC plug into the bottom of the box. There is one cable for each port. Secure each required cable with two screws.

NOTE:

STI CABLE FROM A SECOND HSC FOR
PORT B IS NOT SHOWN
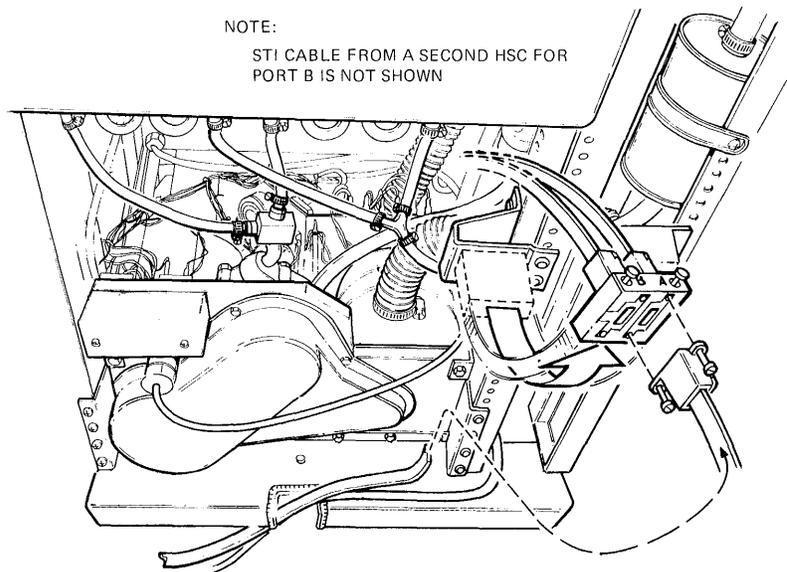
MA-0144-83
SHR-0021-84

Figure 2-12   STI Bus Cable Connection
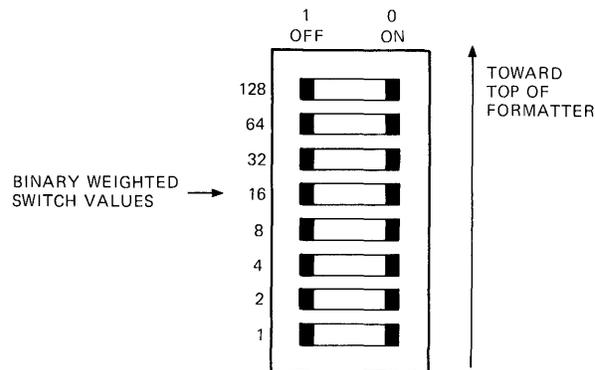
MA-6101A
SHR-0154-84

Figure 2-13   Unit Number Selector Switch

8.   Assign a unique unit number to the transport in the TA78.
     The unit number is a decimal number in the range of 0 to
     255. To assign the unit number, use the small DIP switch
     on the TS78 backplane (Figure 2-13). The DIP switch
     contains eight individual switches with a binary-weighted
     value assigned to each switch. To add the binary weight
     of a switch to the unit number, place the switch in the
     off position (press in on the left side). For example: to
     assign a unit number of 34, set the switches
     corresponding to 32 and 2 off. All other switches should
     be on.

2-15

9.   Place a decal identifying the unit number in the bottom-left corner of the glass in the transport door. The decal has stick-on digits supplied in the ship kit.

10. Connect the remote switching control bus from the HSC to one of the front jacks on the 874-E/872-E power controller. (When both STI ports are used, connect a bus from both HSCs to the 874-E/872-E.)

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

12. Make sure system power is off at the HSC(s). Connect the ac power cable from the 874-E/872-E to the power source.

13. Perform the acceptance testing (Paragraph 2.5).

2.4   MULTIPLE TRANSPORT INSTALLATION
This section provides information for installing a TA78 with more than one transport.

2.4.1   Mechanical Installation
After removing the shipping containers and skids, inspect the tape units. Then roll the cabinets to their approximate positions. Place the TA78 to the left (facing front) of the slave transports.

NOTE
If the TA78/TU78 on either end is placed
next to another system cabinet, do not
remove the adjoining side panels and
bolt the cabinets together. Instead,
leave the TA78/TU78 panels on and
position the drive tightly against the
other cabinet. This practice maintains
proper air flow in both cabinets.

Only the TA78 cabinet is shipped with side panels. As part of the following installation procedure, the TA78 and TU78 slave(s) are bolted together and the TA78 right side panel becomes the end slave transport's left side panel.

Unless otherwise specified, install each cabinet as follows.

1.   The vent in the cabinet front panel is an array of vertical slots. A quick-release latch is about 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 pulling the front panel forward to release one corner. In the same manner, while continuing to pull forward, release the latch at the other end of the array to free the panel. Remove the 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

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 2-5).

4.   Screw the leveler pads into the stabilizer arms.

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

6.   Install the leveler feet in the lower corners of the
        cabinet frame (Figure 2-5).

7.   Extend the two stabilizer arms from each cabinet. Lower
        the leveler pads until they just touch the floor. Do not
        place any weight on the pads.

8.   Open the transport front door in the TA78. Using a
        screwdriver, release the service lock 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 7).

9.   Find the fastener attached to the underside of the TA78
        top cover (Figure 2-14). Release the cover by turning the
        fastener one-quarter turn counterclockwise. When
        released, the fastener hangs by a wire from the cover.
        Pull the cover forward about 1.27 cm (0.5 in) and lift it
        off. Rest the cover on top of the cabinet. Leave the
        ground wire connected.

MA-2533
SHR-0155-84
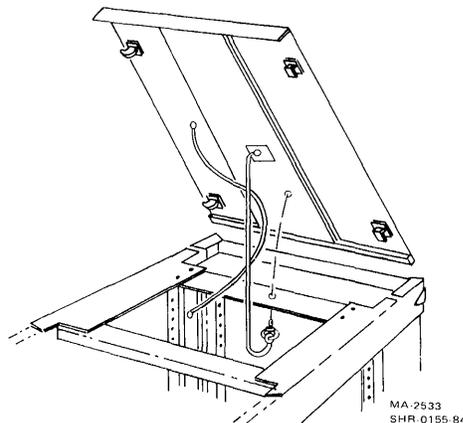
Figure 2-14   Top Cover Fastener

10. Remove the right side panel from the TA78. Grasp the panel on both sides and lift it off the four mounting bolts. If it does not lift off, try loosening the mounting bolts. In this case, remove the front panel trim to access the upper-front mounting bolt. To remove the trim, lift it up and out (Figure 2-15).

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 TA78.

13. Push the cabinets together so they join with the mounting bolt plates side by side.

14. Using the short ground strap included with the slave transports, ground the TA78 and slave cabinets together.

MOUNTING BOLTS

FRONT TRIM

GROUNDING STUDS

MOUNTING BOLTS

MA-2661
SHR-0156-84
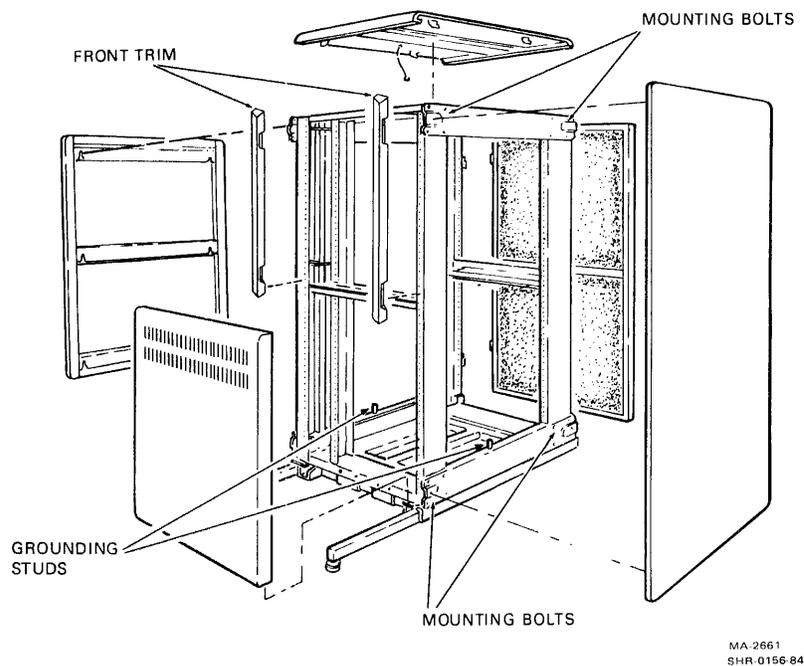
Figure 2-15   Cabinet with Side Panels
and Top Cover Removed

15. Using a 9/16-inch wrench, lower the leveling feet of the highest cabinet until they contact the floor and stabilize the cabinet.

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

17. Level and adjust the adjoining cabinet(s) so that the bolting (middle) holes on the four corner bolting plates align.

NOTE
Before you perform the next step, lay the TU bus cables for all the slave transports loosely between the TA78 and first slave (Figure 2-16). There are two 4.6-m (15-ft) cables (PN BC06R-15) for each slave. Place the cables with the red stripe facing the rear of the cabinet. Do not tape the cables together. Each cable must be free to replace in case of failure.

(FRONT VIEW)

NOTE:
ROUTE CABLES
UP THROUGH SPACE
BETWEEN CABINET
FRAMES.

MA-7022A
SHR-0157-84
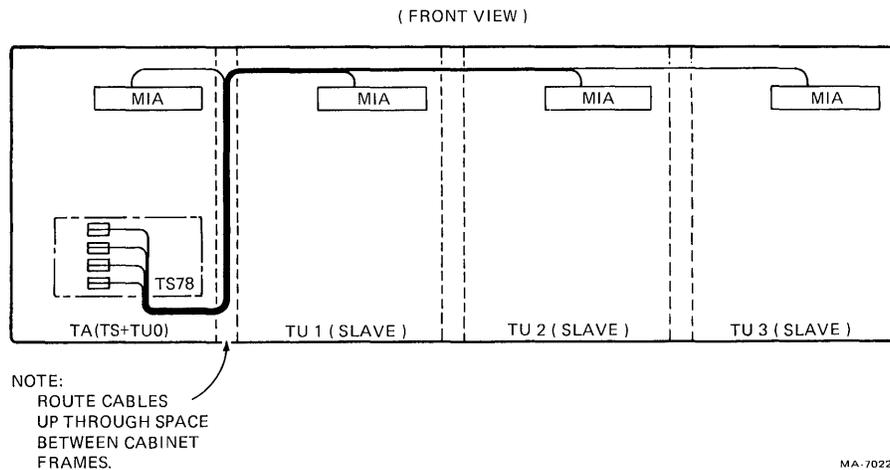
Figure 2-16   TU Bus Cable Routing for
               a Multiple Transport Configuration

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

19. Readjust the leveler pads on the stabilizer arms until they touch the foor. Each pad should slide easily along the floor. Do not place any weight on the pads.

20. Install the four mounting bolts from the TA78 cabinet in the mounting bolt plates of the end slave transport. Remove front panel trim if necessary.

21. 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.

22. Set the side panel from the TA78 next to the slave transport. Connect the panel ground strap to the cabinet frame. Mount the panel on the side of the slave transport.

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

24. Insert a 5/32-inch allen wrench in the rear door latch. Turn it one-quarter turn counterclockwise and open the door.

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

26. Make sure the TS78 is securely mounted to the frame members inside the TA78 cabinet. Check for damage to the backplane (cracks, bent pins, etc.).

27. Remove the two 10-32 screws (Figure 2-7) securing the left side of the TS78 gate. Swing the gate out on its hinge. Loosen the two logic cover retaining screws (Figure 2-8) and remove the cover. Make sure all circuit modules are firmly seated in their correct locations (Figure 1-5). Replace the logic cover and tighten the retaining screws.

2.4.2   Power and Cabling
Figure 2-9 shows the TA78/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 tape units.

   a.   Power cable from 874-E/872-E power controller switched outlet to transport power pack (Figure 2-9)

   b.   Power cable from power controller switched outlet to cabinet exhaust blowers

   c.   Power cable from power controller switched outlet to pneumatic system heat exchanger blowers

   d.   Power cable from power controller switched outlet to TS78 power supply (TA78 only)

   e.   Power cable from power controller switched outlet to TS78 logic cage blower (TA78 only)

   f.   DC power cable harness from TS78 power supply to TS78 logic gate (TA78 only)

2.   Make sure the power on/off circuit breaker on the power controller is on and the remote/local switch is set to REMOTE ON (Figure 2-10).

3.   Check the fuses on the power pack fuse panel (Figure 1-9). You can see the fuses from the front of the cabinet. (In the TA78 cabinet, swing the TS78 logic gate out on its hinge to see the fuses.)

4.   Remove the cover from the power transformer terminal strip (Figure 2-11). (Also remove the ac input plug on the power pack.) Make sure the blue, brown, and white/red wires are connected according to Table 2-1. The terminals are numbered 1 through 9 from left to right. Replace the cover and connect the power pack connector.
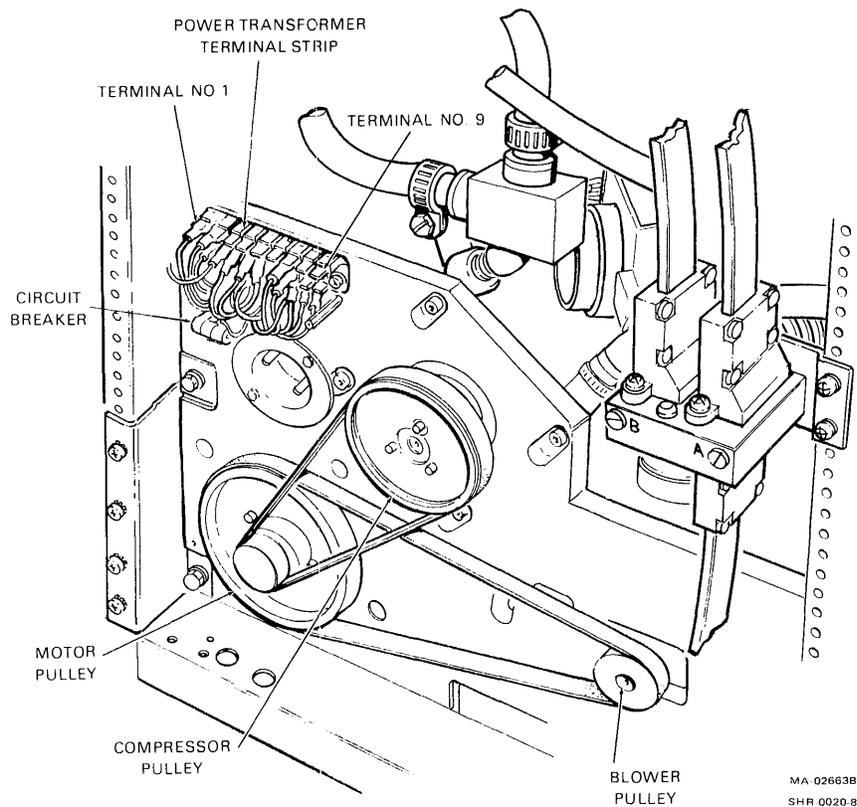
5.   Make sure the circuit breaker on the rear of the power pack is in the on (up) position.

NOTE
All TU78s are manufactured to operate at an elevation of 0 to 610 m (0 to 2000 ft). If the transport you are installing is to operate at a higher elevation, install a high altitude belt and pulley kit. Refer to Paragraph 2.3.2, step 6 for instructions.

6. Connect the BC26V flat STI bus cable to the bulkhead
    connector (Figure 2-12). The bulkhead connector is a box
    at the rear of the TA78 cabinet only. Cables from the HSC
    plug into the bottom of the box. There is one cable for
    each port. Secure each required cable with two screws.

7. Install the TU bus cables between the TS78 in the TA78
    cabinet, and the slave transport(s). Figure 2-16 shows
    the cable positions in relation to the cabinet frames.
    The TU bus for the transport in the TA78 is prewired at
    the factory. Figure 2-17 shows the electrical connection
    for each TU bus cable. Each transport has a unique set of
    cables. The jacks to which they connect (on the TS78)
    determine the cable number and part of the unit number.
    For installation, start at the TS78 end of the cable and
    work toward the MIA end.
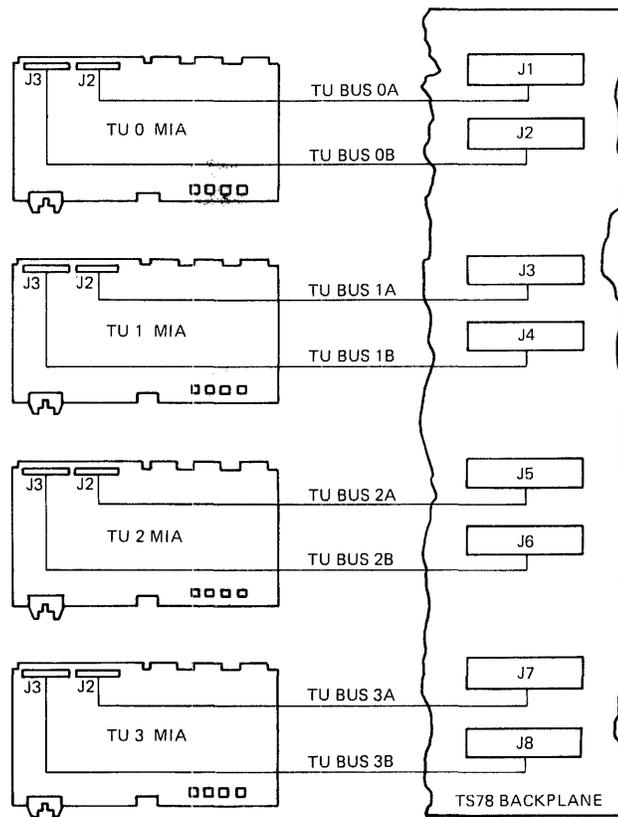
MA-6172A
SHR-0158-84

Figure 2-17 Radial TU Bus Connections

8.   To route cables from the TS78, first remove the two cable retainers. Then form and lay the new cable pairs. Figure 2-18 shows the placement of the cables within the TS78. Install the cable pair for the highest tape unit number first; install the pair for the lowest tape unit number last. In other words, work from jack J8 toward jack J1 so that all cables lie flat. Place the connectors so that the colored stripes on the cables are away from the backplane. Then replace the two cable retainers.

9.   The TU bus cables should exit through the space between the frame members of the TA78 and the first slave transport. (Refer to note after step 17, Paragraph 2.4.1.) 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.
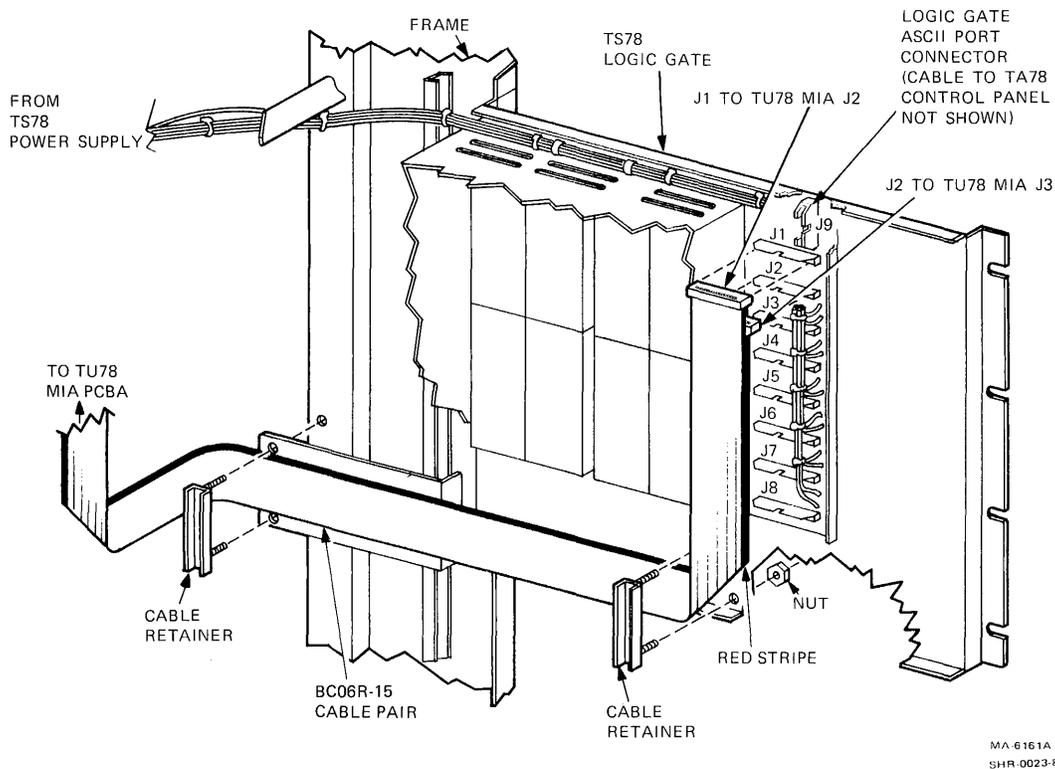
Figure 2-18   TU Bus Cable Routing and Hardware

RED STRIPE

J3 J2

RED STRIPE

CABLES IN
FROM TS78

FOLDING
DETAIL

MA 7023A
SHR-0159-84
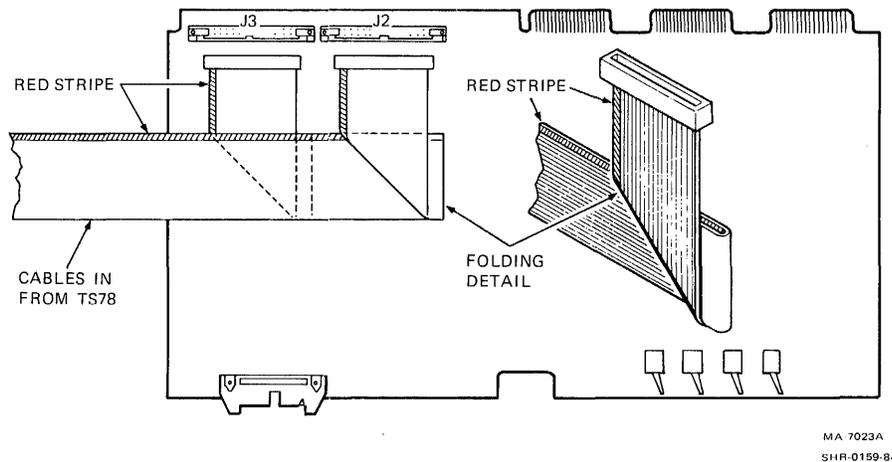
Figure 2-19   Cable Orientation on TU78 MIA PCB
(Slave Only)

10. Dress and bend the cables as shown in Figure 2-19. Note
    the orientation of the red stripe. Plug the appropriate
    cables into the two MIA jacks (J2 and J3). Take up, fold,
    and tie-wrap any slack in the cables.

11. Repeat this procedure for each set of cables going to
    each slave transport. Lay the cables for each succeeding
    transport over the preceding transport's MIA card (Figure
    2-16).

12. Assign a unique unit number to each transport attached to
    the TS78. The unit number is a decimal number in the
    range of 0 to 255. A transport unit number is equal to a
    base unit number plus the transport cable number. Setting
    the base number automatically sets all the transport
    numbers.

13. To assign the base number, use the small DIP switch on the TS78 backplane (Figure 2-13). The DIP switch contains eight individual switches with a binary-weighted value assigned to each switch. To add the binary weight of a switch to the base number, place the switch in the off position (press in on the left side). For example: to assign a base number of 34, set the switches corresponding to 32 and 2 off. All other switches should be on.

14. To determine a transport's unit number, add its cable number to the base number. A transport's cable number, in turn, is determined by the jacks on the TS78 into which the transport's TU bus cables plug (Figure 2-17). For example: with a base number equal to 34, the four transports connected to the TS78 have unit numbers of 34, 35, 36, and 37. For the transport in the TA78 cabinet, note that the base number is always equal to the unit number because the transport cable is 0.

15. Place a decal identifying the transport unit number in the bottom-left corner of the glass in the transport door. The decal has stick-on digits supplied in the ship kit.

16. Connect the remote switching control bus in a daisy chain. Connect the bus from the HSC to one of the jacks on the front of the 874-E/872-E power controller in the TA78. Using another cable, connect the bus from one of the other jacks on the power controller to the power controller in the next tape unit. Continue the daisy chain until all the tape units connect to the remote switching control bus. (When both STI ports are used, connect a bus from both HSCs to the power controller in the TA78.)

17. Make sure the system power is off at the HSC(s). Connect the ac power cable from each 874-E/872-E to a power source.

18. Install the cabinet front panels and close and secure all base assemblies.

19. Perform the acceptance testing (Paragraph 2.5).

2.5   ACCEPTANCE TESTING

This section describes all acceptance tests required for the TU78 transport and the TS78 formatter. If the tests are performed satisfactorily, then the units have been installed and are operating properly.

There are three categories of acceptance testing: turn-on and loading checkout, tape drive quick check, and subsystem level diagnostics. The turn-on and loading checkout verifies only basic functions of the transport and formatter. The tape drive quick check involves calling certain microcoded test routines via the ASCII port. The subsystem level diagnostics exercise the formatter and transport to the fullest extent.

If you are unfamiliar with interlocks and other conditions affecting autoload/manual load selection, refer to Paragraph 2.2.2 in the TA78 Magnetic Tape Drive User Guide.

2.5.1   Turn-On and Loading Checkout

The turn-on and loading checkout applies power to the tape drive so you can 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 to check for the proper responses. The checkout uses flowcharts to show the proper sequence of events for each loading operation. The flowcharts include minor troubleshooting aids to help find simple problems caused by bad tape or improper loading procedures. Perform the following operations in order.

2.5.1.1 Power On -- Follow the instructions and check for the specified events.

1. Remove the lower front panel of the TA78 cabinet to access the TS78 formatter.

2. Turn both TS78 STI bus ports off-line by placing the PORT SELECT A and B buttons on the TS78 control panel in the disable (out) position.

3. Turn on the power. This may be done remotely by turning on the HSC or locally by flipping the remote/local switch on the power controller to LOCAL ON. (When both STI ports are used, use only the HSC connected to port A if remote turn-on is desired.)

4. Check for the following conditions.

    a. All fans turn on.

    b. The following indicators on the TU78 control panel light: power, file protect, 6250. All other indicators on the TU78 control panel remain unlit.

5.   Press the MASTER RESET button on the TS78 formatter. All
     three control/indicators on the TS78 control panel should
     light for about 4 seconds. During this time, the TS78
     microcomputer runs the minimum integrity and power-up
     microdiagnostics. If the three indicators stay on, the
     microcomputer is probably bad. If other hardware has
     caused a test to fail, the FAULT indicator lights. Press
     and release the FAULT button to obtain the base error
     code. Refer to the troubleshooting procedures in this
     manual.

2.5.1.2 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 2-20.

```
┌─────────────────────┐          ┌──────────────────────┐
│ PRESS THE RESET     │          │ SUPPLY HUB STOPS.    │
│ BUTTON ON THE TU78  │          │ PRESSURE AND         │
│ CONTROL PANEL.      │          │ VACUUM SOLENOIDS     │
└─────────┬───────────┘          │ DE-ENERGIZE.         │
          │                      └──────────┬───────────┘
┌─────────▼───────────┐                     │
│ PRESS LOAD/REW      │          ┌──────────▼───────────┐
│ BUTTON.             │          │ SUPPLY HUB           │
└─────────┬───────────┘          │ ROTATES CCW.         │
          │                      └──────────┬───────────┘
┌─────────▼───────────┐                     │
│ AC MOTOR STARTS.    │          ┌──────────▼───────────┐
│ TAKE UP REEL TURNS  │          │ PRESSURE AND         │
│ CW. (NO SUPPLY HUB  │          │ VACUUM SOLENOIDS     │
│ MOTION.) CARTRIDGE  │          │ ENERGIZE.            │
│ MOTOR OPENS.        │          └──────────┬───────────┘
└─────────┬───────────┘                     │
          │                      ┌──────────▼───────────┐
┌─────────▼───────────┐          │ TAKE UP REEL STOPS.  │
│ PRESSURE AND        │          │ SUPPLY HUB STOPS.    │
│ VACUUM SOLENOIDS    │          │ AC MOTOR STOPS.      │
│ ENERGIZE.           │          │ PRESSURE AND VAC-    │
└─────────┬───────────┘          │ UUM SOLENOIDS DE-    │
          │                      │ ENERGIZE. LOAD FAULT │
┌─────────▼───────────┐          │ LAMP FLASHES ON      │
│ SUPPLY HUB          │          │ AND OFF.             │
│ ROTATES CW.         │          └──────────┬───────────┘
└─────────┬───────────┘                     │
          │                      ┌──────────▼───────────┐
┌─────────▼───────────┐          │ PRESS THE RESET      │
│ TAKE UP REEL        │          │ BUTTON ON THE TU78   │
│ COMPLETES ABOUT     │          │ CONTROL PANEL.       │
│ TEN REVOLUTIONS.    │          └──────────┬───────────┘
└─────────────────────┘                     │
                                 ┌──────────▼───────────┐
                                 │ CARTRIDGE MOTOR      │
                                 │ CLOSES. LOAD FAULT   │
                                 │ LAMP GOES OFF.       │
                                 └──────────────────────┘
```

MA-2639A
SHR-0160-84

Figure 2-20   Loading Sequence
              Without Tape

2.5.1.3 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 on the supply hub. Close the transport front door. Follow the instructions and check for the events specified in Figure 2-21.

2.5.1.4 Autoload Sequence -- Remove the tape from the leader. Allow the magnetic tape to come off the supply reel. Make sure 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 2-22.

MA 2649A
SHR-0161-84

Figure 2-21   Inhibited Autoload Sequence

2-28

PRESS THE RESET BUTTON ON THE TU78 CONTROL PANEL.

↓

PRESS LOAD/REW BUTTON.

↓

FILE PROTECT LAMP GOES OFF. AC MOTOR STARTS. CARTRIDGE MOTOR OPENS. TAKE-UP REEL TURNS CW. (NO SUPPLY REEL MOTION.)

↓

SUPPLY REEL TURNS CCW.

↓

PRESSURE AND VACUUM SOLENOIDS ENERGIZE.

↓

SUPPLY REEL TURNS CW.

↓

TAPE THREADS AND WRAPS ONTO THE TAKE-UP REEL. — NO → (A)

YES ↓

BOT LAMP FLASHES ONCE. — NO → (C)

YES ↓

(B)

(A)

↓

TAKE UP REEL COMPLETES ABOUT TEN REVOLUTIONS.

↓

SUPPLY REEL STOPS. PRESSURE AND VACUUM SOLENOIDS DE-ENERGIZE.

↓

SUPPLY REEL TURNS CCW.

↓

PRESSURE AND VACUUM SOLENOIDS ENERGIZE.

↓

SUPPLY REEL TURNS CW.

↓

TAPE THREADS AND WRAPS ONTO THE TAKE UP REEL. — NO →

YES →

(B)

↓

PRESSURE AND VACUUM SOLENOIDS DE-ENERGIZE.

↓

TAPE ENTERS VACUUM COLUMNS.

↓

LOOPS ARE SET.

↓

TAPE RUNS REVERSE TO BOT AND STOPS. BOT LIGHT COMES ON. — NO →

YES ↓

(DONE)

(C)

↓

TAPE HAS A BOT MARKER. — NO → INSTALL A BOT MARKER 4.6M (15 FT.) FROM THE BEGINNING OF THE TAPE. REPEAT THE AUTOLOAD PROCEDURE.

YES ↓

BOT MARKER HAS PASSED BOT SENSOR AND IS ON THE TAKE UP REEL. — NO → BOT MARKER IS TOO FAR FROM BEGINNING OF TAPE. MARKER SHOULD BE FROM 4.3 TO 4.9 M (14 TO 16 FT.) FROM BEGINNING OF TAPE. REPOSITION THE MARKER AND REPEAT THE AUTOLOAD PROCEDURE. IF THE SAME PROBLEM OCCURS AGAIN, REPEAT THE PROCEDURE WITH ANOTHER REEL OF TAPE. IF THE LOAD SEQUENCE IS STILL UNSUCCESSFUL, REFER TO TROUBLESHOOTING PROCEDURES IN THE TA78 SERVICE MANUAL.

YES ↓

REPEAT THE AUTOLOAD PROCEDURE WITH ANOTHER REEL OF TAPE. IF THE LOAD SEQUENCE IS STILL UNSUCCESSFUL, REFER TO TROUBLESHOOTING PROCEDURES IN THE TA78 SERVICE MANUAL.

TAKE UP REEL COMPLETES ABOUT TEN REVOLUTIONS.

↓

SUPPLY REEL STOPS. PRESSURE AND VACUUM SOLENOIDS DE-ENERGIZE.

↓

SUPPLY REEL TURNS CCW.

↓

PRESSURE AND VACUUM SOLENOIDS ENERGIZE.

↓

TAKE UP REEL STOPS. SUPPLY REEL STOPS. PRESSURE AND VACUUM SOLENOIDS DE-ENERGIZE. AC MOTOR STOPS. LOAD FAULT LAMP FLASHES ON AND OFF. FILE PROTECT LAMP COMES ON.

↓

CHECK PARAGRAPH 2.2.5 FOR PROBABLE CAUSE. ATTEMPT ANOTHER AUTOLOAD. IF THE AUTOLOAD PROCEDURE FAILS AGAIN, REFER TO TROUBLESHOOTING PROCEDURES IN THE TA78 SERVICE MANUAL.

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Figure 2-22   Autoload Sequence

2.5.1.5 Manual Load Sequence -- Install a write-enable ring on a 216- or 178-mm (8.5- or 7-in) tape reel. Mount the reel on the supply hub. Make sure the leader has no creases or rips. If necessary, crimp the end of the tape with the tape crimper. Insert 8 to 10 cm (3 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 2-23.

2.5.1.6 Unload Sequence -- Follow the instructions and check for the events specified in Figure 2-24.
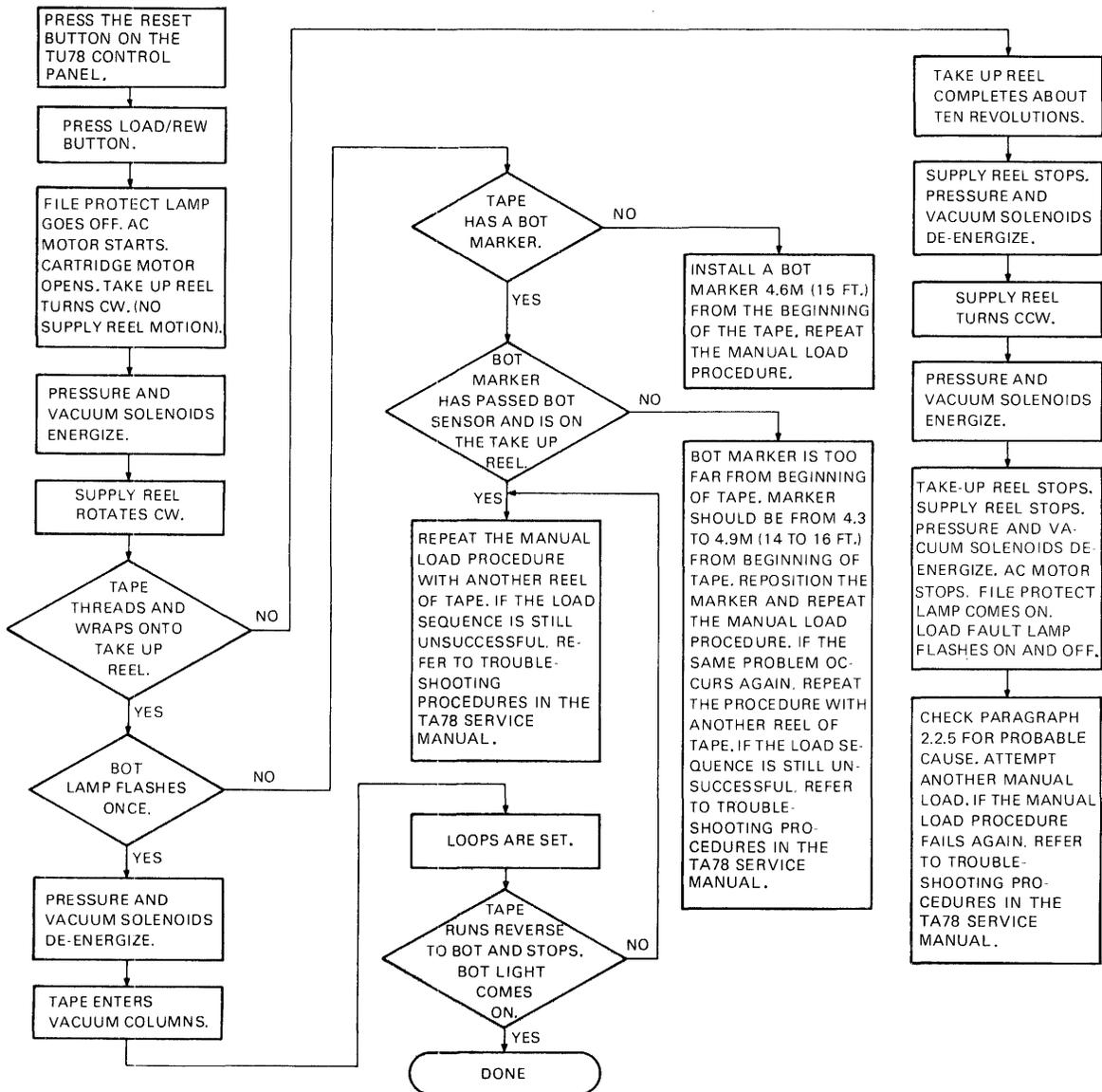
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Figure 2-23 Manual Load Sequence

```
┌─────────────────────┐
│ PRESS THE RESET     │
│ BUTTON ON THE TU78  │
│ CONTROL PANEL.      │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ PRESS UNLOAD        │
│ BUTTON.             │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ AC MOTOR STOPS.     │
│ SUPPLY REEL TURNS   │
│ CCW. TAKE UP REEL   │
│ TURNS CW AND        │
│ THEN CCW.           │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ TAPE UNLOADS AND    │
│ WRAPS ONTO SUPPLY   │
│ REEL.               │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ SUPPLY REEL         │
│ STOPS.              │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ CARTRIDGE MOTOR     │
│ CLOSES.             │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ TAKE UP REEL STOPS. │
│ FILE PROTECT LAMP   │
│ COMES ON.           │
└─────────────────────┘
```
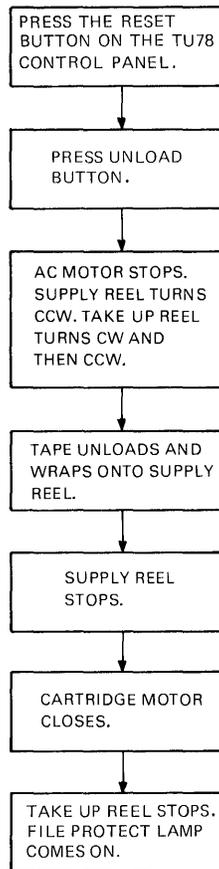
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Figure 2-24   Unload Sequence

2.5.1.7   **Manual Load Repeatability** -- Perform the following steps.

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

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

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

4.   Close the transport front door.

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

2-31

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 eight tests, continue manual loading up
      to 20 tests. There should be no more than three failures
      in 20 successive tests.

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

2.5.1.8 Autoload Repeatability -- Perform the following steps.

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

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

3.   Close the transport door.

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

5.   If the tape 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 try fails, the load fault
      indicator flashes. This counts as one failure.

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

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

2.5.2   Tape Drive Quick Check

This procedure uses TA78-resident test routines to check some functions of the transport(s). Perform the following operations starting with transport 0.

1.   Set the transport rotary switch in the number 1, 2, or 3 position (maintenance mode).

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

3.   Plug an RS232-compatible, external terminal -- a handheld terminal (HHT) for example -- into the EIA connector on the TS78 control panel (Figure 2-25). For terminals that require +5 V power, +5 V (at 1 A maximum) is available at a 3-pin Mate-N-Lok connector on the panel.

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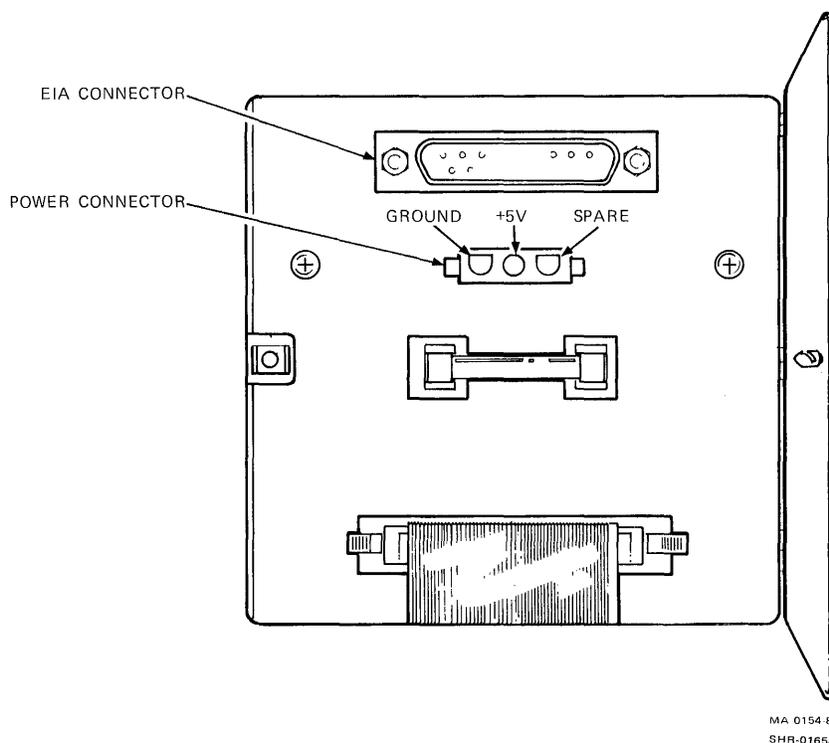
Figure 2-25   TA78 Maintenance Port

4.   Turn the external terminal on. Steps 5 through 11 describe acceptance testing initiated through the external terminal.

5.   Access the TA78 as follows.

     a. Type **CTRL C** on the terminal keyboard. Repeat the entry until **TA78>** appears.

     b. Type **RUN KEYPAD**. The acceptable response is **KEYPAD>**.

6.   To select a transport, type **UNIT X** where **X** is the transport cable number (Ø, 1, 2, 3) shown in Figure 2-17. To start testing, set **X** to **Ø** selecting the transport in the TA78 cabinet.

7.   Type **WRITE** to test the transport's functions. The tape drive executes a write GCR command on the selected transport. The drive then displays the results as a two-digit code on the external terminal and waits for another command. The only acceptable responses are **ØØ** and **Ø2**. Any other response is not acceptable and indicates a problem somewhere in the tape drive. Refer to the troubleshooting procedures in this manual.

8.   Repeat steps 1, 2, 6, and 7 for any slave transport present.

9.   Type **CTRL Z** to exit from the keypad program. The tape drive responds by echoing ^Z and displays **TA78>**.

1Ø. Type **CTRL Z** to exit from the terminal mode. The drive echoes ^Z.

11. Disconnect the external terminal from the TS78 control panel.

12. Verify each TU78 vacuum and pressure setting by performing the adjustment procedures in Paragraph 3.6. This step is especially important if you have just installed a high altitude kit. Adjust any setting that is out of tolerance.

2.5.3   Subsystem Level Diagnostics

Mount and load a write-enabled 267-mm (1Ø.5-in) tape reel. Place the transport on-line and make sure the on-line indicator lights. Depending on the STI port being driven, set the PORT SELECT A or B button on the TS78 control panel to the enable (in) position. If exercising a dual port configuration, press the PORT SELECT A button to the in position.

Two subsystem level diagnostics, ILTAPE and ILEXER, verify proper TA78 operation. The paragraphs that follow briefly describe these two diagnostics.

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In-Line Tape Diagnostic (ILTAPE) -- Forty-seven routines thoroughly test the TS78 formatter logic. A canned sequence, using the basic tape commands, tests the TU78 transport functions.

In-Line Exerciser (ILEXER) -- This diagnostic exercises from 1 to 10 units in any combination of disk and tape drives connected to an HSC. Logic is tested by writing and reading predetermined data patterns and recording modes.

ILTAPE and ILEXER are run from the HSC ASCII port. Refer to the appropriate HSC user documentation for more information.

Perform the following procedure to test the TA78.

1.   Run ILTAPE (47 diagnostics and the canned sequence) for three passes. No errors are allowed. (When both STI ports are used, also run ILTAPE through the second port for one pass.)

2.   Run ILEXER. Use the GCR worst case data pattern (22) for 15 minutes. Table 2-4 lists the acceptable error criterion. (When both STI ports are used, also run ILEXER through the second port for 15 minutes.)

Table 2-4   Maximum Error Number

Error Type Designation	Description	Allowed Number
Hard	Nonrecoverable	0
Media	Tape media	20
Double Trkerr	Double track correction (read)	1
Double Trkrev	Double track correction (read reverse)	1
Single Trkerr	Single track correction (read)	5
Single Trkrev	Single track correction (read reverse)	5
Other Err A	Other (read and read reverse)	10
Other Err B	Status (read and read reverse)	0
Other Err C	Other (write)	10

NOTES

1. Other (read and read reverse) -- successful operation without error correction, but with interesting occurrence (AMTIE or PHTIE flag).

    Status (read and read reverse) -- successful operation after retries.

    Other (write) -- write retry succeeded in same physical location that previous write retry failed.

2. If the TA78 does not meet these specifications, additional run time is necessary to determine the validity of errors.

3.1   PREVENTIVE MAINTENANCE

A preventive maintenance (PM) program is necessary for the TU78 transport. The PM tasks should only be performed by trained, qualified service personnel. Assuming moderate use, these tasks should be performed every six months. If use exceeds 2500 vacuum-on hours in six months, the PM frequency should increase proportionally. Table 3-1 lists the individual tasks and references the appropriate paragraph for individual procedures.

Perform the tasks in the order listed in the table. It is not necessary to alter any adjustment on the TU78 if it is performing in a satisfactory manner, and the check being performed is within the allowable tolerance. While conducting the semiannual PM, visually inspect the equipment for loose electrical connections, dirt, cracks, binding, excessive wear, and loose hardware.

Table 3-1   Preventive Maintenance

Procedure	Paragraph Number
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.	3.9
CAUTION Observe warnings and notes in Paragraph 3.9	
Remove and clean foam cabinet filters inside front door and rear door. Perform general cleaning of cabinet area.	--
Remove and clean air bearings, air guide, and circular ceramic guide.	6.2.3, 6.2.4

Table 3-1 Preventive Maintenance (Cont)

Procedure	Paragraph Number
Remove tape cleaner and clean blades.	6.2.2
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.	6.2.1
Check all hoses and tubing for cracks and tighten all connection clamps if necessary.	--
Clean dirt from heat exchanger fins.	--
Remove pneumatic belt guard and check belts for wear and proper tracking.	Figure 6-6
Clean compressor intake muffler/filter element.	--
REPLACE COMPRESSOR IN-LINE FILTER.	--

NOTE
If any of the following checks are out of tolerance, perform the associated adjustment.

Procedure	Paragraph Number
Check vacuums and pressures.	3.6
Check supply reel load speed.	3.8.2
Check take-up reel load speed.	3.8.3
Check loop positions.	3.8.4
Check cartridge limit switches.	6.2.8 (Steps 8, 9, 10)
Check PE amplitudes.	3.10.3
Check read skew (azimuth).	3.10.1

3.2   GENERAL ADJUSTMENT NOTES

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

Some adjustments may require prerequisite (performed before) and/or corequisite (performed with) adjustments of other parameters (Table 3-2). 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.

Table 3-2   Required Prerequisite/Corequisite Adjustments

Paragraph	Adjustment	Prerequisites Paragraph	Corequisites Paragraph
3.3	Power distribution	--	--
3.4	EOT/BOT adjustment	3.3	--
3.5	Pack sense adjustment	3.3	--
3.6	Vacuum and air pressure adjustments	--	--
3.6.1	System vacuum adjustment	--	3.6.2
3.6.2	Takeup reel vacuum adjustment	3.6.1	--
3.6.3	Air bearing pressure adjustment	--	--
3.6.4	Thread block and cartridge pressure adjustment	--	--
3.7	Capstan servo adjustments	3.3	3.10.3
3.8	Reel servo adjustments	--	--
3.8.1	Reel servo offset	3.3	--
3.8.2	Supply reel load speed adjustment	--	--
3.8.3	Takeup reel load speed adjustment	--	--
3.8.4	Tape loop position adjustment	3.6	--
3.10	Read/write adjustments	3.9, 3.3 3.7	--

Some adjustments require using the ASCII port with an external terminal. Procedures for operation via the ASCII port are provided in each alignment step that requires its use. For more information on the ASCII port and its functions, refer to Paragraph 4.7.

Some adjustments also require that the front door be open and the interlock switch be defeated. 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 you have problems during any alignment procedure, refer to Chapter 5 (TU78 Troubleshooting) for fault isolation procedures.

3.3   TU78 POWER SUBSYSTEM ADJUSTMENTS

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 2-1 for proper jumper configuration.)

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

3.   Remove the two retaining screws from the left side of the TS78 logic gate and swing the gate out on its hinge (TA78 only).

4.   Make sure the power controller 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 on the power supply fuse panel. Refer to Figure 3-1 for fuse locations and Table 3-3 for proper voltage readings. If the readings are incorrect go to Chapter 5 for troubleshooting information.

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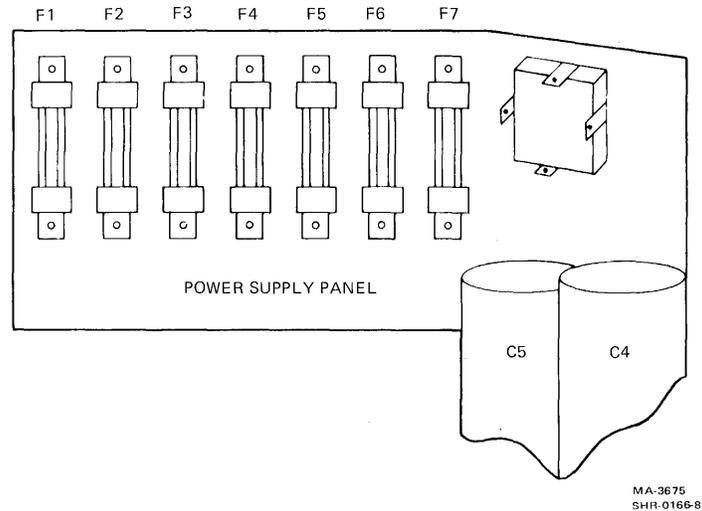
Figure 3-1   Power Supply Fuse Panel

Table 3-3   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 b
    monitoring TP11, TP15, and TP18 with respect to TP1 on
    the capstan/regulator PCBA. Figure 3-2 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 3-2).
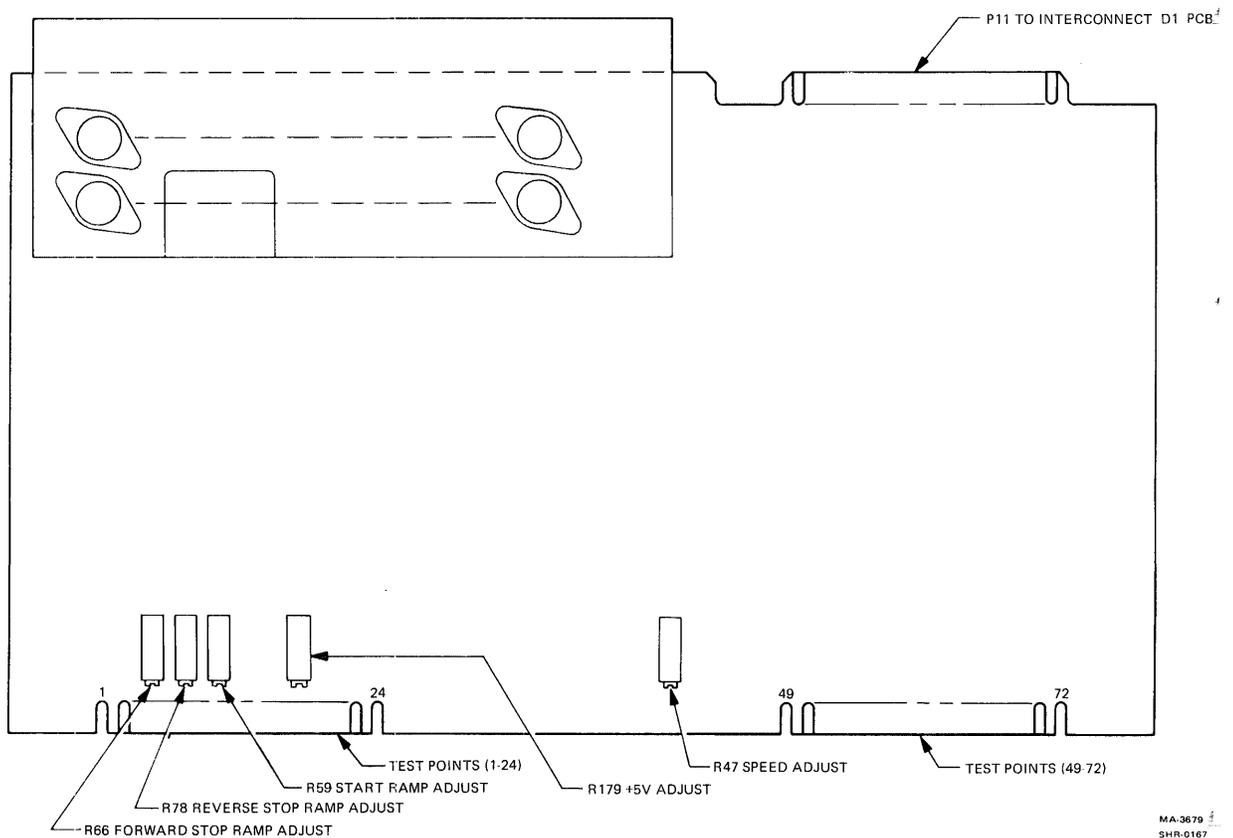
Figure 3-2   Capstan/Regulator PCBA Adjustments and Test Points

3.4 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 3.3.

2. On the interconnect F1 PCBA, connect a DVM with its positive lead to TP6 and its negative lead to TP5 (Figure 3-3).

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.

R1   SUPPLY POSITION ADJUST
R30   SUPPLY GAIN
R9   TAKE-UP POSTION ADJUST
R31   TAKE-UP GAIN
R17   PACK SENSE (LOW TAPE) ADJUST
R22   EOT/BOT ADJUST

REMOVE PIN 1 BEFORE
INSTALLATION

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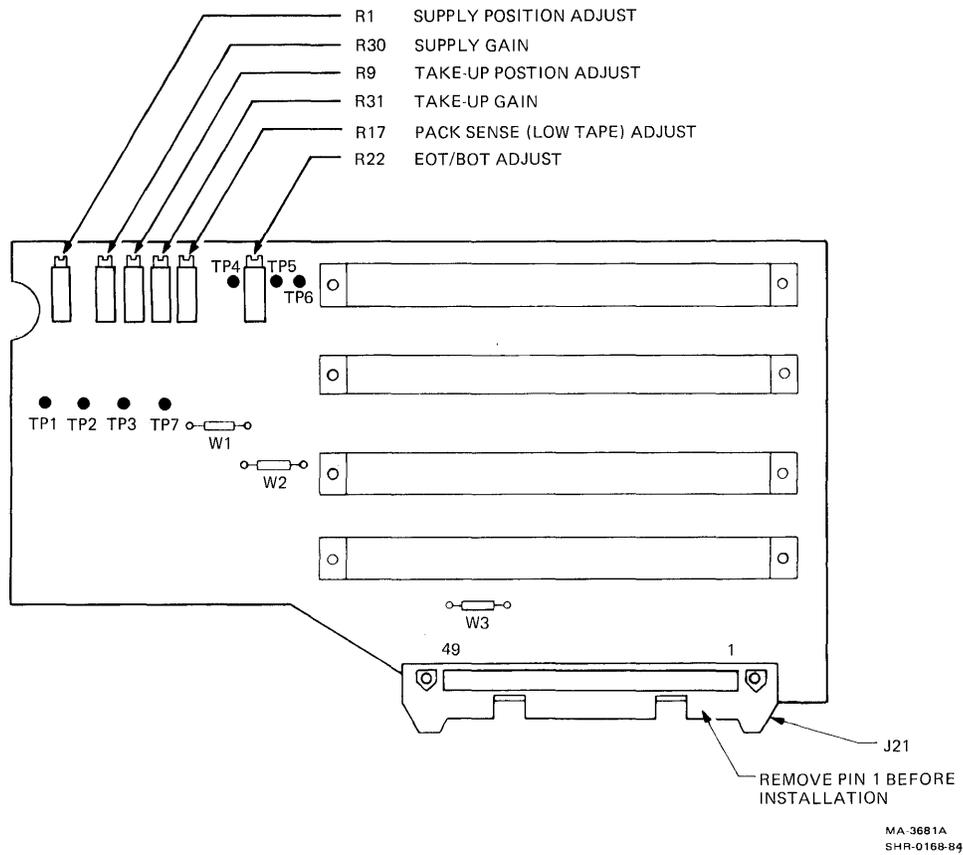
Figure 3-3   Interconnect F1 PCBA Adjustments
and Test Points

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 3-4). 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) and -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 3-3).

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.

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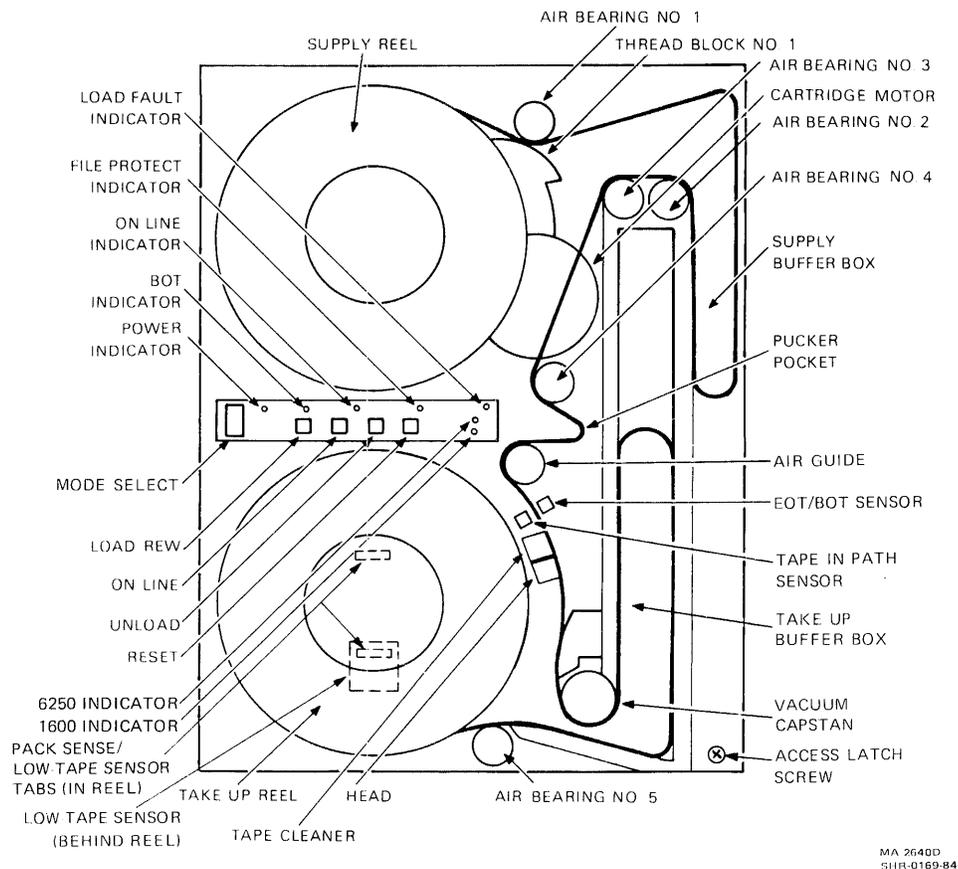
Figure 3-4   Base Assembly Front Components

10.   Remove the work tape and disconnect the DVM.

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

3.5   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 3.3.

2.   On the interconnect F1 PCBA, connect a DVM with its
      positive lead to TP4 and its negative lead to TP7 (Figure
      3-3).

3.   Open the transport front door.

4.   Rotate the take-up reel until the sensor tab (on the
      inside of the outer flange of the reel) is in line with
      the low tape sensor behind the reel (Figure 3-4).

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 3-3).

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.

3.6 VACUUM AND AIR PRESSURE ADJUSTMENTS

3.6.1 System Vacuum Adjustment

Refer to Figure 3-5 and Table 3-4 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 access 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 3-6) toward the front of the transport to drive tape forward.

(A) VALVE ORIENTATION ON BASE ASSEMBLY
(REAR VIEW)

(B) VACUUM VALVE DETAIL

(C) PRESSURE VALVE DETAIL

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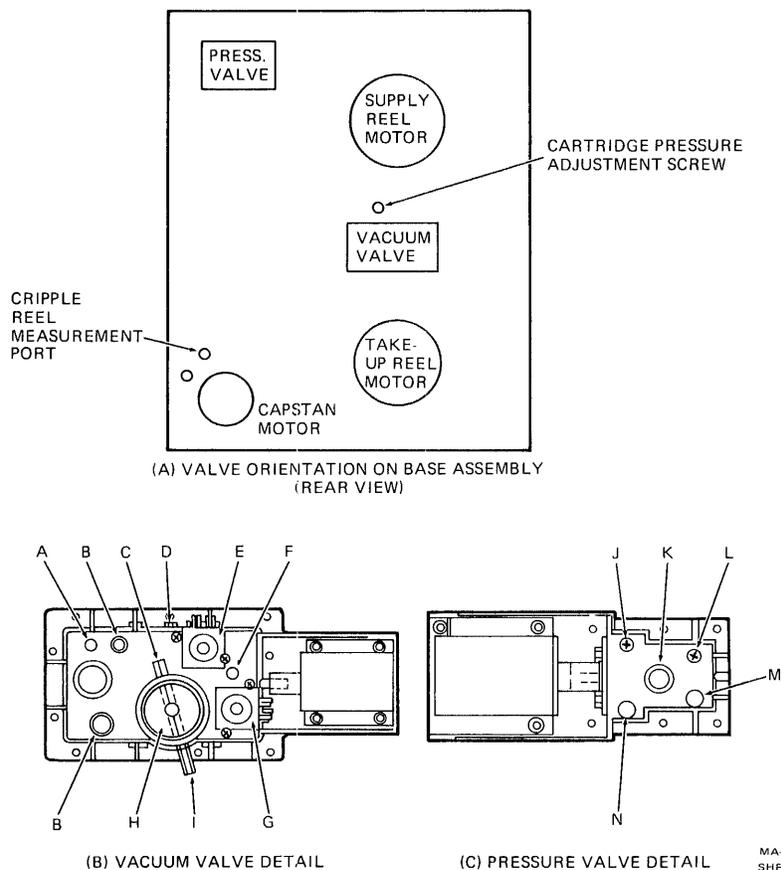
Figure 3-5 Vacuum Valve and Pressure Valve Test Points

Table 3-4   Vacuum and Pressure Valve Components

Figure 3-5 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
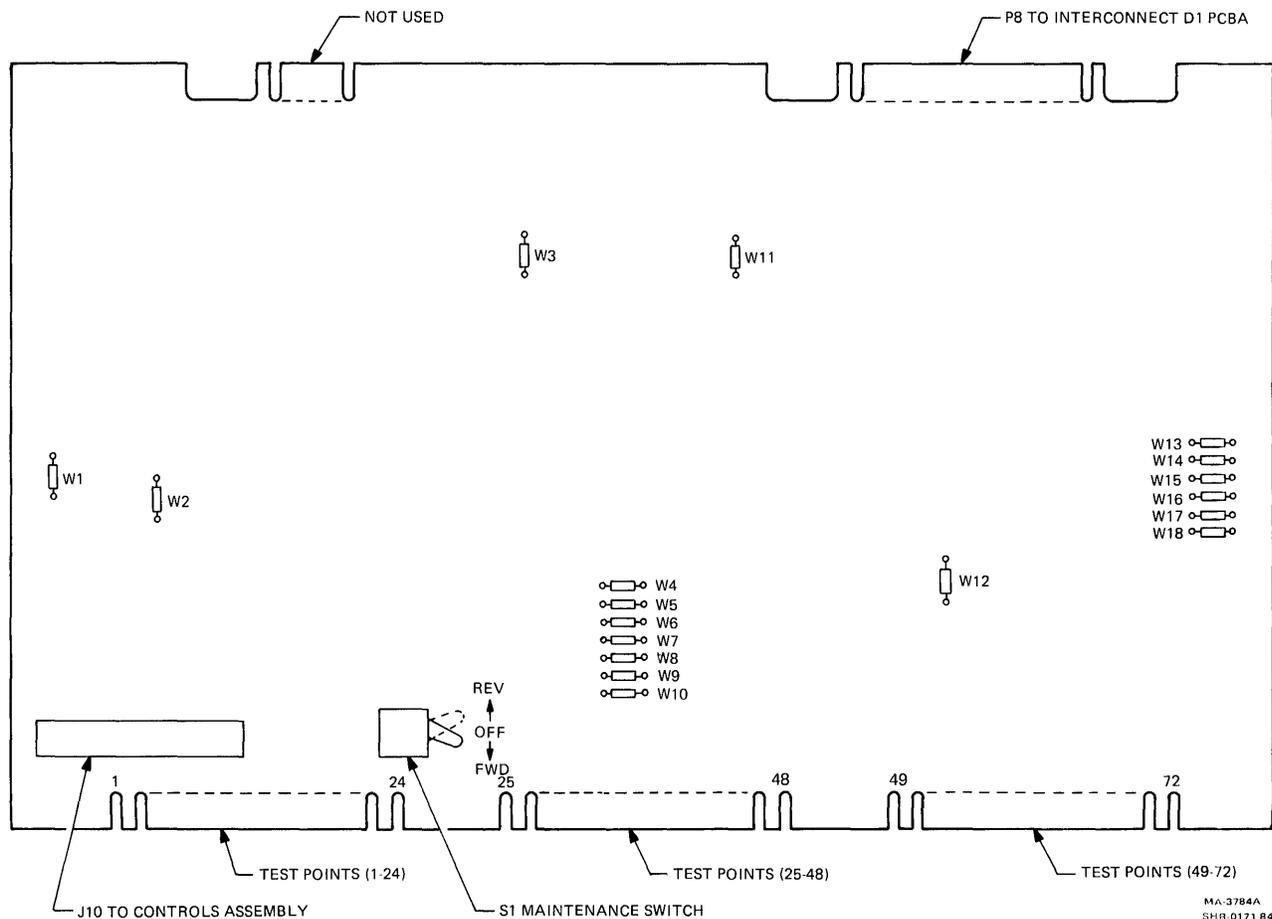
Figure 3-6   Control M2 PCBA Adjustments and Test Points

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 3.6.2.

3.6.2   Takeup Reel Vacuum Adjustment
Refer to Figure 3-5 and Table 3-4 while performing this adjustment.

1. Before starting this adjustment, make sure system vacuum is within the specified limits outlined in Paragraph 3.6.1.

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

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

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

5. Connect a differential air gauge with a range of Ø to 1Ø16 mm (Ø to 4Ø 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 button on the TU78 control panel.

8. Immediately rotate the take-up reel three full turns to deactivate the load fault zero function.
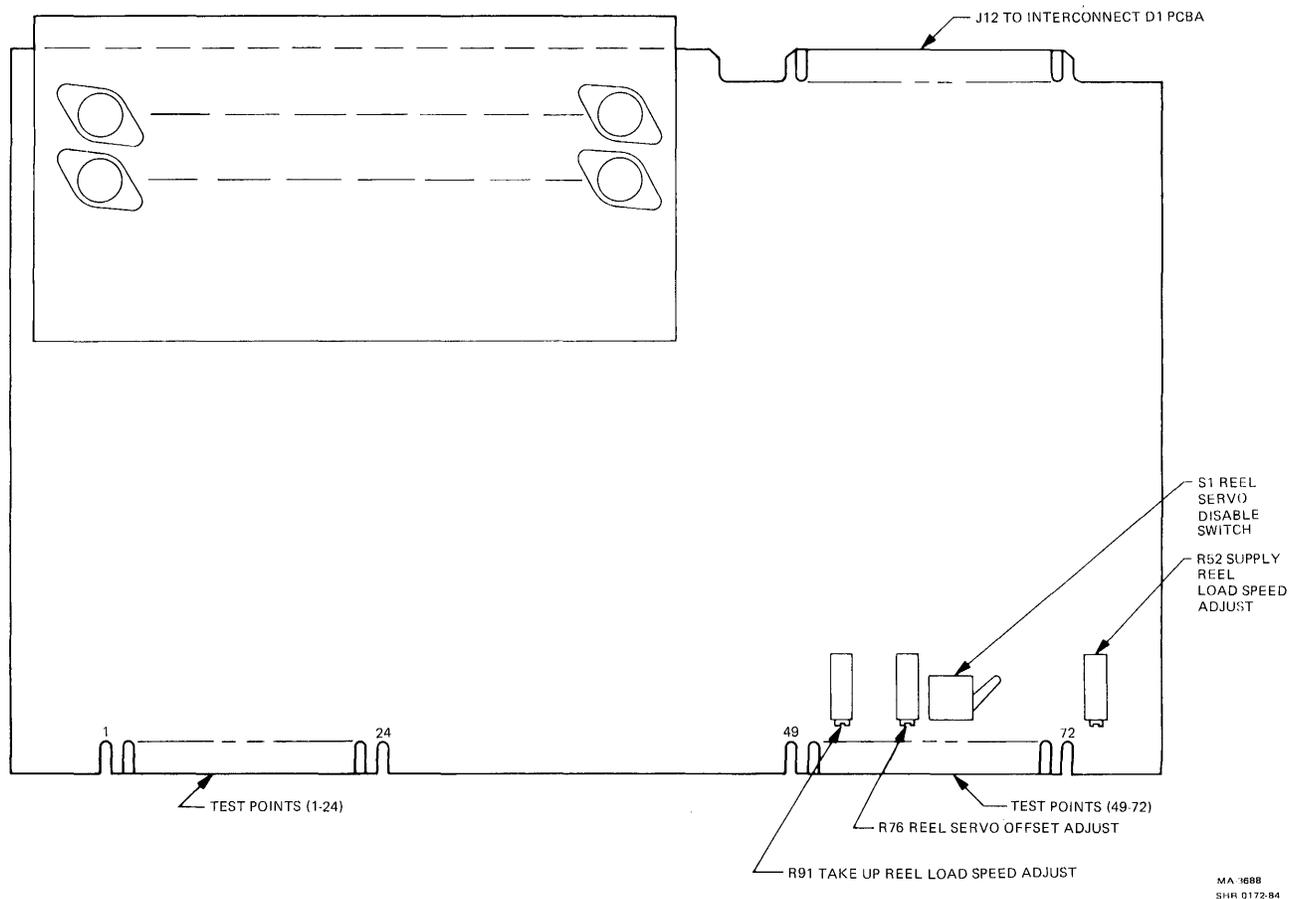
Figure 3-7   Reel Servo PCBA Adjustments and Test Points

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.

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 on the TU78 control panel.

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

NOTE
The two vacuum adjustments (Paragraphs 3.6.1 and 3.6.2) are interactive, and after performing one, the other should be rechecked.

3.6.3   Air Bearing Pressure Adjustment
Refer to Figure 3-5 and Table 3-4 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 access the rear.

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 3-6) 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 locknut damages port threads. Use extreme care.

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

10. Unload the tape.

3.6.4   Thread Block and Cartridge Pressure Adjustment

Refer to Figure 3-5 and Table 3-4 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 3-7) 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 TU78 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.

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. Use extreme care.

8.   Press and release RESET on the TU78 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 3-8), and install the tube fitting (PN
      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 TU78 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, and 50.8 mm (2 in) of water,
      minimum.

CARTRIDGE PRESSURE PORT

LOWER CARTRIDGE RESTRAINT
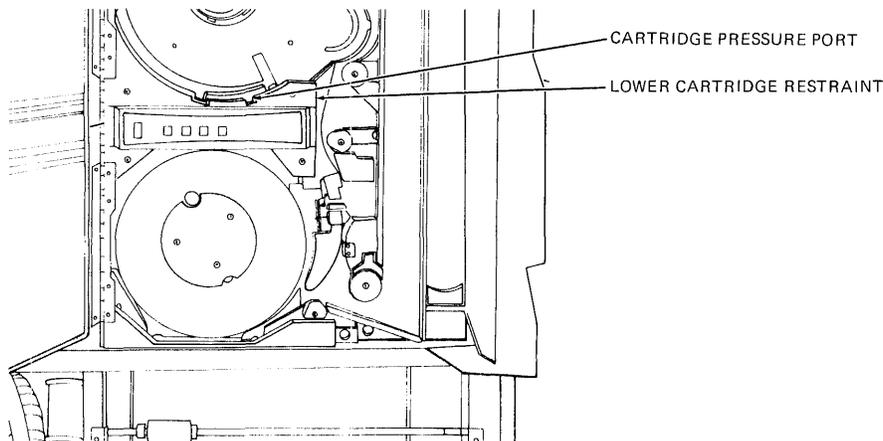
MA-3484
SHR-0173-84

Figure 3-8   Cartridge Pressure Check Point

14. With no cartridge if the reading is out of tolerance, adjust the cartridge pressure adjustment screw (Figure 3-5) for a reading of 63.5 mm (2.5 in) of water.

15. Check cartridge pressure with tape and cartridge loaded. The pressure with a cartridge should be greater than 229 mm (9 in) of water.

16. Press and release RESET on the TU78 control panel.

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

18. Steps 3 through 16 may have to be repeated several times to ensure adjustment integration. Observe all cautions.

NOTE
An alternate method to the preceding steps would be to acquire two differential air gauges. Connect both gauges to the respective ports, and make adjustments while observing both gauges.

19. Place the servo disable switch S1, on the reel servo PCBA, toward the front of the transport (servo enable position).

3.7 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 3.3.

2. Place both STI ports off-line by placing the PORT SELECT A and B buttons on the TS78 control panel in the disable (out) position.

3. Set the transport rotary switch in the number 1, 2, or 3 position (maintenance mode).

4. Load any write-enabled 267 mm (10.5 in) tape on the desired transport. Place the transport on-line.

5.	Plug an RS232-compatible, external terminal -- a handheld
terminal (HHT) for example -- into the EIA connector on
the TS78 control panel (Figure 2-25). For terminals that
require +5 V power, +5 V (at 1A maximum) is available at
a 3-pin Mate-N-Lok connector on the panel.

6.	Turn the external terminal on.

7.	Type **CTRL C** on the terminal keyboard. Repeat the entry
until **TA78>** appears.

8.	To check capstan speed, type **RUN VELOCITY/UNIT=X** where X
is the desired transport cable number: 0, 1, 2, or 3. (If
X=0, you may omit "/UNIT=X" from the command.) The tape
drive runs the capstan speed check routine on transport X
and displays a message on the external terminal.

9.	A displayed message of **OK** indicates the capstan velocity
is within specifications. If this is the case, proceed to
step 13. If capstan velocity requires adjustment, the
tape drive runs the routine repeatedly and the displayed
message is similar to the one shown below.

	Velocity test: R47 CAPSTAN SERVO O *

	The "*" indicates the ideal value. The "O" indicates the
actual value and can be on either side of the asterisk.

10.	To adjust capstan velocity, adjust potentiometer R47 on
the capstan/regulator PCBA (Figure 3-2) while observing
the display, until the "O" and "*" merge. If the "O" is
on the left of the "*", the capstan speed is too low and
R47 must be turned clockwise. If the "O" is on the right
of the "*", the capstan speed is too high and R47 must be
turned counterclockwise.

			NOTE
		If EOT is detected, the tape drive
		rewinds the tape and contines to repeat
		the test routine. Do not adjust R47
		during the rewind operation.

11.	Press and release **CTRL C** to exit from the test. The tape
drive displays **TA78>**.

12.	Type **RUN VELOCITY/UNIT=X** where X is defined as in step 8.
The displayed message should be **OK**.

13. If you suspect an intermittent capstan speed problem, type **RUN VELOCITY/UNIT=X/LOOP** where X is defined as in step 8. The tape drive then runs the capstan speed check routine repeatedly on transport X. The displayed message is similar to the error message in step 9. Observe the display for about 3Ø seconds noting any irregularities. Then press and release **CTRL C** to exit from the test.

> NOTE
> An alternate procedure for measuring capstan speed is to measure the frequency of the tach pulses. Connect a scope to control M2 PCBA, TP4Ø (Figure 3-6). The time period from trailing edge to trailing edge should be 8Ø $\pm$Ø.8 us.

14. If it was necessary to adjust capstan speed, then the PE gains must be adjusted (Paragraph 3.1Ø.3).

15. To check the start ramp, type **RUN RAMP/UNIT=X** where X is defined as in step 8. This tests the start ramp as the capstan velocity was tested in step 8.

16. If the displayed message is **OK**, no adjustment is required and you can proceed to step 2Ø. Otherwise, the start ramp requires adjustment. The routine is run repeatedly and the displayed message is similar to the one shown below.

     Start ramp: R59 CAPSTAN SERVO O   *

     The "*" and "O" indicate the ideal and actual values as described in step 9.

17. To adjust the start ramp, adjust potentiometer R59 on the capstan/regulator PCBA (Figure 3-2) while observing the display, until the "O" and "*" merge. If the "O" is on the left of the "*", the capstan speed is ramping up too slowly and R59 must be turned clockwise. If the "O" is on the right of the "*", the capstan speed is ramping up too quickly and R59 must be turned counterclockwise.

18. Press and release **CTRL C** to exit from the test.

19. Type **RUN RAMP/UNIT=X** where X is defined as in step 8. The displayed message should be **OK**.

2Ø. If you suspect an intermittent start ramp problem, type **RUN RAMP/UNIT=X/LOOP** where X is defined as in step 8. The start ramp routine is then run repeatedly and the displayed output is similar to the error message in step 16. For 3Ø seconds, observe the display for irregularities and then use **CTRL C** to exit the test.

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

● Rewind the tape and place the
  transport on-line.

● Create a 3200 FCI pattern on the tape
  by executing a WRTMAI command through
  the ASCII port in keypad mode. (Both
  STI ports 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 3-9)

● 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 3-10a for a
  representative scope waveform and
  settings.

● The start ramp rise time (0 to 95
  percent) 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 except
  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 about 10 to
  20 ms or more before a reverse motion
  command. Refer to Figure 3-10b for a
  representative scope waveform and
  settings.
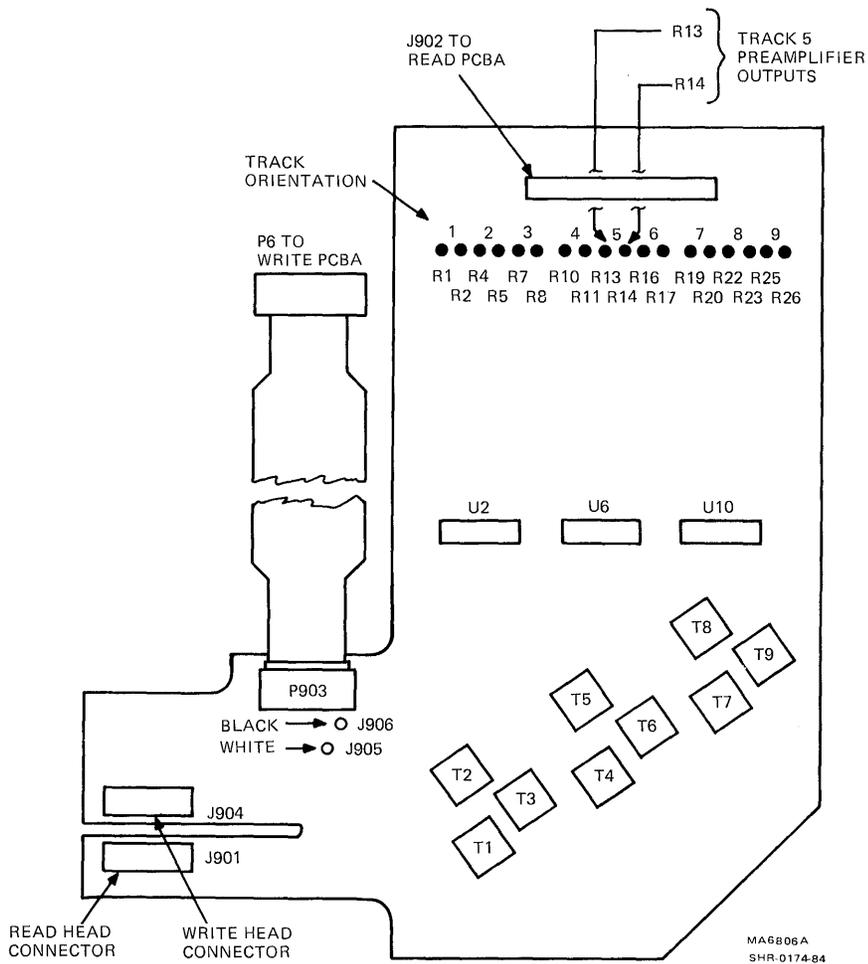
Figure 3-9   GCR/PE Preamp 1 PCBA Test Points
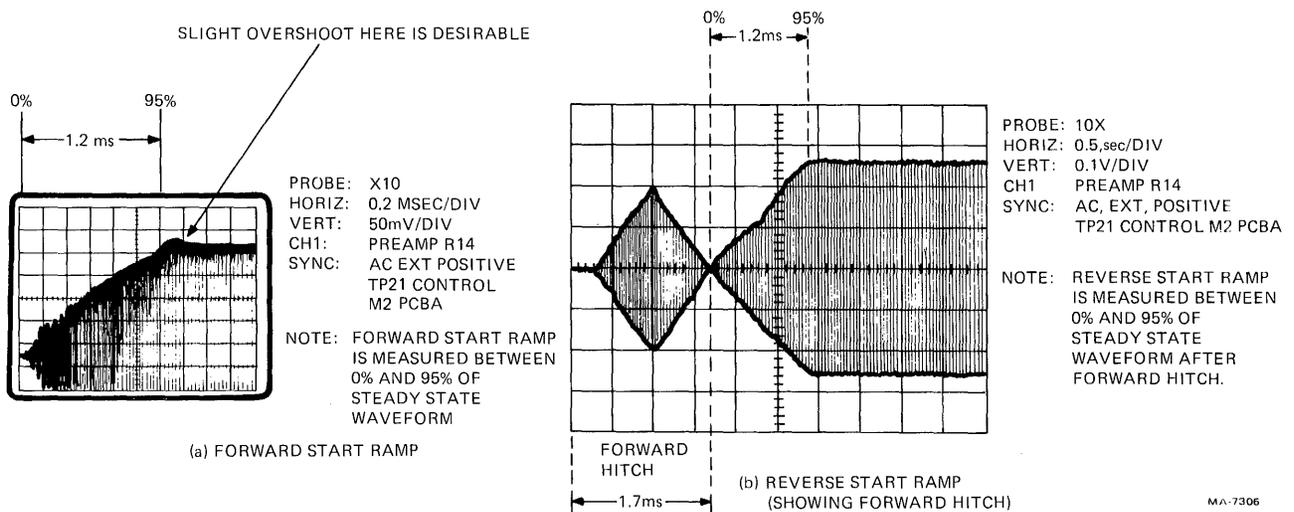
Figure 3-10   Forward Start Ramp

21. To check the forward stop ramp, type **RUN FWDSTOP/UNIT=X** where X is defined as in step 8.

22. If the displayed message is **OK**, no adjustment is required and you can proceed to step 26. Otherwise, the forward stop ramp requires adjustment. The routine is run repeatedly and the displayed message is similar to the one shown below.

    Fwd stop ramp: R66 CAPSTAN SERVO   *   O

    The "*" and "O" indicate the ideal and actual values as described in step 9.

23. To adjust the forward stop ramp, adjust potentiometer R66 on the capstan/regulator PCBA (Figure 3-2) while observing the display, until the "O" and "*" merge. If the "O" is on the left of the "*", the capstan speed is ramping down too slowly and R66 must be turned clockwise. If the "O" is on the right of the "*", the capstan speed is ramping down too quickly and R66 must be turned counterclockwise.

24. Press and release **CTRL C** to exit the test.

25. Type **RUN FWDSTOP/UNIT=X**. The displayed message should be **OK.**

26. If you suspect an intermittent forward stop ramp problem, type **RUN FWDSTOP/UNIT=X/LOOP**. The forward stop ramp routine is then run repeatedly and the displayed output is similar to the error message in step 22. For 30 seconds, observe the display for irregularities and then use **CTRL C** to exit the test.

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

- Rewind the tape and place the transport on-line.

- Create a 3200 FCI pattern on the tape by executing a WRTMAI command through the ASCII port in keypad mode. (Both STI ports 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 3-9), external sync to control M2 PCBA TP21 (Figure 3-6)

- Connect a jumper between the control M2 PCBA TP3Ø and TP25.

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

- Refer to Figure 3-11 for a representative scope waveform and settings.

- The forward stop ramp fall time (1ØØ to 5 percent) should be in the 1.Ø2 to 1.13 ms range.

- If it is out of adjustment, adjust capstan/regulator PCBA R66 for 1.Ø8 ms.

- Return control M2 PCBA S1 to the center position.

```
100%        5%

|◄──1.08ms──►|
```
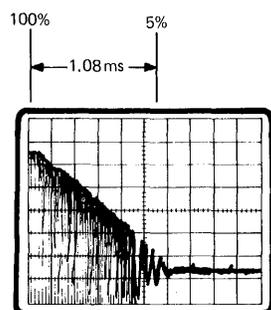
```
PROBE:  X10
HORIZ:  0.2 MSEC/DIV
VERT:   50mV/DIV
CH1:    PREAMP R14
SYNC:   AC EXT NEGATIVE
        TP21 CONTROL M2 PCBA

NOTES:  1.          STOP
                RAMP IS MEASURED
                BETWEEN 100% AND 5%
        2.  ADJUST THE FALL
            TIME FOR NO
            OVERSHOOT
```

a. CORRECT WAVEFORM
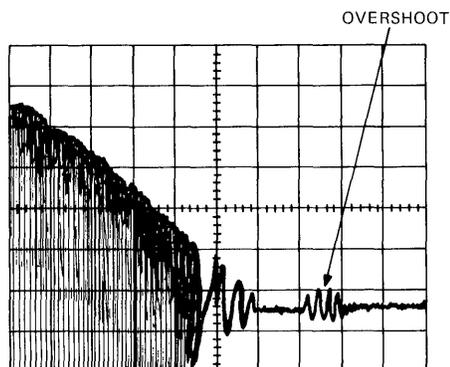
OVERSHOOT

b. INCORRECT WAVE FORM SHOWING OVERSHOOT

MA-7305
SHR-0176-84

Figure 3 11   Stop Ramp

3-23

27. To check the reverse stop ramp, type **RUN REVSTOP/UNIT=X** where X is defined as in step 8.

28. If the displayed message is **OK**, no adjustment is required and you may proceed to step 32. Otherwise, the reverse stop ramp requires adjustment. The routine is run repeatedly and the displayed message is similar to the one shown below.

    Rev stop ramp: R78 CAPSTAN SERVO   *   O

    The "*" and "O" indicate the ideal and actual values as described in step 9.

29. To adjust the reverse stop ramp, adjust potentiometer R78 on the capstan/regulator PCBA (Figure 3-2) while observing the display, until the "O" and "*" merge. If the "O" is on the left side of the "*", the capstan speed is ramping down too slowly and R78 must be turned clockwise. If the "O" is on the right of the "*", the capstan speed is ramping down too quickly and R78 must be turned counterclockwise.

30. Press and release **CTRL C** to exit from the test.

31. Type **RUN REVSTOP/UNIT=X**. The displayed message should be **OK**.

32. If you suspect an intermittent reverse stop ramp problem, type **RUN REVSTOP/UNIT=X/LOOP**. The reverse stop ramp routine is then run repeatedly and the display is similar to the error message in step 28. For 30 seconds, observe the display for irregularities and then use **CTRL C** to exit the test.

> NOTE
> The following is an alternate procedure for measuring the reverse stop ramp.

- Rewind the tape and place the transport on-line.

- Create a 3200 FCI pattern on the tape by executing a WRTMAI command through the ASCII port in keypad mode. (Both STI ports 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 3-9), external sync to control M2 PCBA TP21 (Figure 3-6)

- Connect a jumper between the control M2 PCBA TP3Ø and TP25.

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

- Refer to Figure 3-11 for a representative scope waveform and settings.

- The reverse stop ramp fall time (1ØØ to 5 percent) should be in the 1.Ø2 to 1.13 ms range.

- If it is out of adjustment, adjust capstan/regulator PCBA R78 for 1.Ø8 ms.

- Return control M2 PCBA S1 to the center position.

33. Press and release CTRL Z to exit from the terminal mode. The drive echoes ^Z.

34. Unload the tape.

3.8   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 3.8 must be performed in its entirety). Refer to Figure 3-7 for reel servo adjustment and test point locations.

3.8.1   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 3.3.

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 button on the TU78 control panel. 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 button on the TU78 control panel.

10. Turn transport power off.

11. Reconnect the take-up reel motor leads.

12. Turn transport power back on.

3.8.2   Supply Reel Load Speed Adjustment

Using Handheld 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 clockwise.

4.   Measure the supply reel speed directly in rpm with the
      handheld tachometer (PN 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 Handheld 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
      clockwise.

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 on 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.

3.8.3 Take-up Reel Load Speed Adjustment

Using Handheld 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 rotate clockwise.

4. Measure the take-up reel speed directly in rpm with the handheld tachometer (PN 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 Handheld 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 clockwise.

4. Connect an oscilloscope input lead to TP43 (low tape sensor input) of the control M2 PCBA (Figure 3-6).

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.

3.8.4   Tape Loop Position Adjustment

NOTES

1. Check, and adjust if necessary, all vacuum and pressure readings outlined in Paragraph 3.6 before trying 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 3-6).

3. Set reel servo disable switch S1, located on the reel servo PCBA (Figure 3-7) 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 about 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 in the
      middle of the park zone. The park zone is the series of
      thirteen small holes in the center of the buffer column,
      shown in Figure 3-12. 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.
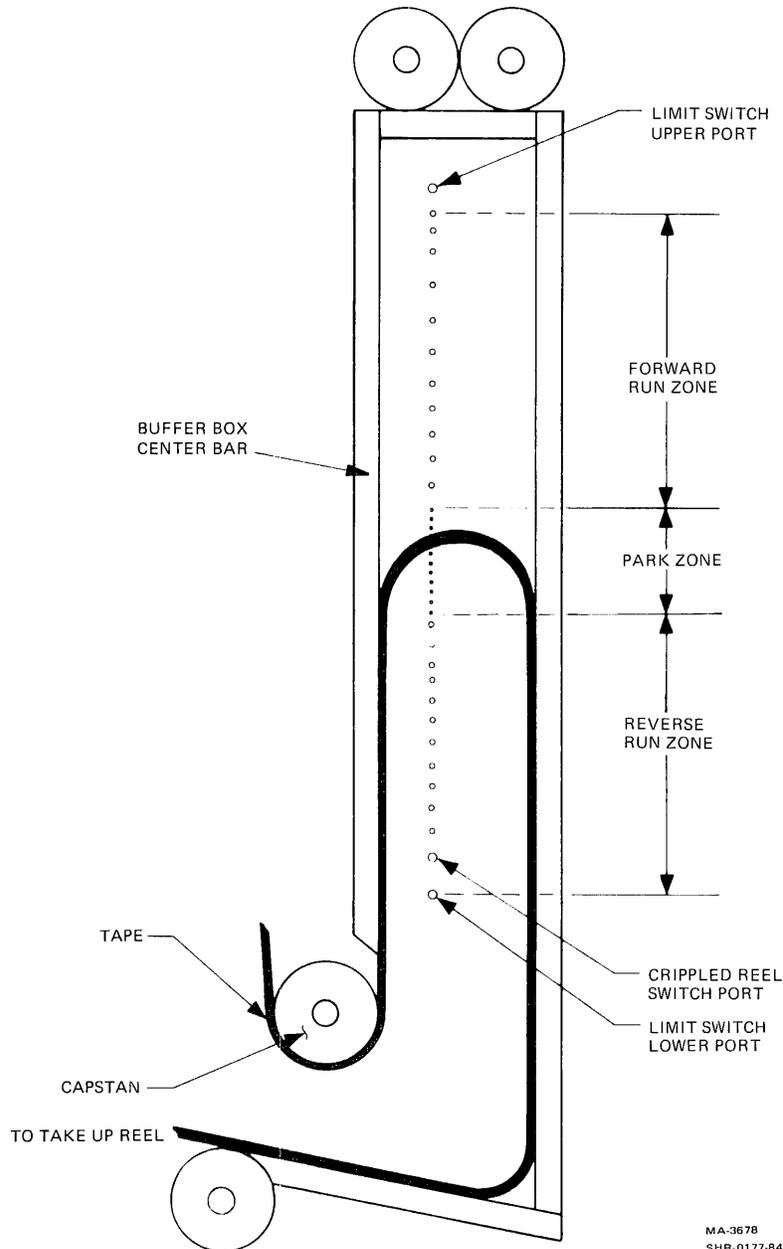
Figure 3-12   Buffer Column Park Zone
               (Take-up column shown)

9. Hold the tape against air bearing number 4 (Figure 3-4) 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 TU78 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 3-3).

15. Connect the DVM positive lead to reel servo PCBA TP66 (SPOS).

16. Observe the DVM. The voltage displayed should be between +0.2 Vdc maximum 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 3.8.4.)

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 5.7).

24. Set gain potentiometers R30 and R31 on the interconnect F1 PCBA (Figure 3-3) fully clockwise. (The potentiometers have a range of about 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 about 9 m (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 about 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 3-13. 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.
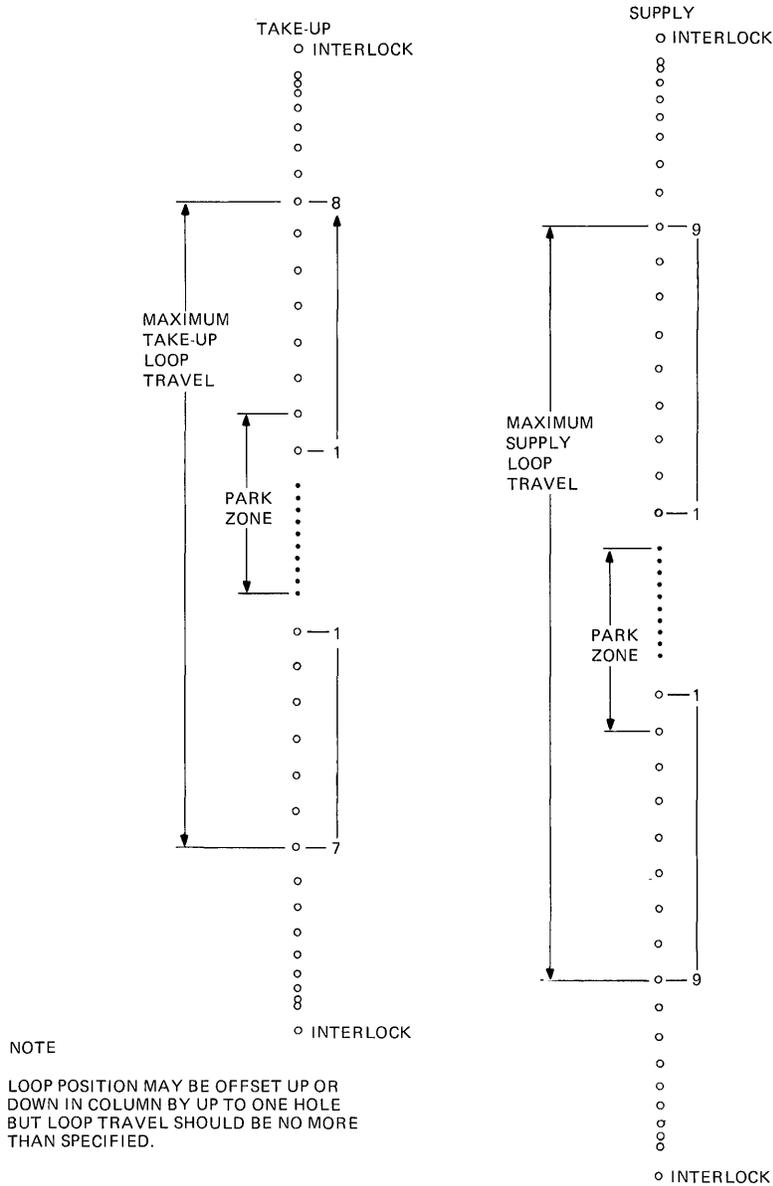
Figure 3-13   Loop Travel Limits

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 m (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.

3.9 TAPE PATH CLEANING

To clean the tape path, you need a tape cleaning fluid, a foam-tipped swab and a lint-free wipe.

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

Cleaning fluid, swabs, and wipes are available in the magnetic tape transport cleaning kit (TUC01) that comes with the TA78. The cleaning fluid in the kit is TF113.

WARNING
TF113 is a nonrestricted, nonhazardous
substance. However, avoid excessive skin
contact. Do not allow it to contact the
eyes and do not swallow it. Use it only
in a well-ventilated area.

Perform the following steps to clean the TU78 tape transport.

1. Dismount the tape from the unit.

2. Lift the plastic cap covering the pour spout of the TF113 can. Pour a little cleaning fluid into the cap and dip the swab into the cap. (Never dip a contaminated cleaning swab or wipe into the cleaning fluid can.)

3. With the swab soaked in cleaning fluid, clean the following components of the transport tape path (Figure 3-14).

   Read/write head
   Erase head
   Tape cleaner
   Air bearings (6)
   Spring-loaded ceramic tape guides (2)
   Thread blocks (6)
   Capstan
   Pucker pocket

   NOTE
   Only use the foam-tipped swabs. Do not touch any part of the tape path since oil from fingers attracts dust and dirt.

4. 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.

5. 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.
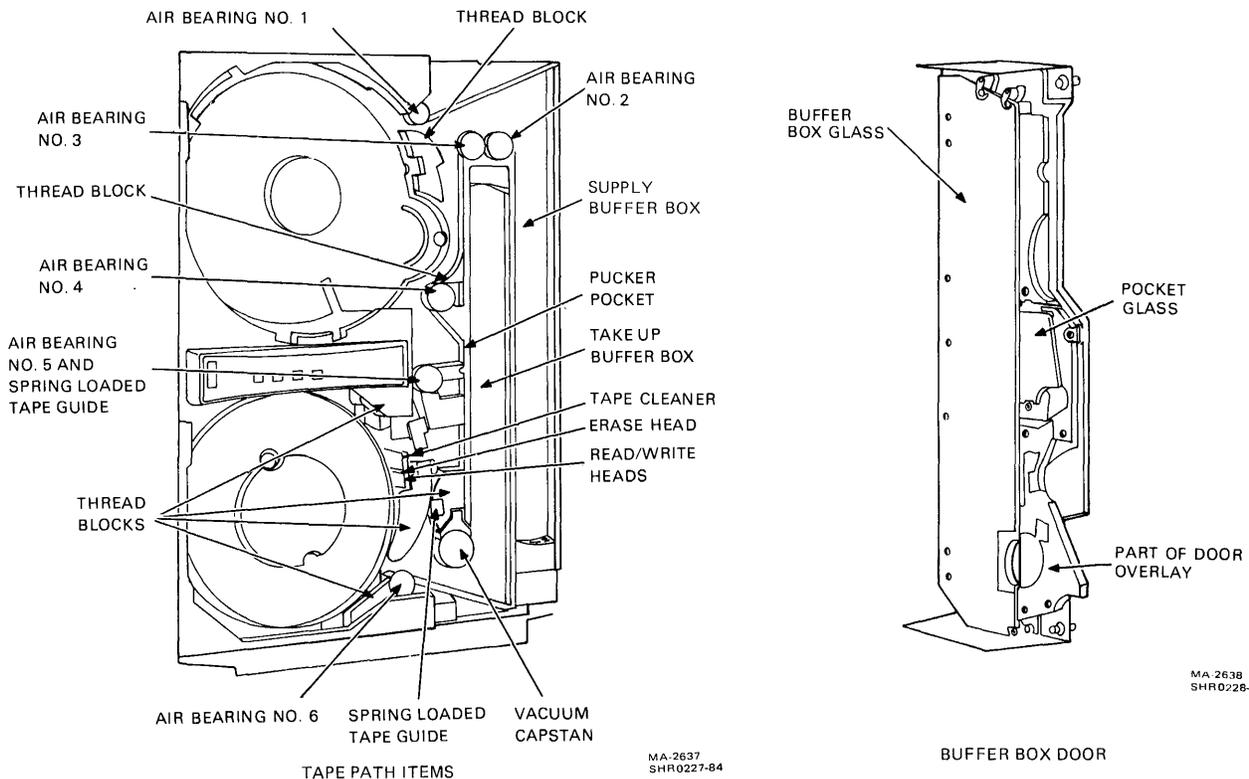
Figure 3-14 Transport Items for Cleaning

6.   Clean the following components of the transport with a lint-free wipe and cleaning fluid (Figure 3-14).

Buffer boxes (2)
Buffer box glass
Pocket glass
Door overlay

7.   When cleaning the inner surface of the door, pass another lint-free wipe over the head. Use a polishing agent to remove any remaining deposits.

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 the area thoroughly with TF113 to remove soapy residues.

3.10   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 3.9), the voltages are correct (Paragraph 3.3), and the capstan servo adjustments are correct (Paragraph 3.7).

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

3.10.1   Read Skew Adjustment (Azimuth)
To make this adjustment, proceed as follows.

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 (Figure 3-15) as follows.

    S2 READ (left)
    S3 1600 (left)
    S4 MAN (right)
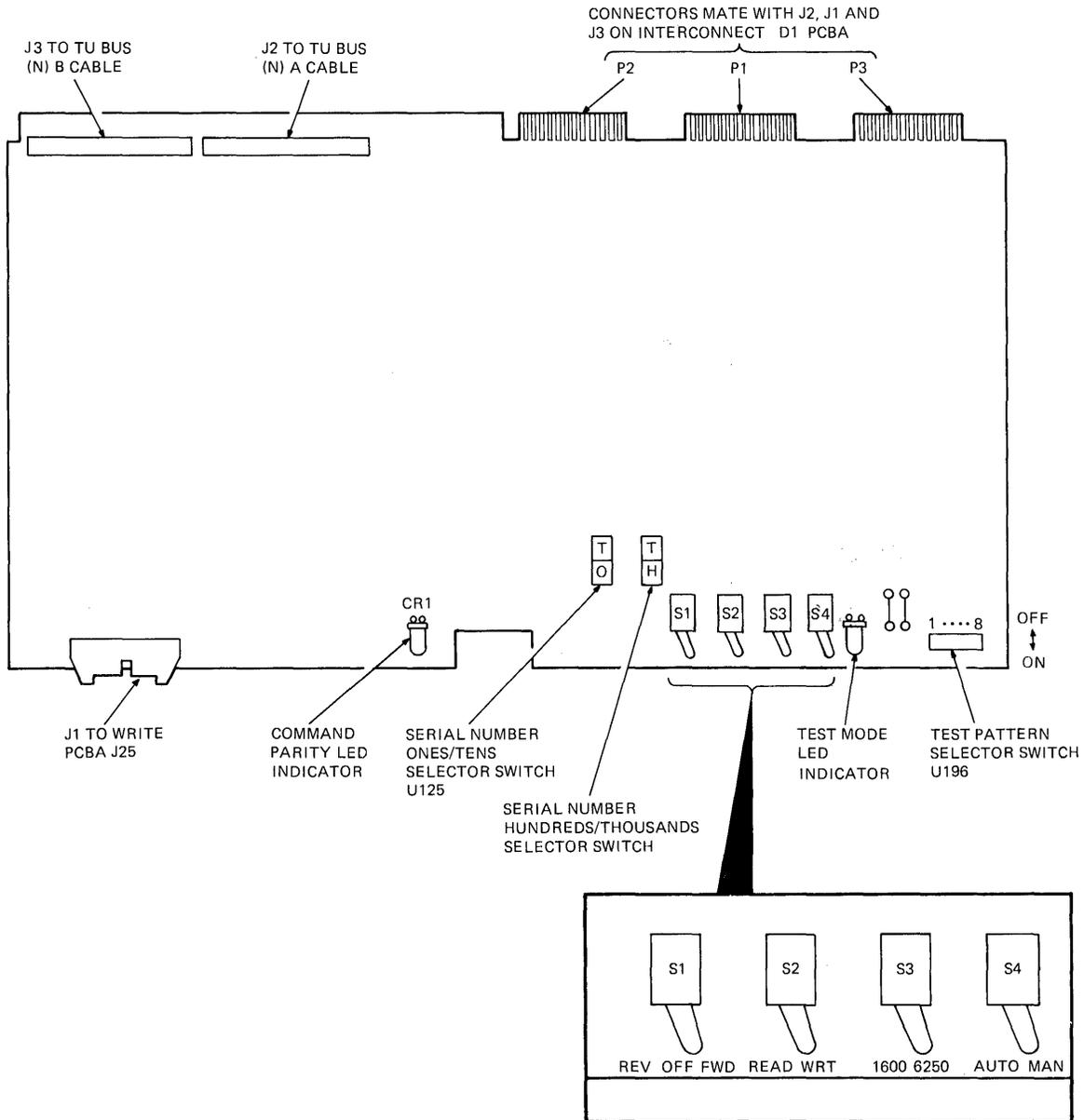
Figure 3-15   Multiple Interface Adapter Controls, Indicators, and Connectors

3. Connect an oscilloscope to read PCBA (Figure 3-16) test
    point 11. Set the scope as follows.

    Vertical   =   0.2 V/div
    Horizontal =   0.5 us/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 us (corresponding to 150 microinches of skew)
    as shown in Figure 3-17.
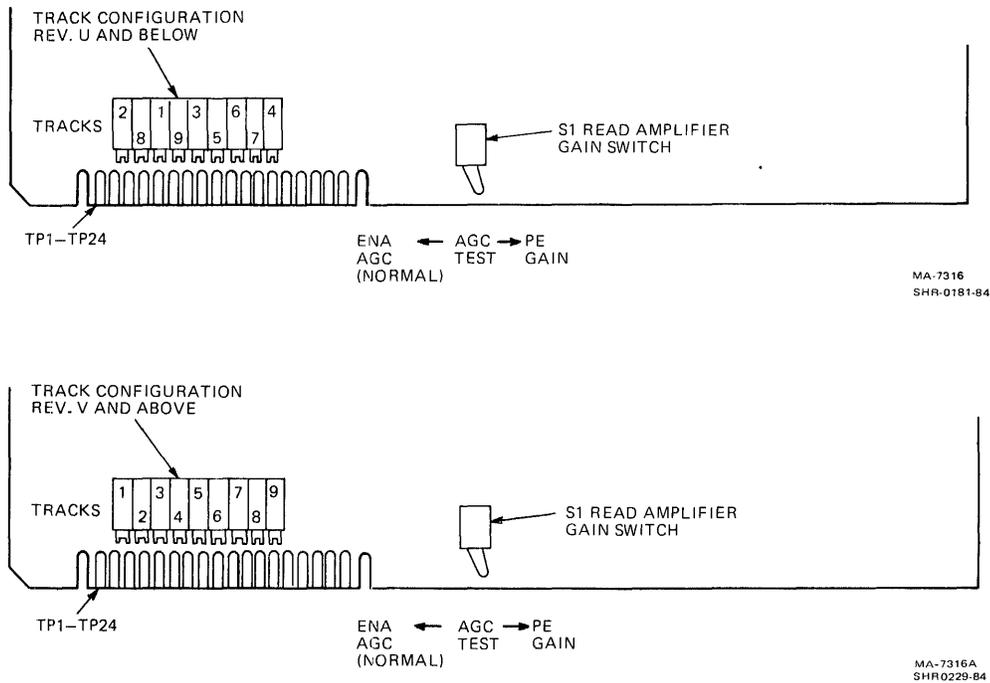
Figure 3-16   Read PCBA Test Points and Adjustments
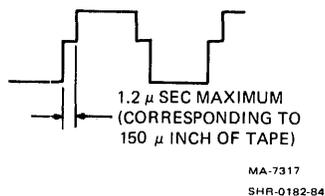
Figure 3-17   Read Skew Adjustment
              Waveforms

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 by
    inserting a 1/8-inch allen driver through the buffer box
    door and into the tape cleaner cap-clip housing (Figure
    3-18).

7. Set MIA switch S1 to the left (run reverse). The step
    width must not exceed 1.2 us. If it does, the capstan
    motor tracking may have to be fine tuned (Paragraph
    6.2.5).

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).

ADJUSTMENT
ACCESS HOLE
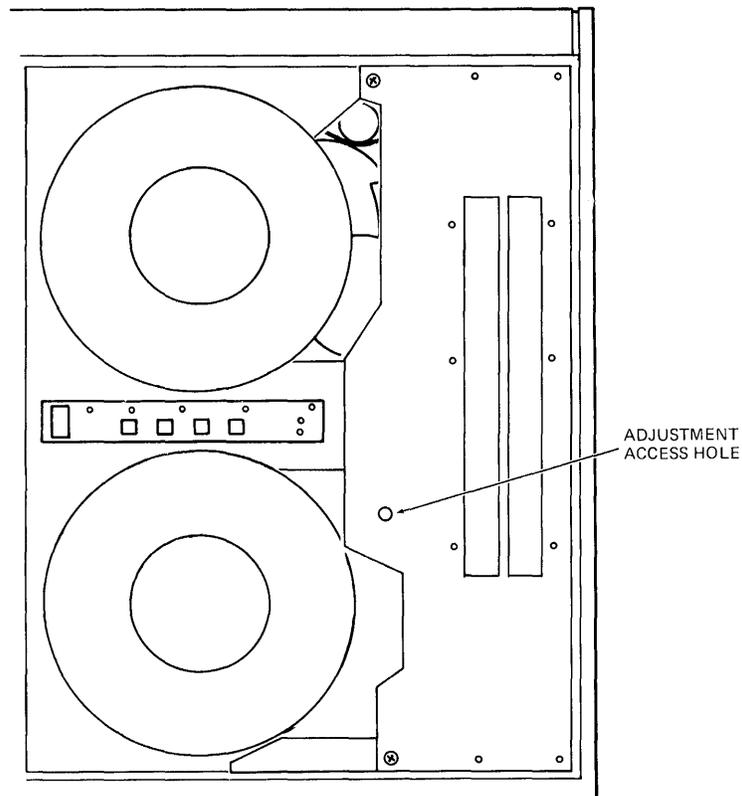
MA-3483
SHR-0183-84

Figure 3-18   Location of Read Skew Azimuth Adjustment

3.10.2   Write Current Adjustments

To make these adjustments, proceed as follows.

1. Verify power supply voltages according to Paragraph 3.3.

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)

3.10.2.1   Phase Encoded Write Current Adjustments -- To make these adjustments, proceed as follows.

1. Connect an oscilloscope to write PCBA (Figure 3-19) test point 6. Set the scope as follows.

   Vertical ch1   =   1.0 V/div, ac (X10 probe)
   Horizontal   =   0.2 us/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 us +.1 us 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 level.

8. Move the scope probe to write PCBA TP2.

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

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

CONNECTS TO J7
INTERCONNECT D1 PCBA

J6

CONNECTS TO
GCR/PE PREAMP
1 CABLE

R39 R36
GCR PE

R22 R19
GCR PE

R48 R50
GCR PE

TEST POINTS
TP1-TP24

J25

AMTIE CABLE
CONNECTS TO MIA J1

PEDESTAL
ADJUST

STEP
ADJUST

STEP TIME
ADJUST

MA-7318
SHR-0184-84
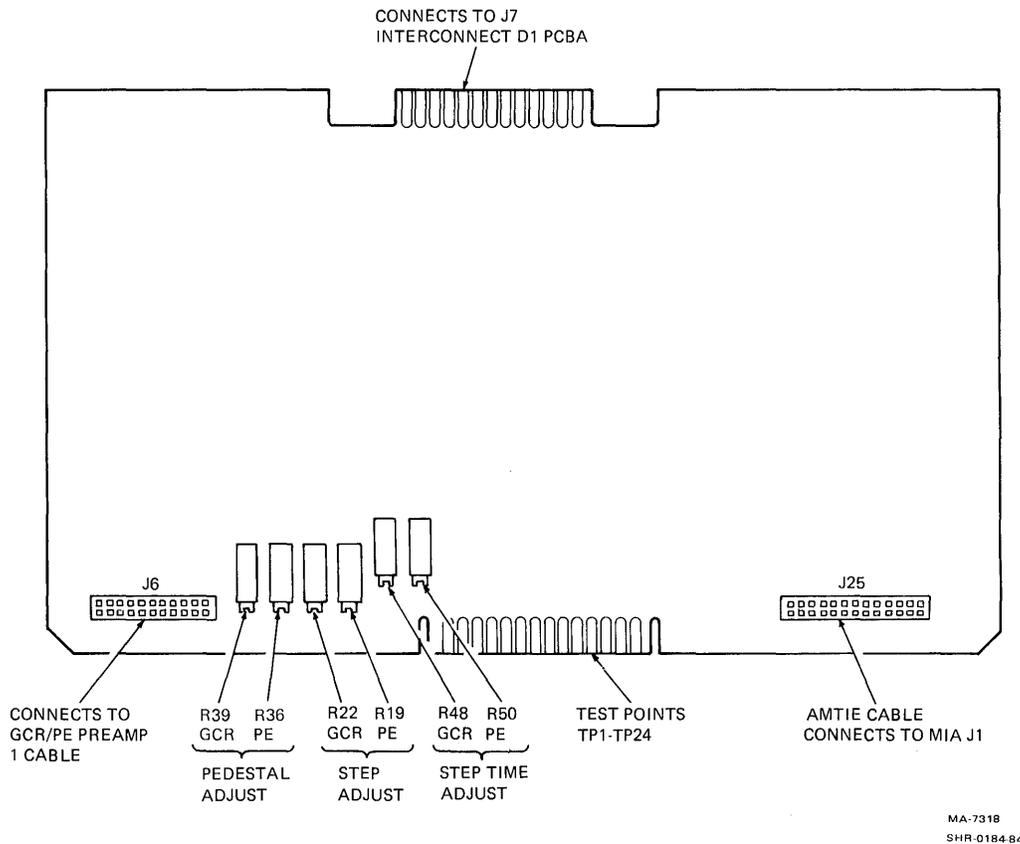
Figure 3-19   Write PCBA Test Points, Adjustments,
and Connectors

3.10.2.2 Group Coded Write Current Adjustments -- These
adjustments involve potentiometers R39, R22, and R48 on the write
PCBA. To make these adjustments, proceed as follows.

NOTE
Use a DVM for all measurements at TP2
and TP3 on the write PCBA.

1.   Set MIA switches S1, S2, S3 and S4 to the right. Data
pattern (U196) equals all ones (all switches forward).

2.   Place AGC switch (S1) on the read module to the right.

3.   Adjust R22 to set TP3 to 0 V.

4.   Adjust R39 to set TP2 to 0 V.

5.   Using a 10X probe, set an oscilloscope to 100 mV/div and
0.5 us/div. Place the probe on track 5 (R13) of the
GCR/PE preamp 1 PCBA (Figure 3-9).

6.   Load a standard output tape (or a good scratch tape) with the write-protect ring in place. Place the transport on-line to start the tape moving.

7.   Adjust R39 counterclockwise (CCW) for peak amplitude. (The pedestal write current is now at about the start of the 100 percent saturation range.)

8.   Measure and record the dc voltage at TP2.

9.   Continue to adjust R39 CCW until the waveform amplitude begins to decrease. (This is about the end of the 100 percent saturation range.)

10. Measure and record the dc voltage at TP2. Place the transport off-line to stop tape motion.

11. Add the two voltages recorded in steps 8 and 10. Divide this sum by 2. Record the result of the division.

12. Place the transport on-line and adjust R39 clockwise (CW) until TP2 is at the voltage calculated in step 11.

13. Adjust the scope's vertical sensitivity until the waveform's peak-to-peak amplitude covers the entire screen (8 cm).

14. Adjust R39 CCW until the peak-to-peak amplitude covers 7.6 cm (about 105 percent to guarantee media saturation). Then measure and record the voltage at TP2.

15. Set TP2 back to the voltage calculated in step 11.

16. Set the scope to 100 percent amplitude over 8 cm as in step 13.

17. Adjust R39 CW until the peak-to-peak amplitude covers 7.6 cm (about 95 percent saturation).

18. Adjust R22 until TP3 is at the voltage recorded in step 14. (The pedestal step current is now set to about the 105 percent saturation point.)

19. Move the scope probe to TP6 on the write PCBA. Using R48 (GCR step time), set TP6 to 350 ns +10 percent at the 50 percent point.

20. Place the AGC switch back to the left position.

3.10.3 Phase Encoded Gain Adjustments

To make these adjustments, proceed as follows.

NOTE

The capstan servo adjustments (Paragraph 3.7) 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 (PN 29-11691). Place the transport off-line.

2. Connect an oscilloscope to GCR/PE preamp 1 PCBA R1 upper lead (Figure 3-9). Set the oscilloscope as follows.

    Vertical Ch 1 = 0.02 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.

5. Adjust the track 1 read PCBA potentiometer R706 (Figure 3-16) so the read data envelope measures 1.25 V peak-to-peak.

6. Refer to Table 3-5 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.

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 In-Line Exerciser (ILEXER) for 15 minutes.

Table 3-5 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

4.1   GENERAL
This chapter describes the aids available for troubleshooting the
TA78. Figure 4-1 is a troubleshooting flowchart which outlines a
general troubleshooting approach. Refer to the paragraphs
identified in the flowchart for further information on
troubleshooting steps. In most cases, failures can be isolated to
a single field replaceable unit (FRU) such as a module or
mechanical assembly.

4.2   FAULT CONTROL AND ERROR CODES
The FAULT indicator lights to show that a potentially fatal error
has been detected in the formatter. When FAULT stays lit, perform
the following procedure.

   1.   Press and release the FAULT button. All three TS78
        control panel indicators light in a lamp test. These
        indicators stay on for as long as you press the FAULT
        button, or for at least one second. After you release the
        FAULT button, the A, B, and FAULT indicators light to
        display a binary error code. The code, defined in Table
        4-1, identifies one of six areas in the formatter that
        may have caused the error.

   2.   Record the displayed fault number.

   3.   Press the FAULT button again for about one second and
        then release it. The formatter then tries to clear the
        error. All three indicators light as long as you press
        the FAULT button or until the clear attempt is finished.
        If the error is cleared, the FAULT indicator turns off
        and PORT SELECT A and PORT SELECT B return to their
        normal meaning. If the error remains, FAULT stays on and
        PORT SELECT A and PORT SELECT B are off.

START

CHECK TS78 CONTROL PANEL

IS FAULT INDICATOR ON — NO → 1

YES

OBTAIN FAULT NUMBER + ASSOCIATED MICRODIAGNOSTIC CHAIN. ATTEMPT TO CLEAR FAULT.   PAR 4.2

IS FAULT INDICATOR STILL ON — NO → 1

YES

CONNECT EXT-ERNAL TERMINAL TO TA78 ASCII MAINTENANCE PORT   FIG 2-25

RUN CHAIN ASSOCIATED WITH FAULT NUMBER   PAR 4.3.1

ERROR REPORT DISPLAYED — NO → A

YES

REPLACE PRIMARY FRU AND RERUN CHAIN. IF ERROR STILL PRESENT, REPLACE SECONDARY FRU AND RERUN CHAIN AGAIN.   PAR 4.3.2

CHAIN RUN WITH NO ERROR — NO

YES

RUN 3 PASSES OF FULL SET (CHAIN 0)

CONNECT EXTERNAL TERMINAL TO HSC ASCII PORT OR USE PREVIOUSLY INSTALLED EXTERNAL TERMINAL

RUN 15 MINUTES OF ILEXER   PAR. 2.5.3

END

A

RUN FULL SET (CHAIN 0)

ERROR REPORT DISPLAYED — NO → 1

3

YES

REPLACE PRIMARY FRU AND RERUN CHAIN 0. IF ERROR STILL PRESENT, REPLACE SECONDARY FRU AND RERUN CHAIN 0 AGAIN   PAR. 4.3.2

CHAIN 0 RUN WITH NO ERROR — YES / NO → 2

SHR01068-84

Figure 4-1   TA78 Troubleshooting Flowchart (Sheet 1 of 2)

NOTES:

1. RUNNING ILTAPE TO TEST FORMATTER RUNS TESTS IN CHAIN 0

2. USE ILTAPE AND ILEXER AS DISCUSSED IN PARAGRAPH 2.5.3 TO VERIFY ANY FIXES EXCEPT FORMATTER ERROR FIXES

3. IF PROBLEM STILL EXISTS WHEN END IS REACHED, CALL SUPPORT

SHR0107B-84

Figure 4-1   TA78 Troubleshooting Flowchart (Sheet 2 of 2)

4. If the FAULT indicator stays on, run the associated microdiagnostic chain specified in Table 4-1 for the recorded fault number. (Refer to Paragraph 4.3.1 for instructions on running microdiagnostics.)

NOTES
1. Pressing the FAULT button cuts off all communication with the HSC. HSC communication returns only if the error is cleared.

2. In step 1, if the indicators fail the lamp test, press and release the MASTER RESET button on the TS78 formatter (Figure 1-4). All three indicators should then light for about four seconds. During this

Table 4-1 TS78 Control Panel Error Code

Indicator FAULT	Display A	B	Fault Number	Associated Microdiag-nostic Chain	Possible Cause General Area	Related Modules
Off	Off	On	1	401	Miscellaneous	--
Off	On	Off	2	402	Read	M8950 (9) M8953
Off	On	On	3	403	Write	M8959 M8958
On	Off	Off	4	404	TU port	M8955 (2)
On	Off	On	5	405	Error correction	M8951
On	On	Off	6	406	STI communication	M8970 M8971
On	On	On	7	407	Microcomputer	M8972

NOTES
1. On = indicator blinking
   Off = indicator always off

2. Fault number 0 is never used.

time, the microcomputer runs the
minimum integrity and power-up
diagnostics. When the indicators
turn off, repeat step 1. However, if
the three indicators stay on, the
microcomputer is probably bad.
Replace the M8972 and repeat step 1.

If the error code does not appear
after releasing FAULT [i.e.;
indicator(s) not flashing], the
microcomputer is probably bad.
Replace the M8972 and repeat step 1.

4.3   MICRODIAGNOSTICS

The TS78 contains 56 microdiagnostic test routines which are
divided into two categories: in-line and off-line. The 16 in-line
tests reside in read-only-memory (ROM) on the M8972 module. The
microprocessor (8085) schedules sequential running of in-line
tests while the formatter is not on-line to verify basic
operation. In most cases, the 8085 only activates self-test
programs in control ROMs on various modules.

The off-line microdiagnostics thoroughly test the formatter and
any tape transport interface (MIA) module connected to the
formatter. However, these tests cannot be run under normal
operating conditions. Thirty-eight off-line tests reside in ROM on
the M8973 module. On request, the 8085 moves a microdiagnostic
from M8973 ROM to the M8972 random access memory (RAM). The 8085
then runs a checksum test on the transferred microdiagnostic and
executes the microdiagnostic. The remaining two off-line tests
reside in M8972 ROM and are simply executed by the 8085 on
request. These two tests present sample reports of passing and
failing microdiagnostics. Note that three off-line tests in M8973
ROM are STI loopback tests that require installation of a loopback
connector(s).

Any one of the 56 microdiagnostics can be run individually through
the ASCII port. Table 4-2 lists the in-line microdiagnostics and
the test numbers used to access them. Table 4-3 lists the off-line
microdiagnostics along with test numbers.

Table 4-2   In-Line Microdiagnostics

Test Number	Test Name	Description
1	INWMC	Write microcontroller self-test
2	INXMC	Translator self-test
3	INRPM	Read path controller self-test
4	INRCH0	Read channel 0 self-test
5	INRCH1	Read channel 1 self-test
6	INRCH2	Read channel 2 self-test
7	INRCH3	Read channel 3 self-test
8	INRCH4	Read channel 4 self-test
9	INRCH5	Read channel 5 self-test
A	INRCH6	Read channel 6 self-test
B	INRCH7	Read channel 7 self-test
C	INRCHP	Read channel P self-test
D	INECC	Error correcting code controller self-test
E	INMEM	Microcomputer RAM memory test
F	INCHK0	Microcomputer ROM checksum test
10	INCHK1	Extended memory ROM checksum test

Table 4-3   Off-line Microdiagnostics

Test Number	Test Name	Description
20	PASS	Prints report for successful test pass
21	FAIL	Prints error report for test failure
100	WMC1TD	Write microcontroller (WMC) microbus interface test
110	WMC2TD	WMC data format/skip count test
120	WMC3TD	WMC write data byte assembly test
130	WMC4TD	WMC write GCR check character generation test
140	WMC5TD	WMC write PE ECC character generation test (note 1)
150	TUP1TD	TU port boards test
160	MTA1TD	MIA board(s) test; includes loop command to status, loop microcomputer to AMTIE lines and loop microcomputer to RD lines for MIA board in any transport present

Table 4-3 Off-line Microdiagnostics (Cont)

Test Number	Test Name	Description
17Ø	MTA2TD	MIA loop threshold/command function test
18Ø	MTA3TD	MIA tachometer line continuity test
19Ø	XMC1TD	Translator (XMC) track enable test
1AØ	XMC2TD	XMC PE preamble/postamble test
1BØ	XMC3TD	XMC GCR preamble/postamble test; with 1 data group
1CØ	XMC4TD	XMC GCR preamble/postamble test; with no data group
1DØ	XMC5TD	XMC GCR 4-to-5 bit data translation test
1EØ	XMC6TD	XMC resync burst test
1FØ	RPM1TD	Read path and channel test; checks TIE bus, RMC command and status registers, and AMTIE bus; runs self-test for M8953, M8951 and M8950s
2ØØ	RPM2TD	Read path and channel test; checks read channel fifos statically, checks read channel data handling from all 4 TU ports, and tests RMC velocity-check circuit
21Ø	RPM3TD	Read path and channel test; checks ability to detect valid tape characters (except mark 2 and end mark) and ability to do GCR 5-to-4 bit translation with valid read forward data
22Ø	RPM4TD	Read path and channel test; checks ability to detect illegal 5-to-4 bit translation patterns in read forward data and ability to do 5-to-4 bit translation with valid read reverse data
23Ø	RPM5TD	Read path and channel test; checks ability to detect mark 2 and end mark and tests fifo depth

NOTES
1. Run time for this test is between 3Ø and 6Ø seconds per pass.
2. Run time for this test is over 6Ø seconds per pass.

Table 4-3 Off-line Microdiagnostics (Cont)

Test Number	Test Name	Description
24Ø	ECC1TD	Error correcting code (ECC) module no correction test; with good data, no TIE pointers and soft TIE pointers
25Ø	ECC2TD	ECC module single-track error correction test; with no TIE pointers and correct TIE pointers
26Ø	ECC3TD	ECC module single-track error correction test; with incorrect TIE pointers
27Ø	ECC4TD	ECC module test; checks double-track error correction with correct TIE pointers and checks no error correction with good data and 3 hard pointers
28Ø	ECC5TD	ECC module test; checks double-track correction with 2 hard pointers and 7 soft pointers and checks error discrimination to correct errors in outer tracks (1 and 9) with 9 soft pointers
29Ø	CCM1TD	Cyclic redundancy checker (CRC) module test (note 2)
2AØ	WMC6TD	WMC read data byte assembly test
2BØ	WMC7TD	WMC read residual group byte assembly test
2CØ	WMC8TD	WMC read byte assembly test; with variable skip count
2DØ	LWRTD	Loop write path to read path at 4 TU ports in PE and GCR
2EØ	MTA4D	Loop write path to read path at available MIA boards in PE and GCR
3ØØ	PMC1TD	Protocol microcontroller (PM) data path test
31Ø	PMC2TD	PM ROM controller/microbus interface test
32Ø	PMC3TD	PM flag EDC and timer test

Table 4-3 Off-line Microdiagnostics (Cont)

Test Number	Test Name	Description
330	STI1TD	STI interface error detection and reset test
350	STI2TD	STI interface port A loopback test
360	STI3TD	STI interface port B loopback test
370	STI4TD	STI interface port A and B loopback test

NOTES
1. Run time for this test is between 30 and 60 seconds per pass.

2. Run time for this test is over 60 seconds per pass.

The TS78 also contains 10 microdiagnostic chains that reside in M8972 ROM. In most cases, these chains specify sequences of related microdiagnostics. You request chains through the ASCII port like the other tests. Table 4-4 defines the chains and the numbers used to access them. Requesting a chain causes the 8085 to run the associated microdiagnostic(s) listed in Table 4-4.

Requesting chain 0 (full set) via the ASCII port runs all the microdiagnostics except the M8970 tests, M8971 tests, and sample report tests (PASS and FAIL). Running the ILTAPE subsystem diagnostic to test the formatter also runs the tests in chain 0.

Chains 401 -- 407 test various parts of the formatter defined by the fault numbers in Table 4-1. After a clear attempt with the FAULT button, the 8085 runs the proper chain to determine if the error is still there. If the error still exists, run the proper chain through the ASCII port to determine the field replacement unit (FRU).

Chain 409 (minimum integrity) quickly tests if the formatter is able to communicate via the STI bus. Running this chain and the appropriate STI loopback provides a more complete test of STI communication. Powering up the TA78 or pressing the MASTER RESET button causes the 8085 to run chains 408 and 409.

Table 4-4 Microdiagnostic Chains

Chain Number	Chain Name	Associated Test Number
Ø	Full set	1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 1A0, 1B0, 1C0, 1D0, 1E0, 1F0, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 2A0, 2B0, 2C0, 2D0, 2E0
401	Misc	10, 2D0, 2E0
402	Read	3, 4, 5, 6, 7, 8, 9, A, B, C
403	Write	1, 2
404	TU port	150
405	Error correction	D
406	STI communication	300, 310, 320, 330
407	Microcomputer	E, F
408	Power-up	1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10, 300, 310, 320, 330
409	Minimum integrity	E, F, 300, 310, 320, 330

4.3.1 Running Microdiagnostics Via the ASCII Port

To run a microdiagnostic test or chain, make sure both STI ports are off-line (i.e.; PORT SELECT A and B are out). Then plug an RS232-compatible terminal into the EIA connector on the TS78 control panel (Figure 2-25) and proceed as follows.

1. Press and release **CTRL C** on the terminal keyboard. Repeat the entry until **TA78>** appears.

2. Type **RUN DIAGNOSTIC/TEST=XXX** where XXX is the hex number for the desired test or chain (Tables 4-1 through 4-4). The tape drive executes the specified test or chain and issues a pass or fail response (Paragraph 4.3.2). (Note that the above command may be abbreviated to **R D T XXX**.)

3. Press and release **CTRL Z** to exit from the terminal mode. The drive echoes **^Z**.

The command listed in step 2 must be used to run any test individually or any fault chain (chains 401 -- 407). However, the remaining chains may be specified by number or with separate RUN commands. Table 4-5 defines the three additional RUN commands.

Table 4-5 also defines six SET commands that allow you to control how the diagnostic is run. Accessing the TA78 ASCII port automatically specifies the default diagnostic control parameters. To change a parameter, use the appropriate SET command. Once specified, a parameter stays in effect until changed with another command or until an exit from terminal mode.

After doing steps 1 and 2 above, the microprocessor runs the specified test or chain with no loop on error, no halt on error, and no repeat. Therefore, a test runs for one pass only. If a chain is specified, each test in the chain is run once.

Table 4-5 Diagnostic Commands

Command	Function
Run Diagnostic/Test=XXX	Run test or chain specified by XXX
Run Diagnostic	Run power-up chain (chain number 408)
Run Diagnostic/Full	Run full set chain (chain number 0)
Run Diagnostic/Qv	Run minimum integrity chain (chain number 409)
SEt Diagnostic/Loop	Enable loop on error; no continuation past failing point unless error clears. (See note 4.)
SEt Diagnostic/NOLoop	Disable loop on error (default)
SEt Diagnostic/Halt	Enable halt on error; exit is to TA78> prompt ending test or if chain running ending entire chain
SEt Diagnostic/NOHalt	Disable halt on error (default)
SEt Diagnostic/Repeat	Enable unconditional loop; repeats entire test or if chain running repeats entire chain
SEt Diagnostic/NORepeat	Disable unconditional loop (default)
SHow DIagnostic	Display current diagnostic control parameters

NOTES
1. In above commands, lowercase letters may be deleted to
    abbreviate a command. In addition, the "/" and "=" characters
    may be replaced by blank spaces. For example, SET
    DIAGNOSTIC/NOREPEAT may be abbreviated to SE D NOR.

2. The tape drive presents error reports for every pass while
    looping on error and just before exit for halt on error.

3. Press and release CTRL C to halt test or chain immediately
    under any conditions. Tape drive responds by echoing ^C and
    displaying TA78>. This is the only way to exit an
    unconditional loop.

4. For loop on error, looping ends if error is no longer
    continuously present. If you are looking for an intermittent
    problem use the REPEAT parameter.

4.3.2   Microdiagnostic Response

To indicate a successful test pass, the tape drive displays:

TEST XXXX DONE

where XXXX is the number of an in-line or off-line test.

For a chain, the TA78 displays a report for each test as it is run
in the sequence. The TA78 also indicates the beginning and end of
the chain. Listed below is the output for a successful run of the
minimum integrity chain with default parameters.

```
CHAIN STARTED
TEST 000E DONE
TEST 000F DONE
TEST 0300 DONE
TEST 0310 DONE
TEST 0320 DONE
TEST 0330 DONE
CHAIN DONE
```

If an error is detected, the TA78 outputs a report in the format
shown below.

```
TEST:XXXX    SUBTEST:XXXX    ERROR:XXXX    UNIT:TXXX
FRU1:M89XXX FRU2:M89XXX
[ASCII text error description]
EXP:XX,XX.....XX (optional)
ACT:XX,XX.....XX (optional)
```

The headings are defined as follows.

TEST	Test number of in-line or off-line microdiagnostic
SUBTEST	Subtest number identifying test segment
ERROR	Error number (Refer to Figure B-1 for a partial definition)
UNIT	T=Tape drive XXX=decimal unit number of transport 0; same as base number assigned with DIP switch on formatter
FRU1	Primary field replacement unit (FRU)
FRU2	Secondary FRU
EXP	Expected test results (e.g.; good data bytes)
ACT	Actual test results (e.g.; bad data bytes)

For the primary FRU, the error report differentiates between the
two TU port modules and nine read channel modules as follows.

M8955-1	TU port module for ports 0 and 1
M8955-2	TU port module for ports 2 and 3
M8950-Y	read channel module where Y is the channel designation (0 -- 7, P)

4.3.3 Using STI Loopback Tests

Test numbers 350, 360, and 370 access the STI loopback tests. For these tests, the TA78 echoes data from its transmitter to its receiver and checks for data integrity at reception. These are the only tests that check the M8971 serial data path. Test 350 checks port A only, test 360 checks port B only, and test 370 checks both ports A and B. To completely test TA78 STI communication, proceed as follows.

1. Run the minimum integrity chain. If a test fails, replace the primary FRU specified in the error report. Then rerun the chain.

2. At the TA78 bulkhead connector, remove the BC26V STI bus cable(s) and plug in two loopback connectors. Each port requires one loopback connector (PN 70-19074-01).

3. Run test 370. If the test passes, the TA78 is probably good. Remove the loopback connectors and refer to the appropriate HSC service manual. If the test fails, note which port is reported bad. You must now determine if the formatter logic is bad or if the cabling is bad between the bulkhead and TS78 logic gate.

4. Gain access to and remove the back cover of the TS78 logic gate.

5. Loosen the two screws that hold the STI cable clamp to the side of the logic gate. Then pull the clamp straight out disconnecting the STI cables from the M8971.

6. Remove the M8971 from the backplane.

7. Plug the loopback connectors into the port connectors on the M8971. Reinstall the M8971 into the backplane.

8. Run test 370. If the test passes for the suspected port, replace the associated STI cable (PN 70-20410-4J) between the bulkhead connector and the logic gate. If the test fails, replace the primary FRU specified in the error report. Then rerun the test.

9. After testing, remove the M8971 from the backplane and remove the loopback connectors. Then reinstall the M8971 and reassemble the logic gate. Also reconnect the BC26V STI bus cable(s) to the bulkhead connector.

4.4 SUBSYSTEM DIAGNOSTICS

Two subsystem level diagnostics, ILTAPE and ILEXER, can be used to troubleshoot the TA78. These two diagnostics are run from the HSC ASCII port. ILTAPE and ILEXER make use of a special TA78 diagnostic mode. The paragraphs that follow briefly describe these two diagnostics and the TA78 diagnostic mode that they use.

4.4.1   In-Line Tape Diagnostic (ILTAPE)

This diagnostic has two major parts: formatter diagnostic and transport functionality test. You may run either part separately but not both parts in the same diagnostic run. Executing the formatter diagnostic segment runs a selected microdiagnostic test or chain resident in the formatter. The default is chain 0 which is the full set (all microdiagnostics except M8970, M8971, and sample report tests). The error report is similar to the microdiagnostic error report which includes a suspected failing FRU (Paragraph 4.3.2).

Executing the transport functionality test runs a selected functional sequence with a selected data pattern. You may select one of five functional sequences. The default is the canned sequence which includes all the basic tape commands (reads, writes and positions). The other four sequences are user defined. Three of these are either previously defined and stored on the TU58 or defined now via the HSC ASCII port. The fourth user sequence must be defined at run time via the HSC ASCII port and cannot be stored.

Four data patterns are available for use in the selected functional sequence. The default pattern is ripple 0s (a rotating 0 in a field of 1s). You may also specify your own data pattern via the HSC ASCII port or the host console terminal.

The transport functionality test yields a data transfer error report every time a hard (nonrecoverable) or soft (recoverable) error occurs. The error report does not specify a suspected failing FRU. However, the report includes a section of numbers labeled **Drive Error Log**. The hex numbers are the bytes transferred from a TA78 extended drive status area at the request of the HSC as a result of the error. These bytes are defined in Paragraph B.2. The output starts with byte number 1 in the upper left. The first 49 bytes (31 in hex) are valid if byte numbers 1 and 2 are 0s. Only the first 4 bytes are valid if byte number 1 or 2 contains a non-zero value.

At the end of the sequence, ILTAPE yields a summary of soft errors. These errors are divided into eight categories defined in Table 2-4.

ILTAPE also has an STI communication test. The test runs microdiagnostics on the selected TDC port in the HSC, verifies the state of the STI line, and executes a diagnostic echo to the formatter.

Figure 4-2 shows a printout of an ILTAPE transport functionality test run. Default parameters are used. The printout includes a data transfer error report for a hard error, and a soft error summary report. Refer to the appropriate HSC maintenance documentation for more information on ILTAPE.

```
                  ^C
          HSC50> RUN DD1:ILTAPE

          ILTAPE>D>14:48 Execution Starting

          DRIVE UNIT NUMBER (U) []?  T5
          EXECUTE FORMATTER DIAGNOSTICS (YN) [Y]?  N
          EXECUTE TEST OF TAPE TRANSPORT(YN) [N]?  Y
          IS SCRATCH MEDIA MOUNTED (YN) [N]?  Y
          ARE YOU SURE (YN) [N]?  Y
          Functional Test Sequence Number (D) [1]?
          ENTER CANNED SEQUENCE RUN TIME IN MINUTES (D) [1]?
          SELECT DENSITY (0=ALL, 1=1600, 2=6250) [0]?
          DATA PATTERN NUMBER (D) [3]?
          SELECT RECORD SIZE (greater than 0) (D) [8192]?
          ITERATIONS (D) [1]?


          ILTAPE>D>14:50 T#004 E#011 U-T00005
          ILTAPE>D>COMMAND FAILURE
          ILTAPE>D>MSCP WRITE MULTIPLE COMMAND
          ILTAPE>D>MSCP STATUS:  000010
          ILTAPE>D>POSITION = 000315


          ILTAPE>D>CANNED SEQUENCE ABORTED
          ERROR-E Tape Drive Requested Error Log at  7-Jun-1984 14:50:49.90
                      Command Ref #    000015FE
                      TA78 unit #      5.
                      Err Seq #        12.
                      Error Flags      40
                      Event            FFFC
                      Position         315.
                      GEDS Text        7D 02 0005 0000013B
                      Drive Error Log  00 00 00 00 4D 38 04 10
                                       46 FF 07 FF 00 10 10 10
                                       81 10 10 FA FF 95 00 00
                                       00 00 00 FF 17 D3 00 08
                                       02 02 E2 FF FF 00 00 00
                                       00 47 F4 E8 00 56 40 07
                                       A2 7C 00 FF 17 D3
          ERROR-I End of error.

          ILTAPE>D>SOFT ERROR SUMMARY:
          ILTAPE>D>Unit  Media  Double  Double  Single  Single  Other  Other  Other
          ILTAPE>D> No   Error  Trkerr  Trkrev  Trkerr  Trkrev  Err A  Err B  Err C

          ILTAPE>D>T005 00000  00000   00000   00000   00000  00000  00000  00000

          ILTAPE>D>14:58 Execution Complete
```

Figure 4-2   ILTAPE Example Printout

4.4.2   In-Line Exerciser (ILEXER)

This diagnostic exercises from 1 to 10 units in any combination of disk and tape drives connected to the HSC. Logic is tested by writing and reading a selected data pattern for a selected number of minutes. You may select 1 of 7 data patterns. The default pattern is alternating four bytes of 0s with four bytes of 1s.

ILEXER counts operations and errors for statistical reporting in performance summaries. Performance summary reports appear periodically during execution and at the end of execution. The performance summary includes a breakdown of soft errors into eight categories defined in Table 2-4.

ILEXER yields a data transfer error report every time a hard (nonrecoverable) or soft (recoverable) error occurs. The error report does not specify a suspected failing FRU. However, the report includes a section of numbers labeled **Drive Error Log**. The hex numbers are the bytes transferred from a TA78 extended drive

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status area at the request of the HSC as a result of the error.
These bytes are defined in Paragraph B.2. The output starts with
byte number 1 in the upper left. The first 49 bytes (31 in hex)
are valid if byte numbers 1 and 2 are 0s. Only the first 4 bytes
are valid if byte number 1 or 2 contains a non-zero value.

Figure 4-3 is a printout of an ILEXER run. The default data
pattern is specified to run for three minutes. The printout
includes data transfer error report for a media error, and a
performance summary report. Refer to the appropriate maintenance
documentation for more information on ILEXER.

```
            ^C
   HSC50> RUN DD1:ILEXER

   ILEXER>D>14:43 Execution Starting

   Do you wish to reuse previous parameters (Y/N) [N] ? N
   Drive Unit Number (U) []?    T5
   Is a Scratch Tape Mounted (YN) []? Y
   Are You Sure (YN) [N]?   Y
   Data Pattern Number (16-22) (D) [21]?
   Density (1=800, 2=1600, 3=6250) [3]?
   Record Length in Bytes (1 to 12288) (D) [8192]?
   Data Compare(YN) [N]?
   Another Drive (YN) []?  N
   Run Time in Minutes (1 to 32767) [10]? 3
   Hard Error Limit (D) [20]?
   Narrow Report (YN) [N]?
   Enable Soft Error Reports (YN) [N]?


   ILEXER>D>T005 Rewinding to Start, Restart, or Exit ILEXER
   ERROR-E Tape Drive Requested Error Log at  7-Jun-1984 14:44:16.50
               Command Ref #    00001D30
               TA78 unit #      5.
               Err Seq #        7.
               Error Flags      40
               Event            FFFC
               Position         49.
               GEDS Text        7D 04 0005 00000031
               Drive Error Log 00 00 00 00 C5 36 04 71
                               47 B2 07 FF 00 00 00 00
                               81 00 00 00 FF 2B 04 00
                               44 04 44 FF 17 7A 00 08
                               02 02 62 FF FF FF FF 00
                               00 47 E6 E0 00 16 40 07
                               A2 4F 44 FF 17 7A
   ERROR-I End of error.

   ERROR-W Tape Drive Requested Error Log at  7-Jun-1984 14:44:16.70
               Command Ref #    00001D30
               TA78 unit #      5.
               Err Seq #        8.
               Error Flags      40
               Event            FFFC
               Position         49.
               GEDS Text        7D 04 0005 00000031
               Drive Error Log 00 08 00 00 06 00 00 B7
                               02 00 04 00 FF FF FF FF
                               FF FF FF FF FF FF FF FF
                               FF FF FF FF FF FF FF FF
                               FF FF FF FF FF FF FF FF
                               FF FF FF FF FF FF FF FF
                               FF FF FF FF FF FF
   ERROR-I End of error.

   ILEXER>D>Unit   R     Serial   Posi    Kbyte        Kbyte      Hard  Soft  Software
   ILEXER>D> No    -     Number   tion    Read         Written    Error Error Corrected
   ILEXER>D>T005       000000004007 00023 0000000680 0000003952  00000 00001  00000

   ILEXER>D>Unit  Media  Double  Double  Single  Single  Other  Other  Other
   ILEXER>D> No   Error  Trkerr  Trkrev  Trkerr  Trkrev  Err A  Err B  Err C
   ILEXER>D>T005  00001  00000   00000   00000   00000   00000  00000  00000
```

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Figure 4-3   ILEXER Example Printout

4.4.3   TA78 Diagnostic Mode

This mode affects four operations: write, write retry, erase gap, and dumping of extended drive status.

In diagnostic mode, a successful write operation has correct data on every track. In normal operation, a single-track error on a write is acceptable.

In diagnostic mode, write retry operations are modified to distinguish between media errors and other soft write errors. On the first write retry after an error, the tape drive does a space reverse and then a write operation. This is an attempt to write the data correctly on the same area of tape. If the write retry is successful, the drive records the error as a miscellaneous soft write error. For an unsuccessful retry, the drive does a space reverse, an erase gap and then a write operation. So on the second retry, data is written on a new area of tape. If the second retry is successful, the drive assumes the previous tape area is bad and records the error as a media error.

The drive continues write retry operations in this sequence until no errors appear or until it reaches the maximum retry count. Only even numbered attempts include erase gap operations. A successful write on an odd numbered retry means a miscellaneous soft write error. Success on an even numbered retry means a media error.

In diagnostic mode, the erasing of tape is modified to detect incorrect current levels in the write head. The space reverse preceding an erase stops the tape prematurely. The write head is now at the start of the record instead of in the gap preceding the record. Therefore, during the erase operation, the erase head does not pass over the entire record. Only the energized write head erases the tape at the start of the record that was initially between the write head and erase head. Improper erasure in this area indicates an incorrect step current level in the write head.

In diagnostic mode, the drive stores codes classifying soft errors in byte numbers 1 and 2 in the extended drive status areas. While running diagnostics, the HSC uses the three least significant bits in these locations as statistical data on soft errors. In normal operation, bytes 1 and 2 are always 0.

While running diagnostics, the HSC receives 49 bytes from a TA78 extended drive status area for every error-yielding operation (including retries). In these packets, byte numbers 1 and 2 are 0s since a soft error can only be classified on a successful operation. For soft error classification, the HSC receives only the first 4 bytes of a TA78 extended drive status area. The non-zero soft error code is in byte number 1 or 2.

Via its ASCII port, the HSC displays the first information packet relating to an error and any soft error packet it receives. Therefore, two packets appear for soft errors involving retries (e.g.; media errors). Only the soft error packet appears for soft

errors corrected during the original operation (e.g.; single-track errors). For hard errors, the first received packet appears describing the original operation before retries.

4.5   VISUAL TROUBLESHOOTING AIDS

In addition to control panel indicators, the basic TA78 has 24 LED indicators for troubleshooting. The TS78 logic gate has 16 indicators, TS78 power supply has 6, and TU78 transport logic has 2. Figures 4-4, 4-5 and 4-6 show the position of the various indicators. Table 4-6 describes their function and possible causes of failure.
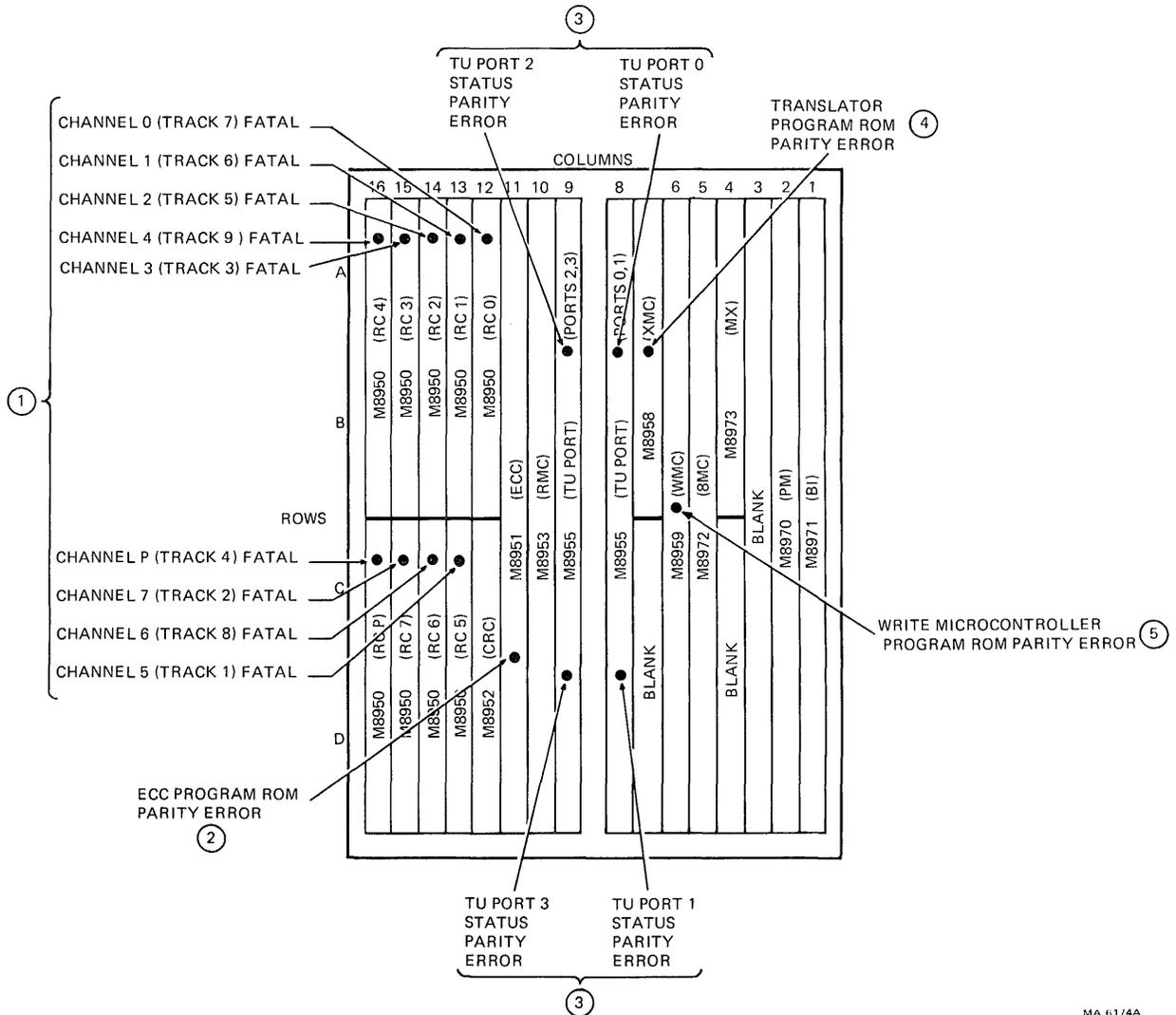
Figure 4-4   TS78 Logic Indicators for Troubleshooting

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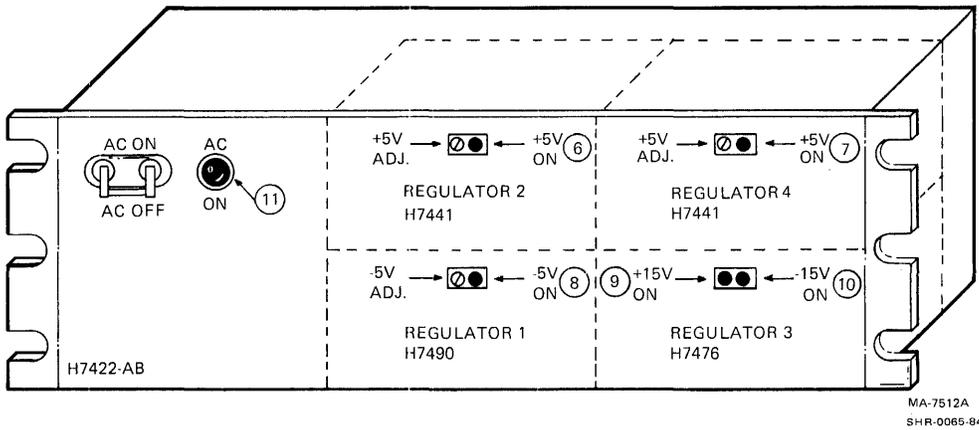
Figure 4-5   TS78 Power Supply Indicators and Adjustments
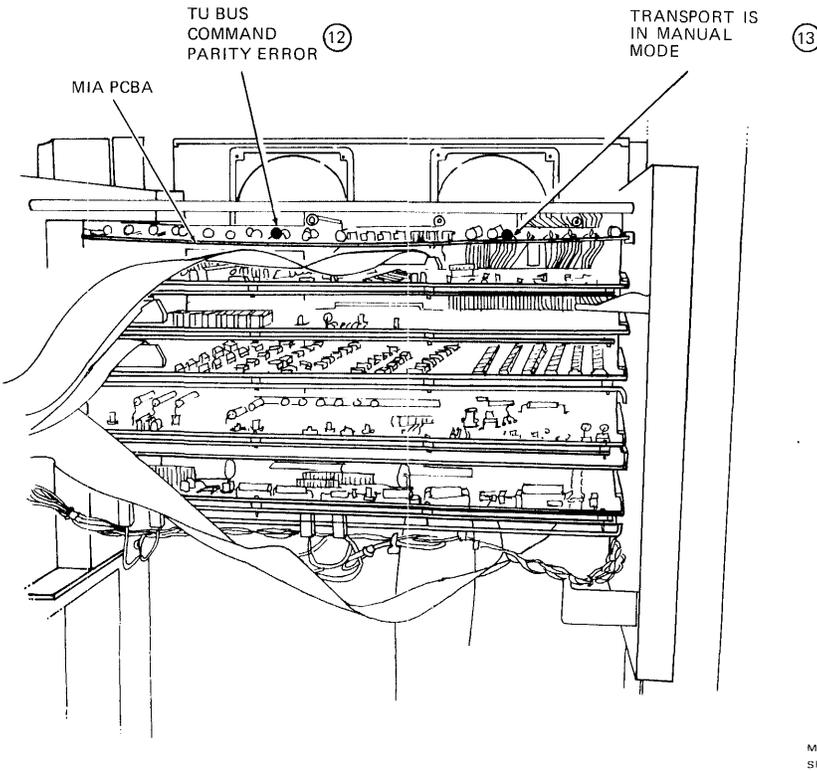
Figure 4-6   TU78 Logic Indicators for Troubleshooting

Table 4-6   Troubleshooting Indicator Functions

Indicator	Normal State	Function	Possible Failing FRU
Figure 4-4			
1	Off	Indicates channel failure. These 9 indicators reflect the quality of the data stream for each channel or track. They indicate loss of sync or track dropout. (not latched)	TU78 transport TU bus cable (n)B M8950 M8955
2	Off	A parity error occurred in the ECC microcontroller. (latched)	M8951
3	Off	Indicates a TU bus status parity error. Wrong parity was received at the TU port on the WCS lines. (latched)	TU bus cable (n)A TU78 MIA M8955
4	Off	A parity error occurred in the translator microcontroller. (latched)	M8958
5	Off	A parity error occurred in the write microcontroller. (latched)	M8959
Figure 4-5			
6	On	The +5 V regulator number 2 is OK. (Supplies TS78 read path.)	H7441 Any module in slots 10--16
7	On	The +5 V regulator number 4 is OK. (Supplies TS78 write path, STI ports, TU ports, microcomputer.	H7441 Any module in slots 1--9

Table 4-6   Troubleshooting Indicator Functions (Cont)

Indicator	Normal State	Function	Possible Failing FRU
8	On	The -5 V regulator number 1 is OK.	H7490 M8971
9	On	The +15 V regulator number 3 is OK.	H7476 M8972 Any M8950
10	On	The -15 V regulator number 3 is OK.	H7476 M8972 Any M8950
11	On	Power is being applied to the H7422 power supply.	H7422 circuit breaker tripped H7422 power cord H7422 supply
Figure 4-6			
12	Off	A command or command address on the WCS lines was received at the MIA with wrong parity.	TU bus cable (n)A M8955 TU78 MIA
13	Off	MIA PCBA maintenance switch S4 is in MANUAL position.	Flip switch to AUTO

4.6   ERROR LOG

All Digital operating systems, under which the TA78 runs, support an error logging scheme. The TA78 contains five microcode areas for storing error log information: one extended formatter status area and four extended drive status areas (one for each transport). When updating a status area, the TA78 alerts the HSC and upon request transmits the information from the requested area. If a software switch is enabled, the HSC then transmits the information to the host.

The extended formatter status area is a 19-byte field that reflects the contents of important RAM locations when a fatal error occurred. (An error is fatal when the FAULT indicator turns on.) Each extended drive status area is a 49-byte field that reflects many 8085 I/O locations in the TS78 and most of the TU78 registers at the time of a failure. In normal operation, the 8085 updates an extended drive status area when one hard error or 100 soft errors is detected during a tape motion operation. A special zero-threshold mode allows updating of an extended drive status area after every soft error. Appendix B lists the bytes in the extended drive and extended formatter status areas.

A Standard Package for Error Analysis and Reporting (SPEAR) program for the TA78 may also be available in the operating system. This program analyzes error log information to aid in fault isolation to a single FRU. It is especially helpful with problems that are: subsystem wide, intermittent, media related, or software related.

4.7   ASCII PORT

The M8972 microcomputer module contains ASCII port firmware that allows an external terminal to communicate with the TA78. This firmware includes 32 commands that are listed and defined in Table 4-7. Eleven commands are associated with the TA78-resident microdiagnostics and are discussed in more detail in Paragraph 4.3.1. Eight commands deal with checking and adjusting the capstan servo, and are discussed in more detail in Paragraph 3.7. Additional commands discussed in succeeding paragraphs are used for: testing switches and indicators, checking revision levels, and entering the keypad mode.

Table 4-7 Top Level ASCII Port Commands

Command	Function
Directory	Displays routines accessed with RUN commands. Output on external terminal is "KEYPAD DIAGNOSTICS VELOCITY RAMP FWDSTOP REVSTOP BLT."
Exit	Exits from terminal mode. After exit, tape drive no longer responds to external terminal except for CTRL C input. Tape drive saves contents of keypad program area and keypad execution parameters.
HElp <ARG>	Displays all possibilities for next word in command string specified by <ARG>. If <ARG> is omitted, output on external terminal is "SET RUN DIRECTORY HELP SHOW EXIT" (i.e.; all possibilities for first word of command string). If <ARG> specifies full command string, output on external terminal is "No further help available."
Run Blt	Runs buttons and lights test (Paragraph 4.7.1).
Run Diagnostic	Runs power-up chain (chain number 408).
Run Diagnostic/Full	Runs full-set chain (chain number 0).
Run Diagnostic/Qv	Runs minimum integrity chain (chain number 409).
Run Diagnostic/Test=XXX	Runs test or chain specified by XXX.
Run Fwdstop/Unit=X	Runs forward stop ramp check routine on transport X. (See note 4.)
Run Fwdstop/Unit=X/Loop	Runs forward stop ramp check routine repeatedly on transport X. After detecting EOT, tape drive rewinds tape and continues to repeat routine. (See note 4.)

Table 4-7   Top Level ASCII Port Commands (Cont)

Command	Function
Run Keypad	Enters keypad mode (Paragraph 4.7.3).
Run RAmp/Unit=X	Runs start ramp check routine on transport X. (See note 4.)
Run RAmp/Unit=X/Loop	Runs start ramp check routine repeatedly on transport X. After detecting EOT, tape drive rewinds tape and continues to repeat routine. (See note 4.)
Run REvstop/Unit=X	Runs reverse stop ramp check routine on transport X. (See note 4.)
Run REvstop/Unit=X/Loop	Runs reverse stop ramp check routine repeatedly on transport X. After detecting EOT, tape drive rewinds tape and continues to repeat routine. (See note 4.)
Run Velocity/Unit=X	Runs tape speed check routine on transport X. (See note 4.)
Run Velocity/Unit=X/Loop	Runs tape speed check routine repeatedly on transport X. After detecting EOT, tape drive rewinds tape and continues to repeat routine. (See note 4.)
SEt Diagnostic/Halt	Enables halt on error; exit is to TA78> prompt ending test or if chain is running ending entire chain.
SEt Diagnostic/NOHalt	Disables halt on error (default).
SEt Diagnostic/Loop	Enables loop on error; no continuation past failing point unless error clears.
SEt Diagnostic/NOLoop	Disables loop on error (default).
SEt Diagnostic/Repeat	Enables unconditional loop; repeats entire test or if chain is running repeats entire chain.
SEt Diagnostic/NORepeat	Disables unconditional loop (default).

Table 4-7 Top Level ASCII Port Commands (Cont)

Command	Function
SEt Memory XXXX:YYYY=ZZ	Moves ZZ to formatter storage location specified by XXXX:YYYY where: XXXX = memory region number (default=FFFF) YYYY = offset into memory region. Microprocessor translates XXXX:YYYY into physical address. (For discussion of memory mapping in TA78, refer to Chapter 3 in TA78 Magnetic Tape Drive Technical Description.) (See note 5.)
SEt Terminal Speed (XXXX,YYYY)	Sets receive and transmit baud rates for TA78 ASCII port where: XXXX = receive (input) baud rate YYYY = transmit (output) baud rate. If receive and transmit speeds are the same, only specify XXXX. Available speeds are: 300, 600, 1200, 2400, 4800, and 9600 baud. (See note 6.)
SHow DEvice	Displays unit number and serial number of transport 0 (i.e.; transport in TA78 cabinet).
SHow DIagnostic	Displays current diagnostic control parameters.
SHow Memory XXXX:YYYY	Displays contents of formatter storage location XXXX:YYYY where: XXXX = memory region number (default=FFFF) YYYY = offset into memory region. Microprocessor translates XXXX:YYYY into physical address. (For discussion of memory mapping in TA78, refer to Chapter 3 in TA78 Tape Drive Technical Description.)
SHow RAdix	Displays output radix of TA78 ASCII port. Tape drive displays HEX on external terminal since all but 4 numeric outputs are in base 16. (See note 3.)

Table 4-7 Top Level ASCII Port Commands (Cont)

Command	Function
SHow ROms	Displays microcode revision level of every ROM on M8972 and M8973. M8972 ROMs are identified as 0-4 and M8973 ROMs are identified as X0-X6.
SHow TErminal	Displays present receive and transmit baud rates of TA78 ASCII port. Output on external terminal is "(XXXX,YYYY)" where: XXXX = receive (input) baud rate YYYY = transmit (output) baud rate.
SHow Versions	Displays TA78 hardware and microcode revision levels, and STI revision level that TA78 is compatible with. Displayed microcode level is highest revision level of all ROMs on M8972.

NOTES
1. In above commands, lowercase letters may be deleted to abbreviate a command. In addition, the "/" and "=" characters may be replaced by blank spaces, except in SET MEMORY and SHOW MEMORY. For example, RUN DIAGNOSTIC/TEST=XXX may be abbreviated to R D T XXX.

2. Letters X, Y and Z in above commands represent maximum number of digits that may be needed to complete a command. Leading 0s in a number are not required.

3. Radix of numeric input is hex, except for baud rates. Radix for numeric output is hex except for: unit number, serial number, STI revision level, and baud rate. These four have decimal radix.

4. In tape motion commands above, X is transport cable number: 0, 1, 2, or 3. If X = 0, you may omit "/UNIT=X" from command. With no transport specified, routine assumes the transport connected to TU port 0 (i.e.; transport in TA78 cabinet). (Refer to Paragraph 3.7 for discussion of displayed output and command usage.)

5. Do not change storage locations in memory region FFFF. To do so may cause microcode crash since offset translates directly into memory address space with no restrictions.

6. The SET TERMINAL SPEED command is only way to introduce split baud rates (i.e.; different rates for receive and transmit). With this command, communication must be at new rate(s) immediately after carriage return. If this does not occur, you may clear ASCII port with TS78 master reset or TS78 power-up. Then use CTRL C to access ASCII port again. (Using CTRL C causes TA78 to autobaud, i.e.; TA78 sets reception rate based on input speed and assigns same rate to transmit.)

To access the ASCII port, make sure both STI ports are off-line. Plug an RS232-compatible terminal into the EIA connector on the TS78 control panel (Figure 2-25). Then press and release CTRL C on the terminal keyboard. Repeat the entry until TA78> appears.

Any one of the 32 commands may be entered after the TA78> prompt. And after entering a command and carriage return, the tape drive immediately tries to execute the command. However, before one of the eight tape (capstan) motion commands can be executed: the desired transport must be in maintenance mode, the transport must contain a write-enabled tape, and the transport must be on-line. If these conditions are not met, trying to execute a tape motion command results in an error message.

NOTE
If you do not respond to a prompt within five minutes, the TA78 exits the terminal mode automatically.

The ASCII port offers two ways to correct input errors. Press and release the DELETE key to erase the last character entered. Press and release CTRL U to erase all characters in a line. The TA78 responds by terminating the present line and issuing another TA78> prompt.

To exit the terminal mode, type EXIT or press and release CTRL Z, after the TA78> prompt. The tape drive then echoes your input. Press and release CTRL C to exit the terminal mode directly while a command is still executing (e.g.; while a tape motion command is looping).

4.7.1   Buttons and Lights Test
The buttons and lights test (BLT) is interactive. It allows you to verify functionality of certain switches and other assemblies not tested by resident microdiagnostics.

To start BLT, type RUN BLT on the external terminal after the TA78> prompt. In response, the TS78 microprocessor (8085) turns on the TA78 control panel indicators one at a time for about 300 ms each. The 8085 then determines what TU ports have transports present, and via the ASCII port outputs the results for display on an external terminal.

For the remainder of the test, you may manipulate switches without affecting the operational microcode. The 8085, in turn, monitors several switches and other assemblies via its I/O ports. Any changes in state are displayed on the external terminal. Table 4-8 shows displayed messages associated with the switches and assemblies, and the I/O register bits used to monitor these quantities. To exit from BLT, press and release CTRL C on the external terminal.

Table 4-8 BLT Devices and Messages

Switch/Assembly	Corresponding I/O Register and Bit	Possible Messages
FAULT	PSWI (85), bit 6	Fault switch pressed Fault switch released
PORT SELECT A	PSWI (85), bit 5	Port A switch pressed Port A switch released
PORT SELECT B	PSWI (85), bit 4	Port B switch pressed Port B switch released
Unit number selector	INDNI (8A), bits 7-0	Unit number changed to XXX
TU cabling	PSTAT (48), bit 4	Drive X existent Drive X nonexistent
Mode select	MIA status B (40-2), bits 2, 1, and 0	Drive X rotary switch changed to Y
ON LINE	TU status (40-0), bit 5	Drive X online Drive X offline
BOT	TU status (40-0), bit 2	Drive X at BOT Drive X not at BOT
EOT	TU status (40-0), bit 1	Drive X at EOT Drive X not at EOT
Write protect	TU status (40-0), bit 0	Drive X write enabled Drive X write locked

NOTES
1. Numbers in parentheses are I/O port addresses. Addresses for MIA registers in transport include microprocessor I/O address and MIA register number.

2. In unit number selector message, XXX is 3-digit decimal number between 0 and 255.

3. Microprocessor checks TU present bit (PSTAT, bit 4) for every TU port to determine if TU78 is cabled to port.

4. In any displayed message, Drive X identifies a transport with the TU port number (0, 1, 2, or 3) that it is cabled to. For example, "Drive 0" refers to the transport in the TA78 cabinet cabled to port 0.

5. In mode select message, Y should correspond to rotary switch position: 0, 1, 2, or 3. Y = ? if microprocessor detects illegal code in I/O bits for this switch.

Enabling a TS78 control panel switch causes the 8085 to turn on the corresponding indicator in addition to outputing a message. On a transport, the write-protect message always agrees with the status shown by the file protect indicator. However, the messages for ON LINE and BOT do not always agree with the corresponding indicators. Pressing the ON LINE switch may cause the on-line indicator to light. But the corresponding message does not appear until a vacuum interlock is present (i.e.; after loading tape). Also, the BOT indicator should light after loading tape. But the corresponding BOT message does not appear unless the transport is on-line. These discrepancies occur because in certain cases status indicator signal lines differ from monitored I/O bit signal lines. (Refer to Appendix B for definitions of TU Status and MIA Status B register bits.)

4.7.1.1 **Running BLT (Example)** -- This example shows how to use BLT to test the STI port switches and unit number selector switch. The example assumes only transport 0 is present in a TA78. Proceed as follows.

1. Type **RUN BLT**. In response, each TS78 control panel indicator lights for about 300 ms. The displayed message on the external terminal is **Drive 0 existent**.

2. Press PORT SELECT A. The PORT SELECT A indicator turns on. The displayed message is **Port A switch pressed**.

3. Press PORT SELECT A again. The PORT SELECT A indicator turns off. The displayed message is **Port A switch released**.

4. Test the PORT SELECT B switch as PORT SELECT A was tested in steps 2 and 3.

5. Change the position of the bottom switch in the unit number selector switchpack on the TS78 formatter. (The bottom switch has a binary value of 1.) The displayed message is **Unit number changed to XXX**. Ignore the value of XXX.

6. Move the bottom switch back to its original position. The displayed message is **Unit number changed to XXX** where XXX is the unit number of transport 0 (identified in the bottom-left corner of the transport glass in the TA78 cabinet).

7. Press and release **CTRL C** to exit from the test. The tape drive responds by displaying **TA78>**.

4.7.2   Checking TS78 Revision Levels

To check TS78 revision levels, use the ASCII port and revision management document. Proceed as follows.

1.   Type **SHOW VERSIONS**. The tape drive responds by displaying the TA78 hardware and microcode revision levels, and the STI revision level that the TA78 is compatible with.

2.   Look up the displayed hardware level in the revision management document. Determine the proper revision level for each TS78 module.

3.   If necessary, remove each TS78 module from the backplane and check the module's actual revision for proper level.

4.   Type **SHOW ROMS**. The drive displays the microcode revision level of every ROM on the M8972 and M8973. The revision level for every M8972 ROM should match the microcode revision level displayed by SHOW VERSIONS. If this is not the case, replace the M8972.

4.7.3   Keypad Mode

The keypad mode allows you to program and run tape motion routines, and to retrieve and run prewritten tape motion routines. The keypad firmware provides a 30-location keypad program area, 55 instructions, and a 131-location parameter area. In addition, a 16-bit address counter and 8-bit accumulator are included. And in the parameter area, four 16-bit counters are included.

To enter the keypad mode, type **RUN KEYPAD** on the external terminal after the TA78> prompt. The tape drive displays **KEYPAD>** on the external terminal. Any one of the 55 commands may be entered after the KEYPAD> prompt. And after entering a command and carriage return, the tape drive immediately tries to execute the command. However, before a tape motion command can be executed: the desired transport must be in maintenance mode, contain a write-enabled tape, and be on-line. If these conditions are not met, trying to execute a tape motion command results in an error message.

The 55 commands are divided into two categories: immediate execution and deferred execution. The 11 immediate execution commands can be executed only after the KEYPAD> prompt as previously described. The 44 deferred execution commands may be executed immediately or placed in the keypad program area for execution later. Tables 4-9 and 4-10 list and define the immediate and deferred execution commands. Table 4-10 also includes the locations of parameters that affect or are affected by execution of a command in the keypad mode.

Most of the immediate execution commands are used to manage programming in the keypad mode. Some functions are: entering deferred execution command(s) into the program area, listing the contents of the program area, and starting program execution.

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Table 4-9 Immediate Execution Commands

Command	Function
INIt	Clears keypad program area and reset execution parameters to default values
Get X	Loads tape motion routine X into program area (Paragraph 4.8)
ENTer XX	Begins input of program command(s) for deferred execution starting at location XX in program area. Tape drive displays message on external terminal asking for user input. (You may omit XX if XX = 00.)
END	Ends input of command(s) to program area. Tape drive displays KEYPAD> prompt on external terminal.
LIst XX YY	Displays contents of YY location(s) in program area starting at location XX. Tape drive displays "(null)" on external terminal for any location that contains no command.
STArt XX	Starts program execution at location XX in program area. (You may omit XX if XX = 00.)
Continue	Continues running previously halted program at one program location after last executed command.
EXAmine XXXX	Displays contents of location XXXX. (See note 4.)
DEPosit XXXX YY	Deposits YY into location XXXX. (See note 4.)
DIRect	Displays listing of all keypad mode commands
EXIt	Exits from keypad mode. Tape drive displays TA78> prompt on external terminal. Tape drive saves contents of keypad program area and keypad execution parameters.

NOTES
1. In above commands, lowercase letters may be deleted to abbreviate a command. For example, EXAMINE XXXX may be abbreviated to
    EXA XXXX.

2. Letters X and Y in above commands represent maximum number of digits that may be needed to complete a command. Leading 0s in a number are not required.

3. In keypad mode, default radix of numeric input is hex. Radix is decimal if you follow numeric input with a period ("."). Radix for numeric output is hex.

4. Before using EXAMINE or DEPOSIT, address mode must be previously defined with MEM, IO or PARAM. If memory mode is used, a region should also be specified. (Refer to Tables 4-10 and 4-11.)

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Table 4-10   Deferred Execution Commands

Command	Function	Associated Parameter Address
Nop	No operation	--
HAlt	Halts program execution and displays program location (PC) of last executed command.	--
UNIt X	Selects transport X for tape motion. (X is transport cable number: 0, 1, 2, or 3.)	0
Fmdump	Updates extended formatter status area.	--
DUmp	Updates extended drive status area.	0
ADdress XXXX	Loads XXXX into address counter.	--
INCR	Increments address counter by 1.	--
MEmory	Specifies memory address mode; address counter, EXAMINE command and DEPOSIT command point within microprocessor memory address space.	2, 3
IO	Specifies I/O address mode; address counter, EXAMINE command and DEPOSIT command point within microprocessor input/output address space.	--
Param	Specifies parameter address mode; address counter, EXAMINE command and DEPOSIT command point within keypad parameter address space.	--
STOre	Moves contents of accumulator to location specified by address mode and address counter.	--
LOad	Loads accumulator with contents of location specified by address mode and address counter.	--
MVi XX	Loads XX into accumulator.	--
ANd XX	Logically ands XX with contents of accumulator and stores result in accumulator.	--
Test XX	Logically ands XX with contents of accumulator. (Contents of accumulator are not affected.)	--

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Table 4-10 Deferred Execution Commands (Cont)

Command	Function	Associated Parameter Address
DISplay	Displays contents of accumulator (AC) on external terminal. In program deferred mode only, current program location (PC) also displays.	--
LD0cntr XXXX	Loads XXXX into counter 0.	D, E
LD1cntr XXXX	Loads XXXX into counter 1.	F, 10
LD2cntr XXXX	Loads XXXX into counter 2.	11, 12
LD3cntr XXXX	Loads XXXX into counter 3.	13, 14
INC0	Increments counter 0 by 1.	D, E
INC1	Increments counter 1 by 1.	F, 10
INC2	Increments counter 2 by 1.	11, 12
INC3	Increments counter 3 by 1.	13, 14
DECR0	Decrements counter 0 by 1.	D, E
DECR1	Decrements counter 1 by 1.	F, 10
DECR2	Decrements counter 2 by 1.	11, 12
DECR3	Decrements counter 3 by 1.	13, 14
BZ XX	Branches to program location XX if last operation produced 0.	--
BNZ XX	Branches to program location XX if last operation produced nonzero result.	--
BR XX	Branches unconditionally to program location XX.	--
WRIte	Writes one record.	0, 1, 5, 9, A, B
WRTmai	Writes continuously on all tracks until EOT.	0, 1, 5, B

Table 4-10 Deferred Execution Commands (Cont)

Command	Function	Associated Parameter Address
RDFwd	Reads forward one record.	0, 1, 6 or 7, C
RDRev	Reads reverse one record.	0, 1, 6 or 7, C
REwind	Rewinds tape.	0
UNLoad	Rewinds and unloads tape.	0
ERase	Erases gap.	0
DSe	Data security erase from current position to past EOT and rewinds tape.	0
WTm	Writes one tape mark.	0, 1, 5
SPFwd XXXX	Spaces forward XXXX records or until end of file.	0, 6 or 7
SPRev XXXX	Spaces reverse XXXX records or until end of file.	0, 6 or 7
SEFwd XXXX	Spaces forward XXXX gaps (includes gaps between records and gaps between files).	0, 6 or 7
SERev XXXX	Spaces reverse XXXX gaps (includes gaps between records and gaps between files).	0, 6 or 7

NOTES
1. In above commands, lowercase letters may be deleted to abbreviate a command. For example, LD0CNTR XXXX may be abbreviated to LD0 XXXX.

2. Letter X in above commands represents maximum number of digits that may be needed to complete a command. Leading 0s in a number are not required.

3. In keypad mode, default radix of numeric input is hex. Radix is decimal if you follow numeric input with a period ("."). Radix for numeric output is hex.

The keypad mode offers three address modes: memory address mode, I/O address mode, and parameter address mode. The memory address mode allows you to access the entire 64K 8085 address space. This space contains ROM, RAM, and I/O registers. The I/O address mode allows you to access only the I/O registers which are in the top 4K of the memory address space. The parameter address mode allows you to access the parameter address space which is within the RAM. Executing the INIT command, a TS78 master reset or a TS78 power-up automatically specifies the parameter address mode as a default.

After executing a tape motion command, the TS78 microprocessor (8085) loads a status byte into the keypad accumulator. Figure 4-7 shows the status byte bit assignments. You may wish to test this byte for any detected tape motion errors.

In a deferred program, only execution of the DISPLAY and HALT commands results in displayed values on the external terminal. However, many commands result in displayed values when executed in immediate mode (i.e.; after the KEYPAD> prompt). Executing the commands that affect the accumulator cause the display of the new accumulator value. Executing the TEST command causes a display of the result. Executing commands that increment or decrement a general purpose counter cause the display of the logical "or" of the two counter bytes. Note that in all cases the displayed value is a two-digit hex code.

In any command input, you may press and release the DELETE key to erase the last character entered. Press and release CTRL U to erase all characters in a line. The TA78 terminates the present line and issues another prompt.

To end deferred program execution, press and release CTRL G. The external terminal then identifies the last program location executed and displays the KEYPAD> prompt. Type EXIT or press and release CTRL Z after the KEYPAD> prompt to exit the keypad mode.

07	06	05	04	03	02	01	00
TM	EOT	BOT	UNC	BSY	AMT	COR	FTL

TAPE MARK

BEGINNING OF TAPE

END OF TAPE

AMTIE

FATAL ERROR

CORRECTABLE ERROR

TRANSPORT IS BUSY

UNCORRECTABLE ERROR
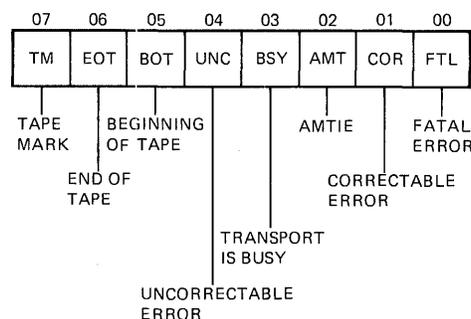
SHR-0102-84

Figure 4-7   Tape Motion Returned Status
(Keypad Mode)

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The external terminal then displays your input and the TA78>
prompt. Press and release **CTRL C** to exit the keypad mode directly
while a program is still executing.

When entering a command after the KEYPAD> prompt, you may end the
line by pressing and releasing **CTRL Z** instead of using a carriage
return. Ending a command with **CTRL Z** causes the tape drive to
execute the command and then exit from the keypad mode. Because of
their nature, ending a START or CONTINUE command in this manner
causes a keypad mode exit only after a HALT instruction is
executed or after you press and release **CTRL G**.

Figure 4-8 shows a sample printout that includes: entering an
8-step program, listing the program, executing the program,
modifying the program, and executing the modified program. Each
command to be entered is outlined and must be followed by a
carriage return. The remaining printout shows the tape drive's
responses and several commments that have been added for clarity.
The comments are enclosed in parenthesis and do not appear in a
TA78 printout.

```
                ^C
    TA78:RUN KEYPAD
    KEYPAD:INIT
    KEYPAD:UNIT 0                    (0 IS TRANSPORT CABLE NUMBER)
    KEYPAD:ENTER                     (ENTER PROGRAM)
    PC= 00    ?| WRITE
    PC= 01    ?| TEST 4
    PC= 02    ?| BZ 4
    PC= 03    ?| HALT
    PC= 04    ?| TEST 40
    PC= 05    ?| BZ 0
    PC= 06    ?| REWIND
    PC= 07    ?| BR 0
    PC= 08    ?| END
    KEYPAD:LIST 0 A                  (LIST PROGRAM)
    00:   WRITE
    01:   TEST   0004
    02:   BZ     0004
    03:   HALT
    04:   TEST   0040
    05:   BZ     0000
    06:   REWIND
    07:   BR     0000
    08:   (null)
    09:   (null)
    KEYPAD:START                     (EXECUTE PROGRAM. PRESS AND RELEASE
    HALT AT PC= 04                   CTRL G TO END PROGRAM EXECUTION.)
    KEYPAD:ENTER 1                   (MODIFY PROGRAM)
    PC= 01    ?| TEST 17
    PC= 02    ?| END
    KEYPAD:LIST 0 8                  (LIST MODIFIED PROGRAM)
    00:   WRITE
    01:   TEST   0017
    02:   BZ     0004
    03:   HALT
    04:   TEST   0040
    05:   BZ     0000
    06:   REWIND
    07:   BR     0000
    KEYPAD:START                     (EXECUTE MODIFIED PROGRAM. PRESS AND
    HALT AT PC= 00                   RELEASE CTRL G TO END PROGRAM
    KEYPAD:^Z                        EXECUTION.)
    TA78:^Z
```

Figure 4-8   Keypad Mode Program Example

When executing the program first entered in Figure 4-8, the tape drive writes records testing for an AMTIE error at the end of every record. The drive halts at program location 3 if an AMTIE error has been detected. For error-free operation, the drive continues to write records until EOT and then rewinds the tape. The drive then continues writing and testing.

Modifying program location 1 as shown in Figure 4-8 causes the tape drive to halt at program location 3 if any error is detected. Any error includes: a correctable error, uncorrectable data error, AMTIE error, or fatal error.

4.7.3.1 Parameter Area -- The 131-location parameter area is divided into four areas listed below. To access the parameter area, use the PARAM command.

Parameter Address Range	Parameter Area Designation
Ø -- 23	Execution area
24 -- 56	Extended drive status area
57 -- 6A	Extended formatter status area
6B -- 82	Operational status area

The execution area contains parameters that directly affect how a command is executed, and parameters that are affected by command execution. Table 4-11 lists and defines the execution parameters and their default values. Except for location Ø, the execution parameters are independent of the transport selected.

The three remaining parameter areas reflect various 8Ø85 RAM and I/O locations. You may wish to analyze these locations after running programs since these locations contain valuable internal status information. The extended drive and extended formatter status areas are copies of the areas used for error logging information. The contents of these two areas are discussed in Appendix B. The operational status area contains RAM locations that are periodically updated with formatter and transport status during normal operation. Table 4-12 lists and defines the operational status parameters. Note that the contents of the extended drive status and operational status areas is dependant on the transport selected in parameter Ø.

WARNING
Do not write in the operational status
area (addresses 6B--82). To do so, may
cause a microcode crash.

Table 4-11 Execution Parameters

Address	Name	Default Value	Description
0	KEYUNI	0	Transport cable number (0, 1, 2 or 3). This number identifies the transport with the TU port number that it is cabled to.
1	KEYDEN	0	Recording density. 　0 = GCR format (9042 fr/in) 　Nonzero = PE format (3200 fr/in)
2	KP$REG	FF	Memory region number (low byte).
3	--	FF	Memory region number (high byte).
			In memory address mode, 8085 translates 16-bit memory region number and 16-bit offset into physical address. Offset is in address counter. (For discussion of memory mapping in TA78, refer to Chapter 3 in TA78 Magnetic Tape Drive Technical Description.) (See note.)
4	KP$KDY	3	Instruction delay. This number affects elapsed time between execution of keypad commands. The larger the number, the longer the elapsed time.
5	KP$CLK	10	Write function clock control.
6	--	12	Read GCR function clock control.
7	--	13	Read PE function clock control.
8	KP$CLD	10	Loop write-to-read function clock control.

Deq / – n

8085 loads contents of appropriate
location (5, 6, 7 or 8) into clock
control register before executing
desired function. Bits 7 and 6 are
forced to 0, bits 5-3 specify write
path clock, and bits 2-0 specify read
path clock.

Bit	Value	Function
5:3	0	-10% clock
5:3	1	+10% clock
5:3	2	Normal clock
5:3	3	-30% clock
2:0	0	Normal clock (write)
2:0	1	+20% clock
2:0	2	+10% clock (GCR read)
2:0	3	-20% clock (PE read)

Values not listed should not be used.

Table 4-11 Execution Parameters (Cont)

Address	Name	Default Value	Description
9	KP$WSZ	Ø	Write record size (low byte).
A	--	A	Write record size (high byte).
			8Ø85 uses contents of 9 and A as 16-bit byte count for write record operations.
B	KP$WPA	FF	Write data or test pattern. In write record operations, 8Ø85 loads contents of B into DDR for use as 8-bit record data. In write continous operations, 8Ø85 loads contents of B into MIA test pattern register. This pattern is then written repeatedly on all tracks until EOT.
C	KP$RDA	Ø	Read data. Contains contents of DDR after last data byte is read in record during read forward or read reverse operation.
D	KEYCTØ	Ø	General purpose counter Ø (low byte).
E	--	Ø	General purpose counter Ø (high byte).
F	KEYCT1	Ø	General purpose counter 1 (low byte).
1Ø	--	Ø	General purpose counter 1 (high byte)
11	KEYCT2	Ø	General purpose counter 2 (low byte).
12	--	Ø	General purpose counter 2 (high byte).
13	KEYCT3	Ø	General purpose counter 3 (low byte).
14	--	Ø	General purpose counter 3 (high byte).
			These four 16-bit counters can be loaded, incremented, decremented, and tested by the 8Ø85 in accordance with keypad commands.
15--23	--	Ø	Spare locations. These parameter locations may be used for temporary data storage (i.e.; as a scratchpad area).

NOTE: Do not change storage locations in memory region FFFF. To do so may cause microcode crash since offset translates directly into memory address space with no restrictions.

Table 4-12 Operational Status Parameters

Parameter Address	Description	
	Bit	Description
	7	Tape unit was ready and on-line.
	6	Maintenance mode was requested.
	5	Tape unit was on-line but not necessarily ready.
	4	Last operation was tape rewind.
	3	Last density: 1=PE, Ø=GCR.
	2	BOT marker on tape was at BOT sensor.
	1	EOT marker on tape was at or past EOT sensor while tape was moving in forward direction.
	Ø	Tape unit was write locked.
6C	Current TU software status byte.	
	Bit	Description
	7	Current density: 1=PE, Ø=GCR.
	6	Tape unit exists and power is on.
	5	Tape unit is in maintenance mode.
	4	Last operation wrote on tape.
	3	Not used.
	2	Direction of last motion: Ø=Forward, 1=Reverse.
	1	DSE in progress.
	Ø	Rewind in progress.
6D	Pending TU software status byte.	
	Bit	Description
	7	Request to unload tape.
	6	Request to erase tape past EOT during DSE.
	5	DSE or rewind in progress.
	4	Clean tape operation in progress.
	3	Update of extended formatter status or extended drive status is in progress.
	2	Request for diagnostic mode.
	1	Request for zero threshold mode.
	Ø	Requested density: 1=PE, Ø=GCR.

Table 4-12 Operational Status Parameters (Cont)

Parameter Address	Description
6E	Drive mode byte.

Bit	Description
7	Tape mark is detected.
6	EOT marker on tape is at or past EOT sensor while tape moving in forward direction.
5	BOT marker on tape is at BOT sensor.
4	Tape unit is write locked.
3	Tape unit is on-line and ready.
2	Tape unit is ready but not on-line.
1	Maintenance mode request.
Ø	Error log information available.

Parameter Address	Description
6F	Drive error byte.

Bit	Description
7	Drive error occurred (miscellaneous).
6	Lengthy operation in progress.
5	Tape position lost.
4	Exception occurred (bit 7, 6 or 5 of byte 6E is set).
3	Data transfer error occurred (operation aborted).
2	Not used.
1	Not used.
Ø	Not used.

Parameter Address	Description
70	Write byte count (low byte).
71	Write byte count (high byte).
72	Modulo 7 count.
73	Gap count (first byte, least significant).
74	Gap count (second byte).
75	Gap count (third byte).
76	Gap count (fourth byte, most significant).
77	Soft error count.

Table 4-12 Operational Status Parameters (Cont)

Parameter Address	Description
78-7C	Spare locations.
7D	Error number (low byte) (Paragraph A.2.1).
7E	Error number (high byte) (Paragraph A.2.1).
7F	Low byte for number of gaps (in space operation) or for byte count (in read operation).
80	High byte for number of gaps (in space operation) or for byte count (in read operation).
81-82	Spare locations.

4.8 PREWRITTEN TAPE MOTION ROUTINES

The TA78 contains 11 prewritten test routines (0-A) which involve tape motion. Most of these routines write and/or read data on tape. The routines are intended as transport troubleshooting or adjustment aids. For example, test 2 can be used to test peakshift.

The routines are in M8972 ROM and are written in keypad code. Any of these routines can be accessed and run via the ASCII port. A routine must be moved to the keypad program area in M8972 RAM before execution. Once in RAM, the routine may also be modified.

4.8.1 Running Instructions

To run a prewritten tape motion routine, make sure: both STI ports are off-line, the desired transport is in maintenance mode, the transport contains a write-enabled scratch tape, and the transport is on-line. Then plug an RS232-compatible terminal into the EIA connector on the TS78 control panel (Figure 2-25) and proceed as follows.

1. Press and release **CTRL C** on the terminal keyboard. Repeat the entry until **TA78>** appears.

2. Type **RUN KEYPAD**. The acceptable response is **KEYPAD>**.

3. Type **INIT**. This clears the keypad program area and resets the keypad execution parameters to known default values.

4. To select a transport, type **UNIT X** where X is the desired transport's cable number (0, 1, 2, 3) shown in Figure 2-17. The default number is 0 which selects the transport in the TA78 cabinet.

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5. Type **GET X** where X is the hex test number of the desired prewritten tape motion routine (Paragraph 4.8.2). The microprocessor moves the routine from M8972 ROM to the keypad program area in M8972 RAM.

6. Type **START**. The tape drive executes the tape motion routine in M8972 RAM on the selected transport. In most cases, the tape drive repeats the routine indefinitely with no displayed output.

7. Press and release **CTRL G** to exit from a tape motion routine. The tape drive displays **HALT AT PC=XX** where XX is a program location. The drive then displays **KEYPAD>**.

8. Press and release **CTRL Z** to exit from the keypad mode. The tape drive echoes **^Z** and displays **TA78>**.

9. Press and release **CTRL Z** to exit from the terminal mode. The drive echoes **^Z**.

In the above procedure, you may select a transport other than 0. Otherwise, unless specified in its code, the selected test routine uses default parameters.

However, you may make additional changes in unspecified parameters using the **PARAM** and **DEPOSIT** commands in the immediate execution mode, before running the routine in step 6 above. For example, no test routine specifies density in its code. To change the density from the default GCR to PE, type the following between steps 4 and 5.

    PARAM
    DEPOSIT 1 1

Once specified, a parameter remains in effect until changed with another command. To return all execution parameters to their default values, use the **INIT** command. This command also clears the keypad program area.

Once moved into RAM, a prewritten tape motion routine is like any other keypad program. To display a routine use the **LIST** command. To modify a routine, use **ENTER** and **END**. (Refer to Paragraph 4.7.3 for a discussion of keypad mode.)

4.8.2 Descriptions and Listings
This paragraph contains a descriptive summary and code listing for each prewritten tape motion routine. The code format here is the same as the format displayed on an external terminal in response to a LIST command.

Nondefault write parameters specified in a routine's code are mentioned in a routine's summary. Writing a record with default parameters results in a 2.5K-byte GCR record with all 1s data. Writing continuously (in nonrecord format) with default parameters results in an all 1s test pattern written at 9042 fr/in.

4.8.2.1 Test 0 -- In this test, the tape drive writes an all 1s test pattern continuously on all tracks until EOT. The drive then rewinds the tape and the test repeats.

```
00:   PARAM
01:   ADDRESS   000B
02:   MVI   00FF
03:   STORE
04:   REWIND
05:   WRITE
06:   WRTMAI
07:   BR   0004
```

                              NOTE
              Modifying step 2 modifies the test
              pattern.

4.8.2.2 Test 1 -- This test is the same as test 0 except test pattern 10010011 is used here. The program listing is the same as for test 0 except step 2 is MVI 0093 here.

4.8.2.3 Test 2 -- This test is the same as test 0 except test pattern 11100111 is used here. The program listing is the same as for test 0 except step 2 is MVI 00E7 here.

4.8.2.4 Test 3 -- In this test, the tape drive writes a series of 32-byte records. The drive delays about 4 ms before writing each new record. After detecting EOT, the drive rewinds the tape and the test repeats.

```
00:   PARAM
01:   ADDRESS   000A
02:   MVI   0000
03:   STORE
04:   ADDRESS   0009
05:   MVI   0020
06:   STORE
07:   REWIND
08:   LD0CNTR   0100
09:   DECR0
0A:   BNZ   0009
0B:   WRITE
0C:   TEST   0040
0D:   BNZ   0007
0E:   BR   0008
```

4.8.2.5 Test 4 -- In this test, the tape drive repeatedly writes a record and then reads it in the reverse direction. If the EOT marker is detected, the drive rewinds the tape. This prevents running off the tape due to tape creep.

```
00:   REWIND
01:   WRITE
02:   TEST   0040
03:   BNZ  ʷ 0000
04:   RDREV
05:   BR     0001
```

4.8.2.6 Test 5 -- In this test, the tape drive reads records testing for errors at the end of every record. The drive displays a two-digit status word on the external terminal and then halts, if it detects any error (i.e.; correctable error, uncorrectable data error, AMTIE error or fatal error). For error-free operation, the drive continues to read until EOT and then reads reverse until BOT. The test then repeats.

```
00:   RDFWD
01:   TEST   0040
02:   BNZ    0008
03:   TEST   0017
04:   BZ     0000
05:   DISPLAY
06:   HALT
07:   BR     0000
08:   RDREV
09:   TEST   0020
0A:   BNZ    0000
0B:   TEST   0017
0C:   BZ     0008
0D:   DISPLAY
0E:   HALT
0F:   BR     0008
```

4.8.2.7 Test 6 -- In this test, the tape drive spaces forward until it detects: one tape mark, an EOT marker, or a fatal error. The drive then halts. For a halt on EOT or a halt on error, the drive displays a two-digit status word on the external terminal. Therefore, a halt with no status word displayed indicates the end of one file (i.e.; one tape mark detected).

```
ØØ:   LDØCNTR   ØØØ1
Ø1:   SPFWD     FFFF
Ø2:   TEST      ØØ8Ø
Ø3:   BNZ       ØØØ8
Ø4:   TEST      ØØ41
Ø5:   BZ        ØØØ1
Ø6:   DISPLAY
Ø7:   HALT
Ø8:   DECRØ
Ø9:   BNZ       ØØØ1
ØA:   HALT
ØB:   REWIND
ØC:   BR        ØØØØ
```

NOTE
Modifying step Ø allows spacing forward
until a specified number of tape marks
have been found as opposed to just one
tape mark.

4.8.2.8 Test 7 -- In this test, the tape drive writes records testing for errors at the end of every record. If it detects any error, the drive displays a two-digit status word on the external terminal and then halts. For error-free operation, the drive continues to write records until EOT and then rewinds the tape. The test then repeats.

```
ØØ:   REWIND
Ø1:   WRITE
Ø2:   TEST      ØØ4Ø
Ø3:   BNZ       ØØØØ
Ø4:   TEST      ØØ17
Ø5:   BZ        ØØØ1
Ø6:   DISPLAY
Ø7:   HALT
Ø8:   BR        ØØØ1
```

4.8.2.9 Test 8 -- In this test, the tape drive writes records testing for errors at the end of every record. If it detects any error, the drive displays a write error count on the external teminal and then does a write retry operation. The write retries continue as long as an error remains and the drive updates the display for every failed retry (i.e.; whenever an error is encountered). For error-free operation, the tape drive continues to write records until EOT and then rewinds the tape. The test then repeats.

```
ØØ:     LDØCNTR   ØØØØ
Ø1:     PARAM
Ø2:     ADDRESS   ØØØD
Ø3:     REWIND
Ø4:     WRITE
Ø5:     TEST   ØØ4Ø
Ø6:     BNZ   ØØØ3
Ø7:     TEST   ØØ17
Ø8:     BZ   ØØØ4
Ø9:     INCØ
ØA:     LOAD
ØB:     DISPLAY
ØC:     SPREV   ØØØ1
ØD:     ERASE
ØE:     BR   ØØØ4
```

4.8.2.1Ø Test 9 -- In this test, the tape drive writes a record and then reads it in reverse and forward, testing for errors after every operation. The drive does a write retry operation(s) to correct any write error detected. However, the tape drive halts if 5Ø retries fail to yield an error-free record. For a read or read reverse error, the drive displays a read error count on the external terminal and then delays about 1Ø seconds. The read error count is the total number of bad records detected during reads in forward and reverse since starting the test. With no write or read reverse errors detected, the drive continues to write, read reverse and read until EOT and then rewinds the tape. The test then repeats.

```
ØØ:     LDØCNTR   ØØØØ
Ø1:     PARAM
Ø2:     ADDRESS   ØØØD
Ø3:     REWIND
Ø4:     LD1CNTR   ØØ32
Ø5:     WRITE
Ø6:     TEST   ØØ4Ø
Ø7:     BNZ   ØØØ3
Ø8:     TEST   ØØ17
Ø9:     BNZ   ØØ11
ØA:     RDREV
ØB:     TEST   ØØ17
ØC:     BNZ   ØØ17
ØD:     RDFWD
ØE:     TEST   ØØ17
```

```
ØF:   BNZ   ØØ17
1Ø:   BR    ØØØ5
11:   SPREV   ØØØ1
12:   ERASE
13:   DECR1
14:   BNZ   ØØØ5
15:   HALT
16:   BR    ØØØ4
17:   INCØ
18:   LOAD
19:   DISPLAY
1A:   LD2CNTR   2ØØØ
1B:   DECR2
1C:   BNZ   ØØ1B
1D:   BR    ØØØ5
```

4.8.2.11 Test A -- In this test, the tape drive: writes 1ØØ records, reads reverse 99 records, reads forward 98 records, writes 97 records, reads reverse 96 records, reads forward 95 records, writes 94 records, and so on. After a write operation with 1 record, the sequence repeats. After detecting EOT, the drive rewinds the tape and the test repeats.

```
ØØ:   REWIND
Ø1:   PARAM
Ø2:   LDØCNTR   ØØ65
Ø3:   LD1CNTR   ØØØØ
Ø4:   LD2CNTR   ØØØ3
Ø5:   DECR2
Ø6:   DECRØ
Ø7:   BZ    ØØØ2
Ø8:   ADDRESS   ØØØD
Ø9:   LOAD
ØA:   ADDRESS   ØØØF
ØB:   STORE
ØC:   ADDRESS   ØØ11
ØD:   LOAD
ØE:   BNZ   ØØ11
ØF:   RDFWD
1Ø:   BR    ØØ18
11:   TEST   ØØØ1
12:   BNZ   ØØ17
13:   WRITE
14:   TEST   ØØ4Ø
15:   BNZ   ØØØØ
16:   BR    ØØ18
17:   RDREV
18:   DECR1
19:   BNZ   ØØØC
1A:   LOAD
1B:   TEST   ØØØ7
1C:   BNZ   ØØØ5
1D:   BR    ØØØ4
```

5.1   GENERAL

This chapter defines specific procedures for troubleshooting the TU78 transport only. It is assumed that you have already isolated a malfunction to the transport, using troubleshooting aids discussed in Chapter 4 or other methods. It is also assumed that you understand the normal operation of the TU78 as described in Chapter 4 of the TA78 Magnetic Tape Drive Technical Description. This knowledge plus the troubleshooting information in this chapter should enable you to isolate malfunctions to a single field replaceable unit (FRU) such as a module or mechanical assembly.

5.2   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.

5.2.1   Functional Description

The MIA PCBA is the interface between the TS78 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 3-15 shows where these components are and Tables 5-1 and 5-2 list their functions. A more detailed description of MIA theory is found in Paragraph 4.6 of the TA78 Magnetic Tape Drive Technical Description.

Table 5-1 MIA LEDs

CR Number	Function
CR1	Command parity error
CR2	Manual mode

Table 5-2 MIA Switch Functions

Switch Number	Function Left Position	Right Position
S1	Reverse	Forward
S2	Read	Write
S3	1600 mode	6250 mode
S4	Auto (on-line)	Manual (test)

5.2.2   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 TU78 control panel ON LINE switch in order
to receive the MIA commands. Also, when in manual mode, the
mode select switch on the control panel has no effect and can be
placed in any position.

The eight test pattern DIP switches (Figure 3-15, DIP U196) can be
set to write a repeating eight character pattern to tape. Switch
number 1 of U196 determines whether characters 1, 9, 17, etc., are
all 1s or all 0s. Switch number 2 corresponds to characters 2, 10,
18, and so on to switch 8 for characters 8, 16, 24, and so on. For
a detailed description of test write data generation, refer to
Paragraph 4.6.5.8 in the TA78 Magnetic Tape Drive Technical
Description.

The right LED (CR2) is lit when in manual mode. The left LED (CR1)
is lit 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.

4. Switch number 4 must be placed in
    the auto (left) position before
    returning the transport to operating
    system on-line usage.

5.3   USING THE PCBA EXTENDER (PN 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 cannot be extended, but can be
accessed by removing the cabinet top cover. The capstan/regulator
and reel servo PCBAs cannot be extended due to heat sinking
requirements. Figure 5-1 shows the PCBA extender.


```
TO J8           TO J7          TO J5
CONTROL M2      WRITE          READ
```

EXTENDER PLUG FINGERS

TO PIN 36   TO PIN 37

TO PIN 1   TO PIN 72

TEST   CABLE   CABLE   TEST
POINTS   POINTS

                               DO NOT CROSS
                               CABLES

EXTENDER
JACK
                               PLUG FROM
                               PCBA UNDER
                               TEST

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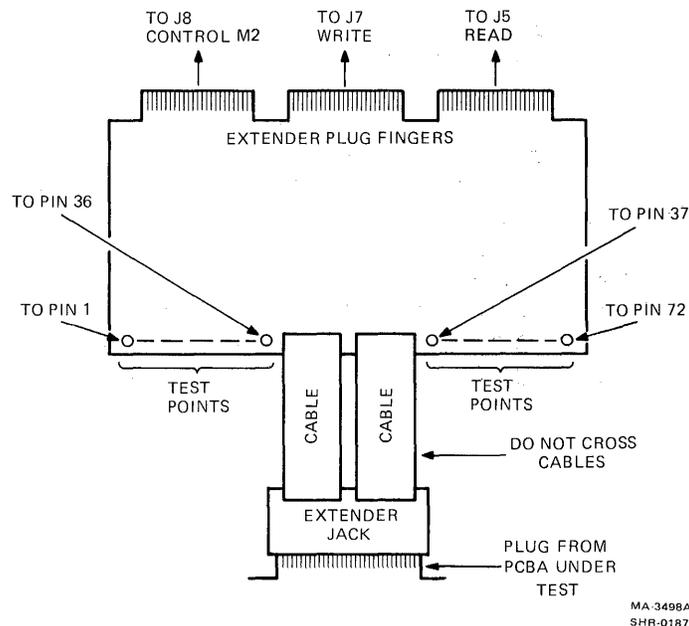
Figure 5-1   PCBA Extender

To extend a PCBA, first remove the PCBA retainer bracket (Figure 2-6), then remove the PCBA to be extended from the card cage. Insert the extender into the slot vacated and push it firmly into the interconnect D1 PCBA. The orientation of the extender must be observed as it can be inserted 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 5-1. 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.

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. Figure 5-2 shows 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 5-1).

UPPER ANGLE BRACKETS

LOWER ANGLE
BRACKETS

PCBA BOARD

LOWER
BRACKET FITS
BETWEEN BOARD
AND SUPPORT BAR

SUPPORT BAR

LOWER ANGLE BRACKET

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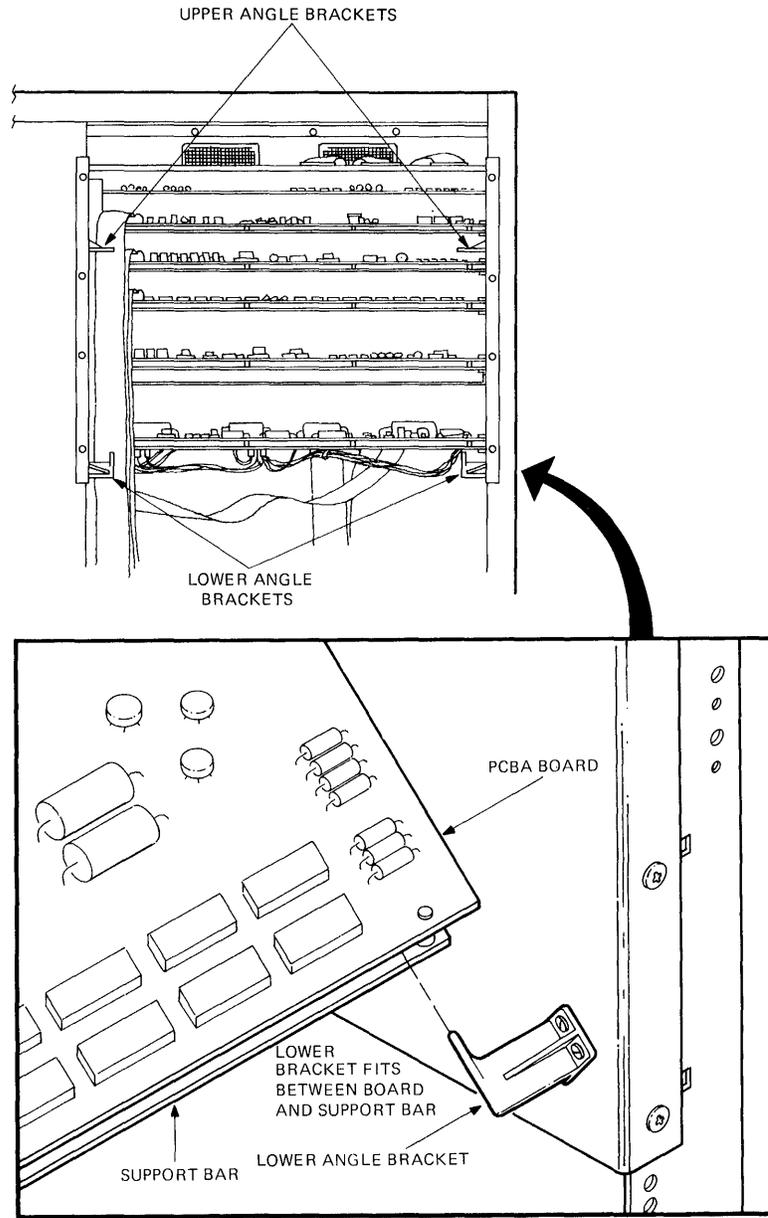
Figure 5-2   PCBA in Extended Position

5.4 POWER SUPPLY TROUBLESHOOTING

This section contains a failure analysis of the power supply and power distribution. For theory, refer to Paragraph 4.5 in the TA78 Magnetic Tape Drive Technical Description. For a large functional block diagram, refer to Figure 2 in Volume 1 of the TU78 Magnetic Tape Transport Technical Manual. 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.

5.4.1 Troubleshooting Rules

When troubleshooting power supply problems, follow these 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.

5.4.2 Troubleshooting Hints

These hints are helpful when troubleshooting.

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.

5.4.3 Troubleshooting Charts

In checking the various areas of the power supply/distribution system, refer to the troubleshooting chart in Table 5-3. Refer to Figure 3-1 for fuse locations.

Table 5-3   Power Supply Troubleshooting Chart

Problem	Check	Result	Cause
No TU78 operator panel lights/no functions	Fans and blower at rear operating	No	Problem is in power controller or line voltage.
		Yes	Breaker CB1 tripped. Check +5 V (TP11 of capstan/reg PCBA). Power jumpers are incorrect at A1-TB1
No +5 V TP11 of capstan (regulator PCBA)	+12 V at A2-TB1-6	No	Troubleshoot +12 V.
		Yes	Capstan/regulator PCBA is bad. Etch on interconnect D1 PCBA is burnt.
+5 V output too low	--	--	Capstan/regulator PCBA is bad or out of adjustment. Bridge rectifier CR2 is partially open.
No +12 V (A2-TB1-6)	8.5 Vac at A2-TB1-10	Yes	Fuse F1 is blown. Bridge rectifier CR2 is open. Capacitor C3 shorted.
		No	Transformer T1 is defective.
No +15 V (TP15 of capstan/ regulator PCBA)	+24 V at A2-TB1-7	No	Troubleshoot +24 V.
		Yes	Capstan/regulator PCBA is bad. Etch on interconnect D1 PCBA is burnt.
No -15 V (TP18 of capstan/ regulator PCBA)	-24 V at A2-TB1-8	No	Troubleshoot -24 V.
		Yes	Capstan/regulator PCBA is bad. Etch on interconnect D1 PCBA is burnt.
No +24 V (A2-TB1-7)	--	--	Fuse F2 is blown. Bridge rectifier CR1 is open. Capacitor C1 is shorted. Transformer T1 is bad.
No -24 V (A2-TB1-8)	--	--	Fuse F3 is blown. Bridge rectifier CR1 is open. Capacitor C2 is shorted. Transformer T1 is bad.
No +36 V (A2-TB1-1)	--	--	Fuse F4 is blown.

Table 5-3   Power Supply Troubleshooting Chart (Cont)

Problem	Check	Result	Cause
No +36 V (Reel servo PCBA TP12)	--	---	Fuse F6 is blown.
No +36 V (Reel servo PCBA TP4)	--	---	Fuse F7 is blown.
No +36 V anywhere	--	---	Bridge rectifier CR3 is open. Capacitor C4 is shorted.
No -36 V (A2-TB1-5)	-36 V at reel servo PCBA TP1Ø and TP18	Yes No	Fuse F5 is blown. Bridge rectifier CR3 is open. Capacitor C5 is shorted.

5.5   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 Ø through 6 to correspond with the loading flowchart in the engineering print set (control M2 logic Schematic Number 1Ø6875, sheets 11 and 12) in Volume 1 of the TU78 Magnetic Tape Transport Technical Manual.

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 in Figures 2-22 and 2-23 should be followed. Also refer to Schematic Number 1Ø6875 (control M2 PCBA), sheets 11 and 12, for a functional loading flowchart and Figure 5-3 for an autoload timing diagram. Figure 4 in Volume 1 of the TU78 Magnetic Tape Transport Technical Manual shows the major signals necessary to accomplish a load cycle.
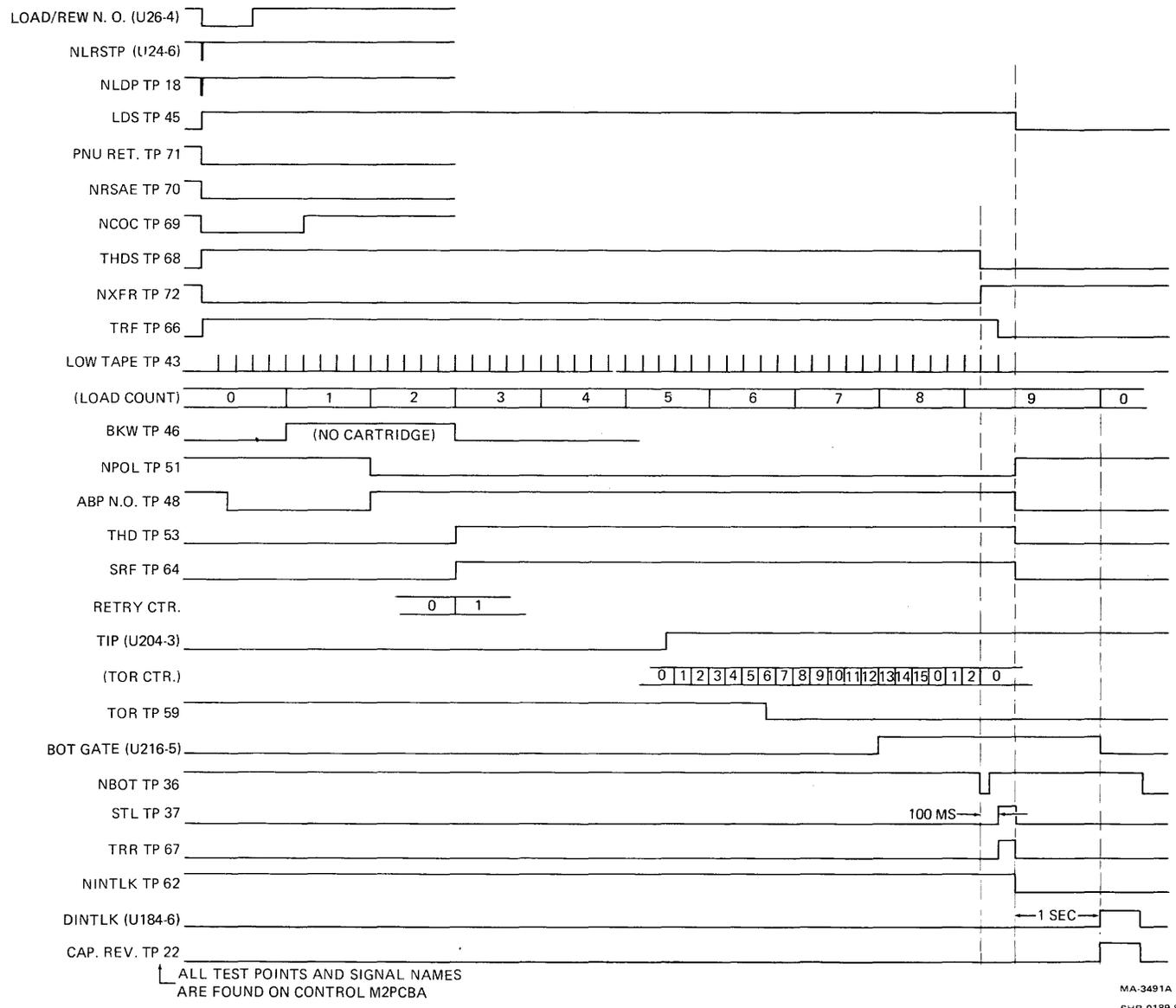
Figure 5-3   Autoload Timing Diagram

5.5.1   Load Faults

When a load fault occurs (flashing load fault LED on the TU78 control panel) it can be categorized into one of seven possible load fault areas. 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 5-4 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 5-4 through 5-10 are the load fault flow diagrams.

Table 5-4   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
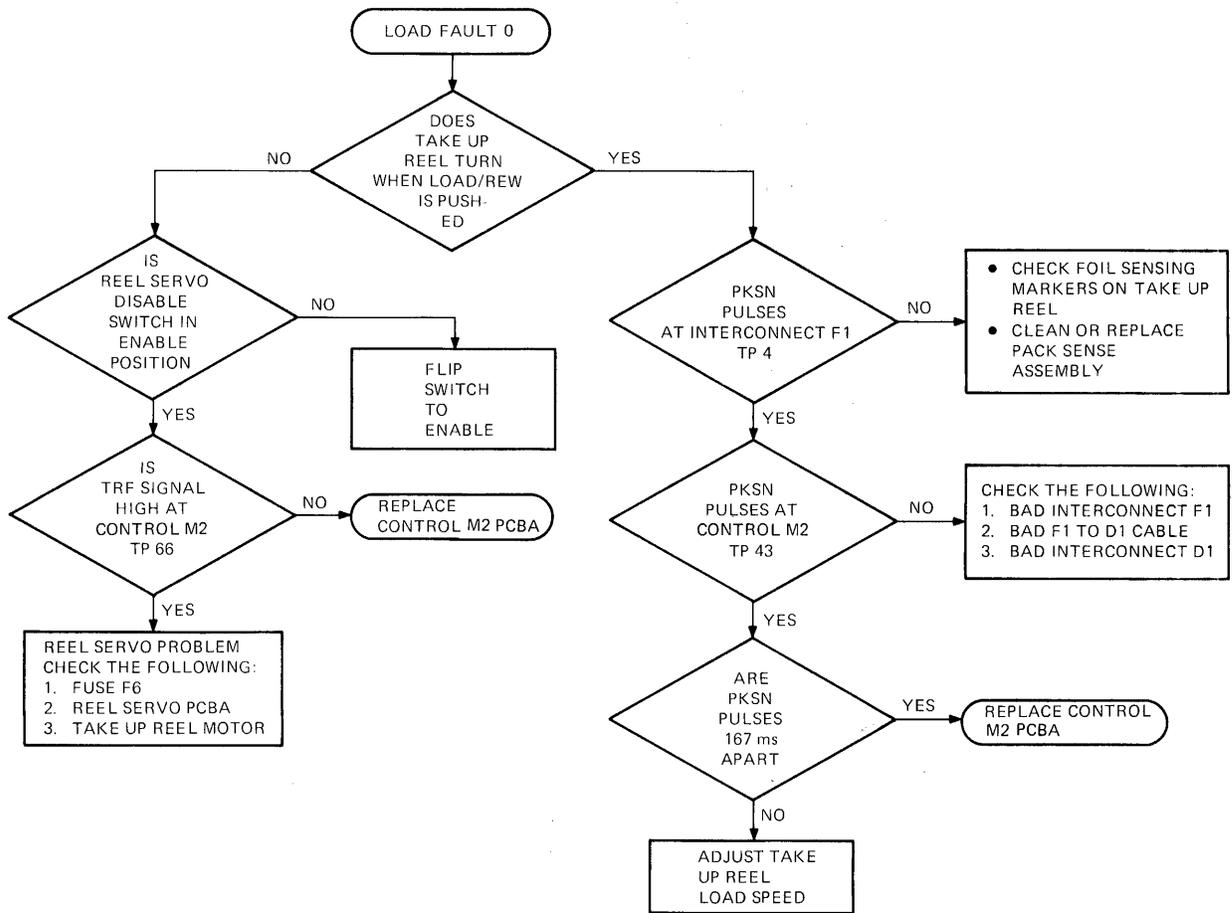
Figure 5-4   Load Fault 0 Flow Diagram

Figure 5-5 Load Fault 1 Flow Diagram

```
                    ( LOAD FAULT 2 )
                           │
                           ▼
                          DOES
          YES           CARTRIDGE
    ┌───────────────────  OPEN
    │                    VISIBLY
    │                       │ NO
    ▼                       ▼
┌───────────────┐   ┌──────────────────┐
│ FAULTY OR     │   │ PUT SCOPE ON     │
│ MISALIGNED    │   │ CONTROL M2 TP 69 │
│ CARTRIDGE     │   │ (NCOC)           │
│ MOTOR SENSING │   └──────────────────┘
│ SWITCHES      │            │
└───────────────┘            ▼
                    ┌──────────────────┐
                    │ PRESS LOAD/REW   │
                    │ AND ALLOW FAULT  │
                    │ TO OCCUR. DO NOT │
                    │ PRESS RESET      │
                    └──────────────────┘
                             │
                             ▼
                           NCOC          NO    ┌──────────────────┐
                           GOES  ──────────────│ REPLACE          │
                           LOW                 │ CONTROL M2 PCBA  │
                             │ YES             └──────────────────┘
                             ▼
                    ┌──────────────────────┐
                    │ PUT SCOPE ON         │
                    │ CAPSTAN/REGULATOR    │
                    │ TP 71 (CART. MTR.+)  │
                    └──────────────────────┘
                             │
                             ▼
                        CART. MTR.+       NO    ┌──────────────────────┐
                           AT     ──────────────│ REPLACE              │
                          −24 V                 │ CAPSTAN/REGULATOR    │
                             │ YES              │ PCBA                 │
                             ▼                  └──────────────────────┘
                    ┌──────────────────────┐
                    │ ● FAULTY CARTRIDGE   │
                    │   MOTOR              │
                    │ ● FAULTY OR          │
                    │   MISALIGNED         │
                    │   CARTRIDGE MOTOR    │
                    │   SENSING SWITCHES   │
                    └──────────────────────┘
```

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Figure 5-6   Load Fault 2 Flow Diagram

5-13

```
            ╭──────────────────╮
            │   LOAD FAULT 3   │
            ╰──────────────────╯
                     │
            ┌──────────────────┐
            │ PUT SCOPE ON     │
            │ CONTROL M2 TP 60 │
            │ (VAC N.O.)       │
            └──────────────────┘
                     │
            ┌──────────────────┐
            │ MOUNT TAPE.      │
            │ PRESS RESET.     │
            │ PRESS LOAD/REW.  │
            └──────────────────┘
                     │
                   ◇ DID          NO    ┌──────────────────────────┐
                    VAC. N.O. ─────────▶ │ PNEUMATIC FAULT; CHECK:  │
                    GO LOW            │ • BLOWER MOTOR           │
                   ◇                 │ • BLOWER BELT            │
                     │               │ • BLOWER                 │
                    YES              │ • VACUUM SENSING SWITCH  │
                     │               └──────────────────────────┘
            ┌──────────────────┐
            │ PUT SCOPE ON     │
            │ CONTROL M2 TP 48 │
            │ (ABP N.O.)       │
            └──────────────────┘
                     │
            ┌──────────────────┐
            │ PRESS RESET.     │
            │ PRESS LOAD/REW.  │
            └──────────────────┘
                     │
                   ◇ DID          YES   ┌──────────────┐
                    ABP N.O.  ─────────▶ │ REPLACE      │
                    GO LOW            │ CONTROL M2   │
                   ◇                 │ PCBA         │
                     │               └──────────────┘
                    NO
                     │
    ┌──────────────────────────┐
    │ PNEUMATIC PROBLEM        │
    │ CHECK:                   │
    │ • COMPRESSOR BELT        │
    │ • COMPRESSOR             │
    │ • AIR BEARING PRESSURE   │
    │   SENSING SWITCH         │
    └──────────────────────────┘
```

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Figure 5-7   Load Fault 3 Flow Diagram

LOAD FAULT 4

IS TAPE VISIBLY SNAKING THROUGH TAPE PATH AND ENTERING TAKE UP REEL AREA — NO

YES

IS TAPE ADHERING TO TAPE UP REEL — YES

NO

IS CONTROL M2 TP72 (NXFR) GOING LOW — NO → YES

YES

CHECK:
- SYSTEM VACUUM
- VACUUM TRANSFER VALVE
- CAPSTAN/REGULATOR PCBA

IS CONTROL M2 TP59 (TOR N.O.) GOING LOW — NO

YES

DEFECTIVE CONTROL M2 PCBA

DEFECTIVE TAPE ON REEL SENSING SWITCH

IS SUPPLY REEL TURNING C.W. TO SPILL OUT TAPE — NO

YES

IS PRESSURE VALVE VISIBLY CHANGING STATE — NO

YES

IS CONTROL M2 TP51 (NPOL) GOING LOW — NO

YES

CHECK:
- PRESSURE VALVE/SOLENOID
- CAPSTAN/ REGULATOR PCBA

REPLACE CONTROL M2 PCBA

IS TAPE SPILLING OUT OF SUPPLY REEL INTO FIRST THREAD BLOCK — NO

YES

CHECK THREADING PRESSURE ADJUSTMENT

CHECK LOWER RESTRAINT PRESSURE ADJUSTMENT

IS CONTROL M2 TP64 (SRF) HIGH — NO

YES

SUPPLY REEL SERVO PROBLEM

CHECK:
- FUSE F7
- REEL SERVO PCBA
- SUPPLY REEL MOTOR

REPLACE CONTROL M2 PCBA

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Figure 5-8   Load Fault 4 Flow Diagram

```
          ┌─────────────────┐
          │  LOAD FAULT 5   │
          └────────┬────────┘
                   ┆         ┌──────────────────┐
                   ┆ ─ ─ ─ ─ │ BOT NOT SENSED   │
                   │         │ IN TIME          │
                   │         └──────────────────┘
                 ╱   ╲
                ╱ DOES ╲
               ╱TAPE HAVE╲
              ╱BOT POSITION╲        ┌──────────┐
             ╱ED 15± 1FT *  ╲  NO   │   FIX    │
             ╲FROM END      ╱───────│   TAPE   │
              ╲OF TAPE     ╱        └──────────┘
               ╲         ╱
                ╲       ╱
                 ╲  ┆  ╱
                  YES
                   │
                 ╱   ╲
                ╱  IS ╲
               ╱ BOT MARKER╲        ┌────────────────────┐
              ╱SEEN GOING   ╲  YES  │ CHECK:             │
              ╲ONTO TAKE-UP ╱───────│  • BOT SENSOR      │
               ╲REEL       ╱        │  • CONTROL M2 PCBA │
                ╲        ╱           └────────────────────┘
                 ╲  ┆  ╱
                  NO
                   │
          ┌─────────────────┐
          │ TAKE UP REEL    │
          │ TIMING TOO      │
          │ FAST. ADJUST    │
          │ TAKE UP REEL    │
          │ LOAD SPEED      │
          └─────────────────┘
```
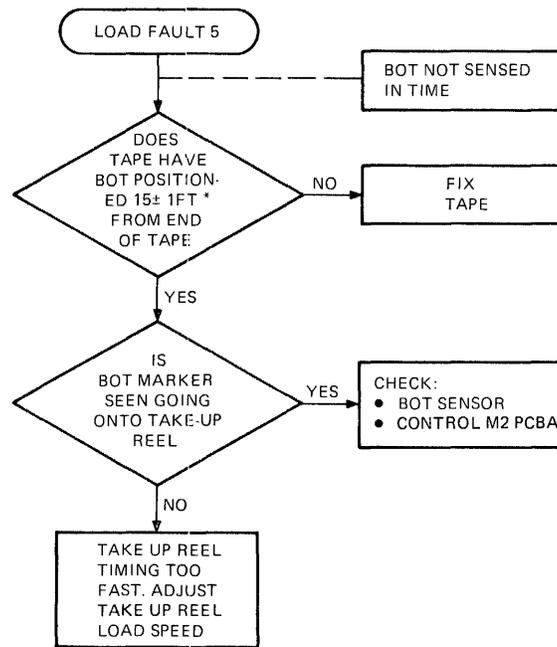
*15 FT. IS OPTIMUM. TRANSPORT WILL LOAD AT UP TO 30 FT.
IF PROBLEMS ARE EXPERIENCED DUE TO LEADER BEING TOO LONG, CUT IT
DOWN TO 15 FT.

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Figure 5-9   Load Fault 5 Flow Diagram

5-16

LOAD FAULT 6

LOOPS FAIL TO FORM IN BUFFER COLUMNS WITHIN ≈ 1.5 SECONDS AFTER "SET LOOPS" COMMAND

ARE LOOPS FORMING IN BUFFER COLUMNS

- NO → IS CONTROL M2 TP3 (STL) GOING LOW
  - NO → REPLACE CONTROL M2 PCBA
  - YES → IS VACUUM TRANSFER VALVE VISIBLY MOVING BACK TO REST POSITION
    - NO → CHECK:
      - VACUUM TRANSFER VALVE
      - CAPSTAN/REGULATOR PCBA
      - CONTROL M2 PCBA
    - YES → CHECK SYSTEM VACUUM ADJUSTMENT. CHECK FOR:
      - HOSE LEAKS
      - CLEAN CAPSTAN
      - BUFFER BOX DOOR CLOSED PROPERLY

- YES → ARE LOOPS FORMING BUT THEN MOVING UP OR DOWN RAPIDLY
  - NO → IS CONTROL M2 TP62 (NINTLK) GOING LOW
    - YES → (to REPLACE CONTROL M2 PCBA)
    - NO → CHECK:
      - BOTH LIMIT SENSING SWITCHES
      - CONTROL M2 PCBA
  - YES → REEL SERVO FEEDBACK LOOP NOT FUNCTIONING PROPERLY FOR ONE OR BOTH REELS. CHECK:
    - REEL SERVO PCBA
    - POSITION TRANSDUCER ASSEMBLY
    - CAPSTAN SERVO LOOP

MA-3497A
SHR-0196-84

Figure 5-10   Load Fault 6 Flow Diagram

5.6   PNEUMATIC SYSTEM TROUBLESHOOTING

WARNING
If the ac motor in the power supply/pneumatic assembly has stopped because of overheating it will restart when the temperature is normal. Always turn off or disconnect ac power before working near motor pulleys and belts.

The pneumatic system, located in the power supply/pneumatic assembly and distributed on the base assembly, provides positive (pressure) and negative (vacuum) air to accomplish loading and running operations.

The accompanying flowchart (Figure 5-11) is used to troubleshoot a major pneumatic system failure. 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
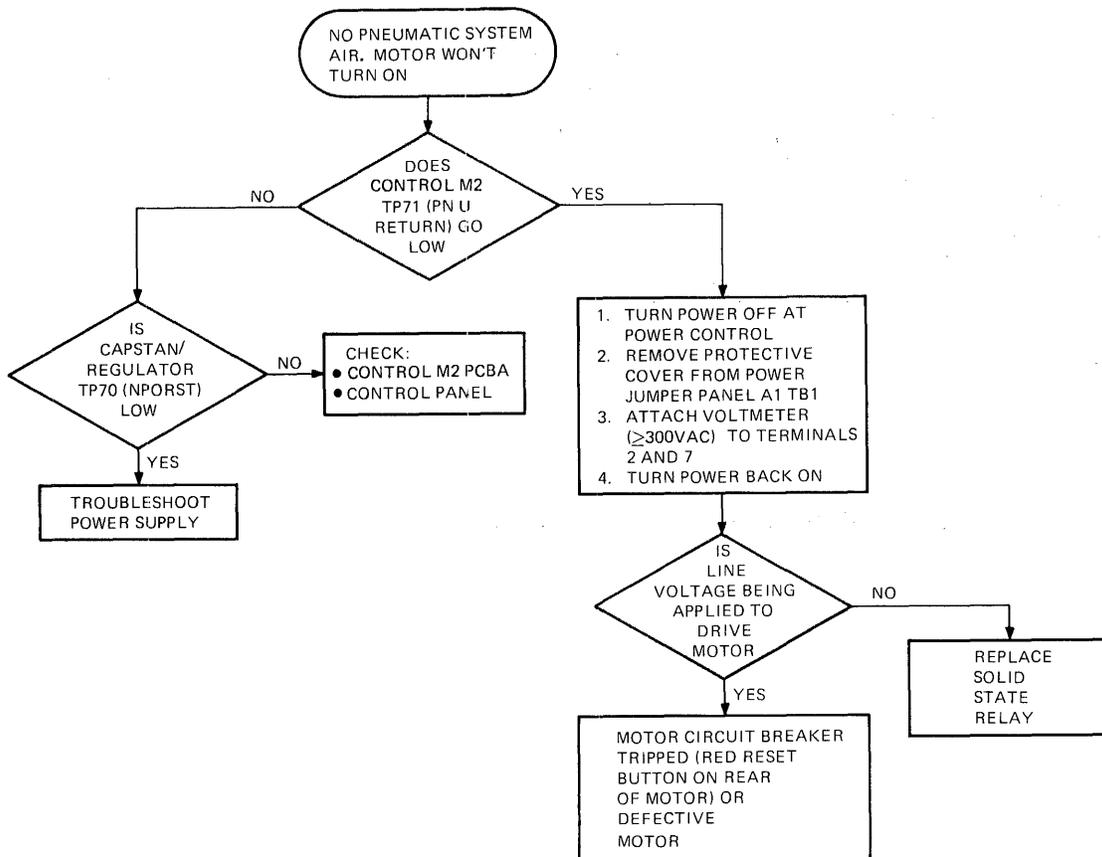
MA-3501A
SHR-0197-84

Figure 5-11   Pneumatic Troubleshooting Flow Diagram

tension of both drive belts. Check all positive and negative air
values as outlined in Paragraph 3.6. Both the muffler filter and
air filter at the input of the positive air system are changed
during semiannual PM. However, a particularly dirty environment
could cause these filters to clog prematurely and should be
suspected. For a schematic of the air system, refer to the
air/load control functional block diagram (Figure 4 in Volume 1 of
the TU78 Magnetic Tape Transport Technical Manual).

5.7   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) in the card cage
assembly. Inputs to the reel servo PCBA consist of power, control
signals, and feedback signals, and are summarized in Tables 4-6
and 4-7 of the TA78 Magnetic Tape Drive Technical Description. If
the reel servo PCBA is suspected, it must be replaced since it may
not be extended for troubleshooting due to heat sinking
requirements. (For a reel servo functional block diagram, refer to
Figure 5 in Volume 1 of the TU78 Magnetic Tape Transport Technical
Manual. Also refer to Figure 5-12 in this manual for a simplified
schematic diagram of the supply reel servo.)

Check all input power sources and voltages developed on the reel
servo PCBA. Table 5-5 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.
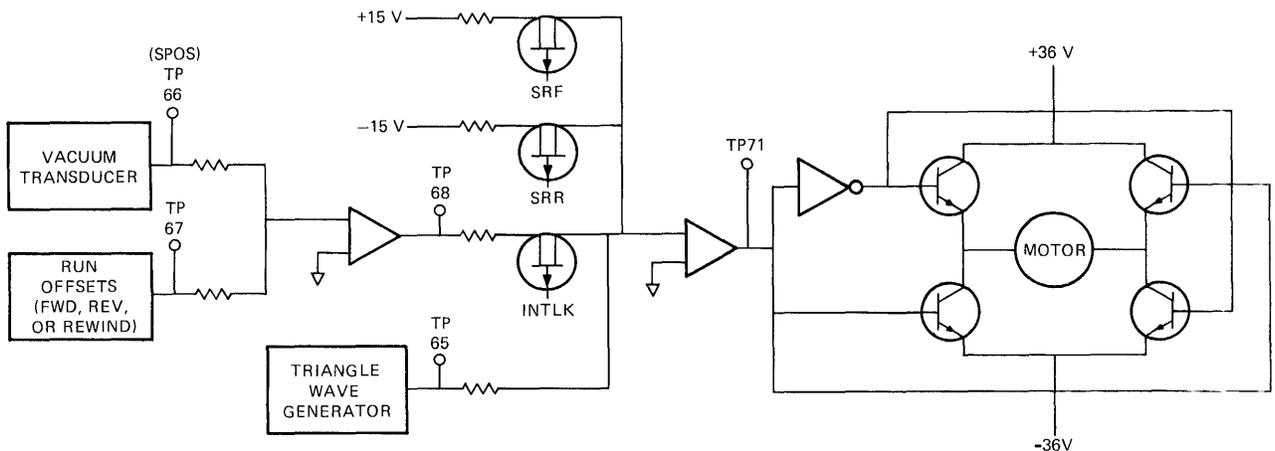
Figure 5-12 Supply Reel Simplified Schematic Diagram

Table 5-5   Reel Servo PCBA Operating Voltages

Test Point	Voltage Name	Voltage Reading	Voltage Source
TP62	+15 V	+15 $\pm$1	Capstan/regulator PCBA
TP64	-15 V	-15 $\pm$1	
TP12	+36 V(s)	+40 $\pm$2	Power supply/pneumatic
TP18	-36 V(s)	-40 $\pm$2	assembly
TP4	+36 V(t)	+40 $\pm$2	
TP10	-36 V(t)	-40 $\pm$2	
TP53	+5 V(s)	5.3 $\pm$.3	Reel servo PCBA

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 4-27 in the TA78 Magnetic Tape Drive Technical Description.) 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. Figure 3-12 shows 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 3.6).

2.   Turn transport power off.

3.   Set reel servo disable switch S1, 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 about 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 3-4) 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 TU78 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.)

5.7.1   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 forward.

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.

5.8 DATA PATHS TROUBLESHOOTING

5.8.1 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 on the TS78 control panel and the basic integrity of the HSC and formatter has been established by running the in-line tape diagnostic (ILTAPE).

If the in-line exerciser (ILEXER) 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 ILEXER 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 3.9).

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 3.3).

4. Check all vacuums and pressures (Paragraph 3.6).

5. Check all capstan servo adjustments (Paragraph 3.7).

6. Check head wrap angle (forward/reverse differential) adjustment (Paragraph 6.2.1, steps 6 through 14).

7. Check tape tracking (Paragraph 6.2.5, steps 8 through 31).

8. Check that air bearings are not installed wrong (Paragraph 6.2.4).

9. Check read/write adjustments (Paragraph 3.10).

5.8.2 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 5-13) 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 5-13 provides pin charts so you may scope other channels as well.

1. Mount and load a write-enabled scratch tape to BOT. Flip the MODE SELECT switch to position 1, 2, or 3 (maintenance mode), 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 3-15) 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 the MIA PCBA, and the 1600 density indicator on the TU78 control panel are both lit. The transport is not moving tape.

4. Place MIA switch S3 to the right (6250). The 1600 density indicator goes out and the 6250 density indicator comes 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 preampliers. Set the scope as follows.

Vertical	= CH1, 0.5 V/div, ac (using 10X probe)
Horizontal	= 2 us/div
Sync	= Norm, ac, Ch 1

Figure 5-13   Write Path One Function Block Diagram

MA-7319
SHR-0086-84

7. Place the channel 1 probe on the upper lead of preamp output resistor R1. This resistor is one of a pair for track 1 (channel 5). Refer to Figure 3-9 for location.

8. Place MIA switch S4 to manual (right). The transport moves tape and tries to write an all ones continuous record down tape. The tape can be started and stopped with the TU78 control panel ONLINE switch, and rewound with the LOAD/REW switch when desired.

9. Look at the waveform on the scope. It should look exactly like the waveform in Figure 5-14. The sinusoidal waveshape should have a 5.4 us period and have an amplitude of about 1.2 volts peak-to-peak.

    Amplitude varies according to the PE gain setting for each track and the type of tape used.
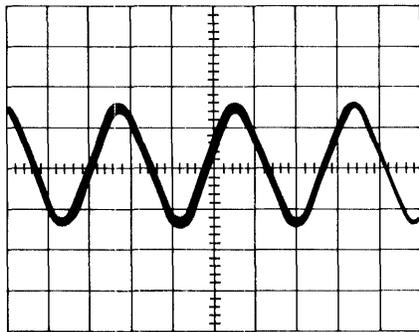
MA-7310
SHR0200-84

Figure 5-14   Read Preamplifier
Output Waveform

10. Monitor each output resistor pair of each channel for a similar signal. Refer to Figure 3-9 to locate the resistors. If all signals from all channels are acceptable, assume the following and go on to read path troubleshooting (Paragraph 5.8.3).

    ● 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 5-14), or are missing, the problem could be one of the following things.

- Write PCBA
- Preamplifier PCBA
- MIA PCBA
- Head
- Cables to MIA

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, $\pm$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 us/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. For capacitor locations, refer to Figure 3-9 in this manual or Figure 23 in Volume 1 of the TU78 Magnetic Tape Transport Technical Manual.

e. Place MIA switch S1 to the forward (right) position.
    The waveform on the scope should be sinusoidal,
    similar to that shown in Figure 5-15.

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SHR0201-84
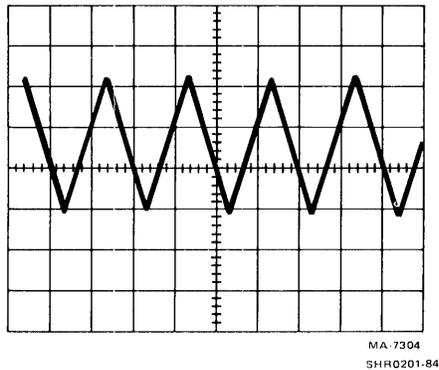
Figure 5-15   Normal Read Head Output
              While Reading

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 about 8.2 ohms, while an
    open winding shows about 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 5-16.
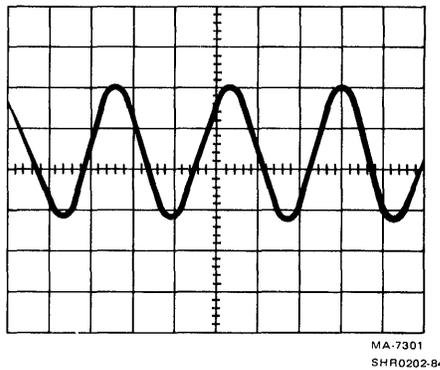
Figure 5-16   Normal Read Head Output
While Writing

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.

    • 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 5.8.3).

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 5.3 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 Chl   = 0.2 V/div, ac (X10 probe)
    Horizontal   = 0.5 us/div
    Sync   = Norm, HF rej, Chl

16. Flip MIA switch S1 to the right (FWD) and scope each of
    the write PCBA outputs at J6. Refer to Figure 5-13 for a
    pin diagram and signal table for J6. Figure 5-17 shows a
    write amplifier output waveshape with no load (P6
    unplugged).
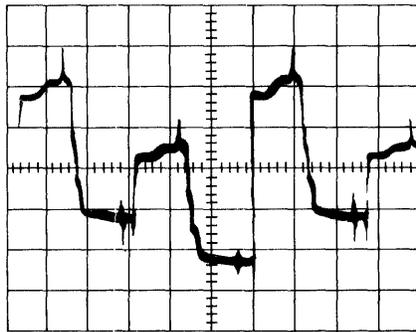
MA-7311
SHR0203-84

Figure 5-17   Write Amplifier Output
              With No Load

17. If any of the nine channels look significantly different,
    trace the signal back to the MIA PCBA using Figure 5-13
    as a guide. Figure 5-18 shows the waveshape for write
    data and a write data strobe entering the write PCBA.

WDS

WD (N)
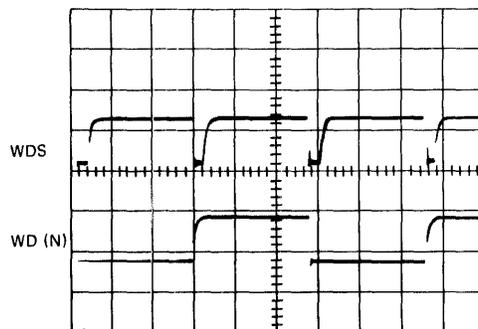
MA-7313
SHR0204-84

Figure 5-18   Write Data At Input
              To Write PCBA

5-30

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 5-19 as a guide. Keep in mind that each write head winding is center tapped. Each half of the winding should measure about 3 ohms. If any winding shows open or shorted, replace the head assembly following the procedure in Paragraph 6.2.1.

19. If the write head continuity checks okay, and the head poles are not worn excessively (Paragraph 6.2.1), check the erase head continuity. The resistance between P6 pins 11 and 24 should be about 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.
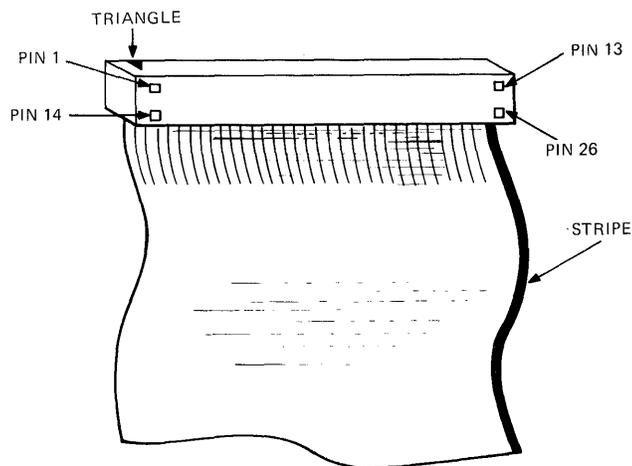
WRITE HEAD CONTINUITY CHECK
PIN 1 (CENTER TAP) TO PINS 2,3,4,5,14,15,16,17 = 3Ω
PIN 23 (CENTER TAP) TO PINS 6,7,8,9,10,18,19,20,21,22 = 3Ω

MA-7303
SHR0205-84

Figure 5-19   Write/Erase Head Plug (P6)
Test Points

5.8.3   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 5-20) is provided so you may trace the data flow completely through the transport, from the head to the TU bus, using channel 5. Figure 5-20 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 5.8.2). If the write path checks did not localize a problem, proceed as follows to continue troubleshooting the read path.

5.8.3.1 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. For an explanation of the AGC circuits, refer to Paragraph 4.12.5.3 in the <u>TA78 Magnetic Tape Drive</u> <u>Technical Description.</u> 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).
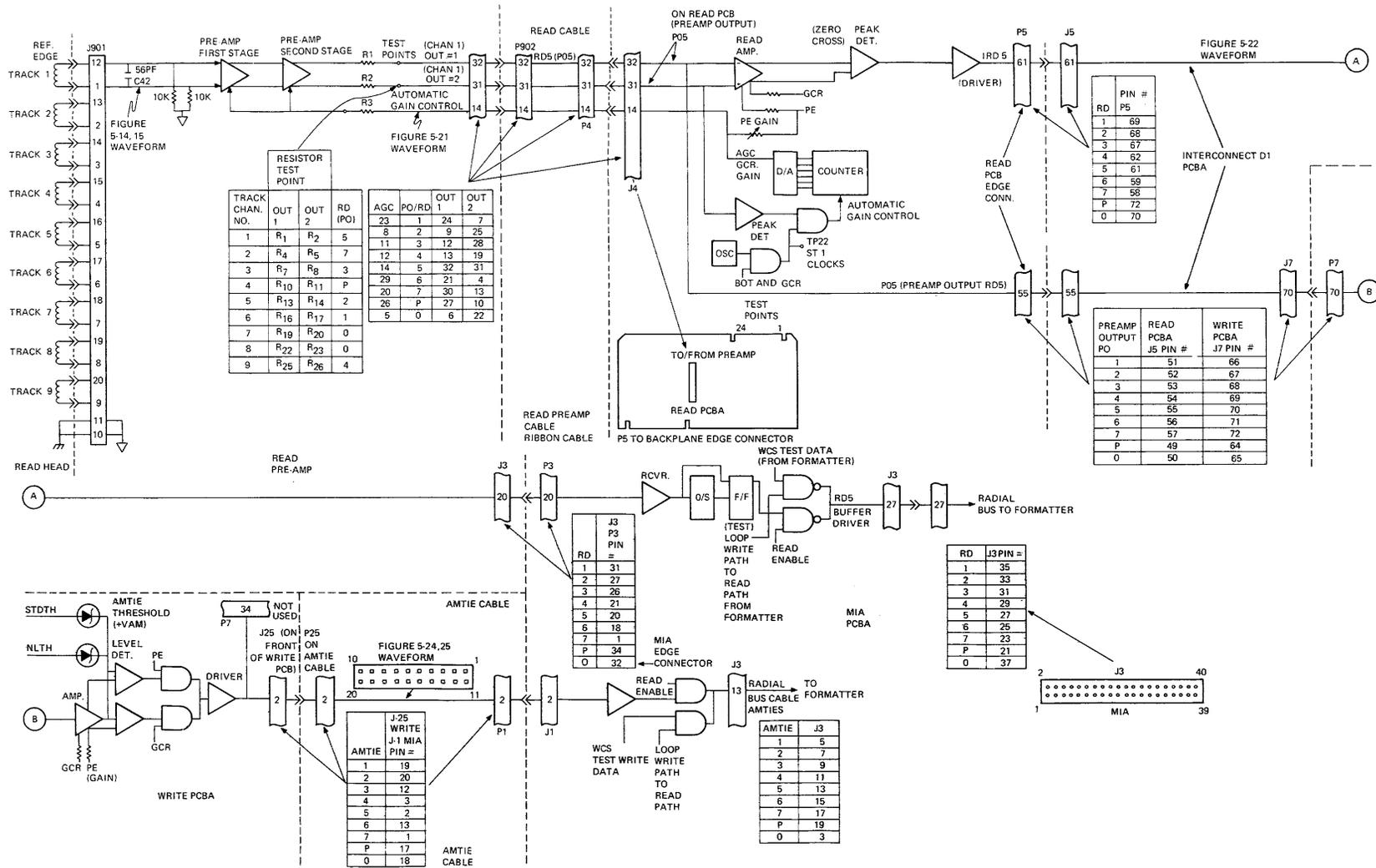
Figure 5-20   Read Path One Functional Block Diagram

5-33

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 us +85 us. Refer to Figure 5-21. Position the
    Ch2 trace (straight line) on the bottom graticule of
    the screen.

ST1 CLOCK

AGC (N)

MA-7300
SHR0207-84
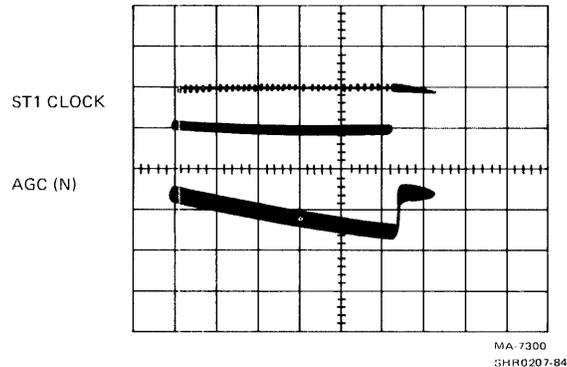
Figure 5-21   Automatic Gain Control
               (AGC) Waveform - GCR Mode

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

    Make sure the scope probe is grounded to the preamp
    to eliminate unwanted noise. Refer to the lower trace
    shown on Figure 5-21. The waveform dc level should
    start at about +1.7 V (PE gain level) and ramp down,
    in a staircase pattern, to about +1.2 V.

i. If any of the AGC waveforms are incorrect, the likely
    cause is the read PCBA (AGC source). Replace it.

5-34

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 descending 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.

        ●   The trace on Ch1 (ST1 CLOCK) shortens to about 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 track's
        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 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 stays at the
        lower voltage (about 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.

    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 5-20 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 5-22 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.
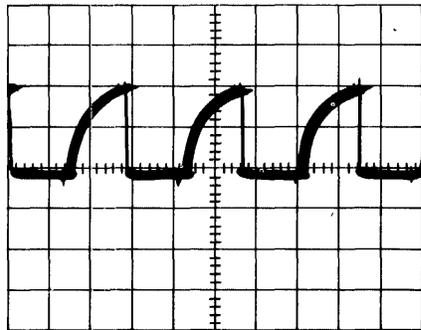
MA-7312
SH R0208-84

Figure 5-22   Read Data Output

5.8.3.2 AMTIE Paths Troubleshooting -- The TS78 uses AMTIEs to
detect active/inactive tracks. They determine the following.

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 5-23 shows a block diagram of the AMTIE generation
circuitry.
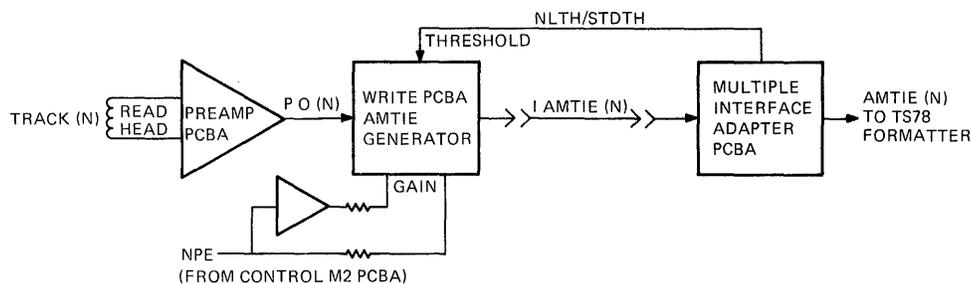
Figure 5-23   AMTIE Generation Circuitry

1.   Troubleshooting +VAM AMTIE threshold voltage without TS78
     formatter

     a.   Set the scope controls as follows

          Vertical Chl   = 1.0 V/div, dc (10X probe)
          Horizontal   = 0.1 ms/div
          Sync   = Auto, dc, Chl

     b.   Remove power from the tape transport. Place Chl probe
          on the front lead of write PCBA R324 (signal +VAM).
          Refer to Figure 5-24 for locations.
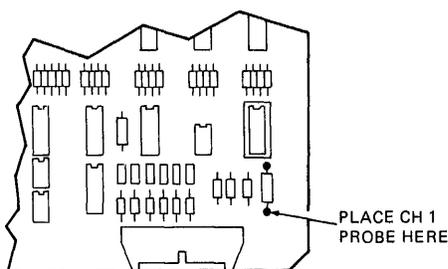
Figure 5-24   +VAM Test Point
              on Write PCBA

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 TS78 formatter.

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. Set the MODE SELECT switch to position 1, 2 or 3 (maintenance mode), and place the transport on-line. Then plug an RS232-compatible terminal into the EIA connector on the TS78 control panel (Figure 2-25).

e. Press and release CTRL C on the terminal keyboard. Repeat the entry until TA78> appears.

f. Type the eight commands, shown in the printout below, on the terminal keyboard. Each command is shown here in boldface type and should be followed by a carriage return. The remaining printout shows the tape drive's responses, and a comment has been added in parentheses for clarity only.

```
TA78>RUN KEYPAD
KEYPAD>INIT
KEYPAD>UNIT X   (X is transport cable number; e.g., 0)
KEYPAD>ENTER
PC 00   ? WRITE
PC 01   ? BR 0
PC 02   ? END
KEYPAD>START
```

The tape drive repeatedly executes a write GCR command on transport X.

g. The +VAM AMTIE threshold signal shown on the scope should be similar to Figure 5-25. The voltage goes from +4.5 Vdc, +0.5 Vdc to +10 Vdc, +0.5 Vdc.
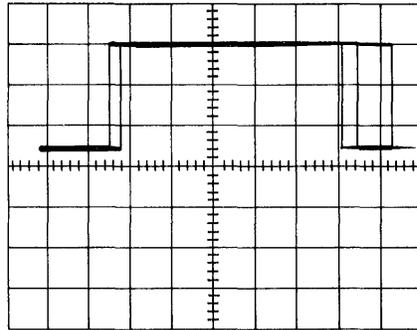
MA-7309
SHR0211-84

Figure 5-25   +VAM AMTIE Threshold Voltage

h. Press and release **CTRL G** to exit from the tape motion routine. The tape drive displays **HALT AT PC=XX** where XX is a program location. The drive then displays **KEYPAD>**.

i. Type **REWIND** and a carriage return. The tape drive rewinds the tape and displays **2Ø** on the external terminal.

j. If test 1 (without TS78 formatter) works properly, but test 2 (with TS78 formatter) does not, the likely cause is the MIA PCBA. If neither test works, the likely cause is the write PCBA.

k. Press and release **CTRL Z** to exit from the keypad mode. The tape drive echoes ^Z and displays **TA78>**.

l. Press and release **CTRL Z** to exit from the terminal mode. The drive echoes ^Z.

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 c, but change the horizontal setting to 1.Ø us/div.

c. Set the MIA switches as follows.

    Pattern select =   SW1 forward, all others rear
                       (1ØØØØØØØ).
    S1   = FWD (right)
    S2   = WRT (right)
    S3   = 16ØØ (left)
    S4   = MAN (right)

d. Look at each AMTIE output at the cable connector with the scope. Refer to Figure 5-2Ø for pin numbers. Each output should be about 5.Ø Vdc.

e. Place the transport on-line. The transport drives the tape forward and writes the 1ØØØØØØØ 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 5-26.
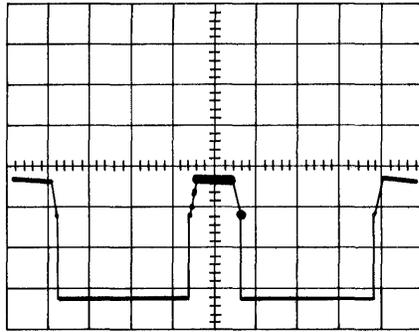
MA-7308
SHR0212-84

Figure 5-26   AMTIE Signal Switching

f.   All AMTIE channels should look similar to Figure
     5-26. If one or more do not, trace the signal back
     using Figure 5-20.

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 TS78 or
     diagnostics indicate an AMTIE problem, replace the
     MIA PCBA.

6.1   TS78 REMOVAL/REPLACEMENT PROCEDURES

Table 6-1 lists all major FRUs and the associated removal/replacement paragraph (if any).

Table 6-1   TS78 Field Replaceable Units

Part Number	Description	Removal/Replacement Paragraph
70-20415-01	Wire and harness assembly (backplane assembly)	6.1.1
M8950-M8953 M8958,M8959 M8970-M8973 M8955	Logic modules	None
54-15170-00	TS78 control panel board	6.1.2
12-10930-01	Fan (230 Vac)	6.1.3
BC26V-25	25 ft STI cable	None
70-17381-08	Flat cable (TS78 control panel board to backplane assembly)	None
H7422-AB	TS78 power supply chassis	6.1.4
H7441	+5 V regulator	6.1.5
H7490	-5 V regulator	6.1.5
H7476	$\pm$15 V regulator	6.1.5
54-14192	AC/DC LO board	6.1.6

6.1.1   TS78 Backplane Assembly (70-20415-01)

Use this procedure to remove the TS78 backplane assembly. See step 15 to replace the backplane assembly.

1. Remove power from the TA78 and all slave TU78s connected to it, by switching the power controllers (872 or 874) off.

2. Swing open the TS78 logic gate.

3. Disconnect the TS78 control panel cable (PN 70-17381-08), noting the position of the red stripe.

4. Disconnect all TU bus cables, noting their position.

5. Remove the back cover of the TS78 logic gate.

6. Loosen the two screws that hold the STI cable clamp to the side of the logic gate. Then pull the clamp straight out disconnecting the STI cables from the M8971.

7. Remove all modules from the backplane.

8. Swing open the TU78 base assembly and unplug the five dc power connectors from the rear of the TS78 power supply. Cut tie-wraps to free the wire harness.

9. Unplug the TS78 cooling fan from the power controller.

10. Remove the two screws holding the dc power wiring harness to the top of the card nest.

11. Remove the backplane assembly from the cabinet by removing the five screws at the hinge. The lower two screws also retain the limit bracket. Support the backplane assembly from underneath while removing the screws.

12. Lay the assembly flat on a work surface with the pin side of the backplane facing up.

13. Remove the eight screws that retain the card nest enclosure to the backplane assembly and lift the backplane off the enclosure. Notice a plastic spacer with two holes in it. This belongs on the card side of the backplane assembly and insulates the backplane from the card nest enclosure.

14. Remove the hinge assembly from the old backplane and attach it to the new one.

15. Install the new backplane assembly in reverse order. Be sure to plug the fan power cord into a switched outlet of the power controller.

NOTE
Where metal flat washers are used, they must not contact any etches.

6.1.2   TS78 Control Panel Board (54-15170-00)
Use this procedure to remove the control panel board. See step 6 to replace the board.

1. Remove power from the TS78 by switching the power controller off.

2. Open the door on the TS78 control panel. Disconnect the flat cable from the TS78 control panel board (behind the door), noting the position of the red stripe.

3. Remove the left side panel from the TA78 cabinet. Grasp the panel on both sides and lift it off the four mounting bolts. Disconnect the side panel ground strap from the cabinet frame and set the panel aside. (You may have to open the rear door to grasp the panel.)

4. Remove the four screws that hold the control panel board and bracket to standoffs. Then remove the board and bracket as a unit.

5. Remove the two screws holding the board to the bracket. Then remove the board.

6. Reinstall the new control panel board by reversing the above procedure.

7. Check the new control panel board by performing the following steps.

   a. Make sure PORT SELECT A and B switches are in the disable (out) position.

   b. Reapply power. All three TS78 control panel indicators should turn on for about 4 seconds.

   c. Press the FAULT switch for at least 1 second and then release it. All three TS78 control panel indicators light in a lamp test for as long as you press the switch.

d.   Plug an RS232-compatible, external terminal into the EIA connector on the TS78 control panel board (Figure 2-25).

e.   Press and release **CTRL C** on the terminal keyboard. Repeat the entry until TA78> appears.

f.   Test the three TS78 control panel switches using the buttons and lights test (Paragraph 4.7.1).

g.   Press and release **CTRL Z** to exit from the terminal mode. The drive echoes ^Z.

8.   Depending on the STI port being driven, set the PORT SELECT A or B switch to the enable (in) position.

6.1.3   Fan (12-10930-01)

Use this procedure to remove the fan. See step 7 to replace the fan.

1.   Remove power from the TS78 by switching the power controller off.

2.   Swing open the logic gate.

3.   Unplug the fan power cord from the power controller.

4.   Remove the six screws holding the bottom of the enclosure to the card nest assembly.

5.   Unplug the power cord from the fan.

6.   Remove the fan by removing the four screws and nuts holding it to the enclosure bottom.

7.   Install the new fan by reversing the above procedure. Fan air flow should be into the card nest.

8.   Plug the fan power cord into a switched outlet on the power controller.

6.1.4   TS78 Power Supply Chassis (H7422-AB)

Use this procedure to remove and replace the power supply chassis.

1.   Remove power from the TS78 by switching the power controller off.

2.   Swing open the TU78 base assembly and unplug the five dc power connectors and the ac power cord from the rear of the power supply.

3.   Remove the four dc power regulators from the chassis (Paragraph 6.1.5).

4.   Remove the ac/dc lo board from the chassis (Paragraph 6.1.6).

5.   Support the power supply chassis from underneath and remove the six screws holding it to the frame.

6.   Install the new power supply chassis in reverse order.

6.1.5   Power Supply Regulators (H7441, H7476, H7490)
Use this procedure to remove the power supply regulators. See step 9 to replace the regulators.

1.   Remove power from the TS78 by switching the power controller off. Turn off the power supply circuit breaker.

2.   Swing open the TU78 base assembly to gain access to the rear of the power supply.

3.   Loosen but do not remove the two screws holding the top cover to the rear of the power supply. Remove the top cover.

4.   Remove the five screws holding the front cover to the front of the power supply (rear of the transport). Remove the front cover to expose the regulators.

5.   Two regulator enclosures are visible now. Each enclosure contains two regulators. Select the enclosure that contains the regulator you wish to replace, and slide it toward you until the two connectors are free of any interference.

6.   Unplug both connectors by pulling on the plastic connector housing, not the wires. If the enclosure you are removing is the one with a cooling fan attached to it, unplug the two power leads from the fan.

7.   Slide the regulator enclosure the rest of the way out of the power supply chassis.

8.   To remove an individual regulator, stand the enclosure on end, remove the two screws holding the regulator in the enclosure, and slide it out.

9.   Install the new regulator by reversing the above procedures. When sliding the enclosure back into the chassis, note how the enclosure hooks onto a tab protruding from the chassis sheet metal.

10. Adjust the output voltage of regulator 1, 2, 3, or 4, using Table 6-2 as a guide. Measure the voltage with a digital voltmeter and perform the adjustment with a trimpot alignment tool or an insulated screwdriver. Figure 1-6 shows the location of the adjustments.

Table 6-2   Power Supply Regulator Adjustments

Regulator	Test Point on Backplane	Voltage Setting
H7441 (number 2)	A16A2	+5 Vdc, +0.1 Vdc
H7441 (number 4)	A09A2	+5 Vdc, +0.1 Vdc
H7476 +15 V (number 3)	A16B2 J12-7	+15 Vdc, +0.75 Vdc
H7476 -15 V (number 3)	A16E2 J12-32	-15 Vdc, +0.75 Vdc
H7490 (number 1)	A01V2	-5 Vdc, +0.16 Vdc

NOTE: While the +15 V supplies have a voltage tolerance, their magnitudes should measure within 0.2 V of each other. That is, if the +15 V supply measures +15.1 V, the -15 V supply should measure between -14.9 V and -15.3 V. The +15 V supplies are not adjustable.

6.1.6   AC/DC LO Board (54-14192)
Use this procedure to remove and replace the AC/DC LO board.

  1.   Remove power from the TS78 by switching the power controller off. Turn off the power supply circuit breaker.

  2.   Remove both regulator enclosures (Paragraph 6.1.5).

  3.   The ac/dc lo board is now exposed at the inside rear of the power supply chassis. Unplug the two connectors from the board.

  4.   Use a 5/16 inch nutdriver to remove the four nuts holding the board to the mounting standoffs. Remove the board.

  5.   Install the new board by reversing the above procedure.

6.2   TU78 REMOVAL AND REPLACEMENT PROCEDURES
This section details step-by-step removal and replacement procedures for all field replaceable parts that require such instructions. Figures are referenced in 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 6-3.)

Table 6-3   Parts Replacement/Adjustment Cross Reference

Paragraph	Removal or Replacement Procedure	Corequisite Check/Adjustment
6.2.1	Head replacement procedure	3.10
6.2.2	Tape cleaner removal, cleaning and alignment	_____
6.2.3	Air guide disassembly and cleaning	_____
6.2.4	Air bearing removal and cleaning	_____
6.2.5	Capstan motor replacement	3.10.1, 3.6.1, 3.6.2
6.2.6	Supply reel motor replacement	3.8.2, 3.8.4
6.2.7	Vacuum reel assembly replacement and takeup reel motor replacement	3.8.3, 3.8.4
6.2.8	Cartridge actuator motor replacement	_____
6.2.9	Controls assembly removal and replacement	_____
6.2.10	Blower/compressor ac motor replacement	3.6
6.2.11	Blower removal and replacement	3.6.1, 3.6.2
6.2.12	Compressor removal and replacement	3.6.3, 3.6.4
6.2.13	Air valve solenoid replacement	_____
6.2.14	PCBA removal/replacement	_____
6.2.14.1	MIA PCBA	_____
6.2.14.2	Read PCBA	3.10.3
6.2.14.3	Write PCBA	3.10
6.2.14.4	Control M2 PCBA	_____
6.2.14.5	Capstan servo PCBA	3.3, 3.7, 3.10.3
6.2.14.6	Reel servo PCBA	3.8, 5.7.1

Table 6-3   Parts Replacement/Adjustment Cross Reference (Cont)

Paragraph	Removal or Replacement Procedure	Corequisite Check/Adjustment
6.2.14.7	GCR/PE Preamp 1 PCBA	6.2.1 (steps 7--14), 3.10
6.2.14.8	Interconnect F1	3.4, 3.5, 3.8.4
6.2.14.9	Interconnect D1	_____

6.2.1   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).

Use this procedure to replace the head (Figure 6-1).

1. Turn transport power off.

2. Open transport front door and 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.

5. Carefully tip the bracket and disconnect the head from the PCBA. Remove the erase head leads from the PCBA.

THREAD BLOCK NO. 3
AIR GUIDE
TAPE PATH
NOTE 1
CIRCULAR CERAMIC GUIDE
LOWER POCKET BAR
RECTANGULAR CERAMIC GUIDE
CAP
TAPE CLEANER
CLIP
ERASE HEAD
GCR/PE PREAMP 1 PCBA
WRITE/READ HEAD
NOTE 2
GUIDE BLOCK
RETAINING SCREWS
RECTANGULAR CERAMIC GUIDE
CAPSTAN
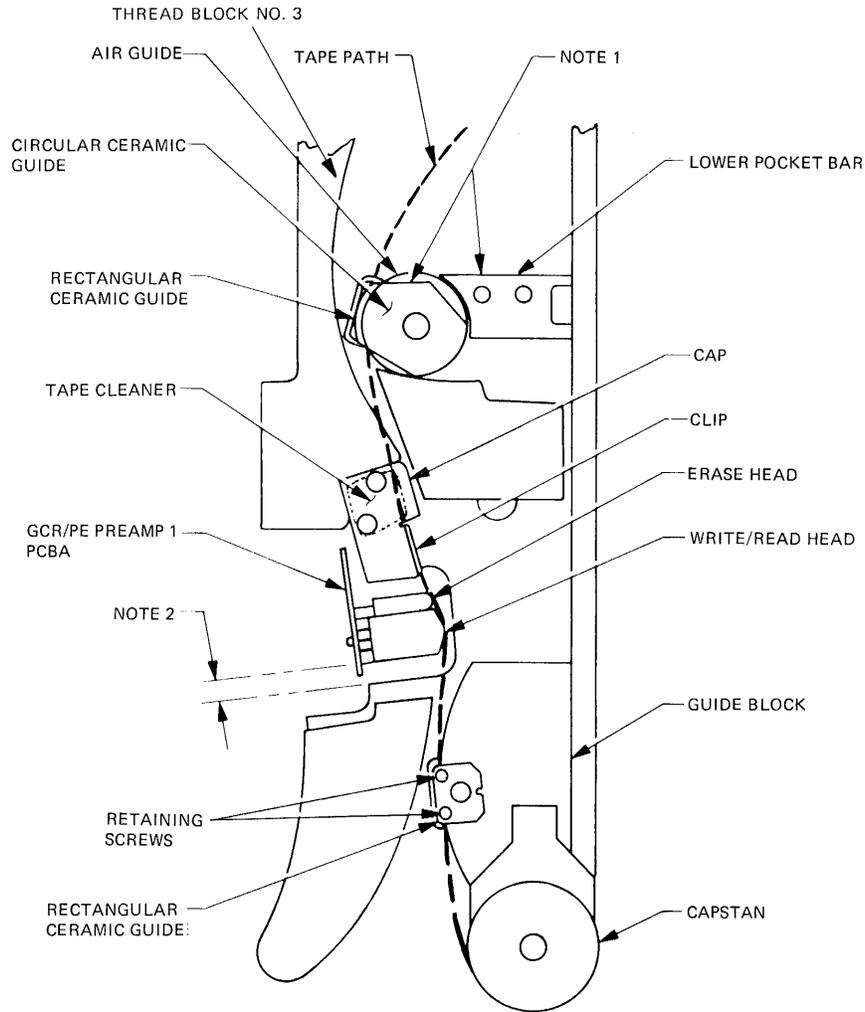
NOTES:
1. SURFACES MUST BE PARALLEL
2. INITIALLY EDGE OF HEAD MUST BE PARALLEL WITH METALLIC OVERLAY

MA-3670A
SHR0213-84

Figure 6-1   Read/Write Head, Tape Cleaner and
               Air Guide Removal and Replacement

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 J906.

7. Initially align head by visually aligning lower edge of head with inclined edge of base metallic overlay. (Refer to Note 2 of Figure 6-1.) 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.

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 3-6).

11. Using an oscilloscope, observe waveform at the upper lead of R13 (track 5) of the GCR/PE preamp 1 PCBA (Figure 3-9).

12. While operating in the shuttle mode, mechanically rotate the GCR/PE preamp 1 PCBA until the amplitude difference between forward and reverse operation is minimal. The forward/reverse amplitudes must be in the 800 mV +100 mV range, peak-to-peak. The lower amplitude must be within 10 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 read/write adjustments (Paragraph 3.10).

6.2.2   Tape Cleaner Removal, Cleaning, and Alignment
Use the following procedure to remove and reinstall the tape cleaner.

1. Open transport door and buffer box door.

2. Remove two screws attaching the tape cleaner and its cap to the base casting (Figure 6-1).

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.

6.2.3   Air Guide Disassembly and Cleaning
Use the following procedure to disassemble and clean the air guide.

1.   Open transport door.

2.   Remove seven trim assembly mounting screws, and trim assembly from unit.

3.   Open buffer box door.

4.   Remove thread block 3 (Figure 6-1), allowing it to hang by its leads.

5.   Remove circular ceramic guide from air guide on front of base assembly (Figure 6-1).

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 6-1).

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 6-1). 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.

6.2.4 Air Bearing Removal and Cleaning

There are five air bearings, excluding the air guide (Figure 6-2). The air guide disassembly and cleaning procedure is given in Paragraph 6.2.3. 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 transport front door and buffer box door.

2. Remove air bearing number 1 (Figure 6-2). 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 6-2.

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.

AIR BEARING NO. 1

CIRCULAR
CERAMIC GUIDE

THREAD BLOCK 1

AIR BEARING NO. 3

AIR BEARING NO. 2

CARDBOARD
STRAIGHT EDGE

AIR BEARING
NO. 4

SYMMETRICAL WITH VERTICAL
CENTERLINE OF TRANSPORT

AIR BEARING
NO. 5

CIRCULAR
CERAMIC GUIDE

NOTE:
"A" IS TANGENT POINT
"B" IS ORIFICE REGION

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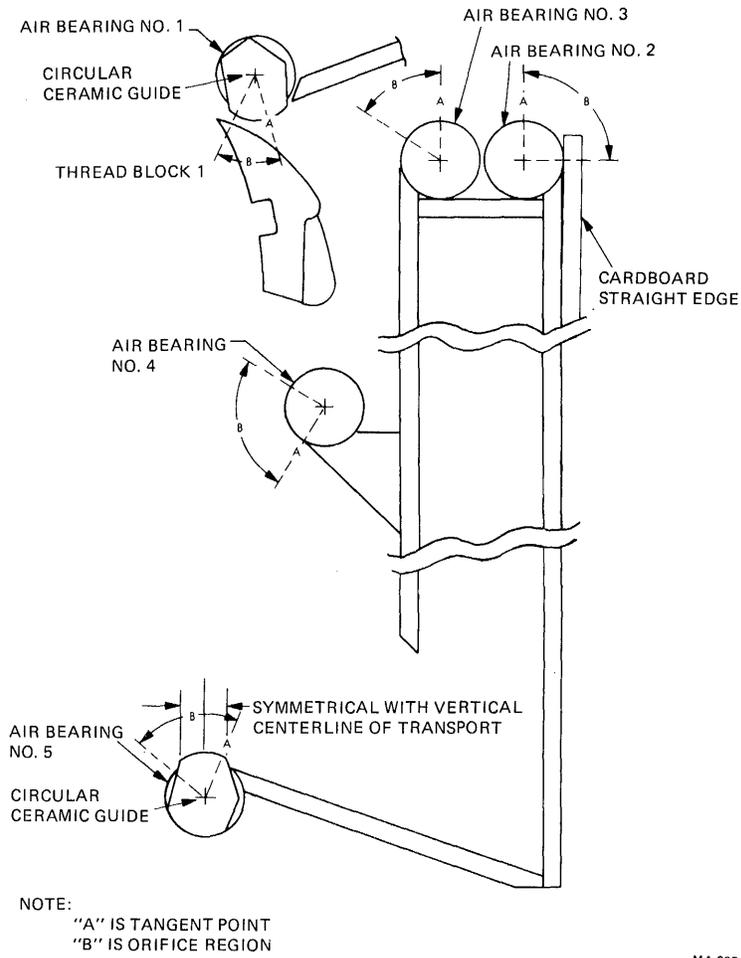
Figure 6-2   Air Bearing and Ceramic Guide
Orientation

6.2.5   Capstan Motor Replacement

The capstan motor and mounting plate is replaced as an assembly. Use the following procedure to replace the motor and mounting plate.

1.   Turn transport power off.

2.   Disconnect wires, hose, and tube at the motor. Remove tachometer wires from interconnect F1 PCBA.

3.   Remove the two hex nuts, lock washers, cups, and Belleville washers retaining motor plate to the base assembly at two locations (Figure 6-3A).
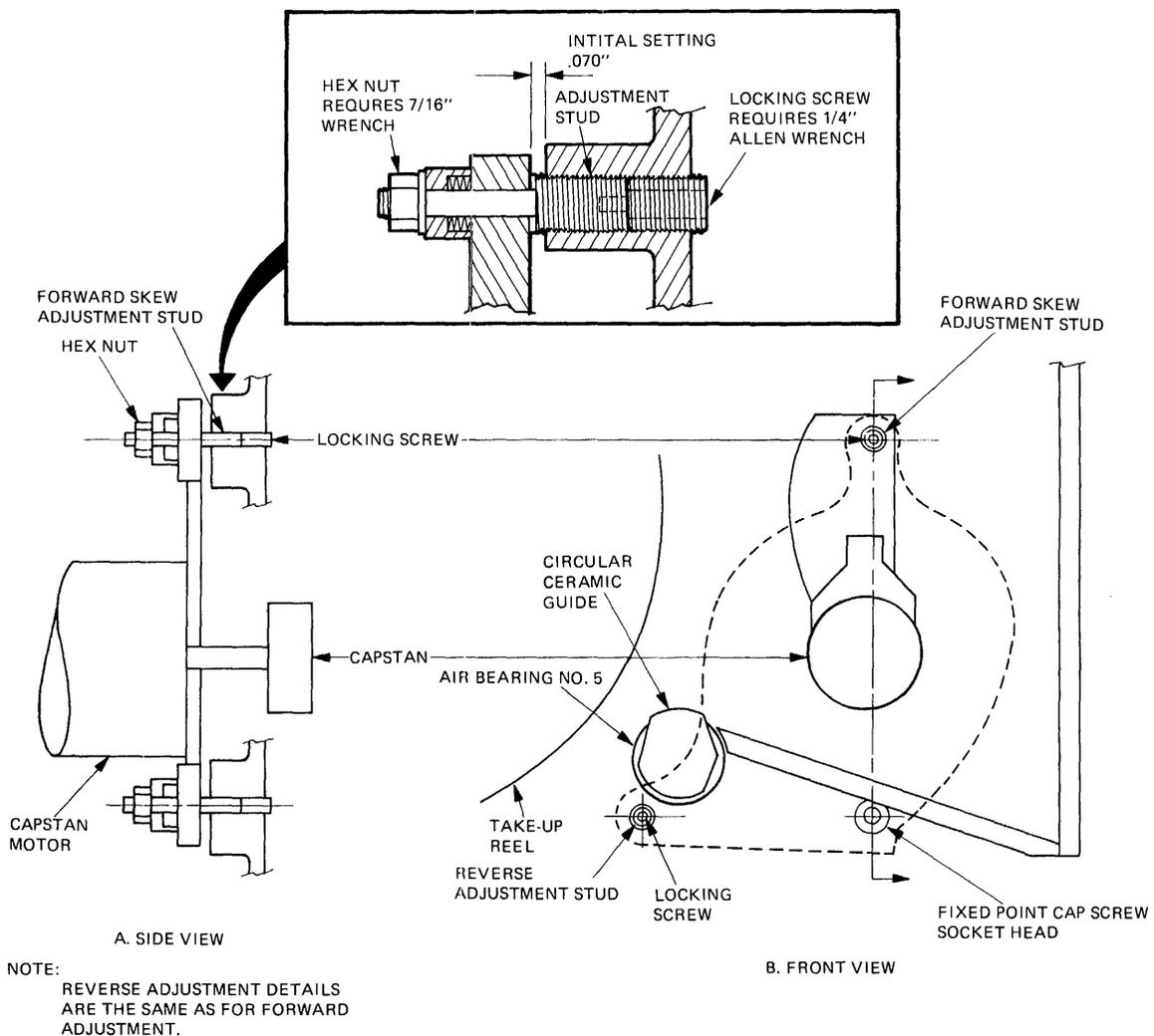
Figure 6-3   Capstan Motor Mounting

4. Cradle motor in your hand. At front of base assembly, remove socket-head cap screw (fixed point) (Figure 6-3B), 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 by repeating steps 2 through 5 in reverse order.

NOTE
The following steps are the procedure to achieve capstan perpendicularity necessary to ensure proper tape tracking over the guide block/head area. Steps 7 through 21 are the coarse adjustment of tape tracking. Steps 22 through 32 are the fine tuning of tape tracking.

7. Turn transport power on.

8. Mount and load a work tape to BOT.

NOTE
The tape edge may be damaged 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 3-6) 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 are the hex nuts referred to in step 3. They are at the forward and reverse tracking adjustment points.

12. On the front of the base assembly, about 50.8 mm (2 in) down from the capstan, loosen the fixed point socket-head cap screw 1/4 turn (Figure 6-3).

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 6-1).

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. Push the guide straight back with the swab positioned in the middle of the guide.

16. Close the buffer box door assembly.

17. Perform a system vacuum check (Paragraphs 3.6.1 and 3.6.2).

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 6-4) so tape edge is aligned with guide block edge where 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. Adjust reverse adjustment stud from the front of the base assembly (Figure 6-4) so tape edge is aligned with the guide block.
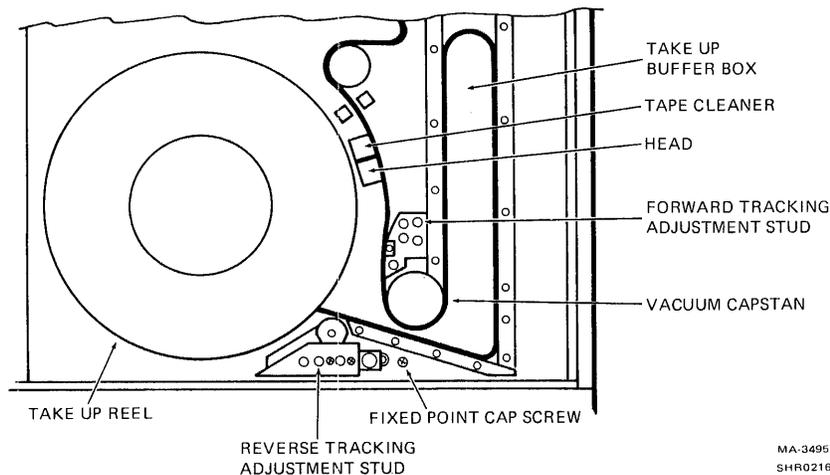
Figure 6-4   Capstan Tape Tracking Adjustment Studs

21. Repeat steps 19 and 20 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 3-9) 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 6-4) for minimum differential between tracks 1 and 9 (outside two tracks of the read head).

NOTE
Only very slight adjustments are required. It may not be possible to achieve no differential at this point 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 3.10.1).

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 3.10.1).

6.2.6   Supply Reel Motor Replacement
Use the following procedure to replace the supply reel motor.

1. Turn transport power off.

2. Open 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 needed to prevent the nuts for these screws from turning. Insert a small open-end wrench 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 (PN 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 3.8.2)
    Tape loop position (Paragraph 3.8.4)

6.2.7 Vacuum Reel Assembly and Take-up Reel Motor Replacement
Use the following procedure to replace the vacuum reel assembly and take-up reel motor. The vacuum reel assembly must be removed 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.

6-19

8.   Install replacement motor, aligning the elbows properly. Center motor in base casting clearance bore using centering tool (PN 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 (PN 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 3.8.3)
     Tape loop position adjustment (Paragraph 3.8.4).

6.2.8   Cartridge Actuator Motor Replacement
Use the following procedure to replace the cartridge actuator motor.

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 6-5).

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.
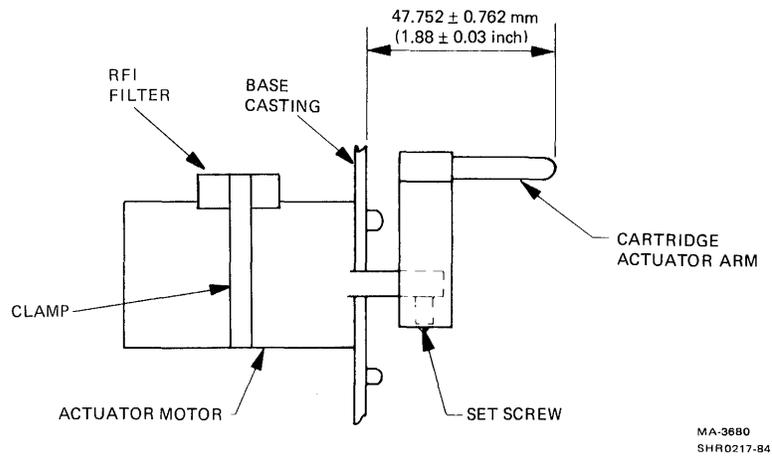
Figure 6-5   Cartridge Actuator Motor Alignment

6.   Install new motor with the four mounting screws. Set arm height shown in Figure 6-5 and tighten set screw.

7.   Install a new RFI filter (PN 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 button on TU78 control panel. Arm must rotate clockwise, then stop without bouncing and motor must stop driving. Adjust bottom limit switch if necessary.

10.   Press RESET button on TU78 control panel. Arm must swing counterclockwise, then stop without bouncing and motor must stop driving. Adjust top limit switch if necessary.

11.   Reassemble supply reel overlay.

6.2.9   Control Assembly Removal and Replacement
Use the following procedure to remove and replace the control assembly.

1. Turn transport power off at cabinet power controller.

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 base assembly, remove the four control assembly mounting screws and slide the flat cable through base casting.

5. Install replacement assembly in reverse order.

6.2.10   Blower/Compressor AC Motor Replacement
Use the following procedure 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 controller and disconnect power cord.

CAUTION
Do not try 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
Two people are needed to lift the transformer.

5. Remove cover to motor leads and remove leads.

6. Remove four mounting screws at rear of power pack assembly and remove motor from the front.

7. Install replacement motor.

8. Reassemble in reverse order aligning pulley on shaft set (Figure 6-6). 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 controller.

10. Perform vacuum and air pressure adjustments (Paragraph 3.6).
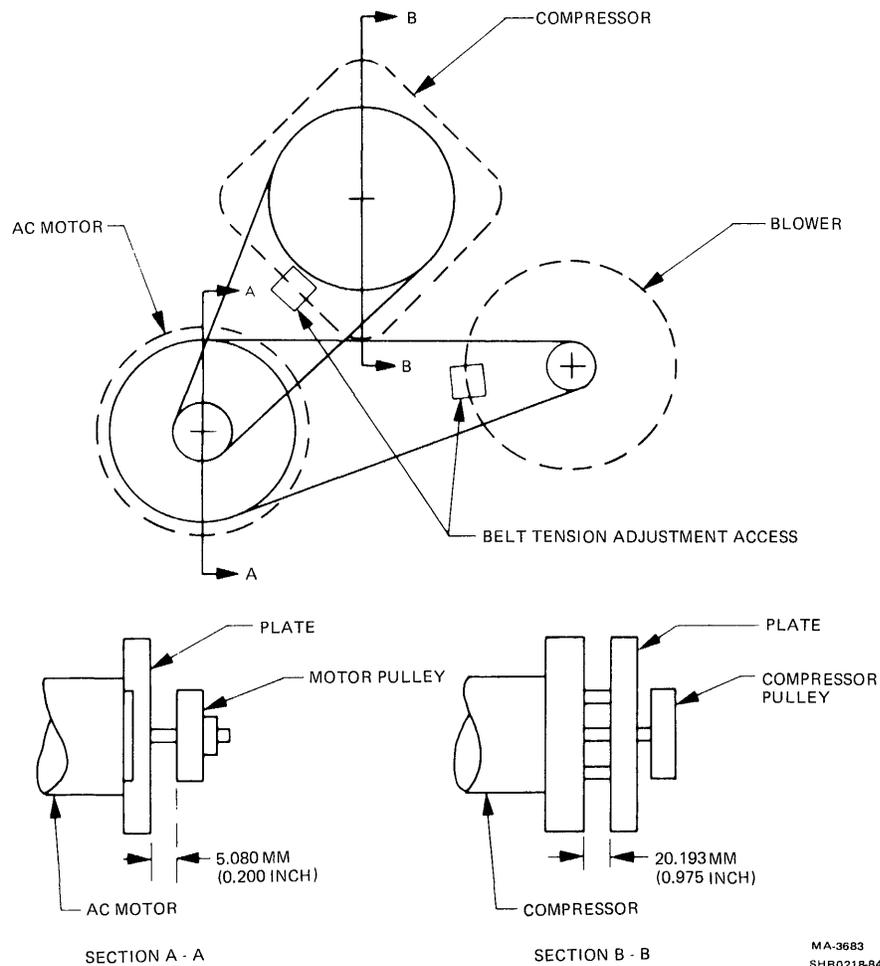
Figure 6-6   Blower and Compressor Pulley Alignment

6.2.11   Blower Removal and Replacement
Use the following procedure to remove and replace the blower.

1.   Turn transport power off at the cabinet power controller 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 6-6).

> 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 about 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 controller.

11.   Perform system vacuum adjustment (Paragraph 3.6.1).

12.   Perform takeup reel vacuum adjustment (Paragraph 3.6.2)

6.2.12   Compressor Removal and Replacement
Use the following procedure to remove and replace the compressor.

1.   Turn transport power off at the cabinet power controller 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 6-6.

10. Exert about 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 controller.

13. Perform the following related adjustments.

     Air bearing pressure adjustment (Paragraph 3.6.3)
     Thread block and cartridge pressure adjustment (Paragraph 3.6.4).

6.2.13   Air Valve Solenoid Replacement

When replacing the solenoid on either the vacuum or pressure transfer valve assembly, adjust it 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.

6.2.14   Printed Circuit Board Assembly (PCBA) Removal and Replacement

The procedures necessary to remove and replace all PCBAs are listed in the following nine paragraphs.

6.2.14.1 Multiple Interface Adapter PCBA (Slot 1)

1.   Turn transport power off.

2.   Remove the PCBA retainer clip (Figure 2-6).

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 16 DIP switches (U125, U135) on the old MIA PCBA and sliding the new ones so they are identical (Figure 3-15).

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.

6.2.14.2 Read PCBA (Slot 2)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 2-6).

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 3.10.3).

9. Run the in-line exerciser (ILEXER) for 15 minutes.

6.2.14.3 Write PCBA (Slot 3)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 2-6).

3. Remove the write data cable from J6.

4. 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 read/write adjustments (Paragraph 3.10).

10. Run ILEXER for 15 minutes.

6.2.14.4 Control M2 PCBA (Slot 4)

1. Turn transport power off.

2. Remove the PCBA retainer clip (Figure 2-6).

3. Remove the control cable from J10.

4. Pull the PCBA straight out of the interconnect D1 backplane.

5. Make sure jumpers W1 through W18, on the new PCBA, are configured according to the original PCBA. (Refer to Volume 1 of the TU78 Magnetic Tape Transport Technical Manual, Figure 13, sheet 2, 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.

6.2.14.5 Capstan Servo PCBA (Slot 5)

1. Turn transport power off.

2. Use the 5/32-inch ball-end driver and extension to unscrew, but not remove, the six hex-cap screws holding the PCBA heat sink to the card cage heat sink at the rear.

3. Pull the PCBA out of the card cage. Some rocking action may be needed 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.

     TU78 power distribution (Paragraph 3.3)
     Capstan servo adjustments (Paragraph 3.7)
     PE gain adjustment (Paragraph 3.10.3)

7.   Run appropriate diagnostics to confirm transport operation.

6.2.14.6 Reel Servo PCBA (Slot 6)

1.   Turn transport power off.

2.   Remove the eight connecting wires at the bottom of the PCBA.

3.   Use the 5/32-inch ball-end driver and extension to unscrew, but not remove, the six hex-cap screws holding the PCBA heat sink to the card cage heat sink at the rear.

4.   Pull the PCBA out of the card cage. Some rocking action may be needed 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.

     Reel servo adjustments (Paragraph 3.8)
     Dynamic brake check (Paragraph 5.7.1)

9.   Run appropriate diagnostics to confirm transport operation.

6.2.14.7 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 adjustments.

   Read/write head skew (Paragraph 6.2.1, steps 7 through 14)
   Read/write adjustments (Paragraph 3.10)

10. Run ILEXER for 15 minutes to confirm transport operation.

6.2.14.8 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. 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 3.4)
     Low tape sensor (Paragraph 3.5)
     Tape loop position and gain (Paragraph 3.8.4)

8.   Run appropriate diagnostics to confirm transport
     operation.

6.2.14.9 Interconnect D1 PCBA

1.   Turn transport power off at the power controller.

2.   Remove all card cage PCBAs according to Paragraphs
     6.2.14.1 through 6.2.14.6.

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.

A	Address lines or address on address lines
ACRC	Auxiliary cyclic redundancy check character
address	A specific memory or peripheral register location
AMTIE	Amplitude track in error
ANSI	American National Standards Institute
ARA	Automatic read amplification
architecture	The internal configuration of a processor, system, or subsystem
ASCII	American Standard Code for Information Interchange
asynchronous	A mode of operation scheduled by ready and done signals rather than by time intervals
ATTN	Attention
BAL	Byte assembly logic (M8959)
BCD	Binary coded decimal
BCTC	Byte count terminal count
bit	A binary number, either 0 or 1
bit/in	Bits per inch (also known as characters per inch)
block	A record (sometimes considered to be multiple records within a file)

BOT	Beginning of tape
buffer	A temporary storage area or an isolating circuit used to avoid distortion of the input signal by the driven circuit or transmission line
bus	A group of signal lines that convey information from source to destination. There may be many destinations, but only one source at a given time.
byte	A word consisting of eight bits
character	A single letter, numeral, or symbol used to represent information
char/in	Characters per inch (also known as bits per inch)
CLK	Clock
CLR	Clear
command	A word, byte, or portion of a byte that causes a predefined operation to be performed
CPU	Central processor unit (This is the 8085 microprocessor chip relative to the TS78 controller.)
CRC (C)	Cyclic redundancy check (character)
C TO D	Controller To Drive
D	Data lines or data on data lines
data group	In GCR mode, seven data characters plus an ECC character combined as a group prior to translation. Consists of two data subgroups.
DDR	Diagnostic data register
decoder	A device that detects a certain specific address and produces a corresponding single output
DEM	Demand

density	The nominal distribution per unit length of recorded information, usually expressed in bits or characters per inch
DMA	Direct memory access. A process whereby data is transferred rapidly into RAM by the host computer without microcomputer control.
down-line load	See DMA.
drive	Combination of a formatter and one transport
DS	Drive select
8MC	8085 microcomputer (M8972)
EBL	End of block
EC	Error correction
ECC	Error correcting code (M8951)
ECC character	A special error correcting code character on tape, used for error detection and correction
Ecode	Error code. This code is developed in the write microcontroller and sent to the microcomputer on demand.
EOT	End of tape
EXC	Exception
Fc/In	Flux changes per inch
FIFO	See Shift Register.
file	A logical collection of data treated as a unit. A file may consist of one or more records or blocks on tape.
file gap	A special extended, erased portion on tape just prior to the file or tape mark record
FMK	File mark (also tape mark)
format	The entire set of unique parameters used to define the recording mode

fr/in	Flux reversals per inch
FWD	Forward
GCR	Group-coded recording
GCTC	Group count terminal count
group	See Data Group or Storage Group.
group-coded recording	A recording technique that collects groups of characters and translates or encodes them prior to putting them on tape
HHT	Handheld terminal
HLD A	Hold acknowledged
hold	A state in which the microcomputer may be placed during a host-to-RAM DMA transfer
HSC	Hierarchical storage controller
IBG	Interblock gap (See Interrecord Gap.)
IC	Integrated circuit
IDB	Identification burst
ILR	Illegal register
ILEXER	In-line exerciser
ILTAPE	In-line tape diagnostic
INIT	Initialize
initialize	To set certain logic elements to a known state, or to set program variables to their starting values prior to issuing a subsystem command
in/sec	Inches per second
interrecord gap	A blank space deliberately erased between data records on tape
interrupt	A hardware signal that causes the microprocessor to jump to a specific subroutine

interrupt service routine   The routine or subroutine executed when an interrupt occurs.

I/O   Input/output

I/O page   That portion of memory in which specific locations are associated directly with subsystem peripheral device registers

IRG   Interrecord gap

latch   A circuit that, when triggered, stores whatever appears on its inputs and holds it. When not triggered, the output reflects the input.

LSB   Least significant bit or least significant byte

LSI   Large scale integration

MIA   Magtape interface adaptor

microcomputer   A class of computer having all major central processor functions, memory, and control circuitry self-contained on a single printed circuit board. A microcomputer usually employs a mircroprocessor chip.

microcontroller   A semi-intelligent set of logic that performs simple control functions directed by a microprogram

microprocessor   A single LSI circuit that performs the functions of a CPU

microprogram   A program implemented in microcode for a microprocessor or microcontroller. A microprogram may reside in ROM or RAM.

MM I/O   Memory-mapped I/O

modulo   A mathematical operation that yields the remainder function of a division

monitor   The master control program that interprets subsystem commands and schedules internal operations within the TS78, and external operations within the tape transport

MSB	Most significant bit or most significant byte
NED	Nonexistent drive
NEF	Nonexecutable function
nibble	The low-order or high-order 4-bit half of one byte
NRZI	Nonreturn to zero indiscrete
pad character	A null or zero character in the residual data group
page	A set of 32K contiguous byte locations.
parity bit	A binary digit appended to a group of bits to make the sum of all the bits always odd (odd parity) or always even (even parity). The parity bit is used to verify data integrity.
PCBA	Printed circuit board assembly
PE	Phase encoding
peripheral	In the TS78, any device (register) responding to an address in the I/O page
polling	A process in which the microcomputer interrogates certain command or status registers one at a time to determine if service is required
port	A place through which input/output data is channeled
postamble	Groups of special characters recorded on tape at the end of a data record for synchronization
preamble	Groups of special characters recorded on tape at the beginning of a data record for synchronization
priority	The order in which the microcomputer satisfies simultaneous interrupt requests

program	A set of sequential instructions that a microprocessor or microcontroller follows
program counter	A special register in the microprocessor or microcontrollers that points to the location in memory of an instruction to be executed
PROM	Programmable read only memory
protocol	The set of system or subsystem rules that define handshaking on a bus
RAM	Random access memory (See Read/Write Memory.)
RC	Read channel (M8950)
read/write memory	A RAM in which each cell may be selected by applying appropriate electrical input signals. The binary state of the cell may be either (1) sensed at appropriate output terminals, or (2) changed in response to other similar electrical input signals.
read-only memory	A memory in which the contents are not intended to be altered during normal operation
record	A group of multiple characters on tape, taken in succession. Records are separated on tape by interrecord gaps.
register	A device that stores data
resident	Present in the subsystem or its memory
REV	Reverse
RMC	Read (path) microcontroller (M8953)
ROM	See Read-Only Memory.
RP	Read path
RS	Register select

R/W	Read/write
RWND	Rewind
scratchpad	An area of RAM memory set aside for short and often-repeated calculations, or temporary storage
shift register	A memory in which data enters serially and shifts to successive storage locations. Data may be read when it has sequentially shifted to the output (also known as a FIFO).
skew	The deviation of bits within a tape character from the intended or ideal placement, which is perpendicular to the reference edge
SN	Serial number
stack	Storage in RAM memory for data during subroutines or interrupts
storage group	Ten tape characters created from the 8-character data group via the record code value translation
STI	Standard tape interface
subgroup	One half of a data or storage group
subroutine	A program within a program that performs a specific, often-used function
synchronous	Simultaneous performance of a sequence of operations controlled by an external clock
system	The TS78 microcomputer and its peripherals constitute the formatter control system.
TACH	Tachometer
tape mark	A special control record on tape which serves to separate files
TC	Terminal count
TCU	Tape control unit

TM	Tape mark (also known as file mark)
total character skew	The deviation, during reading, from time coincidence of the bits within a recorded character; the sum of static skew and dynamic skew
TRA	Transfer
trap	An urgent microprocessor interrupt used to flag a power failure or system monitor parity error
tri-state	The property of a bus signal line to be placed in a dissociated (high-impedance) state, as well as the common HI or LO state
TUP	Tape unit port (M8955)
VCO	Voltage-controlled oscillator
vector	A specific address loaded into the microprocessor's program counter to force it to start processing at that address
WCS	Writable control store; RAM storage area that may be overwritten with microprogram information
WD	Write data
WDS	Write data strobe
WMC	Write microcontroller (M8959)
Word	Any group of bits indicating a single number or expression
XMC	Translator microcontroller (M8958)

B.1   INTRODUCTION

This appendix lists the bytes in the extended drive and extended formatter status areas. These bytes are accessible via the HSC and the ASCII port. The HSC may request the bytes in any area as a group. In the listing, the byte number identifies the order in which the TA78 transmits these bytes to the HSC. Via the ASCII port, these bytes may be accessed individually with the parameter addresses listed.

Hardware registers are the source for many extended drive status bytes. The microbus addresses listed are the 8085 I/O locations of these registers. Bytes that do not have a microbus address listed come from RAM locations in the M8972 module. This is the case for all bytes in the extended formatter status area.

B.2   EXTENDED DRIVE STATUS

```
Byte number               1
Parameter address         24
Name                      -- (Diagnostic mode status byte 1)
Microbus address          --
Register location         --
```

Bit	Name	Description
7:0	--	With TA78 in diagnostic mode, byte 1 is one of two status bytes for classifying soft errors. One of 6 codes, listed and defined below, may appear in this byte. In normal operation, byte 1 is a 0 (see note below byte 4).

Partial Diagnostic Mode Soft Error Status

Code	Meaning
00	No soft error (see note 2).
07	Other (write)
0E	Status (read)
16	Status (read reverse)
2D	Transmission (read)
35	Transmission (read reverse)

NOTES:
1. Status (read and read reverse) -- successful operation after
   retries.
   Other (write) -- write retry succeeded in same physical
   location that previous write retry failed.

2. Bytes 1 and 2 must contain Øs to indicate no soft error.

Byte number	2
Parameter address	25
Name	-- (Diagnostic mode status byte 2)
Microbus address	--
Register location	--

Bit	Name	Description
7:Ø	--	With TA78 in diagnostic mode, byte 2 is 1 of 2 status bytes for classifying soft errors. One of 8 codes, defined below, may appear in this byte. In normal operation, byte 2 is a (see note below byte 4).

Partial Diagnostic Mode Soft Error Status

Code	Meaning
ØØ	No soft error
Ø1	Double track correction (read)
Ø2	Double track correction (read reverse)
Ø3	Single track correction (read)
Ø4	Single track correction (read reverse)
Ø8	Media
ØD	Other (read)
15	Other (read reverse)

NOTES
1. Other (read and read reverse) -- successful operation without
   error correction, but with interesting occurrence (AMTIE or
   PHTIE flag).

2. Bytes 1 and 2 must contain Øs to indicate no soft error.

Byte number	3
Parameter address	26
Name	-- (Diagnostic mode status byte 3)
Microbus address	--
Register location	--

Bit	Name	Description
7:Ø	--	This byte is reserved for future use and is always a Ø.

```
Byte number              4
Parameter address        27
Name                     -- (Diagnostic mode status byte 4)
Microbus address         --
Register location        --
```

Bit	Name	Description
7:0	--	This byte is reserved for future use and is always a 0.

NOTE: When a non-zero value appears in byte 1 or two, the TA78 does not update bytes 5 and above in an extended drive status area. The TA78 then transmits only the first 4 bytes of the requested extended drive status area to the HSC.

```
Byte number              5
Parameter address        28
Name                     OPSAV
Microbus address         --
Register location        --
```

Bit	Name	Description
7:0	--	Last STI level 2 command to begin execution before error detection. The table below identifies each available code and its meaning.

Command Code	Meaning
41	Clear drive errors
42	Clear formatter errors
44	Disconnect
47	Get formatter characteristics
48	Get summary status
4B	Initiate rewind
4D	Position tape
4E	Set unit execution mode
50	Set byte count
53	Write tape mark
55	Data error recovery
C0	Change controller flags
C3	Diagnose
C5	Get extended drive status

```
                          Command
                          Code          Meaning

                          C6            Get formatter error log
                          C9            Get unit characteristics
                          CA            Erase gap
                          CC            Online
                          CF            Read memory
                          D1            Set unit characteristics
                          D2            Topology
                          D4            Write memory
```

Byte number	6
Parameter address	29
Name	ERRNUM (Error number low byte)
Microbus address	--
Register location	--

Bit	Name	Description
7:0	—	Eight least significant bits of 10-bit identification number. (Refer to Paragraph B.3.1)

Byte number	7
Parameter address	2A
Name	ERRN1 (Error number high byte)
Microbus address	--
Register location	--

Bit	Name	Description
7	Critical error	True if error is critical; transport should be removed from service. This bit is forced to 0 for error that occurs while operational code is running.
6	Data available	True if data generated by diagnostic code is available. This bit is forced to 0 for error that occurs while operational code is running.
5:3	Fault number	Indicates one of six areas in the formatter that may have caused a potentially fatal error. (Refer to Table 4-1)
2	--	When 1, indicates operational error. When 0, indicates diagnostic error.
1:0	--	Two most significant bits of 10-bit error identification number. (Refer to Paragraph B.3.1)

```
Byte number              8
Parameter address        2B
Name                     RPFAIL (RMC write fail bits)
Microbus address         ØØ-R
Register location(s)     M895Øs (RC3) via M8953 (RP6)
```

Bit	Name	Description
7:Ø	Write fail 7:Ø	These are write fail bits from read channels 7--Ø. Write fail is an OR of certain error conditions, namely: Illegal 5-to-4 translation AMTIE PHTIE Pointer mismatch

```
Byte number              9
Parameter address        2C
Name                     RPATH (Read path status)
Microbus address         Ø1-R
Register location(s)     M8953 (RP6)
```

Bit	Name	Description
7	Velocity ok	True if velocity is within 1Ø% of 125 in/sec or jam velocity ok bit is set (RPCTL, Ø9-W bit 2).
6	Status valid	Indicates M8953 status is valid (set after Ø.1 inch gap found).
5	Preamble error	True if preamble had AMTIE.
4	Data ready	Goes false when M8953 asserts data ready to M8951.
3	Beginning of preamble	True when read path senses that the preamble has just passed the read head.
2	Clock stopped	True if read path clock is stopped.
1	Statistics select	True if TIE bus statistics are being sent to TIE bus.
Ø	Write fail P	Indicates illegal 5 to 4, AMTIE, PHTIE, or pointer mismatch for parity bit.

```
Byte number                     A
Parameter address               2D
Name                            RSTAT (RMC status byte)
Microbus address                02-R
Register location(s)            M8950s via M8953 (RP4)
```

```
Bit         Name                        Description

7:0         RMC status 7:0              This byte contains the read path
                                        microcontroller status codes. The
                                        following table identifies each
                                        code and its meaning.
```

Read Path Microcontroller Status Codes

```
Status                  Meaning
```

Status from ECC self-test command

```
41                      ECC controller passed self-test.
42                      ECC controller failed self-test.
```

Status from an M8953 self-test

```
43                      Read path passed self-test.
44                      Read path failed self-test.
```

Status from an M8950 self-test command

```
46                      Read channel tests all passed.
```

Status from a clear all test command for velocity testing of drive by microcode

```
1                       First tach pulse
81                      Last tach pulse (eleventh; ten spaces)
```

Status from a sample density command

```
88                      NOT CAPABLE found.
89                      GCR ID found.
8A                      PE ID found.
```

Status from a write test of IBG, PE ID, GCR ID, ARA ID, or ARA burst

```
90                      Bad status (write test).
```

Status from a tape mark test command

```
92                      Good tape mark found on tape status.
```

Status resulting from a non-BOT command (read or write FWD or REV, GCR or PE)

98	ARA ID found (not record or tape mark).
99	Tape mark found.
9C	Preamble end not found.
9D	Read path fault 1, too many M8950s have been fataled to continue record processing.
9E	Read path fault 2, 7 or more M8950 modules found illegal 5-to-4 translations.
A1	Unexpected IBG in data; probably creased tape (seven or more AMTIES active).
B1	Postamble long.
B2	Postamble short.
FF	OK

Byte number	B
Parameter address	2E
Name	RCMLP (RMC command loop back)
Microbus address	03-R
Register location(s)	M8953 (RP6)

Bit	Name	Description
7:0	Command 7:0	Contains the last command sent to the M8953 via RCMD (address 0B-W). The table below identifies each code and its meaning.

Command Code	Task
00	NOP
01	Interblock read
02	Test PE ID burst
03	Test GCR ID burst
04	Test ARA ID burst
05	Test tape mark
06	Test ARA burst
07	Normal non-BOT read
08	Run RMC self-test
09	Test unknown ID burst
0A	Run read channel micro's test
0B	Diagnostic read command
0C	Run read channel self-test
0D	Run clear all RMC test program
0E	Run ECC self-test program
0F	Find gap

Byte number	C
Parameter address	2F
Name	RAMT (Read channel AMTIE status)
Microbus address	10-R
Register location(s)	Tape transport via M8955, M8950, and M8953

Bit	Name	Description
7:0	AMTIE 7:0	This byte reflects the state of the AMTIE lines for channels 7 through 0.

Byte number	D
Parameter address	30
Name	RDON (Read channel done status)
Microbus address	11-R
Register location(s)	M8950s via M8953

Bit	Name	Description
7:0	Done 7:0	A given bit is false if the associated M8950 has completed its assigned task.

Byte number	E
Parameter address	31
Name	RILL (Read channel illegal status)
Microbus address	12-R
Register location(s)	M8950 via M8953

Bit	Name	Description
7:0	Illegal 7:0	A given bit is true if the associated M8950 indicates the following.

GCR
Data contained an illegal 5-bit code which was either an error or a tape format control character.

PE
Data error occurred such as no bit time phase transition.

Byte number	F
Parameter address	32
Name	RMK2 (Read channel mark 2 status)
Microbus address	13-R
Register location(s)	M8950s via M8953

Bit	Name	Description
7:0	7:0 Mark 2	When true, indicates that the associated M8950 has detected a Mark 2 tape format control character. If the corresponding illegal 5-to-4 bit is set (RILL 7:0), a Mark 2 was detected during 5-to-4 conversion.

Byte number	10
Parameter address	33
Name	REND (Read channel end status)
Microbus address	14-R
Register location(s)	M8950s via M8953

Bit	Name	Description
7:0	END 7:0	End Mark for read channels 0 -- 7.

Byte number	11
Parameter address	34
Name	RPSTA (Read channel parity status)
Microbus address	15-R
Register location(s)	M8950 parity module

Bit	Name	Description
7	Corrected data P	Contains ECC module corrected output data for parity bit.
6	Data P	Contains M8950 data output for parity bit.
5	Post P	Indicates PE postamble for parity bit.
4	End P	Indicates End Mark for parity bit.
3	Mark 2 P	Indicates Mark 2 for parity bit.
2	Illegal P	Indicates illegal 5-to-4 for parity bit.
1	Not done P	Parity M8950 not done.
0	AMTIE P	Weak amplitude on parity bit.

```
Byte number                12
Parameter address          35
Name                       RPOSTN (Read channel PE postamble detect)
Microbus address           16-R
Register location(s)       M8950s via M8953
```

Bit	Name	Description
7:0	Postamble 7:0	In PE, contains the inverted data for the byte prior to the one currently on the data lines (RC3 D(N) H). Used for PE POSTAMBLE detection.

Not used in GCR.

```
Byte number                13
Parameter address          36
Name                       RDATA (Read channel data)
Microbus address           17-R
Register location(s)       M8950s via M8953
```

Bit	Name	Description
7:0	Data 7:0	Contains data output from read channels 7--0 to ECC module.

```
Byte number                14
Parameter address          37
Name                       CRCWRD (CRC byte)
Microbus address           18-R
Register location(s)       M8952 (CRC3)
```

Bit	Name	Description
7:0	CRC 7:0	These are CRC checker output bits.

```
Byte number                15
Parameter address          38
Name                       ECCOR (Corrected data)
Microbus address           19-R
Register location(s)       M8951 (EC5)
```

Bit	Name	Description
7:0	Corrected data 7:0	Contains corrected data output from ECC module to CRC module.

```
Byte number                16
Parameter address          39
Name                       ECCSTA (ECC status byte)
Microbus address           1A-R
Register location(s)       M8951 (EC5)
```

Bit	Name	Description
7	CRC error	Indicates CRC did not check.
6	ECC ROM parity error	Indicates M8951 program parity error.
5	AMTIE occurred	Indicates AMTIE occurred during data portion of record.
4	ACRC error	Indicates ACRC did not check.
3	Pointer mismatch	Indicates the track in error did not have a pointer.
2	Uncorrectable	Indicates ECC could not correct data error.
1	Two-track error correction	Indicates two-track error correction was performed on data.
Ø	Single-track error correction	Indicates single-track error correction was performed on data.

Byte number   17
Parameter address   3A
Name   -- (Read channels Ø and 1 TIE)
Microbus address(es)   2Ø-R and 21-R
Register location(s)   M895Øs channels Ø and 1

Bit	Name	Description
7	CH1 TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
6	CH1 TIE bus 2	AMTIE
5	CH1 TIE bus 1	PHTIE
4	CH1 TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE. If statistics = 1, indicates any pointer occurred (GCR and PE).
3	CHØ TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)

Bit	Name	Description
2	CHØ TIE bus 2	AMTIE
1	CHØ TIE bus 1	PHTIE
Ø	CHØ TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE.
		If statistics = 1, indicates any pointer occurred (GCR and PE).

Byte number   18
Parameter address   3B
Name   -- (Read channels 2 and 3 TIE)
Microbus address(es)   22-R and 23-R
Register location(s)   M8950s channels 2 and 3

Bit	Name	Description
7	CH3 TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
6	CH3 TIE bus 2	AMTIE
5	CH3 TIE bus 1	PHTIE
4	CH3 TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE.
		If statistics = 1, indicates any pointer occurred (GCR and PE).
3	CH2 TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
2	CH2 TIE bus 2	AMTIE
1	CH2 TIE bus 1	PHTIE
Ø	CH2 TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE.
		If statistics = 1, indicates any pointer occurred (GCR and PE).

```
Byte number                  19
Parameter address            3C
Name                         -- (Read channels 4 and 5 TIE)
Microbus address(es)         24-R and 25-R
Register location(s)         M8950s channels 4 and 5
```

Bit	Name	Description
7	CH5 TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
6	CH5 TIE bus 2	AMTIE
5	CH5 TIE bus 1	PHTIE
4	CH5 TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE. If statistics = 1, indicates any pointer occurred (GCR and PE).
3	CH4 TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
2	CH4 TIE bus 2	AMTIE
1	CH4 TIE bus 1	PHTIE
Ø	CH4 TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE. If statistics = 1, indicates any pointer occurred (GCR and PE).

```
Byte number                  1A
Parameter address            3D
Name                         -- (Read channels 6 and 7 TIE)
Microbus address(es)         26-R and 27-R
Register location(s)         M8950s channels 6 and 7
```

Bit	Name	Description
7	CH7 TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
6	CH7 TIE bus 2	AMTIE
5	CH7 TIE bus 1	PHTIE
4	CH7 TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE. If statistics = 1, indicates any pointer occurred (GCR and PE).
3	CH6 TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
2	CH6 TIE bus 2	AMTIE
1	CH6 TIE bus 1	PHTIE
Ø	CH6 TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE. If statistics = 1, indicates any pointer occurred (GCR and PE).

Byte number	1B
Parameter address	3E
Name	-- (Read channel P TIE and TIE bus)
Microbus address(es)	28-R and 3Ø-R
Register location(s)	M895Ø channel P and M8953

Bit	Name	Description
7:4	TIE bus	Reads TIE bus without enabling any read channel modules. If jam TIE bus (address Ø9-W bit 7) is set, then the value written into address ØA-W is read.
3	CHP TIE bus 3	Indicates illegal 5-to-4 in GCR, and dead track in PE. (Bad track register is ORed into this bit.)
2	CHP TIE bus 2	AMTIE

Bit	Name	Description
1	CHP TIE bus 1	PHTIE
Ø	CHP TIE bus Ø	If statistics = Ø, indicates pointer mismatch in GCR and Ø in PE.
		If statistics = 1, indicates any pointer occurred (GCR and PE).

Byte number   1C
Parameter address   3F
Name   TAMT (AMTIE byte)
Microbus address   44-R
Register location(s) M8955 (TUP 2, 4)

Bit	Name	Description
7:Ø	AMTIE 7:Ø	This byte reflects information on TU bus lines AMTIE 7:Ø L.

Byte number   1D
Parameter address   4Ø
Name   PSTAT (Tape unit port status)
Microbus address   48-R
Register location(s) M8955 (TUP 2, 4)

Bit	Name	Description
7	Status parity error	Indicates a parity error has occurred when reading a TU78 register over the WCS lines.
6	Write data strobe	Reflects the state of the TU bus line WDS.
5	Command parity error	Indicates the TU78 has detected a parity error on the WCS lines during a TS78 command or command/status address write.
4	Tape unit present	Indicates that a TU78 transport is physically cabled to this TU port.
3	Tachometer	Reflects the state of the TU bus line TACH.
2	WCS parity	Reflects the state of the TU bus line WCS P.

Bit	Name	Description
1	Read parity	Reflects the state of the TU bus line RD P.
0	AMTIE parity	Reflects the state of the TU bus line AMTIE P.

Byte number	1E
Parameter address	41
Name	PRDD (TU port read data)
Microbus address	4C--R
Register location(s)	M8955 (TUP 2, 4)

Bit	Name	Description
7:0	Read data 7:0	This byte reflects information on TU bus lines RD 7:0 L.

Byte number	1F
Parameter address	42
Name	PERI (STI bus errors)
Microbus address	81
Register location(s)	M8971

Bit	Name	Description
7	Level 1 protocol error	Indicates that after first frame of level 2 message, a received hamming code is not recognized as valid continue or end code
6	CROM parity error	Indicates M8970 program parity error
5	Data late	Indicates one of three occurrences. An attempt was made to retrieve data from the PM FIFO that was not available. An attempt was made to store data in the PM FIFO before the input was ready. Or in autoshift mode, new data loaded into the hold register before the PM FIFO could accept the previous data.
4	Control parity error	Indicates parity error or synchronization error detected on real-time controller-state line. A parity error applies to the status bits. A synchronization error applies to the pattern of eight 0s and a 1 before the status bits.

Bit	Name	Description
3	Data pulse error	Indicates missing pulse on write/command data line. That is, two positive pulses appear with no negative pulse in between, or two negative pulses appear with no positive pulse in between.
2	Control pulse error	Indicates missing pulse on real-time controller-state line. This error is analogous to a data pulse error.
1	Cable not present	Indicates that there is no cable present between the TS78 logic gate and the TS78 control panel.
Ø	--	Not used

Byte number	2Ø
Parameter address	43
Name	WMCSTA (Write microcontroller status)
Microbus address	DØ-R
Register location(s)	M8959 (WMC1)

Bit	Name	Description
7	XMC not done	If Ø, translator microcontroller is done writing postamble and waiting to be serviced. If 1, translator is busy.
6	WMC not done	If Ø, write microcontroller is done writing PE data or GCR data groups. (Used in diagnostic single-step mode; normally appears for 11Ø ns.) If 1, write microcontroller busy or idle.
5	Transfer	Shifts one nibble on WMC DR bus into translator.
4	ECC to WMC DR bus	Gates HI or LO nibble of ECC character to WMC DR bus.
3	CRC to WMC DR bus	Gates HI or LO nibble of CRC character to WMC DR bus.
2	ACRC to WMC DR bus	Gates HI or LO nibble of ACRC character to WMC DR bus.

Bit	Name	Description
1	Residual to WMC DR bus	Gates HI or LO nibble of residual character to WMC DR bus.
Ø	XMC WCLK	Reflects true state of translator write clock pulse (11Ø ns at normal speed).

Byte number	21
Parameter address	44
Name	TUSELØ (Tape unit port Ø/1 select)
Microbus address	D1-R
Register location(s)	M8955 (port Ø/1 slot Ø8)

Bit	Name	Description
7	Single tape unit port	If Ø, both TUP modules are installed in backplane slots Ø8 and Ø9. If 1, only one TUP module is installed in backplane slot Ø8.
6	Byte count terminal count	If Ø, write microcontroller count terminal count (BCTC) is asserted. If 1, BCTC is unasserted.
5	TU port Ø read path enable	When true, indicates that the read path for tape unit port Ø is enabled.
4	TU port 1 read path enable	When true, indicates that the read path for tape unit port 1 is enabled.
3	TU port Ø write path enable	When true, indicates that the write path for tape unit port Ø is enabled.
2	TU port 1 write path enable	When true, indicates that the write path for tape unit port 1 is enabled.
1, Ø	Tape unit select 1:Ø	A 2-bit binary field that reflects the tape unit port currently selected by the TUSEL register (EØ-W bits 1:Ø).

```
Byte number               22
Parameter address         45
Name                      TUSEL1 (Tape unit port 2/3 select)
Microbus address          D2-R
Register location(s)      M8955 (port 2/3, slot 09)
```

Bit	Name	Description
7, 6	--	Not used.
5	TU port 2 read path enable	When true, indicates that the read path for tape unit port 2 is enabled.
4	TU port 3 read path enable	When true, indicates that the read path for tape unit port 3 is enabled.
3	TU port 2 write path enable	When true, indicates that the write path for tape unit port 2 is enabled.
2	TU port 3 write path enable	When true, indicates that the write path for tape unit port 3 is enabled.
1, 0	Tape unit select 1:0	A 2-bit binary field that reflects the tape unit port currently selected by the TUSEL register (E0-W bits 1:0).

NOTE
This byte is valid only when two TU port
modules are present in the system (i.e.,
TUSEL0, bit 7 = 0.)

```
Byte number               23
Parameter address         46
Name                      WRTDAT (write data)
Microbus address          D3-R
Register location(s)      M8959 (WMC 1)
```

Bit	Name	Description
7:0	DR D7:0 H	Looks at write or read data on the intermediate DRD bus.

```
Byte number               24
Parameter address         47
Name                      -- (Byte counter lo)
Microbus address          D4-R (first read)
Register location(s)      M8959 (WMC 1)
```

Bit	Name	Description
7:0	Byte count 7:0	Low byte of the write micro/byte assembly byte counter word. The first read of location D4 yields this byte.

Byte number   25
Parameter address   48
Name   -- (Byte counter hi)
Microbus address   D4-R (second read)
Register location(s) M8959 (WMC 1)

Bit	Name	Description
7:0	Byte count 15:8	High byte of the write micro/byte assembly byte counter word. The second read of location D4 yields this byte.

Byte number   26
Parameter address   49
Name   -- (Pad counter lo)
Microbus address   D5-R (first read)
Register location(s) M8959 (WMC1)

Bit	Name	Description
7:0	Pad count 7:0	Low byte of the write micro/byte assembly pad character counter word. The first read of location D5 yields this byte.

Byte number   27
Parameter address   4A
Name   -- (Pad counter hi)
Microbus address   D5-R (second read)
Register location(s) M8959 (WMC1)

Bit	Name	Description
7:0	Pad count 15:8	High byte of the write micro/byte assembly pad character counter word. The second read of location D5 yields this byte.

Byte number   28
Parameter address   4B
Name   -- (Error code counter lo)
Microbus address   D6-R (first read)
Register location(s) M8959 (WMC1)

Bit	Name	Description
7:0	Error code 7:0	Low byte of write micro/byte assembly error code count. The first read of location D6 yields this byte. (See byte 29 for Ecode counter values.)

Byte number	29
Parameter address	4C
Name	-- (Error code counter hi)
Microbus address	D6-R (second read)
Register location(s)	M8959 (WMC1)

Bit	Name	Description
7:0	Error code 15:8	High byte of write micro/byte assembly error code count. The second read of location D6 yields this byte.

Ecode counter is normally set to zero at the start of an operation.

Ecode counter values when read at the completion of an operation:

Bit Value	Error Indication
0	Operation completed successfully.
-1	Read skip count >4 in 0 core dump, >3 in 10 compatible, or >8 in 10 high-density compatible.
-2	Read skip count >1 in 11 normal or 15 normal.
-3	Format code >6.
-4	WMC self-test diagnostic error.
-5	Read overrun or write fault.

```
Byte number              2A
Parameter address        4D
Name                     WMCERR (Write microcontroller errors)
Microbus address         DA-R
Register location(s)     M8959 (WMC2)
```

Bit	Name	Description
7	--	Not used
6	DR MBD parity error	Bad (even) parity was received in data at TS78 input port.
5	Error	Write microcontroller diagnostic overall error status bit.
4	WMC ROM parity error	A write microcontroller ROM parity error was detected or the WMC internal microdiagnostic stopped at an error halt.
3	DR read parity error	A parity error was detected on a read data byte sent from the CRC/ACRC to WMC module over the CRC bus.
2:0	--	Not used

```
Byte number              2B
Parameter address        4E
Name                     INTSTA (Interrupt status)
Microbus address         E0-R
Register location(s)     M8972 (8MC1)
```

Bit	Name	Description
7	Interrupt timer (MCLK)	When clear, indicates the M8970 interrupt timer has timed out. First interrupt is 600 us after timer is started and subsequent interrupts are at 1.2 ms intervals until timer is reset.
6	USART receiver ready (RX)	When clear, indicates ASCII port USART has received a byte which is available in the receiver buffer.
5	Power ok	When set, indicates that the TS78 power supply has not signaled an AC LO condition.

Bit	Name	Description
4	Write data register parity	Reflects the state of the DR BYTE PAR H line. Serves as the parity bit for the WRTDAT register (D3-R), or as a PE write operation done flag.
3	KINI	Reflects the state of the KINI bit on the real-time controller-state line. When set, indicates controller request for STI bus initialization.
2	USART transmitter ready (TX)	When clear, indicates the ASCII port USART is ready to accept a new character in the transmitter buffer.
1	PE write parity error	When set, indicates that a vertical parity error has been detected at the output of the translator during a phase-encoded write operation.
Ø	Translator ROM parity error	When set, indicates that the translator microcontroller ROM has experienced a parity error or has branched to an error halt during its internal diagnostic routines.

Byte number	2C
Parameter address	4F
Name	TADRØØ (TU78 status)
Microbus address	4Ø-R (MIA register Ø)
Register location(s)	M8955/MIA (TU78)

Bit	Name	Description
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 the set state. Cleared by a CLR TU command.
5	On-line	The tape unit has been placed on-line; if ready, it will respond to motion commands issued remotely from the formatter.

Bit	Name	Description
4	Rewinding	The tape unit is currently rewinding.
3	PES	The tape unit is currently set to phase-encoded recording format. If reset, the tape unit is set to group-coded 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:

- The EOT marker is positioned at the EOT sensor during a reverse operation with ready set

- The tape unit is commanded to rewind tape

- A CLR EOT command is written into the TU CMD B location.

Bit	Name	Description
Ø	File protect	The tape reel currently loaded does not have the write enable ring in place.

Byte number	2D
Parameter address	5Ø
Name	TADRØ1 (MIA status A)
Microbus address	4Ø-R (MIA register 1)
Register location(s)	M8955/MIA (TU78)

Bit	Name	Description
7	Manual test	The manual test switch is in the MAN 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	Indicates the state of the reverse command bit.

Bit	Name	Description
4	Write	Indicates the state of the write command bit.
3	Write inhibit	Indicates the state of the write inhibit command bit.
2	LWR	Indicates the state of the loop write-to-read command bit.
1	MOT	Indicates that the capstan servo motor is turning.
Ø	DSE	Indicates that a DSE command has been written into the TU CMD B location. Clears when EOT sets, or when a CLR TU command is written into TU CMD B.

Byte number	2E
Parameter address	51
Name	TADRØ2 (MIA status B)
Microbus address	4Ø-R (MIA register 2)
Register location(s)	M8955/MIA (TU78)

Bit	Name	Description
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. 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 in) after BOT, the read amplifier gains failed to achieve the required value. Valid only if ready is set.
4,3	Speed 1:Ø	This 2-bit field indicates the speed of a tape unit; TU78 = 2 (125 in/sec).

Bit	Name	Description
2,1,0	Mode select 2,1,0	Indicates the position of the multiposition mode select switch on the tape unit operator panel. The bits are meaningful only when the mode select bits in the threshold command location have been written to ones.

Bit
Position   Meaning
2   1   0

2	1	0	Meaning
1	1	0	Position 0 (Normal)
1	0	1	Position 1 (Maintenance)
0	1	1	Position 2 (Maintenance)
1	1	1	Position 3 (Maintenance)

Byte number   2F
Parameter address   52
Name   TADR03 (Serial number A)
Microbus address   40-R (MIA register 3)
Register location(s) M8955/MIA (TU78)

Bit	Name	Description
7:4	SN TH 3:0	Most significant (thousands) BCD digit of the tape unit's serial number
3:0	SN HU 3:0	The hundreds BCD digit of the tape unit's serial number

Byte number   30
Parameter address   53
Name   TADR04 (Serial number B)
Microbus address   40-R (MIA register 4)
Register location(s) M8955/MIA (TU78)

Bit	Name	Description
7:4	SN tens 3:0	The tens BCD digit of the tape unit's serial number.
3:0	SN ones 3:0	Least significant (ones) BCD digit of the tape unit's serial number.

Byte number   31
Parameter address   54
Name   TADR05 (Tape unit diagnostics)
Microbus address   40-R (MIA register 5)
Register location(s) M8955/MIA (TU78)

Bit	Name	Description
7	Write bit 4	Indicates the state (polarity) of the write driver for physical track 4 head.
6	Write	There is no current flowing through the write or erase heads
5	Read enable	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. Not valid unless ready = 1.
3	TACH	The state of the output from the capstan motor digital tachometer.
2	--	Zero
1,0	AMTIE THR 1:0	Indicates the value of the AMTIE threshold field in the THRESHOLD command location.

Byte number	--	
Parameter address	55	
Name	--	(Spare location)
Microbus address	--	
Register location(s)	--	

Bit	Name	Description
7:0	--	This location is valid only for temporary data storage when using the ASCII port. Contents of this location are not returned to the HSC for error logging.

Byte number	--	
Parameter address	56	
Name	--	(Spare location)
Microbus address	--	
Register location(s)	--	

Bit	Name	Description
7:0	--	This location is valid only for temporary data storage when using the ASCII port. Contents of this location are not returned to the HSC for error logging.

B.3 EXTENDED FORMATTER STATUS

```
Byte number          1
Parameter address    57
Name                 ERRNUM (Error number low byte)
```

Bit   Description

7:0   Eight least significant bits of 10-bit error
        identification number. (Refer to Paragraph B.3.1)

```
Byte Number          2
Parameter address    58
Name                 ERRN1 (Error number high byte)
```

Bit   Description

7   Critical error. When 1, indicates error is critical;
        formatter should be removed from service. This bit is
        forced to 0 for error that occurs while operational code
        is running.

6   Data available. When 1, indicates data generated by
        diagnostic code is available. This bit is forced to 0 for
        error that occurs while operational code is running.

5:3   Fault number. Indicates one of six areas in the formatter
        that may have caused a potentially fatal error. (Refer to
        Table 4-1)

2   When 1, indicates operational error.
        When 0, indicates diagnostic error.

1:0   Two most significant bits of 10-bit error identification
        number. (Refer to Paragraph B.3.1)

```
Byte number          3
Parameter address    59
Name                 OPSAV
```

Bit   Description

7:0   Last received level 2 opcode. Listed below are the
        available command codes and their meaning.

        Command
        Code   Meaning

        41   Clear drive errors
        42   Clear formatter errors
        44   Disconnect
        47   Get formatter characteristics
        48   Get summary status
        4B   Initiate rewind

```
          Command
          Code              Meaning
          4D                Position tape
          4E                Set unit execution mode
          5Ø                Set byte count
          53                Write tape mark
          55                Data error recovery
          CØ                Change controller flags
          C3                Diagnose
          C5                Get extended drive status
          C6                Get formatter error log
          C9                Get unit characteristics
          CA                Erase gap
          CC                Online
          CF                Read memory
          D1                Set unit characteristics
          D2                Topology
          D4                Write memory
```

Byte number   4
Parameter address   5A
Name   CONNST (Connection state byte)

Bit   Description

7:5   Not used

4   Broken. When 1, indicates minimum integrity failure.
         Formatter cannot communicate via STI bus because of
         internal hardware problem.

3   Off-line. When 1, indicates both formatter ports are
         off-line with respect to controller. (No STI communication
         since PORT SELECT A and B are in disabled position.)

2   Topology. When 1, indicates formatter entered topology
         mode. With one formatter port on-line, second port
         simulates available state for up to 1 second.

1   Available. When 1, indicates one or both formatter ports
         is in available state relative to controller. (PORT SELECT
         A and/or B in enabled position but controller has not
         placed a port on-line.) Controller can access available
         port but access is limited to very few commands such as
         retrieving status.

Ø   On-line. When 1, indicates a formatter port is on-line
         with respect to controller (ready to receive any command
         or data). If PORT SELECT A and B are in enabled position,
         other port is unavailable except if formatter is in
         topology mode.

```
Byte number           5
Parameter address     5B
Name                  SUMMOD (Summary mode byte 1)
```

Bit   Description

7   Formatter attention. When 1, indicates potentially
         significant status change in formatter; not caused by
         reception, validation or execution of controller command.

6   Transport 3 attention. Analogous to bit 7.

5   Transport 2 attention. Analogous to bit 7.

4   Transport 1 attention. Analogous to bit 7.

3   Transport Ø attention. Analogous to bit 7.

2   When 1, indicates formatter entered topology mode. (Refer
         to CONNST bit 2 for further definition.)

1   When 1, indicates PORT SELECT A and/or B is in enable (in)
         position

Ø   When 1, indicates diagnostic request. Formatter requests
         controller to execute diagnostic identified in formatter
         memory region FFFD.

```
Byte number           5
Parameter address     5B
Name                  SUMMOD (Summary mode byte 1)
```

Bit   Description

7   Formatter error. When 1, indicates formatter error
         detected while running operational code.

6   Transmission error. When 1, indicates detection of STI bus
         error that falls into one of the following categories.

         ● Received hamming code of suspected level 1 message is
           not recognized, or received unit number is invalid

         ● Received level 1 command is in improper context
           (e.g.; formatter is not on-line for write command).

         ● Level 1 protocol error; received hamming code is not
           recognized as continue or end, after first frame of
           level 2 message

Bit	Description

- Checksum error; calculated checksum does not agree with received checksum

- Level Ø error; pulse or parity error on real-time controller-state line, or pulse error on write/command data line

5   Level 2 protocol error. When 1, indicates detection of STI bus programming error relating to received message byte(s) in level 2 command. For example, operand has wrong parity or wrong number of message bytes received for specified command).

4   Diagnostic failed. When 1, indicates formatter error detected while running in-line, off-line or subsystem diagnostic. Diagnostic error report is available in formatter memory region 3432.

3:Ø   Not used

Byte number   7
Parameter address   5D
Name   SUMMD2 (Summary mode byte 2)

Bit	**Description**

7:4   Not used

3   When 1, indicates new error log information is available in the extended formatter status area

2:Ø   Retry bits RP, RT and FD. These bits indicate formatter progress in an error recovery sequence instructing the controller what recovery step to do next. Retry codes are listed below.

```
Bit Position
2   1   Ø
RP  RT  FD   Meaning

Ø   Ø   X    No error
Ø   1   Ø    Ready for data transfer in same direction
Ø   1   1    Ready for data transfer in opposite direction
1   Ø   Ø    Retried transfer succeeded
1   Ø   1    Retried transfer failed
1   1   Ø    Ready to position for retry in same direction
1   1   1    Ready to position for retry in opposite
             direction
```

```
Byte number          8
Parameter address    5E
Name                 CONBYT (Controller flag byte)

Bit      Description

7        When 0, indicates normal operation.

         When 1, indicates formatter only responds to commands from
         controller diagnostic. The controller uses this mode to
         execute diagnostics that cannot keep the formatter
         on-line.

6:0      Not used

Byte number          9
Parameter address    5F
Name                 PRTOSV (Port control byte)

Bit      Description

7:4      Not used

3        When 1, indicates formatter transmission enabled on port A
         real-time formatter-state line

2        When 1, indicates formatter transmission enabled on port B
         real-time formatter-state line

1        When 1, indicates formatter reception and transmission
         enabled on port A data lines, and formatter reception
         enabled on port A real-time controller-state line

0        When 1, indicates formatter reception and transmission
         enabled on port B data lines, and formatter reception
         enabled on port B real-time controller-state line

Byte number          A
Parameter address    60
Name                 FSTOSV (Formatter state byte)

Bit      Description

7        When 0, forces transmission of 0s on enabled port(s)
         real-time formatter-state line.

         When 1, allows transmission of state bits on enabled
         port(s) real-time formatter-state line. Bits 6--1 in
         FSTOSV are the state bits.

         Bit 7 is a 1 when formatter is on-line or available, and a
         0 when formatter is off-line. (Refer to CONNST for
         definition of formatter connection states.)
```

Bit	Description

6   Formatter receiver ready. When 1, indicates formatter is ready to receive a new message frame or data. Reception of a valid sync character causes the formatter to clear this bit to 0.

5   Attention. When 1, indicates potentially significant status change not caused by reception, validation or execution of controller command. In most cases, a status change is caused by user intervention such as opening a transport door or pressing the LOAD/REW button. Source of the attention condition is identified in SUMMOD. (See note below.)

4   Acknowledge. When 0, indicates data transfer error occurred (operation aborted) or exception occurred (tape mark, EOT or BOT detected during data transfer). (See note below.)

3   Data ready.
In read operation, leading edge (transition to 1) indicates tape drive is starting sequence to transmit sync character and then data. Falling edge (transition to 0) indicates formatter has transmitted all of the data and part of the byte count.

In write operation, leading edge (transition to 1) indicates tape drive is starting write sequence in autoshift mode. Falling edge (transition to 0) indicates data received and stored with no error, and EDC received and verified.

In position tape operation, toggling of data ready bit indicates progress is being made. Formatter complements data ready for every gap detected (i.e.; every record or tape mark passed). Acceptable progress is a toggling rate of at least twice for every long time-out period. Data ready is a 0 at beginning and end of operation. (See note below.)

2   Not used. (See note below.)

NOTE
Definitions above for bits 5-2 are valid only when formatter is on-line. With formatter in available state, bits 5-2 represent a 4-bit event counter with bit 5 being the most-significant-bit (MSB). The counter records the number of changes in connection state of the transport(s). (The three transport connection states are on-line, available and off-line.)

Bit   Description

1   Available. When 0, indicates formatter is on-line. When 1,
        indicates formatter is available or off-line. (Refer to
        CONNST for definition of formatter connection states.)

0   Parity.
        When 0, allows normal operation; calculate odd parity
        based on bits 6-1 in FSTOSV to yield bit 0 (parity bit) on
        enabled real-time formatter-state line(s).

        When 1, forces parity error; calculate even parity
        yielding a parity bit in bit 0 that is inverted with
        respect to its correct value.

Byte number   B
Parameter address   61
Name   PSWISV (Port switch byte)

Bit   Description

7   Not used

6   When 1, indicates FAULT is being pressed

5   When 1, indicates PORT SELECT A is in enabled (in)
        position

4   When 1, indicates PORT SELECT B is in enabled (in)
        position

3:0   Not used

Byte number   C
Parameter address   62
Name   LASSTA

Bit   Description

7:0   Last checkpoint passed in operational code. (Refer to
        Paragraph B.3.2)

Byte number   D
Parameter address   63
Name   ERRFLG (Error retry flag byte)

Bit   Description

7:6   Not used

5   When 1, indicates initial command was a write

4   When 1, indicates initial command moved tape in reverse
         direction

3   When 1, indicates initial command moved tape in opposite
         direction

2   Most-significant-bit (MSB) of unit number for transport
         that executed initial command

1   Least-significant-bit (LSB) of unit number for transport
         that executed initial command

Ø   Not used

Byte number   E
Parameter address   64
Name   RETCNT (Retry counter)

Bit   Description

7:Ø   Number of retry requests during error recovery sequence

Byte number   F
Parameter address   65
Name   KICNT (STI bus initialization counter)

Bit   Description

7:Ø   Number of initializations since TA78 master reset or
         power-up

Byte number   1Ø
Parameter address   66
Name   --

Bit   Description

7:Ø   Contents of memory location specified in stack pointer
         (SP) after underflow error

```
Byte number            11
Parameter address      67
Name                   --
```

Bit   Description

7:0   Contents of next location (SP+1) after underflow error

```
Byte number            12
Parameter address      68
Name                   --
```

Bit   Description

7:0   Contents of next location (SP+2) after underflow error

```
Byte number            13
Parameter address      69
Name                   --
```

Bit   Description

7:0   Contents of next location (SP+3) after underflow error

NOTE
Bytes 10-13 are only valid if an
underflow error has occurred. Otherwise,
these four bytes are cleared to 0.

```
Byte number            --
Parameter address      6A
Name                   -- (Spare location)
```

Bit   Description

7:0   This location is valid only for temporary data storage
         when using the ASCII port. Contents of this location are
         not returned to the HSC for error logging.

B.3.1   Error Number
A 16-bit error number, shown in Figure B-1, reports both
operational and diagnostic errors. Operational errors are errors
that occur while the operational code is running. Diagnostic
errors are errors that occur while an in-line diagnostic is
running (in normal mode) or while an off-line or subsystem
diagnostic is running. A hex number of C or 4 in the
least-significant-digit (LSD) of the high byte (ERRN1) indicates
an operational error which is identified in Table B-1. Any other
LSD for ERRN1 indicates a diagnostic error which is identified in
a standard error report including FRU and summary description.
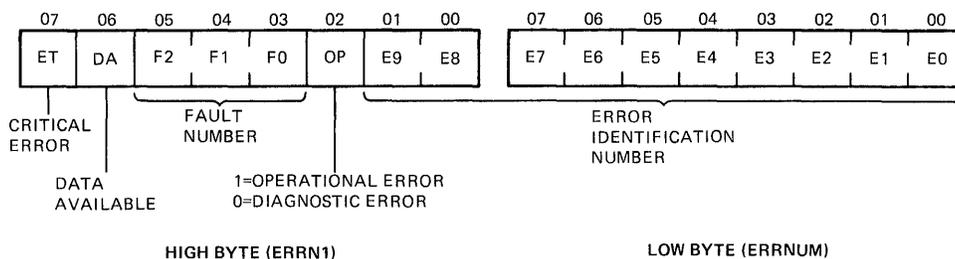
Figure B-1   Error Number Bytes

Table B-1   Operational Error Codes

Error Number High Byte	Low Byte	Fault Number	Error Description
ØØ	ØØ	--	Operation completed with no error detected.
Ø4	Ø1	--	TU CMD did not load correctly to start tape motion in Erase Gap routine.
Ø4	Ø2	--	TU velocity never came up to acceptable speed (i.e.; within 1Ø% of 125 in/s).
Ø4	Ø3	--	Write operation successfully completed beyond EOT marker (exception condition).
Ø4	Ø4	--	Read path could not verify gap at end of Erase Gap routine.
Ø4	Ø5	--	TU velocity changed from proper speed to unacceptable speed during operation.
Ø4	Ø6	--	Write attempted on file protected tape or TU FPT bit set during operation.
Ø4	Ø9	--	TU CMD did not load correctly to start tape motion to write ID burst.
Ø4	ØA	--	TU CMD did not load correctly to set PE tape density at start of write BOT ID burst.
14	ØB	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated when Find Gap command loaded during Erase Gap routine.)

Table B-1 Operational Error Codes (Cont)

Error Number High Byte	Low Byte	Fault Number	Error Description
14	ØC	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated when Verify ID Burst command loaded during write of BOT area.)
Ø4	ØD	--	Failed to write density ID burst correctly.
Ø4	ØE	--	TU CMD did not load correctly to set GCR tape density after reading a GCR Density ID burst.
14	ØF	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated when Verify ARA Burst command loaded during write of BOT area.)
Ø4	1Ø	--	Failed to write ARA burst correctly.
14	11	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated when Verify ARA ID command loaded during write of BOT area.)
Ø4	12	--	Failed to write ARA ID correctly.
Ø4	13	--	ARA error bit set in MIA status B register.
Ø4	14	--	Could not find gap after ID code was written correctly.
Ø4	15	--	TU CMD did not load correctly to start tape motion to write BOT ID burst.
14	16	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated when Verify Gap command loaded during write of BOT area.)
Ø4	17	--	TU CMD did not load correctly to backup tape to BOT after failing to write BOT ID.

Table B-1 Operational Error Codes (Cont)

Error Number High Byte	Low Byte	Fault Number	Error Description
Ø4	18	--	Time-out looking for BOT after failing to write BOT ID.
Ø4	19	--	TU CMD did not load correctly to start tape motion in selected function routine.
14	1A	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated in selected function routine.)
Ø4	1B	--	Failed to write tape mark correctly.
Ø4	1C	--	Tape never came up to acceptable speed while trying to reposition for retry of writing tape mark.
Ø4	1D	--	TU CMD did not load correctly to backup for retry of writing tape mark.
Ø4	1E	--	TU velocity changed from proper to unacceptable speed while trying to reposition for retry of writing tape mark.
Ø4	1F	--	No record found within 7.6 m (25 ft) of tape.
Ø4	2Ø	--	Time-out looking for BOT after detecting ARA ID burst while moving in reverse direction.
Ø4	22	--	Detected BOT marker after tape motion started.
Ø4	23	--	Reverse command issued while tape at BOT.
2C	24	5	ECC ROM parity error.
14	25	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated when Read ID Burst command loaded during read of BOT area.)
Ø4	26	--	ID burst neither PE or GCR.

Table B-1 Operational Error Codes (Cont)

Error Number High Byte	Low Byte	Fault Number	Error Description
Ø4	27	--	No Gap found after ID burst (PE) or ARA ID burst (GCR).
Ø4	28	--	TU CMD did not load correctly to start tape motion to read ID burst.
Ø4	29	--	ARA ID not found.
14	2A	2	Command read from RMC register RMCLP did not match command loaded into RCMD register. (This code generated when Verify ARA ID command loaded during read of BOT area.)
14	2B	2	Command read from RMC register RCMLP did not match command loaded into RCMD register. (This code generated when Verify Gap command loaded during read of BOT area.)
Ø4	2D	--	TU CMD did not load correctly to set PE tape density at start of read from BOT.
Ø4	2E	--	TU CMD did not load correctly to set GCR tape density after reading a GCR Density ID burst.
1C	2F	3	WMC general error during read operation; check Ecode register for reason. May be illegal Format or Skip Count codes.
1C	30	3	RD PE set in WMCERR register with no ECC uncorrectable error in ECCSTA register. Or during read operation, WMC ROM PE in WMCERR is set.
1C	31	3	XMC ROM parity error.
1C	32	3	XMC DONE did not set.
1C	33	3	WMC ROM PE set in WMCERR register during write operation.
1C	34	3	WMC general error during write operation; check Ecode register for reason. May be illegal Format or Skip Count codes.

Table B-1 Operational Error Codes (Cont)

Error Number High Byte	Low Byte	Fault Number	Error Description
Ø4	35	--	Could not find a gap after writing record and read path terminated early.
Ø4	36	--	RSTAT contains error code.
1C	37	3	XMC PE mode parity error set in INTSTA register.
Ø4	38	--	AMTIE, pointer mismatch, uncorrectable, two-track error or single-track error set in ECCSTA register. (This code generated by write PE operations.)
Ø4	39	--	At least one write fail bit set in RPFAIL and RPATH registers.
Ø4	3A	--	GCR characters from WMC and RMC do not match. (This code generated by write PE operations.)
Ø4	3B	--	CRC error, ACRC error, pointer mismatch, uncorrectable or two-track error set in ECCSTA register. (This code generated by write GCR operations.)
Ø4	3C	--	More than one write fail bit set in RPFAIL and RPATH registers. (This code generated by write GCR operations.)
Ø4	3D	--	Could not detect a gap after writing record.
Ø4	3E	--	TU velocity changed while writing PE gap before starting to write record.
Ø4	3F	--	Read path terminated before entire record was written.
Ø4	4Ø	--	Calculated EDC did not match received EDC during write operation.
34	41	6	PM DONE did not set at end of port switch routine.
34	42	6	PM CROM parity error occurred during port switch routine.

Table B-1 Operational Error Codes (Cont)

Error	Number		
High Byte	Low Byte	Fault Number	Error Description
34	43	6	Port enable status read after port switch routine did not match desired port enable status.
34	44	6	PM CROM parity error occurred while receiving message in available state.
34	45	6	PM FIFO input not ready at start of send level 2 message routine.
34	46	6	Data late error caused by attempting to retrieve message from empty PM FIFO during level 1 command validation.
34	47	6	PM FIFO output not ready (so message not available) at start of level 2 command validation.
34	48	6	PM CROM parity error occurred during level 1 command validation.
34	49	6	PM FIFO input not ready during diagnostic echo routine.
34	4A	6	PM CROM parity error occurred during diagnostic echo routine.
34	4B	6	PM CROM parity error occurred during level 2 command validation.
34	4C	6	PM CROM parity error occurred during send level 2 message routine.
0C	4D	1	TS78 control panel cable is not present.
34	4E	6	PM FIFO output ready at start of diagnostic echo response. This indicates too many bytes (over two) were in FIFO.
34	4F	6	PM CROM parity error occurred while receiving message in on-line state.
3C	50	7	Level 2 message byte-count is too large (over 63 bytes) to transmit with send level 2 routine.

Table B-1 Operational Error Codes (Cont)

Error Number High Byte	Low Byte	Fault Number	Error Description
3C	51	7	Message retrieved from PM FIFO, during level 2 command validation, is too large (over 64 frames).
Ø4	52	--	Uncorrectable data error detected.
Ø4	53	--	Tape mark detected while reading a record.
Ø4	54	--	Transmission error detected in PERI register.
34	55	6	PM clock not enabled at start of write routine.
34	56	6	PM CROM parity error occurred during data operation.
3C	57	7	Bad or missing ROM on M8972.
3C	58	7	Write current not inhibited during erase-only portion of write retry operation.
Ø4	59	--	Illegal microdiagnostic number detected while running operational code.
Ø4	5A	--	Correctable error detected.
Ø4	5B	--	Minimum integrity failure.
34	5C	6	PM DONE did not set at end of read routine.
34	5D	6	PM FIFO output ready (so FIFO not empty) at end of read routine.
Ø4	5E	--	Data late error detected in PERI register at end of data operation.
3C	5F	7	Stack underflow error.
3C	6Ø	7	AC LO power interrupt received indicating impending power failure.

Table B-1 Operational Error Codes (Cont)

Error Number			
High Byte	Low Byte	Fault Number	Error Description
3C	61	7	Unexpected RST 1 interrupt. (RST 1 interrupt received but RX or TX interrupt line not asserted in INTSTA register.)
3C	62	7	Unexpected RST 2 interrupt. (RST 2 interrupt received but MCLK or RX interrupt line not asserted in INTSTA register.)
3C	63	7	Unexpected RST 3 interrupt. (RST 3 interrupt received but RX interrupt line not asserted in INTSTA register.)
3C	64	7	Unexpected RST 4 interrupt. (RST 4 interrupt received but MCLK or TX interrupt line not asserted in INTSTA register.)
3C	65	7	Unexpected RST 5 interrupt. (RST 5 interrupt received but TX interrupt line not asserted in INTSTA register.)
3C	66	7	Unexpected RST 6 interrupt. (RST 6 interrupt received but MCLK interrupt line not asserted in INTSTA register.)
3C	67	7	Unexpected RST 7 interrupt. (RST 7 interrupt received but TU STAT parity error not asserted in PSTAT register.)
3C	68	7	Unexpected trap interrupt. (Trap interrupt received but AC LO interrupt line not asserted in INTSTA register.)
3C	69	7	Unexpected RST 5.5 interrupt. (RST 5.5 interrupt received but KINI interrupt line not asserted in INTSTA register.)
3C	6A	7	Unexpected RST 6.5 interrupt. (8085 received illegal instruction.)
3C	6B	7	Unexpected RST 7.5 interrupt. (RST 7.5 interrupt received but TU CMD parity error not asserted in PSTAT register.)

Table B-1 Operational Error Codes (Cont)

| Error Number | | | |
High Byte	Low Byte	Fault Number	Error Description
04	6C	--	Preamble had AMTIE during write operation.
3C	6D	7	8085 interrupts not enabled in off-line state.
04	6E	--	Follow-up write command not received within 2.4 ms of finishing last record in keep going mode.
04	FE	--	Forced fatal drive error during data operation, for testing HSC.
0C	FF	1	Forced fatal formatter error during data operation, for testing HSC.

B.3.2   Last Status (LASSTA) Code
Byte number C in the extended formatter status area contains an 8-bit code that describes the last checkpoint passed in the operational code before error detection. In effect, the LASSTA code provides a progress report up to the error detection. Table B-2 lists and describes the LASSTA codes.

Table B-2 LASSTA Codes

Opcode	Description
00	Not used.
01	Not used.
02	Level 2 protocol error.
03	Transmission error.
04	Diagnostic Echo command executed properly.
05	Asserted KINI state bit recognized and STI-bus initialization executed properly.
06	Change Controller Flags command executed properly.

Table B-2 LASSTA Codes (Cont)

Opcode	Description
Ø7	Clear Drive Errors command executed properly.
Ø8	Clear Formatter Errors command executed properly.
Ø9	Disconnect command executed properly.
ØA	Get Extended Drive Status command executed properly.
ØB	Get Formatter Error Log command executed properly.
ØC	Get Formattter Characteristics command executed properly.
ØD	Get Summary Status command executed properly.
ØE	Get Unit Characteristics command executed properly.
ØF	Erase Gap command executed properly.
1Ø	Initiate Rewind command executed properly (rewind, rewind/unload, or DSE/rewind initiated successfully).
11	Position Tape command executed properly (tape motion routine initiated successfully and making progress).
12	Read Memory command executed properly.
13	Set Byte Count command executed properly.
14	Set Unit Characteristics command executed properly.
15	Topology mode entered successfully.
16	Successful exit of topology mode.
17	Write Tape Mark command executed properly.
18	Write Memory command executed properly.
19	On-line state entered successfully.

Table B-2 LASSTA Codes (Cont)

Opcode	Description
1A	Suspected level 1 frame received and validation starting.
1B	Suspected level 1 frame failed validation (bad hamming code or wrong connection state).
4Ø	Erase Gap subroutine (ERAMOT) entered, and turn-around delay completed if last operation was in reverse direction.
41	TU CMD loaded correctly to start tape motion in Erase Gap subroutine (ERAMOT).
42	Tape erasing completed and verification of gap starting in Erase Gap subroutine (ERAMOT).
43	Gap verified and TU CMD loaded to stop tape motion in Erase Gap subroutine (ERAMOT).
44	TU CMD loaded (but not verified) to start tape motion to write ID burst.
45	ID burst written correctly and starting to verify IBG while writing in BOT area.
46	TU CMD loaded (but not verified) to start backup tape motion for retry of ID burst write.
47	TU CMD loaded (but not verified) to start tape motion to write tape mark.
48	Tape mark written and verified in Write Tape Mark subroutine (WTMMOT).
49	Successfully moved a record while positioning tape.
4A	TU CMD loaded (but not verified) to start tape motion to move forward 1 record.
4B	TU CMD loaded (but not verified) to start tape motion to move reverse 1 record.
4C	TU CMD loaded (but not verified) to start tape motion during read of BOT area.
4D	Sampled ID burst 255 times and starting valid determination of density during read of BOT area.

Table B-2 LASSTA Codes (Cont)

Opcode	Description
4E	ID burst correctly determined and verification of gap starting during read of BOT area.
4F	TU CMDs loaded (but not verified) to start tape motion and start erasing before EOT during DSE operation.
50	At EOT and starting erase of additional 10 ft during DSE operation.
51	Erasure of 5 or 10 ft segment after EOT completed during DSE operation. (If only 5 ft. done, erasing of second 5 ft. segment starting. If 10 ft. done, rewind starting.)
52	Rewind/Unload motion routine entered successfully.
53	Not used.
54	Read reverse subroutine (DORDR) entered successfully.
55	Read or read reverse command recognized (received, validated and starting execution).
56	Read subroutine (DORDF) entered successfully.
57	TU CMD loaded (but not verified) to stop tape motion during read or read reverse operation.
58	Write command recognized (received, validated and starting execution).
59	Write command subroutine (DOWRT) entered successfully.
5A	TU CMD loaded (but not verified) to stop tape motion during write operation.
5B	Data Error Recovery command executed properly (does not include error termination).
5C	Set Unit Execution Mode command executed properly.