TU78
Subsystem

Pocket
Service
Guide

digital

TU78 Subsystem

Pocket Service Guide

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ESB #54 (TUDIAG)

07	06	05	04	03	02	01	00
WRB4	WR	RDEN	EOT DET	TACH	0	AMTIE THR, 1:0	

STATE OF WRITE AMP FOR TK4

READ ENABLE

TACHOMETER PULSE

AMTIE THRESHOLD
0/1= 10% IBG CHECK
2= 25% WRITE
3= 20% READ

NOT WRITING   EOT DETECTED
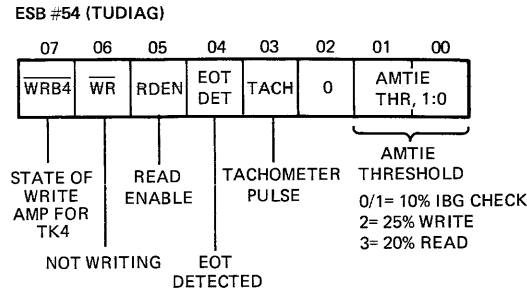
MA-7965

Figure B-15   MIA TU Diagnostics Byte

ESB #56 (RETCNT+1)

07	06	05	04	03	02	01	00
OPP	RD	REV	0	0	0	0	0

LAST RETRY WAS IN THE OPPOSITE DIRECTION OF INITIAL COMMAND

INITIAL COMMAND MOVED TAPE REVERSE

INITIAL COMMAND WAS A READ

MA-7966

Figure B-16   Retry Control Byte

TABLES

ESB #50 (MIA STAT A)

Figure B-13   MIA Status A Byte

ESB #51 (MIA STAT B)

Figure B-14   MIA Status B Byte

Byte	Description
50	MIA register 1; MIA status A (Refer to Figure B-13)
51	MIA register 2; MIA status B (Refer to Figure B-14)
52	MIA register 3; serial NR A
53	MIA register 4; serial NR B
54	MIA register 5; diag (Refer to Figure B-15)
55	Retry counter (RETCNT) – This byte is the count of retry interrupt requests given for the tape unit. When this count is zero, the tape unit is not in a retry sequence.
56	Retry control bits (RETCNT+1) – This byte is used by the microcode to control error recovery. It is meaningful only when the retry counter (byte 55) is not zero. (Refer to Figure B-16)
57	TU software status (TUx). This byte contains information about the tape drive. (Refer to Figure B-17)
58	Transfer control word (XFRCTL) – This byte contains control information used by data transfer commands. (Refer to Figure B-18)
59	Retry suppress and format control (XRETRY). This byte contains the contents of the left half of the MASSBUS register, which contains the retry suppress bit, format, and skip count.
60	Keypad enable flag (ENAON) – This byte is not zero when the keypad is enabled.

1 INTRODUCTION

1.1 GENERAL

This document is designed for use by a person trained to service a TU78 subsystem. A TU78 subsystem is made up of a MASSBUS controller (RHXX), a TM78 formatter, and a TU78 tape transport. Procedures are short, and support a maintenance philosophy of module replacement.

This chapter presents an overview of the formatter and transport for quick review. Chapter 2 is troubleshooting information. Use of error logs, diagnostics, and maintenance panel features allow rapid location of malfunctions. Chapter 3 lists all adjustments in quick reference format.

Programming information is not provided but register summaries for each hardware family type are found in Appendix A. Appendix B lists the extended sense registers available in the diagnostic and error log printouts.

1.2 SUBSYSTEM OVERVIEW

The TU78 subsystem is shown in Figure 1-1. The example shown is a dual-ported TM78 formatter, controlling four TU78 transports. A detailed block diagram of the subsystem may be found on the foldout at the end of this book.

1.3 TM78 ASSEMBLIES

Major TM78 assemblies are shown in Figures 1-2 and 1-3.

1.4 TU78 ASSEMBLIES

Major TU78 assemblies are shown in Figures 1-4, 1-5, and 1-6.

1.5 OPERATOR CONTROLS AND INDICATORS

All operator controls and indicators are on the TU78 control panel. Figure 1-7 shows the panel, Table 1-1 lists the controls and their functions, and Table 1-2 lists the indicators and their functions.

ESB #48 (INTSTA)

07	06	05	04	03	02	01	00
MB SEL	ROM PE	PWR OK	WDR P	MBA OUT	MBB OUT	PE WRPE	XROM PE

MASSBUS PORT SELECT
0=PORT A
1=PORT B

POWER OK

MASSBUS PORT A LOGIC NOT PRESENT

TRANSLATOR (M8959) ROM PARITY ERROR

PE WRITE DONE

TRANSLATOR VPE ON PE WRITE

MICROCOMPUTER (M8960) ROM PARITY ERROR

MASSBUS PORT B LOGIC NOT PRESENT

MA-7961

Figure B-11   Interrupt Status Byte

ESB #49 (TUSTAT)

07	06	05	04	03	02	01	00
TU RDY	RDY ON	ONL	REW	PES	BOT	EOT	FPT

TU IS ON LINE AND READY

TU IS ON-LINE BUT NOT NESSARILY READY

BEGINNING OF TAPE

FILE PROTECTED

0=GCR MODE
1=PE MODE

END OF TAPE

READY WENT SET SINCE LAST TU CLEAR COMMAND

TU IS REWINDING

MA-7962
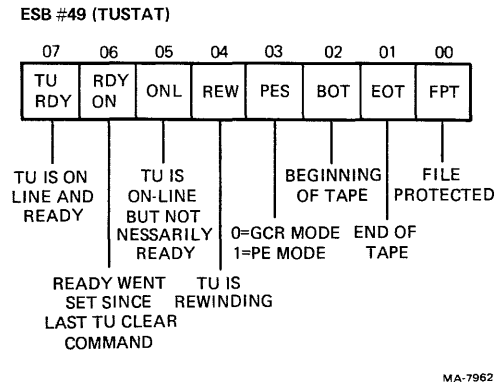
Figure B-12   TU78 Status Byte

Byte	Description
48	Hardware register 340; interrupt status (Refer to Figure B-11)
49	MIA register 0; TU78 status (Refer to Figure B-12)

MA-6109A

TU78 0   TU78 1 *   TU78 2 *   TU78 3 *

RADIAL BUS NETWORK

TU P0/1   TU P2/3

TM78 FORMATTER

PORT A   PORT B *

* OPTIONAL

MASSBUS A   MASSBUS B

MASSBUS INTERFACE A   MASSBUS INTERFACE B

Figure 1-1   Dual-Ported TU78 Subsystem

ESB #34 (DBUS STA)
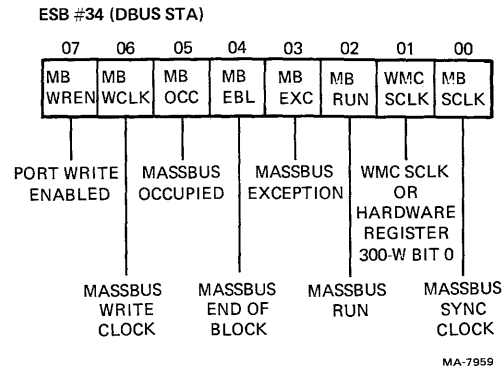
Figure B-9   MASSBUS D Bus Status Byte

ESB #47 (DDR C)
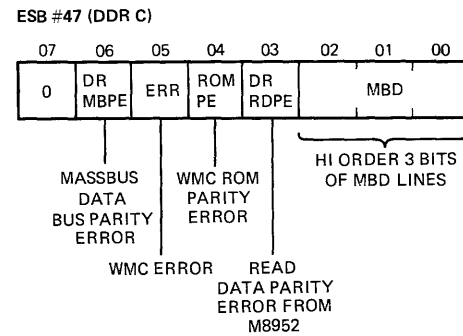
Figure B-10   Write Microcontroller Error Byte

Byte	Description
44	Hardware register 326; ECODE counter <15:8>
45	Hardware register 330; DDR/MBD A
46	Hardware register 331; DDR/MBD B
47	Hardware register 332; WMC errors (Refer to Figure B-10)
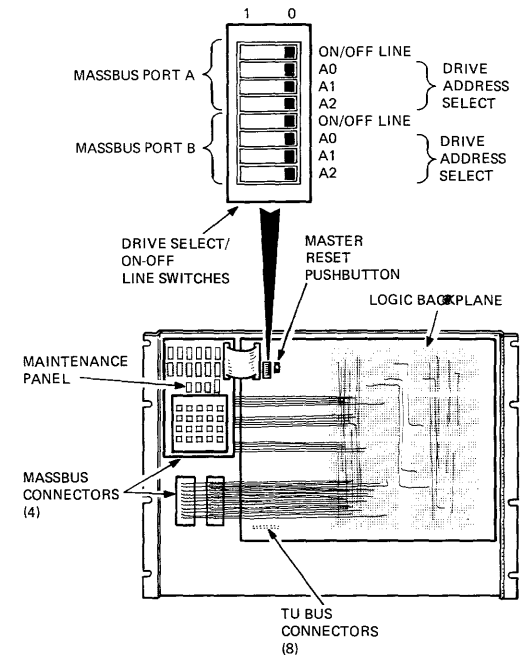
Figure 1-2   TM78 Front View
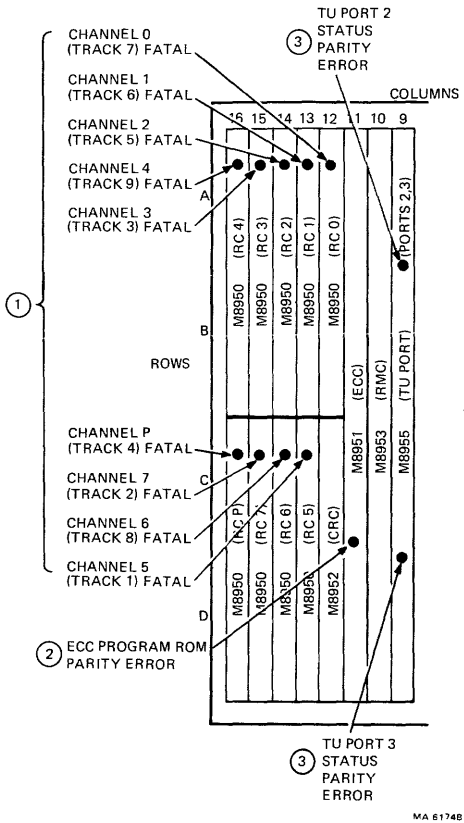
Figure 1-3   TM78 Module Layout (Back View) Showing Maintenance Indicators (Sheet 1 of 2)

ESB #32 (CASSTA)

MA-7957
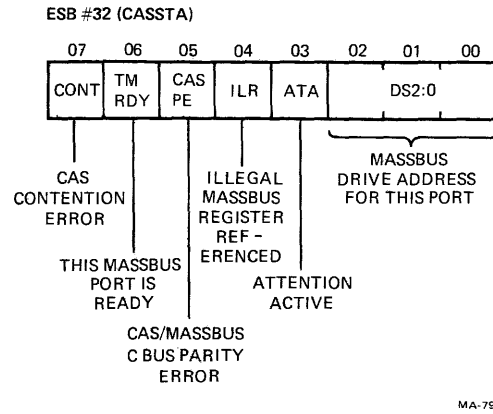
Figure B-7   CAS Port (N) Status Byte

ESB #33 (CBUSSTA)

MA-7958
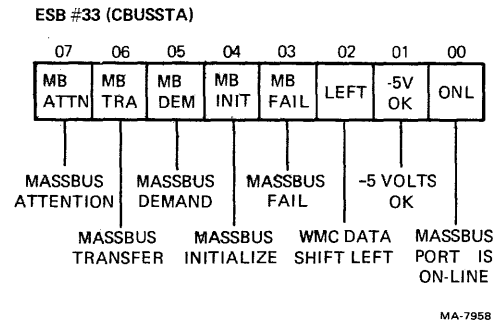
Figure B-8   MASSBUS C Bus Status Byte

Byte	Description
39	Hardware register 324; byte counter <7:0>
40	Hardware register 324; byte counter <15:8>
41	Hardware register 325; PAD counter <7:0>
42	Hardware register 325; PAD counter <15:8>
43	Hardware register 326; ECODE counter <7:0>
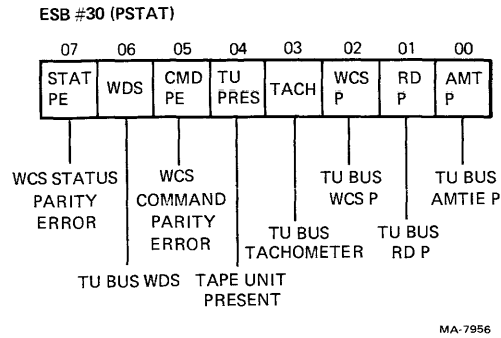
Figure B-6   TU Port Status Byte

Byte	Description
27	Hardware register 50; channel P TIE bus (Refer to Figure B-5)
28	Hardware register 60; TIE bus
29	Hardware register 104; AMTIE (TU Bus)
30	Hardware register 110; PORT status (Refer to Figure B-6)
31	Hardware register 114; read data
32	Hardware register 240; CAS status (Refer to Figure B-7)
33	Hardware register 241; CBUS status (Refer to Figure B-8)
34	Hardware register 300; DBUS status (Refer to Figure B-9)
35	Hardware register 320; WMC status
36	Hardware register 321; TU select 0
37	Hardware register 322; TU select 1
38	Hardware register 323; write data
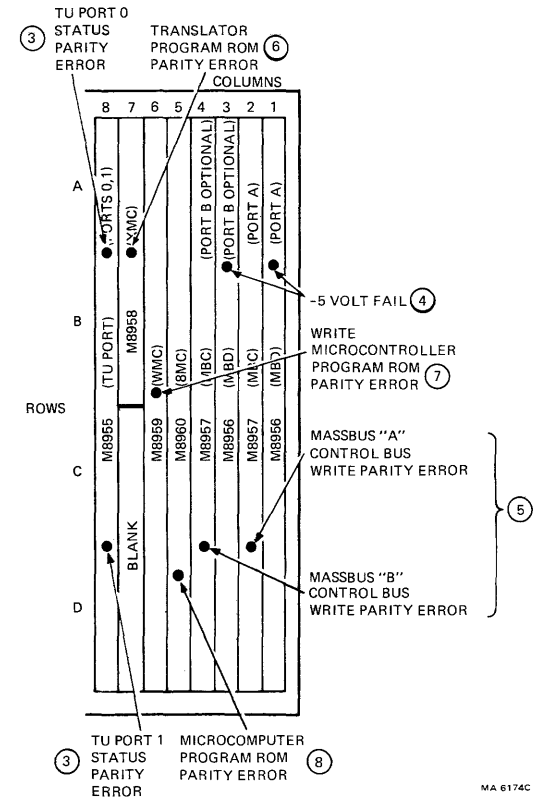
Figure 1-3   TM78 Module Layout (Back View) Showing Maintenance Indicators (Sheet 2 of 2)
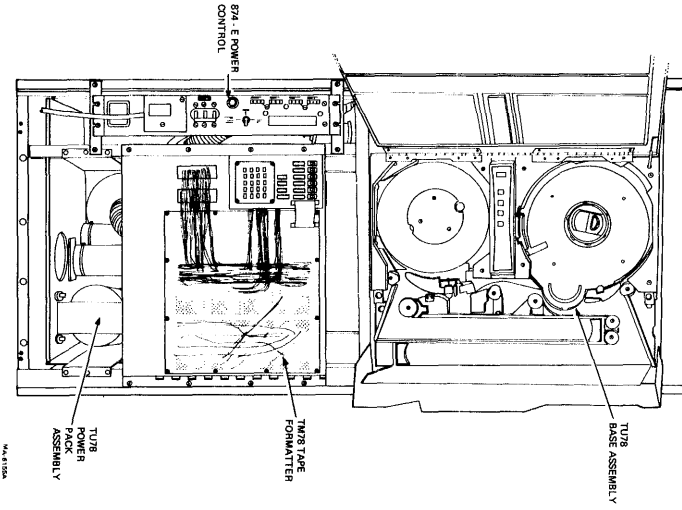
Figure 1-4 TU78 Assemblies (Front View)

ESB #19-27 (CHNTIE)

07	06	05	04	03	02	01	00
0	0	0	0	CH (N) TIE BUS			
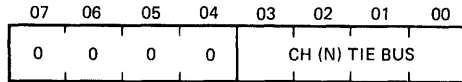
AMTIE

PHASE TIE

GCR=ILLEGAL 5:4   STAT=0*, POINTER MISMATCH IN GCR
PE=DEAD TRACK   STAT=1*, ANY POINTER OCCURRED

*STATISTICS BIT
(BIT 1 IN HARDWARE
REGISTER 011-W;RPCTL)

MA-7955

Figure B-5   Channel (N) Track in Error Byte

ESB #18 (ECCSTA)
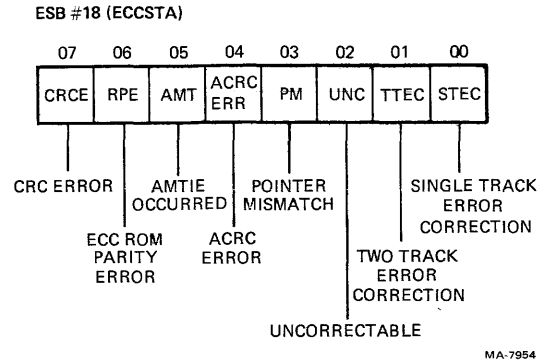
Figure B-4   ECC Status Byte

Byte	Description
17	Hardware register 31; corrected data (CH 7:0)
18	Hardware register 32; ECC status (Refer to Figure B-4)
19	Hardware register 40; channel 0 TIE bus (Refer to Figure B-5)
20	Hardware register 41; channel 1 TIE bus (Refer to Figure B-5)
21	Hardware register 42; channel 2 TIE bus (Refer to Figure B-5)
22	Hardware register 43; channel 3 TIE bus (Refer to Figure B-5)
23	Hardware register 44; channel 4 TIE bus (Refer to Figure B-5)
24	Hardware register 45; channel 5 TIE bus (Refer to Figure B-5)
25	Hardware register 46; channel 6 TIE bus (Refer to Figure B-5)
26	Hardware register 47; channel 7 TIE bus (Refer to Figure B-5)
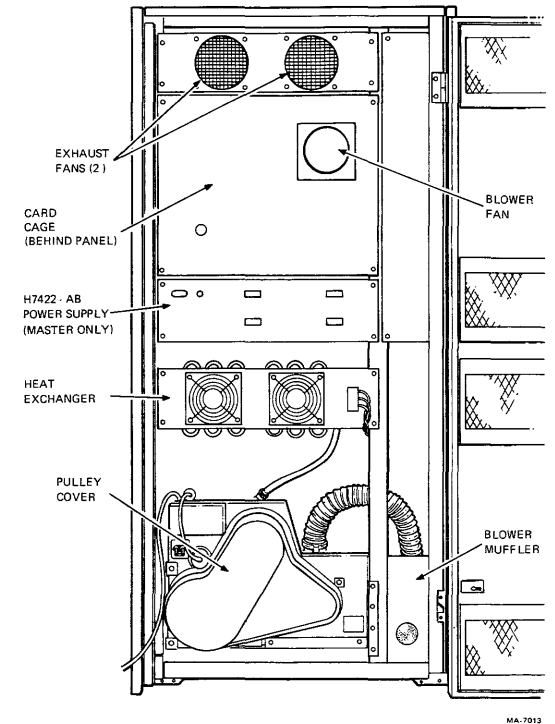
Figure 1-5   TU78 Assemblies (Back View)
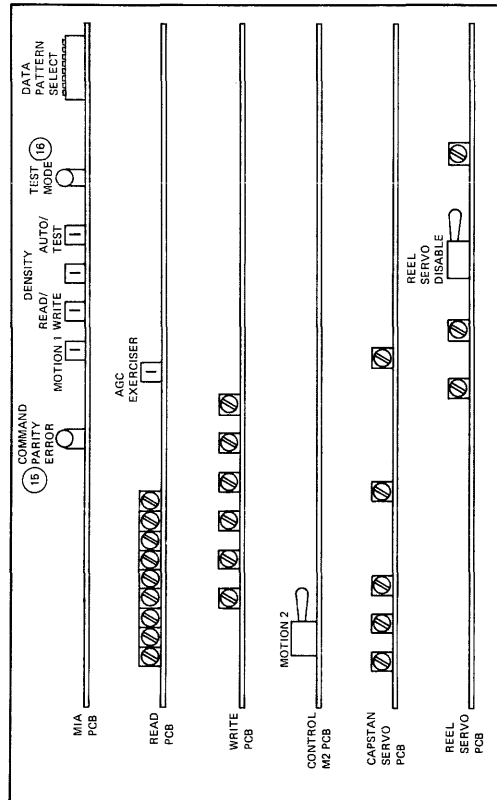
Table B-2   Read Microcontroller Command Codes

CMD Code	Description
00	NOP
01	Interblock read
02	Test PE ID burst
03	Test GCR ID burst
04	Test ARAID burst
05	Test tape mark
06	Test ARA burst
07	Normal NON-BOT read
10	Run RMC self-test
11	Test unknown ID burst
12	Run read channel micro's test
13	Diagnostic read command
14	Run read channel self-test
15	Run clear all RMC test program
16	Run ECC self-test program
17	Find gap

ESB #13 (RPSTA)
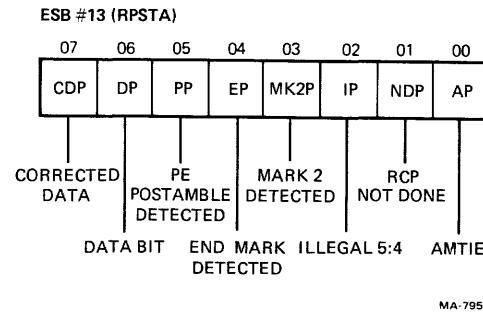
Figure B-3   Parity Read Channel Status Byte

Figure 1-6   TU78 Card Cage Showing Maintenance Controls and Indicators

Byte	Description
13	Hardware register 25; RC PAR bits (CH P) (Refer to Figure B-3)
14	Hardware register 26; postamble detected (CH 7:0)
15	Hardware register 27: data (CH 7:0)
16	Hardware register 30; CRC

Table B-1 Read Microcontroller Status Codes (Cont)

Status	Meaning
236	Read path fault 2; 7 or more M8950 BOARDS found illegal 5 to 4 translations.
241	Unexpected IBG in data; probably creased tape (7 or more AMTIES active)
261	Postamble long
262	Postamble short
377	OK

ESB #7 (RCMLP)

```
    07   06   05   04   03   02   01   00
  ┌────┬─────────────────────────────────┐
  │ RC │          RMC CMD 7:0             │
  └────┴─────────────────────────────────┘
```

RUN CONTINUOUS
(CODES 01-06)

THIS BYTE CONTAINS THE LAST
COMMAND SENT TO THE M8953
READ MICROCONTROLLER.

MA-7952
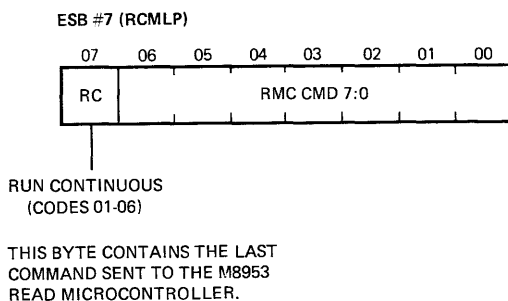
Figure B-2   Read Microcontroller Command Byte

Byte	Description
11	Hardware register 23; mark 2 (CH 7:0)
12	Hardware register 24; end mark (CH 7:0)

MA-2662A

TU78

load fault ○   6250 ○   1600 ○

file protect ○   RESET

on line ○   UNLOAD

bot ○   ON LINE

power ○   LOAD/REW

PORT
0-A
1-B
2-A/B
3-TEST
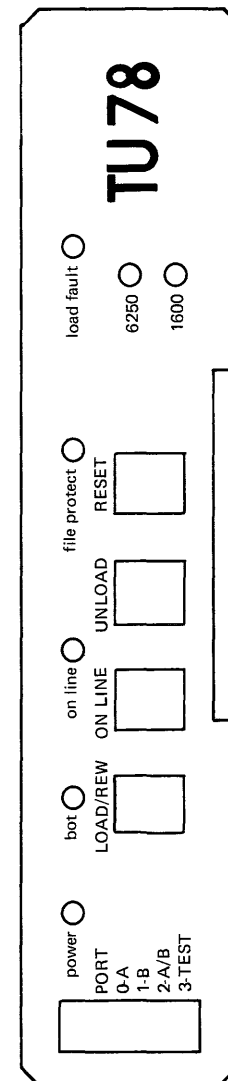
Figure 1-7   TU78 Operator Control Panel

Table 1-1   TU78 Controls

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

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

Control	Function
LOAD/ REW	It starts one of three sequences 1. With no tape in path, it initiates a load sequence. 2. With tape in path but not tensioned, it starts a midreel load sequence. In a midreel load sequence the tape loads and runs in reverse direction to BOT. 3. With tape in path and tensioned, and the transport off-line, the tape rewinds to BOT. If the tape is at BOT or if the transport is on-line, no action occurs.
ON LINE	It switches the transport off-line or on-line.
UNLOAD	If the TU78 is off-line, it causes the tape to rewind and unload. If the tape is at BOT, it unloads. If the TU78 is on-line, button has no effect.
RESET	Terminates all functions and clears a load fault.

Table B-1   Read Microcontroller Status Codes

Status	Meaning
Status resulting from ECC self-test command	
101	ECC sequencer passed self-test
102	ECC sequencer failed self-test
Status resulting from an M8953 self-test	
103	Read path passed self-test
104	Read path failed self-test
Status resulting from an M8950 self-test command	
106	Read channel tests all passed
Status resulting from a clear all test command for velocity testing of drive by microcode	
1	First tach pulse
201	Last tach pulse (eleventh) (ten spaces)
Status resulting from a sample density command	
210	NOT CAPABLE found
211	GCR ID found
212	PE ID found
Status resulting from a write test of IBG, PE ID, GCR ID, ARA ID, or ARA burst	
220	Bad status (write test)
Status resulting from a tape mark test command	
222	Good tape mark found on tape status
Status resulting from a NON BOT command (read or write FWD or REV, GCR or PE)	
230	ARA ID found (not record or TM)
231	Tape mark found
234	Preamble end not found
235	Read path fault 1, too many M8950s have been fataled to continue record processing

APPENDIX B
EXTENDED SENSE BYTES

Byte	Description
1	Command code being executed on last error
2	Interrupt code from last error
3	Failure code last error
4	Hardware register 0; read path write fail bits
5	Hardware register 1; read path diagnostic bits
6	Hardware register 2; read path status (Refer to Figure B-1)
7	Hardware register 3; read path command loop (Refer to Figure B-2)
8	Hardware register 20; AMTIES (CH 7:0)
9	Hardware register 21; RC DONE (CH 7:0)
10	Hardware register 22; illegal 5–4 (CH 7:0)

ESB #6 (RSTAT)

```
┌─────┬─────┬─────┬─────┬─────┬─────┬─────┐
│          RMC STATUS    7:0              │
└─────┴─────┴─────┴─────┴─────┴─────┴─────┘
```
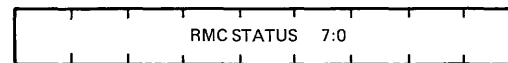
READ PATH MICROCONTROLLER
STATUS CODES ARE RETURNED IN
THIS BYTE. TABLE B-1 IDENTIFIES
EACH CODE AND IT'S MEANING.

MA-7951

Figure B-1   Read Path Status Byte

98

Table 1-2   TU78 Indicators

Indicator	Meaning
Power	DC and secondary ac power are present.
BOT	Tape is at BOT.
On Line	TU78 is on-line. The transport returns to the off-line mode if any of the following occur. 1. ON LINE button is pressed. 2. External rewind unload command is received. 3. Vacuum column interlock is broken. 4. AC power is lost. 5. RESET button is pressed. 6. Front door opens.
File Protect	Tape reel without a write enable ring has been loaded on the transport.
Load Fault	Load fault has occurred. 1. Autoload sequence has failed to load a tape from a 267 mm (10.5 in) reel after two tries. 2. Load sequence has failed to load tape from a 216 mm or 178 mm (8.5 in or 7 in) reels.
1600	Tape transport is set to read or write at 1600 bits/in (PE mode).
6250	Tape transport is set to read or write at 6250 bits/in (GCR mode).

1.6 MAINTENANCE CONTROLS AND INDICATORS

Maintenance controls and indicators may be found on the TM78 logic gate (front and back), the TM78 power supply (H7422), the TU78 logic cage, and the front of the TU78 base assembly.

1.6.1   TM78 Controls and Indicators

Figure 1-2 shows the front of the TM78 logic gate and details the maintenance controls. The maintenance panel is described in Chapter 2. To the right of the maintenance panel is a DIP switch matrix. The DIP switches select the MASSBUS drive address for both ports and sets either or both ports on or off-line. A dual port TM78 is considered off-line for maintenance purposes only when both ports are placed off-line.

Figure 1-3 shows the back of the logic gate and details some of the maintenance indicators that may be used for troubleshooting. Table 2-3 lists the indicators and describes their functions.

Figure 1-8 shows the front of the H7422 power supply and details the maintenance indicators and adjustments.

1.6.2   TU78 Controls and Indicators

Figure 1-9 shows a detail of the base assembly and points out the door safety interlock switch. This switch must be defeated to perform certain maintenance adjustments. To defeat the switch pull its actuator arm down and out with a spring hook.

The rest of the TU78 maintenance controls and indicators are on PCBAs in the card cage assembly (Figure 1-6). Table 1-3 lists the TU78 maintenance controls and Table 2-3 lists the indicators.

1.7   TOOLS

In addition to the standard DIGITAL tool kit, the following tools are needed to service the TM78/TU78.

Description	DEC Part Number	Included in Spares 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
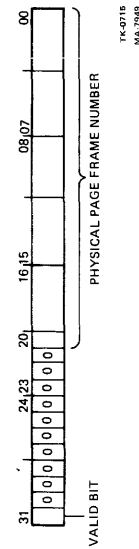
Figure A-16   Map Register
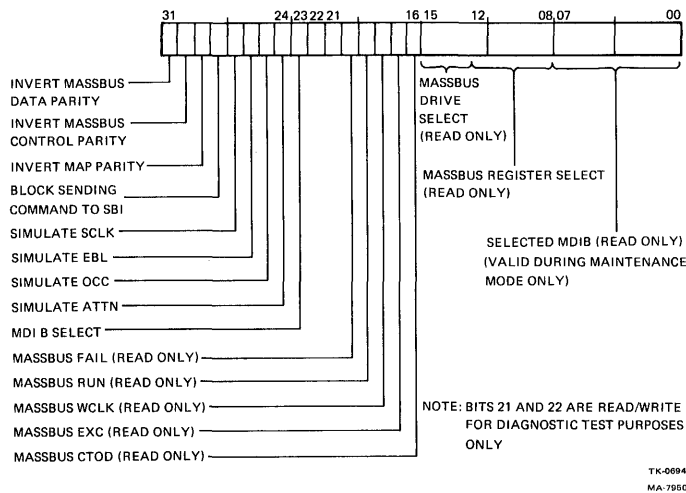
Figure A-15   Diagnostic Register
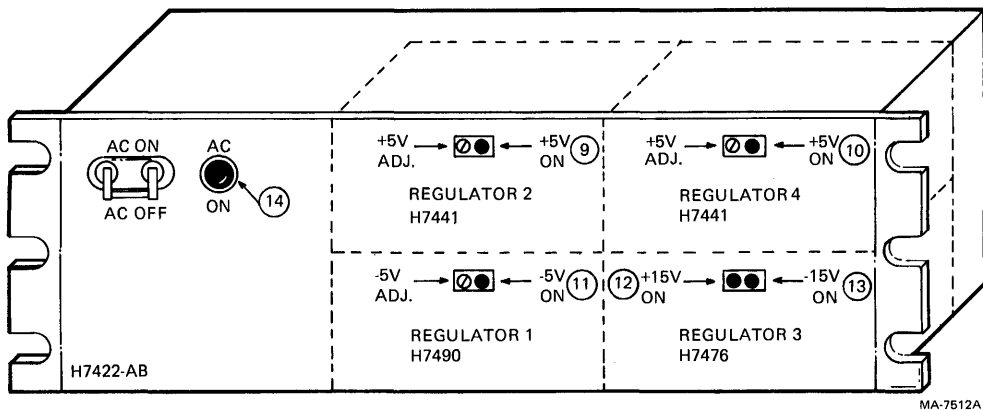
Figure 1-8   H7422 Power Supply Showing Maintenance
Indicators and Controls

MA 3483A
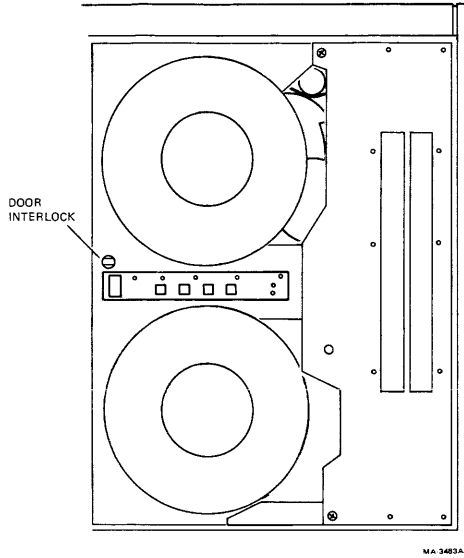
Figure 1-9   Door Safety Interlock Switch

Description	DEC Part Number	Included in Spares Kit
Reel flange locating bar	29-23207	Yes
PCBA extender	29-23218	Yes
Lower restraint tube fitting	29-23228	Yes
Differential pressure gauge (0–40 inch H$_2$0)	29-11650	Yes
Differential pressure gauge (0–5 PSI)	29-11636	Yes
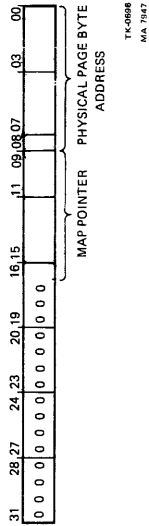
Figure A-13   Virtual Address Register
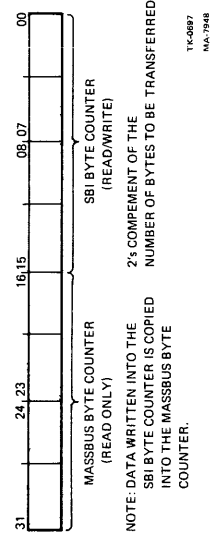
Figure A-14   Byte Counter Register

Description	DEC Part Number	Included in Spares Kit
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 × 4 inch Ballpoint hex driver	29-11630	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 TU78)
Standard output tape	29-11691	No

TK-0698
MA-7946

DATA TRANSFER BUSY
NO RESPONSE CONFIRMATION
CORRECTED READ DATA
PROGRAMMING ERROR
NON EXISTENT DRIVE
MASSBUS CONTROL WRITE ERROR
MASSBUS ATTENTION
DATA TRANSFER COMPLETE
DATA TRANSFER ABORT
DATA TRANSFER LATE
WRITE CHECK-UPPER ERROR
WRITE CHECK-LOWER ERROR
MISSED TRANSFER
MASSBUS EXCEPTION
MASSBUS DATA PARITY ERROR
MAP PARITY ERROR
INVALID MAP
ERROR CONFIRMATION
READ DATA SUBSTITUTE
INTERFACE SEQUENCE TIMEOUT
READ DATA TIMEOUT

NOTE: WRITE 1 TO CLEAR BITS IN THIS REGISTER EXCEPT BIT 31 WHICH IS READ ONLY.

Figure A-12 Status Register

Table 1-3   TU78 Maintenance Controls

Control	Location	Purpose
Motion 1	MIA PCBA	It moves transport forward or reverse when on-line and in manual mode.
Read/ Write	MIA PCBA	It selects read or write mode when on-line and in manual mode.
Density	MIA PCBA	It selects 1600 or 6250 BPI density when on-line and in manual mode.
Auto/Man	MIA PCBA	It selects auto (transport connected to formatter) or test mode. When in test (or manual) mode, transport must be on-line for other MIA switches to function.
Data Pattern Select	MIA PCBA	It selects a repeating 8-frame pattern when on-line and in manual mode.
AGC Exerciser	Read PCBA	It allows Read PCBA to lock AGC to the ARA burst, or to run free.
Motion 2	Control M2 PCBA	It moves transport forward or reverse, on or off-line.
Reel Servo Disable	Reel servo PCBA	It disables the reel servo amplifiers so that certain adjustments can be made.

1.8   SPARES KIT LISTS

1.8.1   TM78 Spares Kit (A2-W0342-10)

The following lists the contents of the TM78 Spares Kit.

DEC Part Number | **Description**

M8950   Read data sync module
M8951   ECC module
M8952   CRC/ACRC module
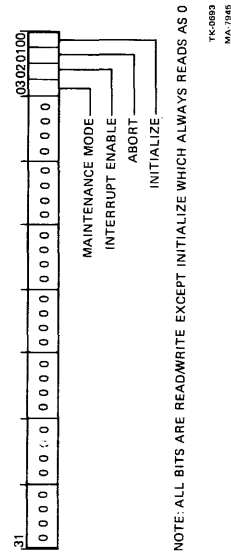
Figure A-11   Control Register
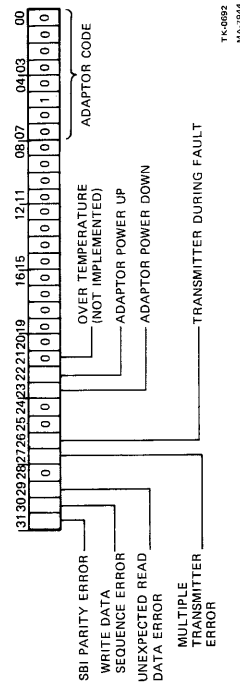
Figure A-10   Configuration/Status Register

DEC Part Number	Description
M8953	Read path microcontroller module
M8955	TU port module
M8956	MASSBUS data interface module
M8957	Common address space module
M8958	Write translator module
M8959	Write micro/byte assembly module
M8960	Microcomputer module
54-14174	Maintenance keypad/display
H7476	Power supply regulator ±15.0 V
H7490	Power supply regulator −5.0 V
H7441	Power supply regulator +5.0 V
54-14192	AC/DC low board

1.8.2   TU78 Spares Kit (A2-W0341-10)

The following lists the contents of the TU78 Spares Kit.

DEC Part Number	Description
29-23766	GCR/PE preamp 1 PCBA
29-23770	Interconnect F1 PCBA
29-23769	MIA PCBA
29-23763	WRITE PCBA
29-23762	READ PCBA
29-23764	Control M2 PCBA
29-23765	Capstan/regulator PCBA
29-23231	Reel servo PCBA
29-23218	Extender PCBA
29-23996	Compressor belt, 50/60 Hz
29-23989	Blower belt, 50 Hz, Lo Altitude
29-23991	Blower belt, 60 Hz, Lo Altitude
29-23220	Muffler
29-23259	Air filter
70-17382-15	15 ft TU bus cable
29-10562	Handle
29-11625	7 inch extension
29-11630	5/32 inch ball-end allen driver
29-11001	Phillips screwdriver blade
29-11635	Tachometer

DEC Part Number	Description
29-11636	Gauge, 0–5 PSI
29-11650	Gauge, 0–40 inch H_2O
29-11647	Accessory kit for gauges (2)
29-23206	Centering tool
29-23207	Locating bar
29-23228	Tube fitting

1.9   RECOMMENDED SPARES LEVELS (RSL)

In addition to the spares kit contents, the following parts are recommended to repair 98 percent of all possible failures.

1.9.1   Additional TM78 RSL Parts

The following are additional RSL parts for the TM78.

DEC Part Number	Description
BC06S-25	25 ft MASSBUS cable
12-10930-01	230 Vac fan
12-11079-00	Pushbutton switch
12-11164-04	DIP switch
70-17381-0D	Flat cable
70-17400-00	Backplane

1.9.2   Additional TU78 RSL Parts

The following are additional RSL parts for the TU78.

DEC Part Number	Description
12-17916-02	Fan, tube axial 230 V
29-16280-00	Switch, MICRO
29-23216-00	Sense assy, reel
29-23217-00	Sense assy, pack
29-23236-00	Motor assy, reel
29-23238-00	Switch, pressure
29-23239-00	Switch, pressure
29-23242-00	EOT/BOT assy
29-23243-00	TIP assy
29-23246-00	Transducer assy, vacuum
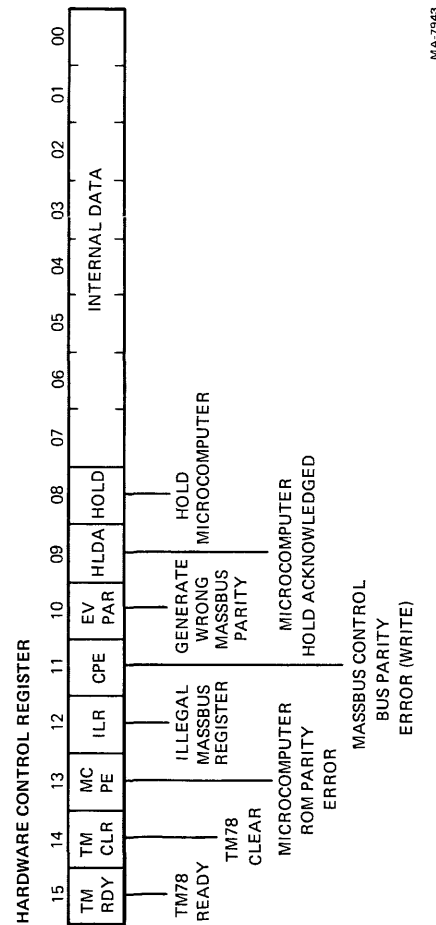
Figure A-9   Hardware Control Register

Table A-2   Nondata Transfer Function Codes (Cont)

Function Code (Go Bit Included)	Name	Description
37	ERG GCR §	Erases three inches of tape, sets GCR
41	Close File PE §	Writes two tape marks, spaces reverse one, sets PE
43	Close File GCR §	Writes two tape marks, spaces reverse one, sets GCR
45	SPACE LEOT	Spaces forward until two tape marks, spaces reverse one
47	SPACE FWD FILE/LEOT ‖	Spaces forward to tape mark, stops if two successive tape marks (logical end of tape)

*Sometimes interrupts when rewind starts; always interrupts after tape motion has stopped.

†Sense registers are valid as long as the ATTN bit is set.

‡Erases at least 3.05 m (10 ft) beyond the EOT marker.

§Recording format is ignored except when tape is at load point (BOT). It is specified by bit 1.

‖Do not use after any reverse operation; the TM78 may skip over an LEOT located where direction was reversed.

DEC Part Number	Description
29-23247-00	Circuit breaker
29-23248-00	Valve assy, vacuum
29-23249-00	Valve assy, pressure
29-23250-00	Bearing, air
29-23251-00	Bearing, air
29-23252-00	Bearing, air
29-23257-00	Compressor
29-23280-00	Motor, gear drv
29-23287-00	Motor, ac
29-23297-00	Switch, backwrap defeat
29-23298-00	Blower assy (Below SN SP002386)
29-24013	Blower assy (SN SP002386 and above)
29-23308-00	Relay reed SS 12 Vdc
29-23321-0P	Cable, flat ribbon (AMTIE)
29-23322-00	Thread block 2
29-23323-00	Thread block 4
29-23324-00	Thread block assy
29-23325-00	Thread block assy
29-23326-00	Thread block assy
29-23475-00	Hub reel
29-23767-00	Head, R/W
29-23768-00	Motor assy, capstan
29-23771-00	Controls assy
10-11643-00	18,000 MFD 25V +75-10%
12-14405-00	Door, tape transport, front
29-23208-00	Hub, machined
29-23209-00	Flange, front
29-23211-00	Interconnect D1
29-23215-00	Door assy, buffer box
29-23219-00	Spring, compression
29-23222-00	Spring, bellville
29-23223-00	Washer
29-23241-00	Cleaner, tape
29-23255-00	Guide plate "R"
29-23256-00	Guide plate "C"

DEC
Part

Number	Description
29-23258-00	Transformer
29-23279-00	Filter, RFI
29-23283-00	Guide, Air
29-23284-00	Hub, motor 50 Hz
29-23285-00	Hub, motor 60 Hz
29-23286-00	Catch, spring
29-23288-00	Receptacle, fastener
29-23309-00	47000 MFD 15 W VDC+75%-10%
29-23310-00	61000 MFD 50 W VDC+100%-10%
29-23311-00	RECT, BRDG 25 A 100 PN
29-23312-00	RECT, BRDG 10 A 100 A
29-23320-00	330 20 W 10% WW
29-23361-00	Cap plug
29-23655-00	Kit, vac hose/tubing
70-17143-00	Fan assembly TU78
90-07221-00	Fuse, reg blow, 5 A, 250 V
90-08835-00	Fuse, reg blow, 20 A, 32 V
90-08838-00	Fuse, reg blow, 10 A, 32 V
29-11691-00	Tape MSTR OTPT 1200X1/2
29-16871-00	Magnasee
29-19224-00	Tape, master skew 1200
29-20273-00	Microscope 50 X
47-00038	Tape crimper
90-08268	Thermal compound

Table A-2   Nondata Transfer Function Codes

Function Code (Go Bit Included)	Name	Description
03	NO OP	Generates a unique NO OP interrupt code
05	Unload	Unloads tape and interrupts immediately
07	Rewind*	Rewinds tape and interrupts when done
11	Sense†	Puts status information into CAS
13	Data Security Erase‡	Erases remainder of tape and rewinds
15	WTM PE §	Writes phase-encoded tape mark
17	WTM GCR §	Writes GCR tape mark
21	SP FWD REC	Spaces forward record, stops if tape mark
23	SP REV REC	Spaces reverse record, stops if tape mark or BOT
25	SP FWD FILE	Spaces forward file (to tape mark)
27	SP REV FILE	Spaces reverse file (to tape mark)
31	SP FWD EITHER	Spaces forward either record or file
33	SP REV EITHER	Spaces reverse either record or file
35	ERG PE §	Erases three inches of tape, sets PE

MOTION COMMAND REGISTER (0-3)

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
			COMMAND COUNT					0	0			NDT F4:0			GO

NON-DATA TRANSFER (MOTION) FUNCTION CODE AND GO BIT (REFER TO TABLE A-2)

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NOTE: THERE ARE FOUR MOTION COMMAND REGISTERS, ONE FOR EACH TU ADDRESS.
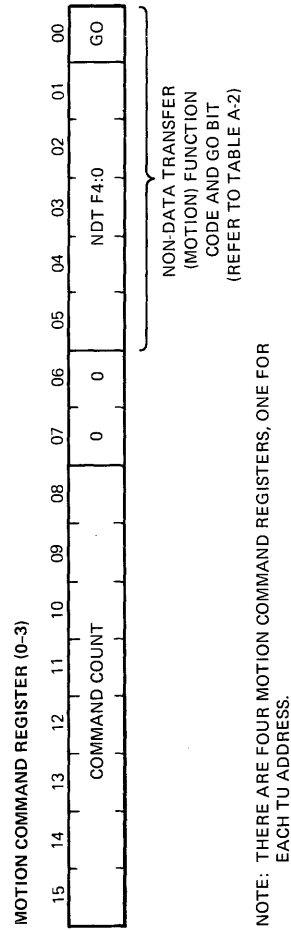
Figure A-8   Motion Command Register

1.10   RELATED DOCUMENTS

The following list describes documents related to the TU78 subsystem.

Title	Document Number	Contents
TM78 Magnetic Tape Formatter User's Guide	EK-0TM78-UG	Description, programming, and installation information of the TM78
TM78 Magnetic Tape Formatter Technical Manual	EK-0TM78-TM	Theory of operation, programming information, installation, and maintenance of the TM78 Formatter and H7422 Power Supply
TU78 Magnetic Tape Transport User's Guide	EK-0TU78-UG	Description, installation instructions, and operating procedures for the TU78.
TU78 Magnetic Tape Transport Technical Manual; Volume 1	EK-1TU78-TM	Schematics and logic prints of TU78
TU78 Magnetic Tape Transport Technical Manual; Volume 2	EK-2TU78-TM	Description, installation, operation, theory, and maintenance of TU78

Title	Document Number	Contents
TU78 Magnetic Tape Transport IPB	EK-TU78-IP	Exploded views and parts lists of TU78 and TM78
874 Power Controller IPB	EK-00874-IP	Exploded views and parts lists of 874
RH20 MASSBUS Controller Unit Description	EK-RH20-UD	Description of RH20 MASSBUS controller
RH780 MASSBUS Adapter Technical Description	EK-RH780-TD	Programming and theory of RH780 MASSBUS adapter
Field Maintenance Print Set	MP01061	Engineering drawings for TU78 mechanics and cabinet, engineering drawings and parts lists for TM78 mechanics and logic, TM78 power supply chassis, +5 volt regulator, ±15 volt regulator, and −5 volt regulator
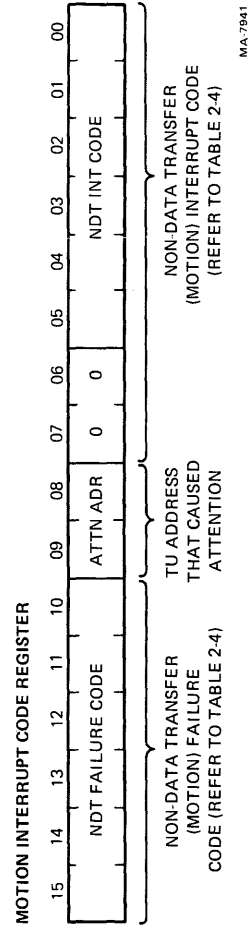
Figure A-7   Motion Interrupt Code Register
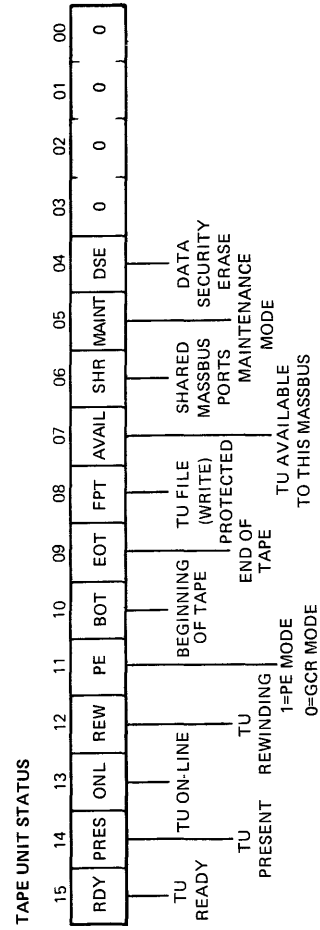
TAPE UNIT STATUS

Figure A-6   Tape Unit Status Register

1.11 SYSTEM DIAGNOSTICS

The following are system diagnostics for both the TU78 and TM78.

Title	Diagnostic Name	
	DECSYSTEM-20	VAX
A. Control Logic Test	DFTUI	EVMAE
B. Data Reliability	DFTUJ	EVMAA

2 TROUBLESHOOTING

2.1 INTRODUCTION

This chapter gives a short description of the tools available for troubleshooting a failure in the subsystem. They include troubleshooting flows, on-line and in-line diagnostic programs, error log summaries, status indicators, and a maintenance panel for exercising the formatter/transport off-line.

2.2 ON-LINE DIAGNOSTICS

Table 2-1 lists and describes the on-line (system level) diagnostics available for each hardware family.

2.3 IN-LINE DIAGNOSTICS

A total of 37 in-line microdiagnostics run continuously when the subsystem is idle. If a microdiagnostic fails to operate correctly, the TM78 raises an attention interrupt to the host CPU(s). Each microdiagnostic may be called up individually for scope loops or repair verification. This is done through the TM78 maintenance panel. Table 2-2 lists each microdiagnostic and its test number.

2.4 ERROR LOGS

All DEC operating systems, under which the TU78 runs, support an error logging scheme. At a minimum, all MASSBUS registers are read and stored away each time a hard or uncorrectable error occurs. MASSBUS registers are listed in Appendix A. As an error log option, the extended sense summary may also be read and stored away. The extended sense summary is a 60-byte field of internal TM78 and TU78 registers. Extended sense tables for each of four possible TU78s are updated after each error. The extended sense bytes are listed in Appendix B.

2.5 STATUS INDICATORS FOR
TROUBLESHOOTING

In addition to the TM78 maintenance panel, a total of 29 LED indicators are available for troubleshooting. Table 2-3 lists each indicator, its function, and location.
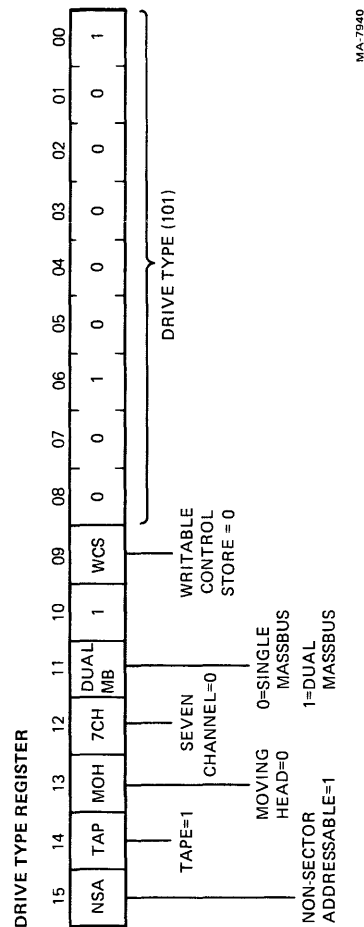
Figure A-5   Drive Type Register
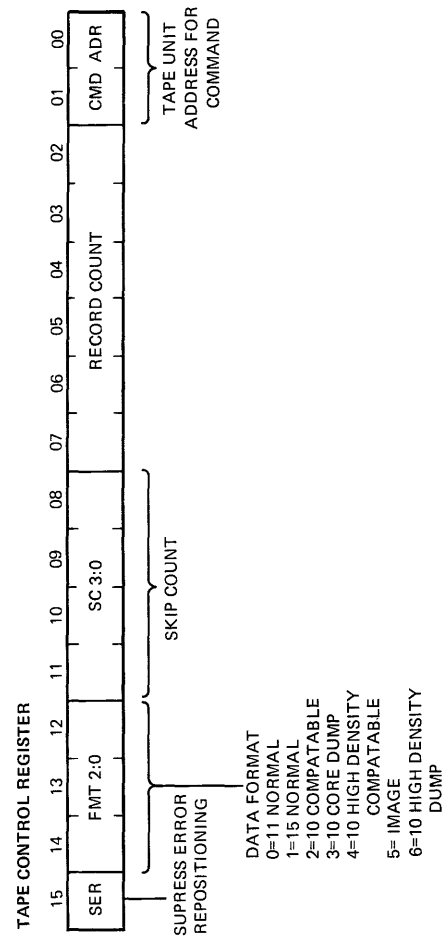
Figure A-4 Tape Control Register

Table 2-1 TM78/TU78 Diagnostics

DECSYSTEM-20	VAX	Description
Control Logic Test		
DFTUI	EVMAE	The Control Logic Test tests MASSBUS controller and TM78 formatter logic. It also tests subsystem basic command functions while checking for proper tape motion timing. The test must be run from each CPU separately, through both MASSBUS ports (if dual port option is present). The test provides error information to the user via console or lineprinter.
Data Reliability		
DFTUJ	EVMAA	The Data Reliability Test tests TM78 circuitry by writing and reading pre-determined data patterns and recording modes. The test provides error information to the user via console or lineprinter. The test may be run in dual port mode (from dual CPUs) driving two or more transports.

2.6 ERROR CODES

The TM78 sends an interrupt code and a failure code to the host CPU at the completion of any command. These same codes are put into the maintenance display at the completion of a command issued through the maintenance keypad. Table 2-4 lists each interrupt code in numerical order followed by each failure code that could occur within that interrupt code.

Note that certain interrupt codes imply that the command completed without error or a nondata record was found (codes 01–06). Others indicate that the transport was not in the correct state to operate on the command, or that another command is necessary (codes 07–27). Still others indicate a possible hardware or software failure (codes 30–32). Interrupt code 77 is a unique code in that it applies only to keypad commands.

Table 2-2   In-Line Self-Test Microdiagnostics

Test Number	Description
0	Write microcontroller self-test (M8959)
1	Translator ROM parity test (M8958)
2	Read path microcontroller self-test (M8953)
3	Read channel 0 (slot AB12) self-test
4	Read channel 1 (slot AB13) self-test
5	Read channel 2 (slot AB14) self-test
6	Read channel 3 (slot AB15) self-test
7	Read channel 4 (slot AB16) self-test
10	Read channel 5 (slot CD13) self-test
11	Read channel 6 (slot CD14) self-test
12	Read channel 7 (slot CD15) self-test
13	Read channel P (slot CD16) self-test
14	Read path error corection self-test (M8951)
15	Microcomputer RAM memory self-test (Loc 40000-40777)
16	Microcomputer RAM memory self-test (Loc 41000-41777)
17	Microcomputer RAM memory self-test (Loc 42000-42777)
20	Microcomputer RAM memory self-test (Loc 43000-43777)
21	Microcomputer RAM memory self-test (Loc 44000-44777)
22	Microcomputer RAM memory self-test (Loc 45000-45777)
23	Microcomputer RAM memory self-test (Loc 46000-46777)
24	Microcomputer RAM memory self-test (Loc 47000-47777)
25	Loop write-to-read at TU port 0 in GCR
26	Loop write-to-read at TU port 0 in PE
27	Loop write-to-read at TU port 1 in GCR
30	Loop write-to-read at TU port 1 in PE
31	Loop write-to-read at TU port 2 in GCR
32	Loop write-to-read at TU port 2 in PE
33	Loop write-to-read at TU port 3 in GCR
34	Loop write-to-read at TU port 3 in PE
35	Loop write-to-read at MIA 0 in GCR
36	Loop write-to-read at MIA 0 in PE
37	Loop write-to-read at MIA 1 in GCR
40	Loop write-to-read at MIA 1 in PE
41	Loop write-to-read at MIA 2 in GCR
42	Loop write-to-read at MIA 2 in PE
43	Loop write-to-read at MIA 3 in GCR
44	Loop write-to-read at MIA 3 in PE
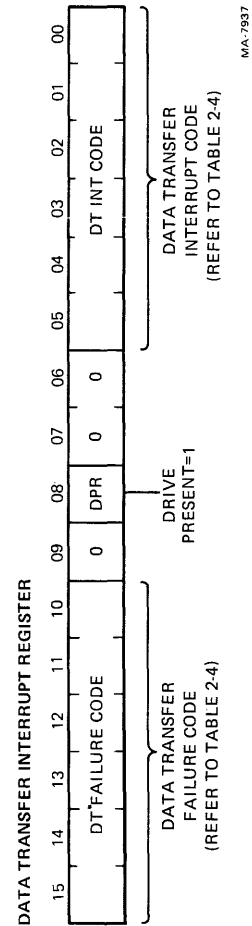
Figure A-3   Data Transfer Interrupt Register

Table A-1   Data Transfer Function Codes

Function Code (Go Bit Included)	Name	Description
51	WRT CK FWD	Write Check Forward – Tape subsystem reads one record in a forward direction. Data is checked in RH controller.
57	WRT CK REV	Write Check Reverse – Tape subsystem reads one record in a reverse direction. Data is checked in RH controller.
61	WRITE PE*	Write phase-encoded records
63	WRITE GCR*	Write group-coded records
71	READ FWD	Read records forward
73	EXSNS	Read extended sense error log
77	READ REV	Read records reverse

*The recording density format is ignored unless the tape is positioned at load point. At load point, the write command specifies the recording format of the entire tape.

Table 2-3   Troubleshooting Indicator Functions

Indicator Number on Figure		Function	Possible Failing FRU
1-3	1*	A channel has failed. These nine indicators reflect the quality of the data stream for each channel or track. They indicate loss of SYNC or track dropout. Nonlatched	• TU78 transport • TU Bus cable (n)B • M8950
1-3	2*	A parity error has occurred in the ECC microcontroller. Latched	• M8951
1-3	3*	There has been 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
1-3	4*	−5 V for the MASSBUS transceivers is out of specification. Nonlatched	• H7490 • H7422 • TM78 backplane
1-3	5*	Wrong parity was received at the MASSBUS port on a control bus command write. Latched	• MASSBUS cable • RHXX controller • M8957
1-3	6*	A parity error has occurred in the translator micro-controller. Latched	• M8958
1-3	7*	A parity error has occurred in the write microcontroller. Latched	• M8959

*The normal state of the indicator is off.

Table 2-3   Troubleshooting Indicator Functions (Cont)

Indicator Number on Figure		Function	Possible Failing FRU
1-3	8*	A parity error has occurred in the microcomputer program ROM. Latched	• M8960
1-8	9†	+5 V regulator 2 is ok (supplies TM78 read path).	• H7441 • Any module in slots 10<16
1-8	10†	+5 V regulator 4 is ok (supplies TM78 write path, MASSBUS ports TU ports and micro-computer.	• H7441 • Any module in slots 1<9
1-8	11†	−5 V regulator 1 is ok.	• H7490 • M8956 (slot 1 or 3) • M8957 (slot 2 or 4)
1-8	12†	+15 V regulator 3 is ok.	• H7476 • Any M8950
1-8	13†	−15 V regulator 3 is ok.	• H7476 • Any M8950
1-8	14†	Power is being applied to the H7422 power supply.	• H7422 circuit breaker tripped • H7422 power cord • H7422 supply
1-6	15†	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
1-6	16†	MIA PCBA mainte-nance switch S4 is in MANUAL position.	• Flip switch to AUTO

*The normal state of the indicator is off.
†The normal state of the indicator is on.

CONTROL AND STATUS REGISTER

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0			0	DVA	0				0			DT F4:0			GO

DRIVE AVAILABLE

DATA TRANSFER FUNCTION CODE AND GO BIT (REFER TO TABLE A-1)

MA-7936
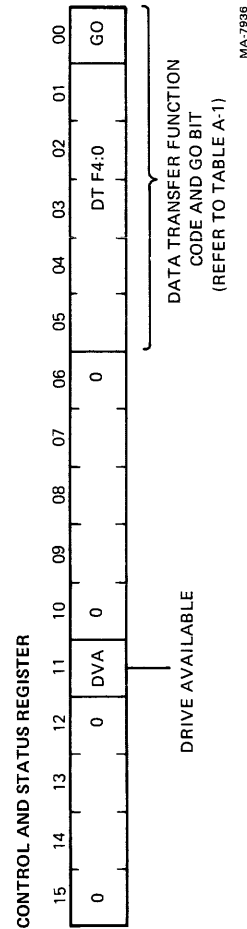
Figure A-2   Control and Status Register
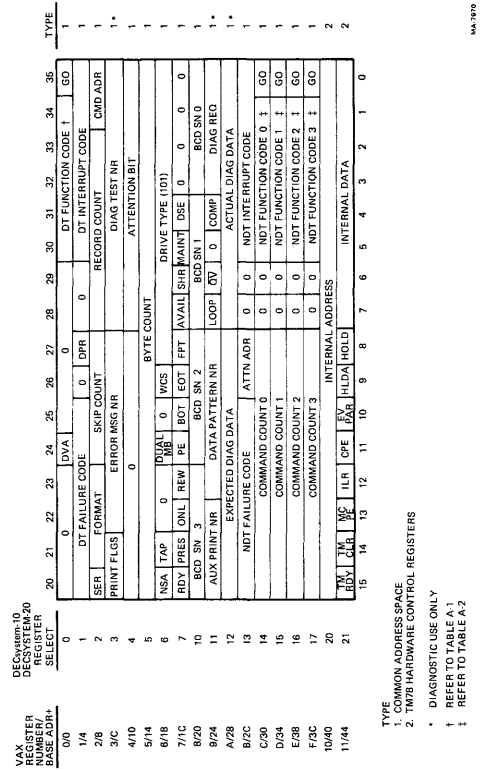
Figure A-1   RH20 and RH780 Addresses

TYPE
1. COMMON ADDRESS SPACE
2. TM78 HARDWARE CONTROL REGISTERS

* DIAGNOSTIC USE ONLY
† REFER TO TABLE A-1
‡ REFER TO TABLE A-2

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Table 2-4 Interrupt Code to Failure Code

Int Code	Name	Failure Code	
01	DONE*	00 –	Extended sense data not updated
		01 –	Extended sense data updated and contains something of interest
02	TAPE MARK*	Always zero	
03	BOT*	01 –	Command was issued with tape at BOT
		02 –	Saw BOT indicator after tape motion started
		03 –	ARA ID detected
04	EOT*	00 –	Extended sense data not updated
		01 –	Extended sense data updated and contains something of interest
05	LOGICAL EOT†	Always zero	
06	NO OP†	Always zero	
07	REWINDING†	Always zero	
10	FPT*	Always zero	
11	NOT READY*	01 –	TU is on-line but not ready (Possible when TU is manually rewound or loading)
		02 –	Fatal error has occurred and this command cannot be performed until error status has been presented and a TM CLEAR received

*The interrupt code is used for nondata transfer or data transfer.
†The interrupt code is used for nondata transfer only.

Table 2-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code	
		03 –	Access to TU is allowed but TU is either rewinding or doing a DSE from another MASSBUS or keypad command
12	NOT AVAIL*	Always zero	
13	OFF LINE*	Always zero	
14	NOT EXECUTABLE*	Always zero	
15	NOT CAPABLE*	01 –	No record found within 25 ft (7.6 m) of tape
		02 –	ID burst neither PE or GCR
		03 –	ARA ID not found
		04 –	No GAP found after ID burst (PE) or ARA ID burst (GCR)
17	ON LINE‡	Always zero	
20	LONG REC§	00 –	Extended sense data not updated
		01 –	Extended sense data updated and contains something of interest
21	SHORT REC§	00 –	Extended sense data not updated
		01 –	Extended sense data updated and contains something of interest
22	RETRY §	01 –	CRC error, ACRC error, pointer mismatch, uncorrectable or two-track error set in ECCSTA register (This code generated by write GCR operations)

APPENDIX A
SUBSYSTEM MASSBUS
REGISTERS

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Table 3-3   Vacuum and Pressure Valve Components

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

Table 2-4   Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
02 –		CRC error, ACRC error or uncorrectable set in ECCSTA register (This code generated by read GCR operations)
03 –		Uncorrectable error set in ECCSTA register (This code generated by read PE operations)
04 –		AMTIE, pointer mismatch, uncorrectable, two-track error or single-track error set in ECCSTA register (This code generated by write PE operations)
05 –		At least one bit set in ECCSTA register
06 –		At least one write fail bit set in RPFAIL and RPATH registers (This code generated by write PE operations)
07 –		More than one write fail bit set in RPFAIL and RPATH registers (This code generated by write CR operations)
10 –		RSTAT contains bad code
11 –		GCR characters from WMC and RMC do not match (This code generated by write PE operations)

*The interrupt code is used for nondata transfer or data transfer.
†The interrupt code is used for nondata transfer only.
‡The interrupt code is used for TM78 initiated.
§The interrupt code is used for data transfer.

Table 2-4   Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code		
		12 –	MASSBUS data bus parity error (write)	
		13 –	Record length incorrect during retry opposite attempt; invalid data has been transferred	
23	READ OPP§	Same as Int Code 22		
24	UNREADABLE§	Same as Int Code 22		
25	ERROR§	Same as Int Code 22		
26	EOT ERROR§	Same as Int Code 22		
27	BAD TAPE*	Same as Int Code 22		
30	TM FAULT A*	01 –	Illegal command code	
		02 –	Data transfer command issued while nondata transfer command in progress on same tape unit	
		03 –	WMC error; check ECODE register for reason – may be Illegal Format or Skip Count codes	
		04 –	RUN not received from MASSBUS controller	
		05 –	Command read from RMC register RCMLP did match command loaded into RCMD register	
		06 –	ECC ROM parity error (M8951)	
		07 –	XMC ROM parity error (M8958)	

MA-3488A

PRESSURE VALVE DETAIL

VACUUM VALVE DETAIL
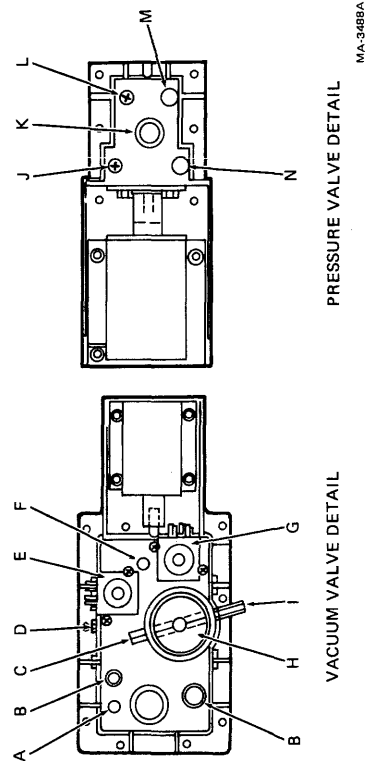
Figure 3-4   Vacuum Valve and Pressure Valve
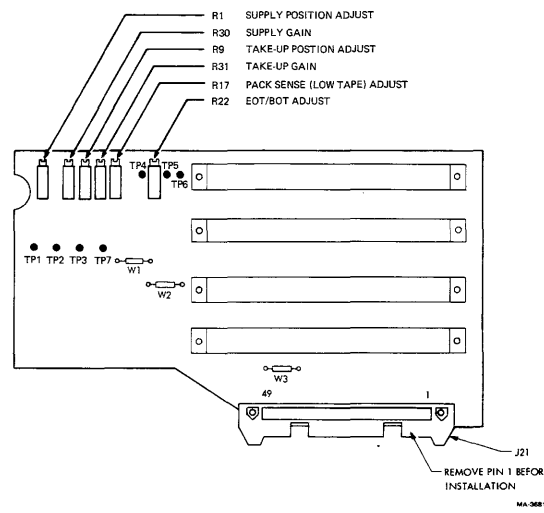
Figure 3-3   Interconnect F1 PCBA
b. Current Model

Table 2-4   Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
10 –		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)
11 –		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)
12 –		Command read from RMC register RCMDP did not match command loaded into RCMD register (this code generated when Verify ARA ID command loaded during write of BOT area)
13 –		Command read from RMC register RCMLP did not match command loaded into RCMD register (this code generated when Verify Gap command loaded during write BOT area)

*The interrupt code is used for nondata transfer or data transfer.
†The interrupt code is used for nondata transfer only.
‡The interrupt code is used for TM78 initiated.
§The interrupt code is used for data transfer.

Table 2-4   Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
14 –		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)
15 –		Command read from RMC register RCMLP did not match command loaded into RCMD register (this code generated when Verify ARA ID command loaded during read of BOT area)
16 –		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)
17 –		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)
20 –		WMC LEFT failed to set in Extended Sense routine
21 –		PE WRITE PE set in INTSTA register (M8958)
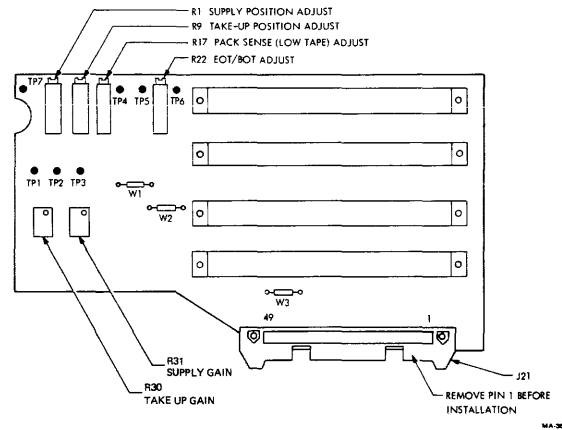
Figure 3-3   Interconnect F1 PCBA
a. Early Model
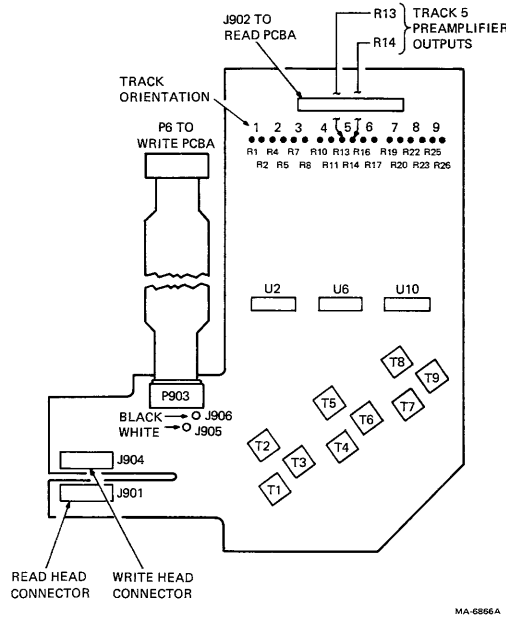
Figure 3-2   GCR/PE Preamp 1 PCBA Test Points

Table 2-4   Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code	
		22 –	XMC DONE did not set (M8958, M8959)
		23 –	WMC ROM PE or RD PE set in WMCERR register (M8959, M8952, M8951)
31	TU FAULT A*	01 –	TU status parity error (MIA)
		02 –	TU command parity error (M8955)
		03 –	Rewinding tape went off-line
		04 –	Tape went not ready during DSE
		05 –	TU CMD status changed during DSE
		06 –	TU velocity never came up to speed
		07 –	TU velocity changed after up to speed and writing started
		10 –	TU CMD did not load correctly to start tape motion in selected function routine
		11 –	TU CMD did not load correctly to set drive density
		12 –	TU CMD did not load correctly to start tape motion to write BOT ID Burst

*The interrupt code is used for nondata transfer or data transfer.

Table 2-4   Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
13 –		TU CMD did not load correctly to backup tape to BOT after failing to write BOT ID
14 –		Failed to write density ID Burst correctly
15 –		Failed to write ARA Burst correctly
16 –		Failed to write ARA ID correctly
17 –		ARA error bit set in MTA status B register
21 –		Could not find a gap after the ID code was written correctly
22 –		TU CMD did not load correctly to start tape motion to read ID Burst
23 –		Time-out looking for BOT after detecting ARA ID burst
24 –		Failed to write tape mark correctly
25 –		Tape never came up to speed while trying to reposition for retry of writing tape mark
26 –		TU CMD did not load correctly to start tape motion in Erase Gap routine
27 –		Could not detect a gap in Erase Gap routine
30 –		Could not detect a gap after writing record
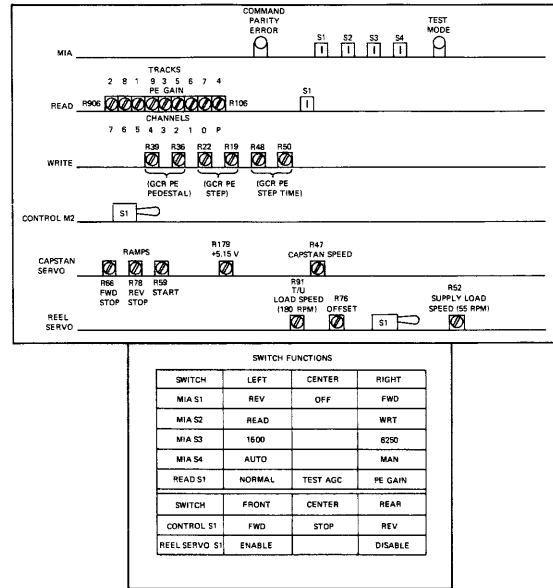
Figure 3-1   TU78 Card Cage Showing Maintenance Switches and Adjustment

Table 3-2 Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
TM78 Power				
+5 V (read path)	+5 Vdc, ±0.1 Vdc	A16A2	A7422 Regulator 2	TM78 Tech Manual Table 5-10
+5 V (write path and control)	+5 Vdc, ±0.1 Vdc	A09A2	H7422 Regulator 4	Table 5-10
-5 V	-5.0 Vdc, ±.16 Vdc	A01V2	H7422 Regulator 1	Table 5-10

Table 2-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
31 –		Read path terminated before entire record was written
32 –		Could not find a gap after writing record and read path terminated early
33 –		TU CMD did not load correctly to backup for retry of write tape mark
34 –		TU velocity changed after up to speed while trying to reposition for retry of writing tape mark
35 –		TU CMD did not load correctly to backup to retry a read of BOT ID
36 –		Time-out looking for BOT after failing to write BOT ID
37 –		TU velocity changed while writing PE gap before starting to write record
40 –		TU CMD did not load correctly to set PE tape density at start of write BOT ID burst
41 –		TU CMD did not load correctly to set GCR tape density after writing Density ID
42 –		TU CMD did not load correctly to set PE tape density at start of read from BOT

Table 2-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code	
		43 –	TU CMD did not load correctly to set GCR tape density after reading a GCR Density ID burst
32	TM FAULT B‡	00 –	RST0 interrupt occurred with TM RDY still set (AC/DC LO)
		01 –	Power failed interrupt
		02 –	Interrupt for unknown reason on channel 5.5
		03 –	Interrupt for unknown reason on channel 6.5
		04 –	Interrupt for unknown reason on channel 7
		05 –	Interrupt for unknown reason on channel 7.5
		06 –	CAS contention retry count expired
		07 –	CAS contention error not retryable
		10 –	Queue error; could not find queue entry
		11 –	Queue entry already full
		12 –	8085 ROM parity error
		13 –	In-line test 0; WMC self test failed = M8959-M8957
		14 –	In-line test 1; XMC ROM parity error M8958-M8959-M8960
		15 –	In-line test 2; RPM self-test failed M8953-M8960

Table 3-2 Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Skew (azimuth)	Leading step width (using skew tape) = 1.2 μs maximum, Adjust for minimum	Read PCBA TP11	Head azimuth screw	6.5.7.1
Write current	Refer to procedure in TM	—	—	6.5.7.2
PE gain	1.25 V PP at Preamp output resistor writing all 1s on a standard output tape	Preamp resistor upper lead R1 R4 R7 R10 R13 R16 R19 R22 R25	Read PCBA Potentiometer R706 R906 R506 R106 R406 R306 R206 R806 R606	6.5.7.3

Table 3-2 Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Supply reel load speed	55 rpm (±5 rpm) Reel servo PCBA TP60 and TP69 to ground (TP49)	—	Reel servo PCBA R52	6.5.6.2
Takeup reel load speed	180 rpm (±18 rpm) Reel servo PCBA TP60 and TP57 to ground (TP49)	—	Reel servo PCBA R91	6.5.6.3
Tape loop position	Refer to procedure in TM	—	—	6.5.6.4
Read/Write —	Clean tape path	—	—	4.3.4

Table 2-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
16 –		In-line test 3; RPM1 channel 0 self-test failure M8950 (slot AB12)
17 –		In-line test 4; RPM1 channel 1 self-test failure M8950 (slot AB13)
20 –		In-line test 5; RPM1 channel 2 self-test failure M8950 (slot AB14)
21 –		In-line test 6; RPM1 channel 3 self-test failure M8950 (slot AB15)
22 –		In-line test 7; RPM1 channel 4 self-test failure M8950 (slot AB16)
23 –		In-line test 10; RPM1 channel 5 self-test failure M8950 (slot CD13)
24 –		In-line test 11; RPM1 channel 6 self-test failure M8950 (slot CD14)
25 –		In-line test 12; RPM1 channel 7 self-test failure M8950 (slot CD15)
26 –		In-line test 13; RPM1 channel P self-test failure M8950 (slot CD16)
27 –		In-line test 14; RPM1 error correction self-test M8950-M8951-M8953
30 –		In-line test 15; 40000 – 40777 RAM memory failure M8960

‡The interrupt code is used for TM78 initiated.
§ The interrupt code is used for data transfer.

Table 2-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
		31 – In-line test 16; 41000 – 41777 RAM memory failure M8960
		32 – In-line test 17; 42000 – 42777 RAM memory failure M8960
		33 – In-line test 20; 43000 – 43777 RAM memory failure M8960
		34 – In-line test 21; 44000 – 44777 RAM memory failure M8960
		35 – In-line test 22; 45000 – 45777 RAM memory failure M8960
		36 – In-line test 23; 46000 – 46777 RAM memory failure M8960
		37 – In-line test 24; 47000 – 47777 RAM memory failure M8960
		40 – In-line test 25; loop write-to-read at TU port 0 – GCR
		41 – In-line test 26; loop write-to-read at TU port 0 – PE
		42 – In-line test 27; loop write-to-read at TU port 1 – GCR
		43 – In-line test 30; loop write-to-read at TU port 1 – PE
		44 – In-line test 31; loop write-to-read at TU port 2 – GCR

Table 3-2   Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Forward stop ramp	Use TM78 maintenance panel Keypad OP code = 36 (REP) Display value = L 00	–	Capstan/ regulator, R66	6.5.5
Reverse stop ramp	Use TM78 maintenance panel Keypad OP code = 40 (REP) Display value = L 00	–	Capstan/ regulator, R78	6.5.5
Reel Servo Servo offset	No rotation of supply reel hub	–	Reel servo PCBA R76	6.5.6.1

Table 3-2   Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Cartridge pressure	2.5 inches of water (±0.5 inches of water)	Cartridge pressure port	Cartridge pressure screw	6.5.4.4
Capstan Servo Tape speed	Use TM78 maintenance panel Keypad OP code = 32 (REP) Display value = L 00	–	Capstan/regulator, R47	6.5.5
Forward start ramp	Use TM78 maintenance panel Keypad OP code = 34 (REP) Display value = L 00	–	Capstan/regulator, R59	6.5.5

Table 2-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
45 –		In-line test 32; loop write-to-read at TU port 2 – PE
46 –		In-line test 33; loop write-to-read at TU port 3 – GCR
47 –		In-line test 34; loop write-to-read at TU port 3 – PE
50 –		In-line test 35; loop write-to-read at MTA 0 – GCR
51 –		In-line test 36; loop write-to-read at MTA 0 – PE
52 –		In-line test 37; loop write-to-read at MTA 1 – GCR
53 –		In-line test 40; loop write-to-read at MTA 1 – PE
54 –		In-line test 41; loop write-to-read at MTA 2 – GCR
55 –		In-line test 42; loop write-to-read at MTA 2 – PE
56 –		In-line test 43; loop write-to-read at MTA 3 – GCR
57 –		In-line test 44; loop write-to-read at MTA 3 – PE

Table 2-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code	
34	MB FAULT	01 –	Control bus parity error (Write)
		02 –	Illegal MASSBUS register referenced
77	KEY FAIL	01 –	Keypad entry error
		02 –	TM78 not off-line
		03 –	Illegal instruction code

2.7   TM78 MAINTENANCE PANEL

A firmware driven TM78 maintenance panel provides access to the operational microcode functions, internal hardware registers, and the resident microdiagnostics.

A table of instructions may be created in RAM through the keypad to exercise the formatter or a single tape transport. Many functions of the maintenance panel can be used while the TM78 is on-line and performing tape operations for a host CPU. Added maintenance functions are provided when the TM78 is switched off-line from the host.

> **NOTE**
> **Because the operational microcode must time-share or interleave the host commands and the maintenance commands, use of the keypad while on-line causes slower response time to the commands issued by the host. Therefore, be sure to check with the system operator before using the maintenance panel to see if this latency is acceptable. If not, use the instruction delay in parameter item No. 2 (Table 2-6).**

The maintenance panel includes a 20-key keypad and a 6-digit octal display cluster. Figure 2-1 shows a detailed view of the maintenance panel.

2.7.1   Keypad Function Summary

The following is a summary of the keypad functions.

Table 3-2   Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Vacuum/Air Pressure System vacuum	34 inches of water water with tape running forward (±1 inch water)	Cripple reel port	Butterfly valve	6.5.4.1
Takeup reel vacuum	19 inches of water (±1 inch water)	Takeup reel vacuum port	Vacuum valve Friction plate	6.5.4.2
Air bearing pressure	3.75 PSI (±0.25 PSI) with tape running forward	Air bearing pressure port	Pressure Valve ABP screw	6.5.4.3
Thread block pressure	24 inches of water (±2 inches of water)	Thread block pressure port	Thread block pressure adjustment screw	6.5.4.4

Table 3-2   Adjustment Specifications

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
TU78 Supply Voltage +5 V	+5.15 Vdc, ±0.15 Vdc	Capstan/ regulator, TP11	Capstan/ regulator, R179	6.5.1
Tape Path Sensors EOT/BOT sensor	0 Vdc, ±0.1 Vdc with EOT/BOT not under sensor	Interconnect F1, TP6(+) TP5(−)	Interconnect F1, R22	6.5.2
Pack sense	0.5 Vdc max with takeup reel sensor tab in line with sensor	Interconnect F1, TP4(+) TP7(−)	Interconnect F1, R17	6.5.3
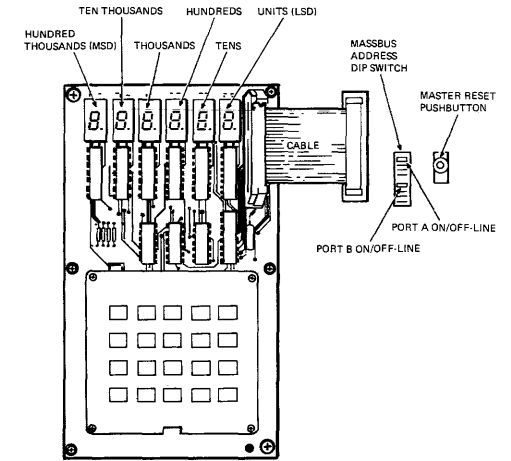
Figure 2-1   TM78 Maintenance Panel

Miscellaneous Keys

ENA   Pressing this key once enables the keypad. Pressing this key again disables the keypad.

CLR   CLEAR erases a number in the display and stops a looping command.

Numeric Keys

0 → 7   The eight numeric keys specify one of the following before a control or operation key is pressed.

Memory address
Memory data
Internal I/O hardware address
Internal I/O hardware data
Parameter item number
Parameter data
Instruction item number
Instruction op-code

Control Keys

INS	The INSTRUCTION key is used to examine and modify any of the sixteen instruction locations.
HDW	The HARDWARE key is used to examine and modify most of the 377 TM78 internal I/O registers. (Appendix B of the *TM78 Technical Manual*.)
PAR	The PARAMETER key is used to examine and modify the set of parameter items that control the microcode in performing maintenance functions.
MEM	The MEMORY key is used to examine and modify locations within the microcomputers memory space.
NXT	The NEXT key causes the next sequential item or location of the group **(INS, HDW, PAR, or MEM)** selected last to be examined.
DEP	The DEPOSIT key is used to modify the contents of an item or location.

Operation Keys

EXE	The EXECUTE key is used to execute a single maintenance instruction one time only.
REP	The REPEAT key causes a single maintenance instruction code to be executed repeatedly.
STA	The START key initiates the execution of instructions previously deposited into the instruction item group.

Table 3-1   Checks/Adjustments When Replacing Parts (Cont)

Part Replaced	Check or Adjustment	Paragraph
Maintenance panel	Keypad/ display power on checks	3.5.1.1*
H7441	+5 V	5.7.5†
H7446	±15 V	5.7.5†
H7490	−5 V	5.7.5†

NOTE
The paragraph number listed is for the full procedure found in the applicable technical manual.

*TU78 Technical Manual (Vol II)
†TM78 Technical Manual

Table 3-1   Checks/Adjustments When Replacing Parts (Cont)

Part Replaced	Check or Adjustment	Paragraph
Takeup reel motor	Takeup reel load speed	6.5.6.3*
	Tape loop position	6.5.6.4*
AC motor	Vacuum/ pressure	6.5.4*
Blower	System vacuum	6.5.4.1*
	Takeup reel vacuum	6.5.4.2*
Compressor	Air bearing pressure	6.5.4.3*
	Thread block and cartridge pressure	6.5.4.4*
Read PCBA	PE gain	6.5.7.3*
Write PCBA	Write currents	6.5.7.2*
	PE gain	6.5.7.3*
Capstan Servo PCBA	Power	6.5.1*
	Capstan servo adjustments	6.5.5*
	PE gain	6.5.7.3*
Reel servo PCBA	Reel servo adjustments	6.5.6*
	Dynamic brake check	6.6.6.1*
Preamp PCBA	PE gain	6.5.7.3*
Inter-connect F1 PCBA	EOT/BOT sensor	6.5.2*
	Pack sense sensor	6.5.3*
	Tape loop position	6.5.6.4*

CON   The CONTINUE key may be used to continue the maintenance instruction program at the item number saved when it was last stopped.

2.7.2   Errors

An error code is displayed whenever a command cannot be performed. Table 2-5 lists all the error codes and the reason for the error.

Table 2-5   Keypad Error/Status Codes

Code in Display	Meaning
E 001	Value of item number or location is too large for this group.
E 002	Value of item number or location is already at high limit when **NXT** key was pressed.
E 003	No numeric value was specified before deposit.
E 004	Privileged function is requested (such as modifying a RAM or hardware location) with TM78 on-line.
E 005	ROM address is not in use.
E 006	Illegal instruction code is selected for an instruction item.
77 – 01	Error is detected when attempting to execute a maintenance instruction to a TU78. Either the TU78 selected by parameter item 0 is not in maintenance mode (port select 3), or the adjustment selected is out of acceptable tolerance.
77 – 02	Privileged maintenance instruction is requested with TM78 on-line.
77 – 03	Illegal instruction code is specified when using **EXE** or **REP** keys.

2.7.3 Parameters

Table 2-6 lists each parameter location and a description of how it conditions or affects the hardware when running maintenance panel instructions.

Table 2-6 Parameter Items

Item Number	Read/ Write	Initialized Value	Description
0	R/W	000	MASSBUS Port/Tape unit port select

This item selects one of two MASSBUS ports and one of four Tape unit ports to communicate with.

Bit	Value	Port Selected
7	0	MASSBUS A
7	1	MASSBUS B
1:0	0	TU Port 0
1:0	1	TU Port 1
1:0	2	TU Port 2
1:0	3	TU Port 3

This item corresponds to hardware register 340-W.

1	R/W	000	Program run control

This item is used by the STA and CON keys. When this item is any number other than 0, a program can be single-stepped one instruction at a time. When this item is 0 the program can run.

2	R/W	000	Instruction delay

This item is used to insert a delay between each instruction pass when in LOOP mode. The larger the number the longer the

3 CHECKS AND ADJUSTMENTS

3.1 PARTS REPLACEMENT

Table 3-1 lists the corequisite check or adjustment that must be made when replacing certain parts in the subsystem. If a part is not listed in the table, then no corresponding check or adjustment is required.

3.2 QUICK REFERENCE ADJUSTMENT SPECIFICATION

Table 3-2 provides a quick reference to the various TM78/TU78 adjustment specifications. Figure 3-1, 3-2 and 3-3 show the location of various controls and switches on the TU78 PCBAs. Figure 3-4 shows the air valves with their test points and adjustments.

Table 3-1 Checks/Adjustments When Replacing Parts

Part Replaced	Check or Adjustment	Paragraph
Read/ write/ erase head	Clean transport	4.3.4*
	Power	6.5.1*
	Capstan servo adjustment	6.5.5*
	Read/write adjustments	6.5.7*
Capstan motor	System vacuum	6.5.4.1*
	Takeup reel vacuum	6.5.4.2*
	Read skew	6.5.7.1*
Supply reel motor	Supply reel load speed	6.5.6.2*
	Tape loop position	6.5.6.4*

*TU78 Technical Manual (Vol II)

Interconnect F1 PCBA

TP 1 S POS
TP 2 T POS 2
TP 3 TIP
TP 4 N PKSN
TP 5 EOT
TP 6 BOT
TP 7 GND

Reel Servo PCBA

TP 1
TP 2
TP 4 +36 V (T)
TP 6 TM (+)
TP 8 TM (-)
TP10 -36 V (T)
TP12 +36 V (S)
TP14 SM (-)
TP16 SM (+)
TP18 -36 V (S)
TP20 UNUSED
TP21 NTDA
TP22 NTDB
TP23 NSDA
TP24 NSDB
TP49 GND
TP50 GND
TP51 Q2 (COLL)
TP52 REEL SERVO BRAKE
TP 53 +5 V (S) TO ALL IC'S
TP54 UNUSED
TP55 TPOS
TP56 NTRRTP57 NTRF
TP58 SUM AMP OUT NDTA/B
TP59 SUM AMP OUT T/U LOOP COMP
TP60 NAE (REEL SERVO ENAB)
TP61 NTINTLK
TP62 +15 V DC
TP63 UNUSED
TP64 -15 V DC
TP65 1.25 KHZ T-WAVE GEN
TP66 SPOS
TP67 OFFSET
TP68 SUM AMP OUT SUP LOOP COMP
TP69 NSRF 1
TP70 NSRR
TP71 SUM AMP OUT NSDA/B
TP72 NSRF 2

Table 2-6   Parameter Items (Cont)

Item Number	Read/Write	Initialized Value	Description
			delay. The delay can be used to reduce the impact on host CPU throughput, to allow tape to stop between instructions, etc.
3	R/W	000	General-Purpose counter
			This counter can be loaded, counted, and tested by maintenance instructions.
4	R	000	Branch status
			Status byte returned by all instructions. Used by conditional branch instructions.
			Bit 0 – error Bit 1 – end of tape Bit 2 – tape mark
5	R	000	Interrupt code (Table 2-5)
6	R	000	Failure code (Table 2-5)
			Items 5 and 6 contain the execute status returned by the last tape command or in-line diagnostic control instruction. Program control and privileged instructions return execute status but do not write into these parameter items. These items make it possible to run a program that performs tape commands and halts if an error is detected. The actual error can be identified by examining these parameter items after the program halts.

Table 2-6 Parameter Items (Cont)

Item Number	Read/ Write	Initialized Value	Description
7	R	000	Program continue address
			The CON key uses this item to determine next instruction address.
10	R/W	*	In-line diagnostic index
			This item selects an in-line diagnostic program for maintenance instruction 16. Refer to Table 2-2 for a listing of the in-line tests available.
11	R/W	120	Data format and skip count
			Data transfer maintenance instructions uses this item and corresponds to hardware register 320-W. Initialized to image format with a zero skip count.

Bit	Value	Description
7	–	Not used
6:4		Format Control
	0	11 normal
	1	15 normal
	2	10 compatible
	3	10 core dump
	4	10 high-density compatible
	5	Image (skip count has no effect)
	6	10 high-density dump
	7	Illegal

TP21 CLEAR
TP22 ST1 CLOCKS
TP23 UNUSED
TP24 UNUSED

Write PCBA

TP 1 CLK 2
TP 2 V PED
TP 3 V STEP
TP 4 V WRT
TP 5 CLK 1
TP 6 V PED AT Q27/28 WD2
TP 7-23 UNUSED
TP24 REWR (REWIND RAMP)

Capstan/Regulator PCBA

TP 1 GND
TP 2 GND
TP 3-10 UNUSED
TP11 +5 V DC
TP12 V SENSE
TP13 MOTOR CURRENT
TP14 UNUSED
TP15 +15 VDC
TP16 UNUSED
TP17 UNUSED
TP18 -15 VDC
TP19 MOTOR VOLTAGE
TP20–24 UNUSED
TP49 CAPSTAN GND
TP50 CAPSTAN GND
TP51 NFPT
TP52 ANALOG TACH
TP53 UNUSED
TP54 UNUSED
TP55 SPARES 1
TP56 CART SOL RET
TP57 VAC SOL RET
TP58 WP SOL RET
TP59 PRES SOL RET
TP60–64 UNUSED
TP65 8.5 VAC
TP66–69 UNUSED
TP70 NPORST
TP71 CART MTR (+)
TP72 UNUSED

Control M2 PCBA

TP35 – LDF 3
TP36 – NBOT
TP37 – STL
TP38 – NEOT
TP39 – CLK C (10 KHZ)
TP40 – TACH AMP
TP41 – LDF 5
TP42 – LDF4
TP43 – LOW TAPE SENSOR
TP44 – NLDFS
TP45 – LDS (LOAD FAULT SENSE)
TP46 – BKW
TP47 – MRL
TP48 – ABP N/O
TP49 – GND
TP50 – GND
TP51 – NPOL
TP53 – THD
TP54 – CC N/O
TP55 – CO N/O
TP56 – U146-5 UNLD
TP57 – S LIMIT N/O
TP58 – NSMRL
TP59 – TOR N/O
TP60 – VAC N/O
TP61 – T LIMIT N/O
TP62 – NINTLK
TP63 – NCCC (CLOSE CART CMD)
TP64 – SRF
TP65 – SRR
TP66 – TRF
TP67 – TRR
TP68 – THDS
TP69 – NCOC (CART OPEN CMD)
TP70 – NRSAE (REEL SERVO ENABLE)
TP71 – PNU RET
TP72 – NXFR

Read PCBA

TP 1
TP 2
TP 3-9 UNUSED
TP10 TRK 9/0 ACTIVE (CH4 & 6)
TP11 TRK 9/1 ACTIVE (CH4 & 5)
TP12-19 UNUSED
TP20 U29-11

Table 2-6   Parameter Items (Cont)

Item Number	Read/ Write	Initialized Value	Description	
			3:0	Skip Count
			00	No skip
			01	Skip 1 byte
			02	Skip 2 bytes
			03	Skip 3 bytes
			04	Skip 4 bytes
			05	Skip 5 bytes
			06	Skip 6 bytes
			07	Skip 7 bytes
			10	Skip 8 bytes
			11-17	Illegal
12	R/W	020	Write function clock control	
13	R/W	022	Read GCR function clock control	
14	R/W	023	Read PE function clock control	
15	R/W	020	LOOP write to read function clock control	
			Items 12 – 15 are the data loaded into the clock control register before the function is performed. Refer to hardware register 360-W in TM78 Technical Manual for a description of the bit combinations.	
16	R/W	005000	Write record size	
			This 16-bit item is the byte count used by write data maintenance instructions to determine the size of the record written. It is used by read data maintenance instructions as the expected record size.	

*Item value is not initialized by enabling keypad.

Table 2-6   Parameter Items (Cont)

| Item Number	Read/ Write	Initialized Value	Description
17	R	000000	Read record size
			This 16-bit item is returned by read data instructions as actual size of record read.
20	R/W	777777	Write data
			This 18-bit item is written into the DDR for write data instructions.
21	R	000000	Read data
			This 18-bit item contains the contents of the DDR after the last read data instruction, if performed in image format. It is cleared on every read in all other formats.
22	R	*	Last fatal interrupt code for port A
23	R	*	Last fatal interrupt code for port B
			Item 23 and 24 are a history of last fatal interrupt code (right justified).
24	R	*	Last fatal failure code for port A
25	R	*	Last fatal failure code for port B
			Items 23 and 24 are a history of the last fatal failure code (left justified).
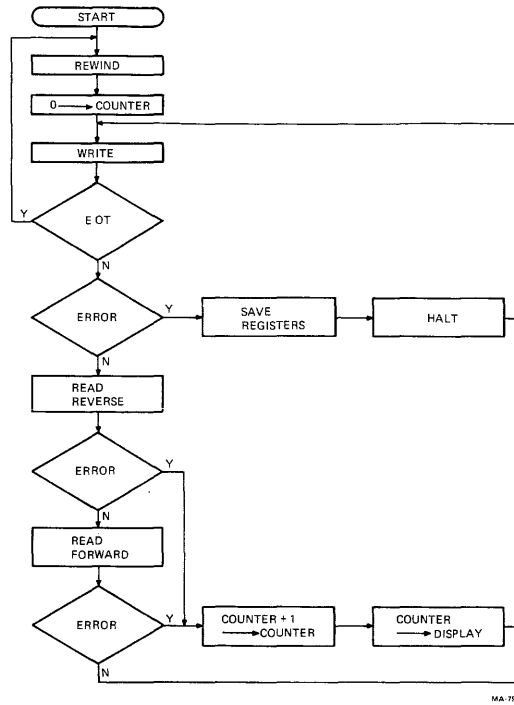
Figure 2-2   Sample Write/Read Routine

Control M2 PCBA

TP19 – CLK E (10 HZ)
TP20 – CLK A (1 MHZ)
TP22 – U71-6 CAPSTAN REV
TP23 – U63-6
TP24 – U66-6 NRDY
TP25 – GND
TP26 – GND
TP27 – LDF 1
TP28 – LDF 6
TP29 – U72-11 RWS
TP30 – MAINT FUNCTION
TP31 – MAINT FUNCTION
TP32 – LDF 2
TP33 – NTAP 2
TP34 – N>80 %

2.7.5 Sample Maintenance Routine

Figure 2-2 shows the program flow for a sample write/read maintenance routine. This routine writes a record, reads it backward and forward, then repeats the operation till the EOT marker is reached where the tape is rewound. A tally of all read errors is put into the display for each tape pass. If a write error occurs, many important TM78/TU78 registers are saved in parameter locations. Then the program halts so that these parameters can be analyzed.

The program coding is shown below.

Instruction Address	Instruction Code	Description
0	7	Rewind tape
1	100	Clear counter
2	61 (63)	Write PE (GCR)
3	240	If EOT, branch to start
4	214	If error, branch to save
5	77	Read reverse
6	211	If error, branch to count update
7	71	Read forward
10	222	Branch to write if no error
11	4	Increment counter +1
12	12	Put count in display
13	362	Branch to write
14	10	Save registers
15	2	Halt
16	362	Branch to write after continue
17	–	–

2.8 TEST POINTS

The following list includes all troubleshooting test points available on the TU78 PCBAs and the corresponding signal name.

Control M2 PCBA

TP 1 – GND
TP 2 – GND
TP 3-12 – UNUSED
TP13 – +5 V DC
TP14 – LDF0
TP15 – CLK B (100 KHZ)
TP16 – U85-2
TP17 – UNUSED
TP18 – NLDP1

Table 2-6   Parameter Items (Cont)

Item Number	Read/ Write	Initialized Value	Description
			The remaining items are stored whenever the execution of a tape unit operation results in an error. The error status in the hardware registers is saved so that it can be interrogated by maintenance personnel. A copy of these items exists for each tape unit and is readable by the host CPU EXT SENSE command.
26	R	*	Command code is being executed on last error.
27	R	*	Interrupt code is 6 bits right justified.
30	R	*	Failure code is 6 bits right justified.

NOTE
Items 26 through 30 are written with zeros when these locations are written as a result of the keypad hardware dump instruction.

Items 31 – 105 are hardware registers.

Item Number	Read/ Write	Initialized Value	Register	Contents
31	R	*	0	Read path write fail bits
32	R	*	1	Read path diagnostic bits
33	R	*	2	Read path status
34	R	*	3	Read path CMD
35	R	*	20	AMTIE
36	R	*	21	RC done
37	R	*	22	Illegal 5-4/
40	R	*	23	Mark 2
41	R	*	24	End mark
42	R	*	25	RC par bits
43	R	*	26	Postamble det
44	R	*	27	Data
45	R	*	30	CRC
46	R	*	31	Corrected data
47	R	*	32	ECC status
50	R	*	40	Channel 0 TIE bus
51	R	*	41	Channel 1 TIE bus

*Item value is not initialized by enabling keypad.

Table 2-6 Parameter Items (Cont)

Item Number	Read/ Write	Initialized Value	Description	
			Register	Contents
52	R	*	42	Channel 2 TIE bus
53	R	*	43	Channel 3 TIE bus
54	R	*	44	Channel 4 TIE bus
55	R	*	45	Channel 5 TIE bus
56	R	*	46	Channel 6 TIE bus
57	R	*	47	Channel 7 TIE bus
60	R	*	50	Channel P TIE bus
61	R	*	60	TIE bus
62	R	*	104	AMTIE
63	R	*	110	Port Status
64	R	*	114	Read data
65	R	*	240	CAS status
66	R	*	241	CBUS status
67	R	*	300	DBUS status
70	R	*	320	WMC status
71	R	*	321	TU select 0
72	R	*	322	TU select 1
73	R	*	323	Write data
74	R	*	324	Byte counter <7:0>
75	R	*	324	Byte counter <15:8>
76	R	*	325	Pad counter <7:0>
77	R	*	325	Pad Counter <15:8>
100	R	*	326	Ecode counter <7:0>
101	R	*	326	Ecode counter <15:8>
102	R	*	330	DDR/MBD A.
103	R	*	331	DDR/MBD B.
104	R	*	332	WMC Errors
105	R	*	340	Interrupt status
106	R	*	0	MIA status
107	R	*	1	MIA status A
110	R	*	3	MIA status B
111	R	*	4	Serial NR A
112	R	*	4	Serial NR B
113	R	*	5	TU diagnostics
114	R	*		Retry counter

This item count of number of retry requests given. A zero means tape unit is not in error recovery.

| 115 | R | * | | Retry control bits |

Table 2-7 Maintenance Instruction Codes (Cont)

Instruction Code	Description	Controlling Parameter Items (Table 2-6)
C. In-Line Diagnostic Control Instructions		
16	Run in-line diagnostic (Table 2-2)	1,10,15
32	Run tape speed adjustment routine	1
34	Run start ramp adjustment routine	1
36	Run forward stop ramp adjustment routine	1
40	Run reverse stop ramp adjustment routine	1
42	Write 13 mm (0.5 in) record pattern generator – PE	1,3,12,147
44	Write 13 mm (0.5 in) record using pattern generator – GCR	1,3,12,147
D. Privileged Instructions (TM78 must be off-line)		
26	Write continuously at 3200 FRPI in all tracks	0,12
30	Write continuously at 9042 FRPI in all tracks	0,12
46	Write continuously using pattern generator – PE	0,3,12,147
50	Write continuously using pattern generator – GCR	0,3,12,147

Table 2-7 Maintenance Instruction Codes (Cont)

Instruction Code	Description	Controlling Parameter Items (Table 2-6)
61	Write data — PE	0,1,11,12,16,20
63	Write data — GCR	0,1,11,12,16,20
71	Read forward	0,1,11,13,14,17,21
77	Read reverse	0,1,11,13,14,17,21

B. Program Control Instructions (Do Not Use with EXE/REP Keys)

0	NO—OP	1
2	Halt	7
4	Increment counter +1	1,3
6	Decrement counter +1	1,3
10	Update parameter items 26 through 157 with current hardware status	0,1
12	Display contents of counter.	1,3
14	Display contents of parameter item addressed by counter.	1,3
100 + n	Load counter with n (n = 0–77)	1,3
200 + x	Branch if error status	1,4
220 + x	Branch if no error status	1,4
240 + x	Branch if EOT detected	1,4
260 + x	Branch if no EOT detected	1,4
300 + x	Branch if tape mark detected	1,4
320 + x	Branch if no tape mark detected	1,4
340 + x	Branch if counter not zero	1,3
360 + x	Unconditional branch	1

x = Item number (0 to 17) of next instruction if branch condition is true

Table 2-6 Parameter Items (Cont)

Item Number	Read/ Write	Initialized Value	Description
			Bit 5 – initial command moved tape in reverse Bit 6 – initial command was a read Bit 7 – last retry requested was in opposite direction of initial command
116	R	*	TU software status
			Bit 0 – DSE command in progress Bit 1 – rewinding command in progress Bit 2 – tape unit exists Bit 3 – motion command (NDT) in progress Bit 4 – moved in reverse direction last Bit 5 – last operation wrote on tape Bit 6 – last record seen was tape mark Bit 7 – Massbus port B issued last command
117	R	*	Transfer control word
			This item is the control word for last data transfer command
			Bits 0–2 – write clock select Bits 3–5 – read clock select Bits 6 – PLO bypass Bit 7 – low read threshold
120	R	*	Retry suppress and format control

*Item value is not initialized by enabling keypad.

Table 2-6   Parameter Items (Cont)

| Item Number	Read/Write	Initialized Value	Description
			This item is a copy of Massbus register containing retry suppress, format and skip count.
121	R	*	Keypad enable flag
			This item is nonzero when keypad is enabled.
122 – 137			Not used
140	R	*	MIA register 0, TU78 status
140	W	*	MIA register 0, TU CMD A
141	R	*	MIA register 1, MIA status a
141	W	*	MIA register 1, TU CMD B
142	R	*	MIA register 2, MIA status b
142	W	*	MIA register 2, AMTIE loop
143	R	*	MIA register 3, serial No. a
143	W	*	MIA register 3, threshold
144	R	*	MIA register 4, serial No. B
144	W		Not used
145	R	*	MIA register 5, TU diagnostics
145	W		Not used
146	–		Not used
147	R/W	*	MIA register 7, pattern generator data
150 – 157			Not used
			Items 140 – 147 are explained in Appendix C of the Technical Manuals.

*Item value is not initialized by enabling keypad.
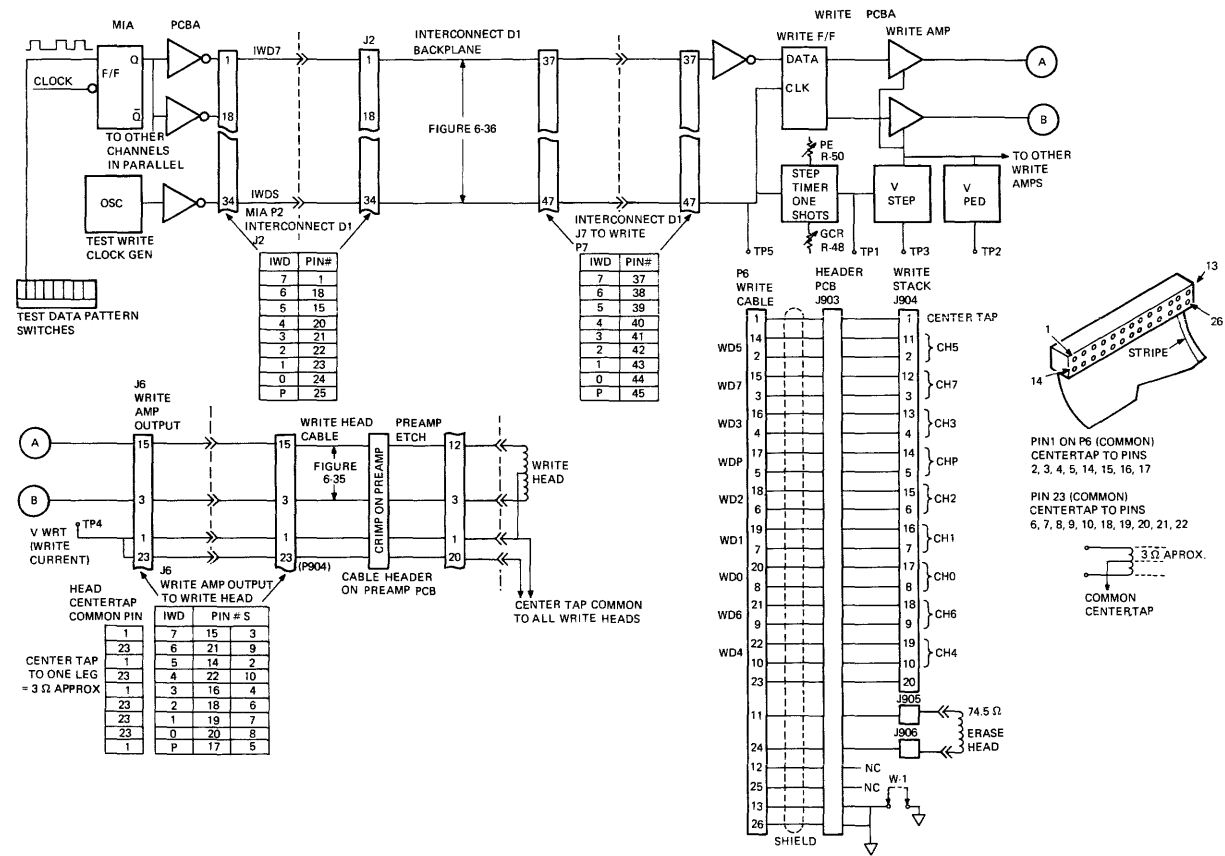
2.7.4   Maintenance Instructions

A table of 16 maintenance instructions may be assembled and run using the INS, STA and CON keys. Single instructions may also be executed with the EXE and REP keys. The transport being exercised must be selected to port #3. Table 2-7 lists all available maintenance instruction codes, their description, and the parameter item codes that influence the execution of that instruction. Tape Command (Group A), Program Control (Group B), and In-Line diagnostic control instructions (Group C) may all be run while the TM78 is off-line or on-line with the host CPU using another transport. However, privileged instructions (Group D) require that both ports of the TM78 be placed off-line.

Table 2-7   Maintenance Instruction Codes

Instruction Code	Description	Controlling Parameter Items (Table 2-6)
A. Tape Commands (Nonprivileged)		
5	Rewind and unload tape	0,1
7	Rewind tape	0,1
15	Write tape mark – PE	0,1,12
17	Write tape mark – GCR	0,1,12
21	Space one record forward	0,1,13,14
23	Space one record reverse	0,1,13,14
31	Space forward one record or file	0,1,13,14
33	Space reverse one record or file	0,1,13,14
35	Erase extended gap – PE	0,1
37	Erase extended gap – GCR	0,1
51	Loop write-to-read at TU port – PE	0,1,15
53	Loop write-to-read at TU port – GCR	0,1,15
55	Loop write-to-read at MIA	0,1,15
57	Loop write-to-read at MIA PCBA – GCR	0,1,15
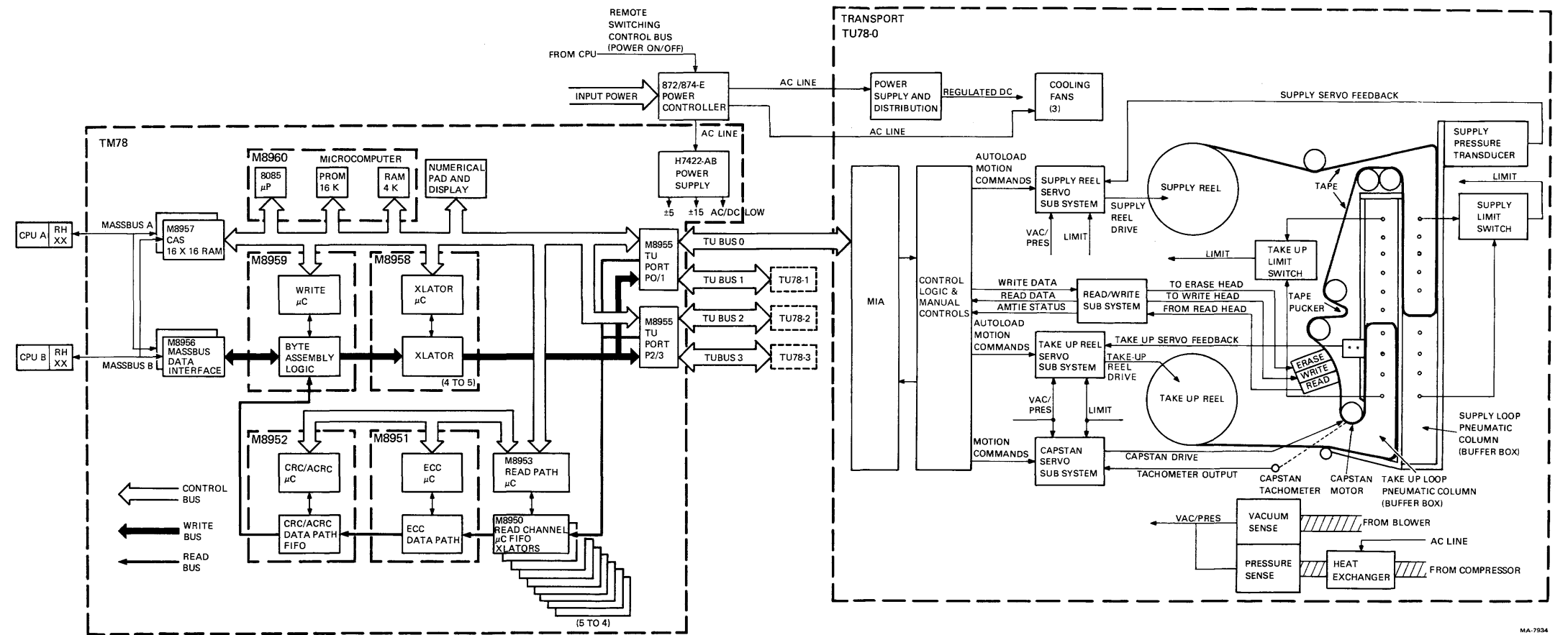
TU78 Subsystem Detailed Block Diagram

Write Path Troubleshooting Diagram

Read Path Troubleshooting Diagram

MA-7319

MA-7320

IWD	PIN#
7	1
6	18
5	15
4	20
3	21
2	22
1	23
0	24
P	25

IWD	PIN#
7	37
6	38
5	39
4	40
3	41
2	42
1	43
0	44
P	45

HEAD CENTERTAP COMMON PIN

IWD | PIN#S |
--- | --- | ---
7 | 15 | 3
23 | 14 | 2
5 | 22 | 10
4 | 16 | 4
3 | 18 | 6
2 | 19 | 7
1 | 20 | 8
P | 17 | 1

RESISTOR TEST POINT

TRACK CHAN. NO.	OUT 1	OUT 2	RD (PO)
1	R_1	R_2	5
2	R_4	R_5	7
3	R_7	R_8	3
4	R_{10}	R_{11}	P
5	R_{13}	R_{14}	2
6	R_{16}	R_{17}	1
7	R_{19}	R_{20}	0
8	R_{22}	R_{23}	0
9	R_{25}	R_{26}	4

AGC PO/RD | OUT 1 | OUT 2 |
--- | --- | --- | ---
23 | 1 | 24 | 7
8 | 2 | 9 | 25
11 | 3 | 12 | 28
12 | 4 | 13 | 19
14 | 5 | 32 | 31
29 | 6 | 21 | 4
20 | 7 | 30 | 13
26 | P | 27 | 10
5 | 0 | 6 | 22

RD	P5
1	69
2	52
3	67
4	62
5	61
6	59
P	58
0	70

PREAMP OUTPUT PO	READ PCBA J5 PIN #	WRITE PCBA J7 PIN #
1	51	66
2	52	67
3	53	68
4	54	69
5	55	70
6	56	71
7	57	72
P	49	64
0	50	65

J3 P3 PIN # (RD)
RD |
--- | ---
1 | 31
2 | 27
3 | 26
4 | 21
5 | 20
6 | 18
P | 34
0 | 32

RD	J3 PIN #
1	35
2	33
3	31
4	29
5	27
6	25
P	23
0	37

AMTIE	J-1 MIA PIN #
1	19
2	20
3	12
4	2
5	2
6	13
P	17
0	18

AMTIE	J3
1	5
2	7
3	9
4	11
5	13
6	15
7	17
P	19
0	3