EK-0TU78-PS-002

TU78 Subsystem

Pocket Service Guide

Issued by
Training Department

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NOT MAINTAINED

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of
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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 (RH32), 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 fold-out 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.

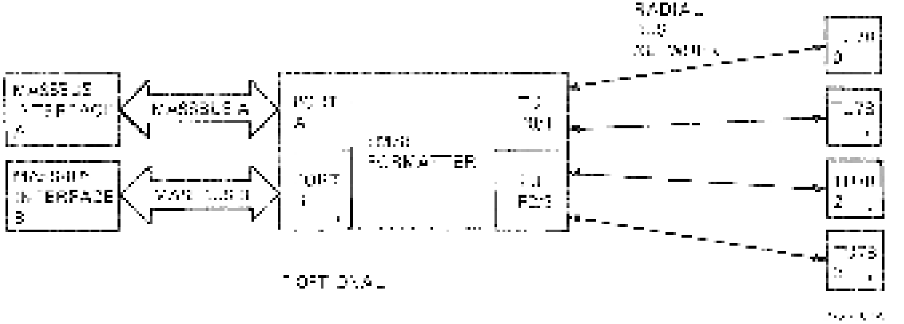


Figure 1 Dual-Ported TU78 Subsystem

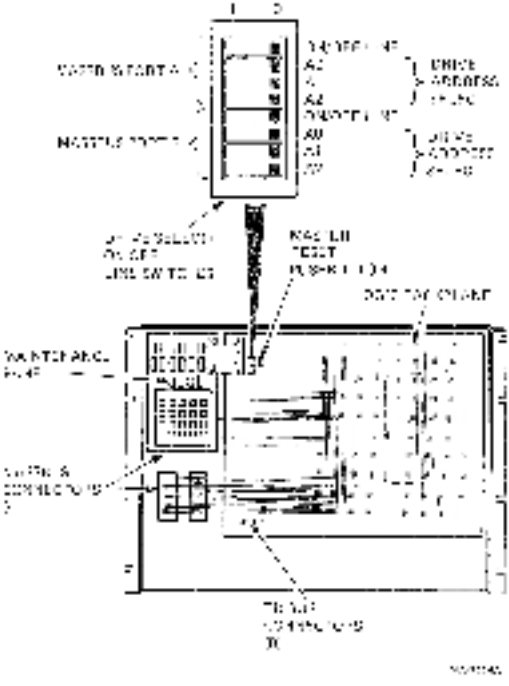


Figure 1-2 TM700 Front View

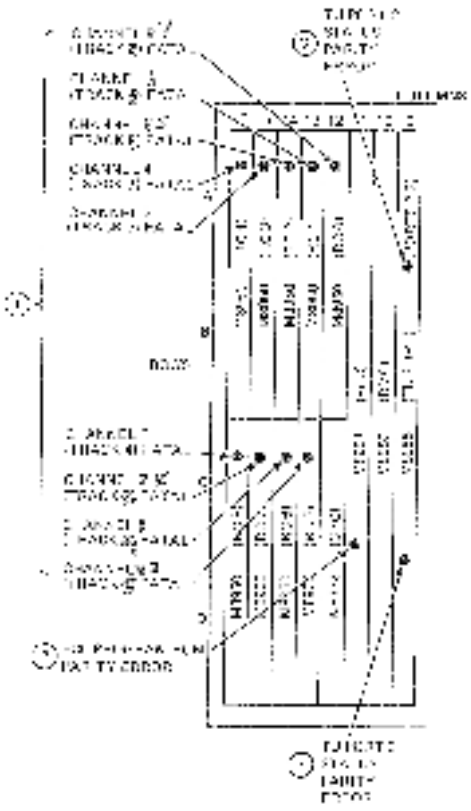


Figure 1-3 TMPS Module Layout (Back View) Showing Maintenance Indicators (Sheet 1 of 2)

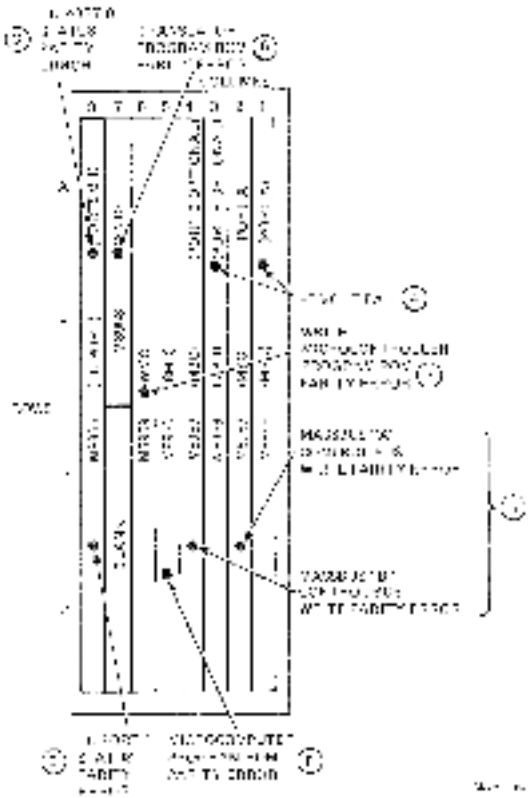


Figure 1-5 C-M38 Module Layout (Back View) Showing Maintenance Indicators (Sheet 2 of 2)

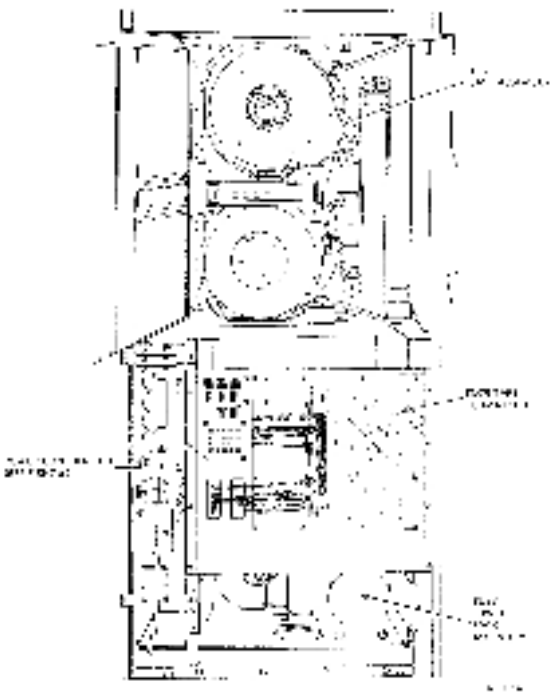


Figure 1-2 TCP8 Assemblies (Front View)

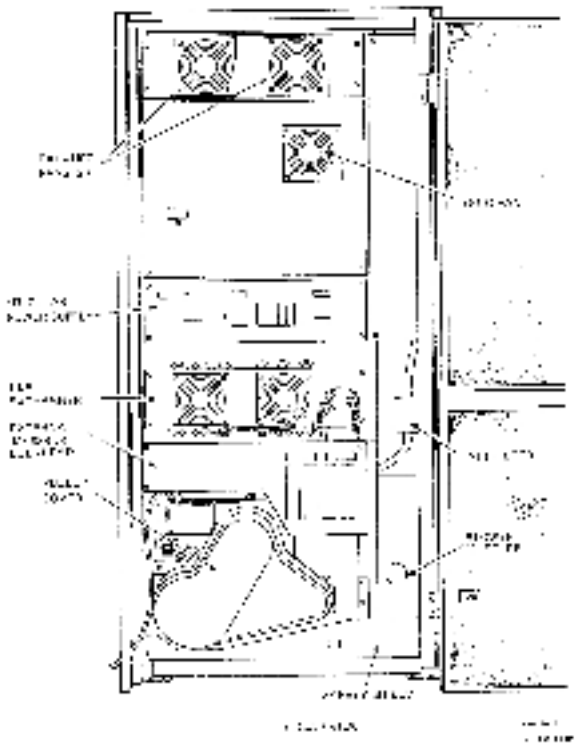


Figure 1-5 TI 78 Assemblies (Back View)

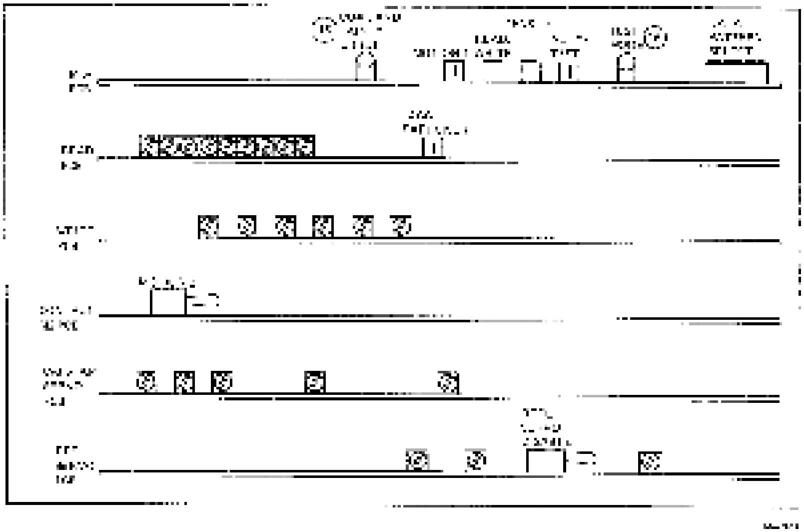


Figure 1-5 7178 Card Cage Showing Maintenance Controls and Indicators

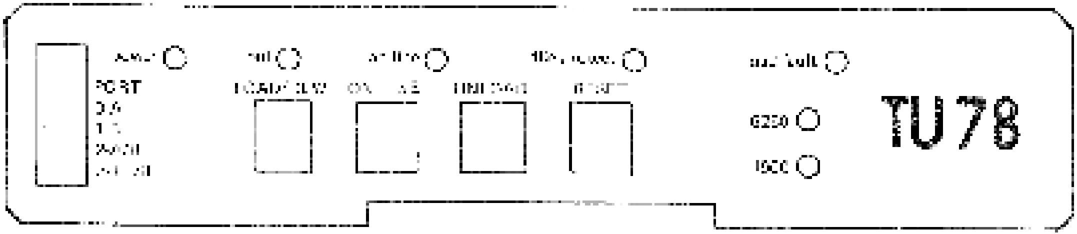


Figure 1-7 TU78 Operator Control Panel

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 TU78 formatter maintenance panel)

LOAD/REW It starts one of three sequences:

With no tape in bufl, it initiates a load sequence.

With tape in buffl but not positioned, it starts a midrecl load sequence. The midrecl load sequence thin tape loads and positions it in reverse direction to BOT.

With tape in buffl and positioned, 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 unloads 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 fatal fault.

Table 1-2 TU78 Indicators

Indicator	Meaning
Power	DC and spacecraft 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. Error occurs.
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 inch) reel after two tries.
	2. Load sequence has failed to load tape from a 216 mm or 178 mm (8.5 inch or 7 inch) 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 TC78 logic cage, and the front of the TC78 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 device address for both ports and sets either or both ports on or off-line. A unit port TM78 is considered off-line for maintenance purposes only when both ports are placed off-line.

Figure 1-2 shows the back of the logic gate and details some of the maintenance indicators that may be used for troubleshooting. Table 2-2 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 PCB A3 in the card cage assembly (Figure 1-6). Table 1-3 lists the TU78 maintenance controls and Table 1-3 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 pair finger dexterity needle extenders	W900	No
Reel motor centering fan	29-25206	Yes

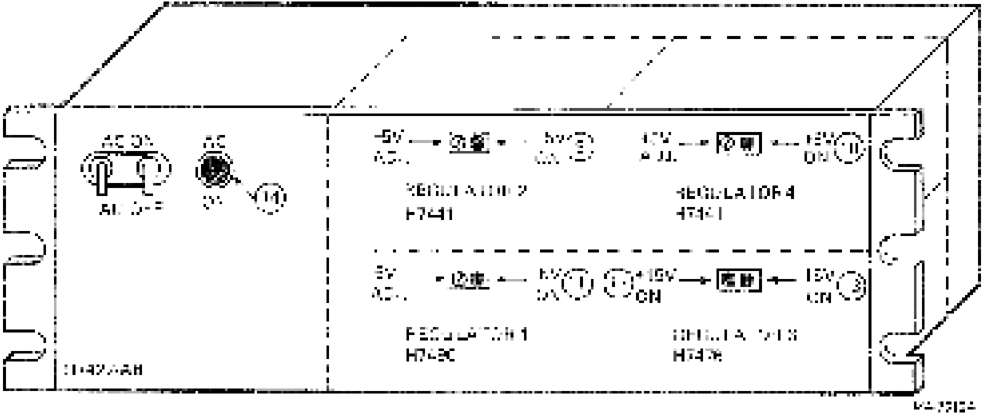


Figure 1-5 H7420 Power Supply Showing Maintenance Indicators and Controls

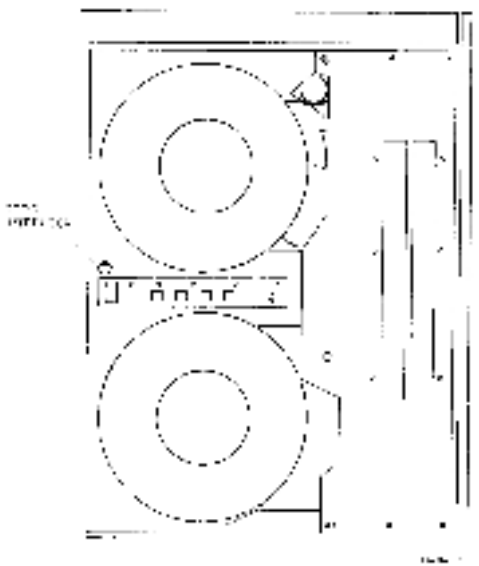


Figure 2-9 Door Safety Interlock Switch

Description	DEC Part Number	Included in Spares Kit
Reel flange locating bar	29-33207	Yes
PCBA extender	29-23218	Yes
Lower restraint tube fitting	29-23228	Yes
Differential pressure gauge (0–40 inch H_2O)	29-11650	Yes
Differential pressure gauge (0–5 PSI)	29-17636	Yes

Description	DRC Part Number	Included in Spares kit
Portable accessory package for gauges (2 needed)	29-11647	Yes
Tachometer (decimal readout)	38-11635	Yes
Tape crimper	17-00038	Yes
Needle Lancet	23-10502	Yes
7 inch calculator	29-11625	Yes
5/32 inch × 4 inch Ballpoint hex driver	29-11620	Yes
Master skew tone (1200 ft)	29-19924	No
Magnetic Slot tape developer	29-15871	No
50X microscope with graticule	29-20273	No
Heat sink compound	90-05268	Yes
Inspection mirror (dental type)	29-19602	No
Cleaning kit	TC-C01	(comes with TC78)
Standard output tape	29-1169	No

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 operation for normal or test mode. When in test (or manual) mode, transport must be off-line for other MIA switches to function.
Data Pattern Select.	MIA PCBA	It selects a repeating 3-frame pattern when on-line and in manual mode.
AGC Enable/	Read PCBA	It allows Read PCBA to lock AGC to the ARA burst or to run free.
Motion 2	Control MP PCBA	It moves transport forward or reverse, on or off-line.
Read Servo Disable	Read servo PCBA	It disables the read servo amplifier so that certain adjustments can be made.

1.8 SPARES KIT LISTS

1.8.1 TM78 Spares Kit (A2-W0342-HB)

The following lists the contents of the TM78 Spares Kit.

DEC Part Number	Description
M8930	Read data sync module
M8931	FCC module
M8933	CRC/ACCRC module

DEC Part Number	Description
M8951	Read path microcontroller module
M8955	TC port module
M8956	MAINBUS 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 +12.0 V
H7490	Power supply regulator −5.0 V
H744	Power supply regulator +5.0 V
54-14192	AC/DC line beam

1.3.2 T1078 Spares Kit (A2-W0341-HB)

The following lists the contents of the TC15 Spares Kit.

DEC Part Number	Description
29-23766	GCR/PE preamp 1 PCBA
29-23770	Interconnect PI PCBA
29-23769	MIA PCBA
29-23767	WRITE PCBA
29-23763	READ PCBA
29-23764	Control 363 PCBA
29-23765	Capstan/tape flow PCBA
29-23231	Rec. servo PCBA
29-23218	Encoder PCBA
29-23496	Capstan belt, 50/60 Hz
29-23989	Blower belt, 50 Hz, Lo Altitude
29-23991	Blower belt, 60 Hz, Lo Altitude
29-23220	Muffler
29-23250	Air filter
70-17282-15	15 ft TC bus cable
29-10562	Handle
29-11625	7 inch extension
29-11630	5/32 inch ball-end allen driver
29-11901	Phillips screwdriver blade
29-11635	Tachometer

DEC Part Number	Description
29-11636	Gauge, 0–5 PSI
29-11650	Gauge, 0–30 inch H2O
29-11647	Accessory kit for gauges (3)
29-23206	Centering tool
29-23207	Locating bar
29-23226	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
13-10930-01	230 Vac fan
12-11079-02	Pushbutton switch
2-11164-04	DIP switch
70-17381-03	Flat cable
70-17403-01	Backplane

1.9.2 Additional TU78 RSL Parts

The following are additional RSL parts for the TU78.

DEC Part Number	Description
12-10916-02	Fan, tube axial 220 V
29-16280-00	Switch, MICRO
29-22216-00	Sense assy, reel
29-22217-00	Sense assy, pack
29-23236-00	Motor assy, reel
29-24218-00	Switch, pressure
29-23229-00	Switch, pressure
29-23242-00	BOT/EOT assy
29-23245-00	TIP assy
29-23246-00	Transducer assy, vacuum

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
29-23253-00	Compressor
29-23280-00	Motor, gear drv
29-23287-00	Motor, ac
29-23297-00	Switch, backwrap detect
29-23298-00	Blower assy (Below SN SP0002386)
29-24013	Blower assy (SN SP002386 and above)
29-23308-00	Relay reed SS 12 Vdc
29-23331-00	Cable, Ext (6800) (AMTEC)
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
29-23367-00	Head, R/W
29-23368-00	Motor assy, capstan
29-23371-00	Control assy
10-17624-00	18,000 MFD 25V — 75-003
12-14405-00	Door, tape transport, front
29-23308-00	Hub, mounted
29-23309-00	Flange, reel
29-23311-00	Interconnect DI
29-23215-00	Door assy, buffer box
29-23219-00	Spring, compression
29-23224-00	Spring, helical
29-23223-00	Washer
29-23241-00	Cleaner, tape
29-23235-00	Guide plate "B"
29-23236-00	Guide plate "C"

DEC Part Number	Description
29-23358-00	Transformer
29-23379-00	Filter, RFI
29-23383-00	Guide, Air
29-27284-00	Hub, motor 50 Hz
29-27285-00	Hub, motor 60 Hz
29-23286-00	Catch, spring
29-23288-00	Receptacle, fastener
29-23309-00	47000 VHD 15 W VDC (75%-105
29-23310-00	61000 VHD 50 W VDC (102%-105
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, 350 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
29-16821-00	Magnasee
29-19224-00	Tape, master slew 1200
29-20273-00	Microscope 20 X
47-00038	Tape crimper
90-08308	Thermal compound

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-07M78-UG	Description, programming, and installation information of the TM78
TM78 Magnetic Tape Formatter Technical Manual	EK-01M78-TM	Theory of operation, programming information, installation, and maintenance of the TM78 Formatter and H7822 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-11178-TM	Schematics and logic print-outs 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
TM78 Magnetic Tape Transport IPB	EK-TM78-IP	Exploded views and parts lists of TM78
872 Power Controller IPB	EK-00872-IP	Exploded views and parts lists of 872
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

1.11 SYSTEM DIAGNOSTICS

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

Title	Diagnostic Name	
	DEC SYSTEM-20	VAX
A. Control Logic Test	DTTLT	EVMAF
B. Data Reliability	DTTUT	EVMAA

2 TROUBLESHOOTING

2.1 INTRODUCTION

This chapter gives a short description of the tools available for troubleshooting failure in the subsystem. They include troubleshooting flows, on-line and off-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 appropriate 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 unrecoverable 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.

Table 2-1 TM78/TU78 Diagnostics

DECSYSTEM-20	VAX	Description
Control Logic Test		
DFTU	EVMAD	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		
DFTU	EVMAA	The Data Reliability Test tests TM78 circuitry by writing and reading pre-covered test 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 soft data 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 B (slot A8B) self-test
4	Read channel A (slot A8B) self-test
5	Read channel D (slot A8A) self-test
6	Read channel C (slot A8A) self-test
7	Read channel 4 (slot A8A) self-test
10	Read channel B (slot C01A) self-test
11	Read channel A (slot C01A) self-test
12	Read channel D (slot C01A) self-test
13	Read channel C (slot C01A) self-test
14	Read path error correction self-test (M8931)
15	Microcomputer RAM memory self-test (Locs 40000–40777)
16	Microcomputer RAM memory self-test (Locs 41000–41777)
17	Microcomputer RAM memory self-test (Locs 42000–42777)
20	Microcomputer RAM memory self-test (Locs 43000–43777)
21	Microcomputer RAM memory self-test (Locs 44000–44777)
22	Microcomputer RAM memory self-test (Locs 45000–45777)
23	Microcomputer RAM memory self-test (Locs 46000–46777)
24	Microcomputer RAM memory self-test (Locs 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

Table 2-3 Troubleshooting Indicator Functions

Indicator Number on Figure		Function	Possible Failing FRU
1-2	1*	A channel has failed. These nine indicators reflect the quality of the data stream for each channel or unit. They indicate loss of SYN Character Dropout Deviation	• TU78 transport • TU Bus cable (rail) • M8930
1-3	2*	A parity error has occurred in the WCS primary control Latched	• M8951
1-3	3*	There has been a TU interface parity error. Wrong Parity was received at the TU port on the WCS lines. Latched	• TU bus cable (rail) • TU78 MIA • M8955
1-3	4*	VV for the MASSBUS transceivers is out of specification. Not Latched	• H7480 • H7477 • UNIBUS backplane
1-3	5*	Wrong parity was received on the MASSBUS port on a control bus command wire. Latched	• MASSBUS cable • RH7XX 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 numeric value of the indicator is 0.

Table 2-3 Troubleshooting Indicator Functions (Cont)

Indicator Number on Figure		Function	Possible Failing FRU
1-2	8*	A parity error has occurred in the microcomputer program ROM. [illegible]	• M8960
1-8	9*	−5 V regulator [illegible] is ok (supplies TM78 read path).	• H7441 • Any module in slots [illegible]
1-8	10*	+5 V regulator 4 is ok (supplies TM78 write path, MASSBUS port, TU port and microcomputer.	• H7441 • Any module in slots 1–9
1-8	11†	[illegible] 5 V regulator is ok.	• H7490 • M8955 (slot 1 or 3) • M8957 (slot 2 or 4)
1-8	12†	5 V regulator 3 is ok.	• H7476 • Any M8950
1-8	13†	12 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 to MIA • M8937 • TU78 MIA
1-6	16†	MIA PCBA maintenance switch S1 is in MANUAL position.	• Flip switch to AUTO

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

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
03	TAPE MARK*	Always zero	
04	BOT*	01 –	Error must be associated with beginning of BOT
		03 –	New BOT indicator after tape motion started
		04	ARA ED detected
05	EOT*	00	Excessive write data after EOT detected
		01 –	Extended sense data updated and contains something of interest
06	LOGICAL EOT*	Always zero	
07	NO OP*	Always zero	
08	DEVICE ONLY	Always zero	
09	PE*	Always zero	
0A	NOT READY*	01	Unit is in the NOT READY state (Possible when TEST UNIT READY command is issued)
		07 –	Unit attention has occurred and the requested command cannot be performed until Error Status has been presented and a TEST CLEAR received

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

Table 2–3 Interrupt Code to Failure Code (Cont.)

Int Code	Name	Failure Code*	
		03	Access to TU is denied or TU is either rewinding or being DSR from system (MASSBUS or keypad command)
12	NOT AVAIL*	Always zero	
13	OFFLINE*	Always zero	
14	NOT EXECUTABLE*	Always zero	
15	NOT CAPABLE*	01	No record found within 25.3 (7.6 m) of tape
		02	ID burst not in PE or GCR
		03	ABRA [1] not found
		04 –	No GAP found after ID burst (PE) or ABRA (Nburst (GCR)
17	ON CNTR*	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, primary mismatch, uncorrectable or two-block error in PDP-8/E mag tape (This code generated by write &/OR operations)

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 RPTAIL and RPATH registers (This code generated by write PE operations)
		07 More than one write fail bit set in RPTAIL and RPATH registers (This code generated by write GCR 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 [illegible] data transfer [illegible].
† The interrupt code is used for nondata transfer only.
‡ The interrupt code is used for [illegible].
§ The interrupt code is used for data transfer.

Table 3-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
		12 MASSBUS data bus parity error (write)
		13 – Record length incorrect during read opposite attempt; invalid data has been transferred
		14 Tape positioned on or beyond EOT
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 another data transfer command in progress on same tape unit
		03 – WMC error check ECODE (ERR CNT register – TU address 125) register for reason – may be Illegal Format or Skip Count codes
		04 – RUN not received from MASSBUS controller
		05 Command from host micro-controller to gnd/check register did not match command loaded into RMC CMD register.
		06 – FCS ROM parity error (M8951)
		07 – XMC ROM parity error (M8952)

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

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

The interrupt code is used for encoder/decoder data transfer.
The interrupt code is used for servo data transfer only.
The interrupt code is used for TMTR write error.
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 ARAE 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)
		19 – WMC LRL not set to zero load Sense routine
		21 PL parity error on data as it leaves translator (checked at translator output)
		23 – WMC DONE bit not set (M8998, M8999)
		25 WMC ROM PE or RD PE set in WMCERR register (M8950, M8952, M8951)

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

Int Code	Name	Failure Code	
		32	XMC DONE did not set (M8955, M8959)
		33	WMC ROM PE or RD PE set in WMCERR register (M8959, M8952, M8951)
31	TU FAULT A*	01 –	TU status parity error (M8A)
		02	TU command parity error (M8955)
		03	Rewinding tape would not finish
		04	Tape would not ready during DSE
		05 –	TU CMD status changed during DSE
		06 –	Capstan did not reach velocity within 2 ms forward or 4 ms reverse
		07 –	TU velocity drifted after up to speed and writing started
		10 –	TU CMD did not load correctly to start tape motion in selected function routine (example: on forward (write) – looks for forward, write, and motion; on reverse – looks for reverse and motion)
		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
		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. Looks for 256 correct samples out of 1200

* The interrupt code is used for non data transfer or data transfer

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

Int Code	Name	Failure Code
		15 Failed to write ARA ID correctly. Looks for 1/4 inch perfect rbt spaces in ARA burst.
		16 — Failed to write ARA ID correctly. Looks for 1/4 inch perfect rbt s. 2 inches
		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 bit was not set correctly to start tape motion to read ID burst
		23 Time out occurs for DO1 after detecting ARA ID burst
		24 Failed to write tape mark correctly
		25 Velocity checks passed, but tape never came up to speed while trying to reposition for retry of writing tape mark
		26 — TU CMD bit was not set correctly to start tape motion for Erase Gap routine
		27 — Could not locate a gap in Erase Gap routine. Gap must be at least 0.3 inch. Check tape for 7 tracks (AM TDV = 1/8 inch)
		30 Could not detect a gap after writing record
		31 Read path terminated before entire record was written. Less than 257 byte count — cross parity. Greater than 257 byte count — cross-tie parity. — or lost data — byte

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

Int Code	Name	Failure Code
		32 – Could not find a gap after writing record, the read path terminated early. Starts looking for gap 0.15 inch before end of record
		33 – TUCMD did not load correctly to backup for retry of write tape mark
		34 – TU lost velocity in reverse while trying to reposition for retry of writing tape mark
		35 – TUCMD did not load correctly to backup for retry of read of BOT ID
		36 – Timeout looking for BOT after failing to write BOT ID
		37 – TU velocity changed while writing ID gap before starting to write record
		40 – TUCMD did not load correctly to set PE tape density at start of write BOT ID burst
		41 – TUCMD did not load correctly to set GCR tape density after writing Density ID
		42 – TUCMD did not load correctly to set PE tape density at start of read from BOT
		43 – TUCMD did not load correctly to set GCR tape density after reading a GCR Density ID burst

Table 3-4 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code	
		43	TU CMD [illegible] only to set GCR tape density after reading a GCR Density ID burst
02	[illegible]	00 –	RST0 interrupt occurred with [illegible]
		01	Power failed interrupt
		02 –	8085 interrupt for unknown reason on channel 5.5
		03 –	8085 interrupt for unknown reason on channel 6.5
		04 –	8085 interrupt for unknown reason on channel 7
		05	8085 interrupt for unknown reason on channel 7.5
		06 –	CAS retry count expired (greater than 255)
		07 –	CAS queue time expired [illegible]
		10 –	Queue entry could not find queue entry
		11 –	8085 queue entry already [illegible]
		12	8085 ROM parity error
		13	In-line test 0: WMC (write microcontroller) self-test failed —M8959-M8957
		14	In-line test 1: XMC ROM (translation microcontroller) parity error M8958-M8959-M8960
		15 –	In-line test 2: RPM (read path microcontroller) self-test failed M8958-M8960
		16	In-line test 3: RPM1 channel 0 self-test failure M8950 (slot AB12)

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

Int Code	Name	Failure Code	
		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 8 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
		31	In-line test 16; 41000–41777 RAM memory failure M8960

* The interrupt code is used for no data transfer or data transfer.
† The interrupt code is used for module installed only.
‡ The interrupt code is used for TMTs initiated.
¶ The interrupt code is used for data transfer.

Table 2-8 Interrupt Code to Failure Code (Cont)

Int Code	Name	Failure Code
		x1 In-line test 16: 1000 – 1777 RAM memory failure MB960
		32 In-line test 19: 42000 – 42777 RAM memory failure MB960
		33 In-line test 20: 43000 – 43777 RAM memory failure MB960
		34 – In-line test 21: 44000 – 44777 RAM memory failure MB960
		35 – In-line test 22: 45000 – 45777 RAM memory failure MB960
		36 In-line test 23: 46000 – 46777 RAM memory failure MB960
		37 – In-line test 24: 47000 – 47777 RAM memory failure MB960
		* 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 28: loop write-to-read at TU port 1 – PE
		* 44 – In-line test 31: loop write-to-read at TU port 2 – GCR
		* 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

Table 2–4 Interrupt Code to Failure Code Matrix

Int Code	Name	Failure Code	
		* 50	In line test 35; loop write to read at MTA 0 — GCR
		* 51	In line test 35; 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
54	MB PARITY	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

* This interrupt code is used for nonData transfer or data transfer.
† This interrupt code is used for nonData transfer only

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 series of instructions may be created in RAM through the keypad to execute the formation of a simple 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 put on 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 interaction 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.

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.

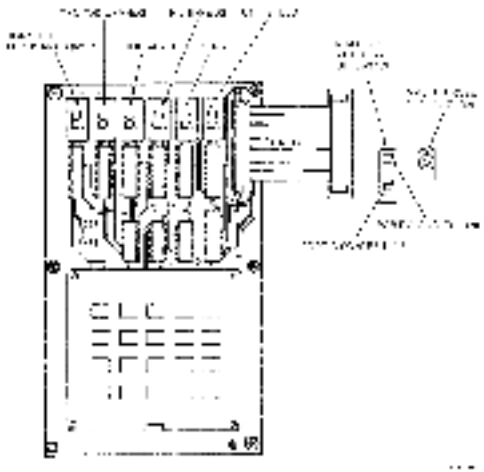


Figure 3-1 EM78 Maintenance Panel

Numeric Keys

0 — 7	The eight numeric keys specify one of the following actions when 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 opcode

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 13478 internal I/O registers. (Appendix B of the *1678 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 microcomputer's 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 load group.

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 [illegible]
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 the tolerance mode (port select 4), 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 RAM or ROM 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/Logical port select This item selects one of two MASSBUS ports and one of four TU epanic ports to communicate with. Bit Value Port Selected 2 0 MASSBUS A 2 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 3740-W.
1	R/W	000	Program run control This item is set by the STA and CON commands. When this item is set to a value other than 0, a program can be single-stepped or run until a fault occurs. When 1 is selected the program runs.
3	R/W	030	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

Table 2-4 Parameter Items (Cont)

Item Number	Read/ Write	Initialized Value	Description
			delay. This delay can be used to explore the impact on host CPU throughput, host-to-tape skew between internal cycles.
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 2-6) 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
9	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 15. Refer to Table 2-2 for a listing of the in-line tests available.
11	R/W	20	Data format and skip count Data [illegible] maintenance instructions this item corresponds to hardware register 20 W. Initialized to image format with a zero skip count.

Bit	Value	Description
7		Not used
6-4		Format Control
	0	10 normal
	1	15 normal
	2	10 compatible
	3	10 core dump
	4	10 high density compatible
	5	Image (skips on loss of [illegible])
	6	10 high-density dump
	7	Illegal

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	027	Read ECC function clock control
14	R/W	021	Read PE function clock control
15	R/W	020	LOOP write/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 0C0 W in TM38 Technical Manual for a description of the bit combinations.
16	R/W	000000	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	000080	Read record size This item is returned by read data instructions as actual size of record read.
20	R/W	000000	Write data This 16-bit item is written into the DDR to send data instructions.
21	R	000000	Read data This 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 other formats.
22	R	*	Last fatal interrupt code for port A
23	R	*	Last fatal interrupt code for port B Items 22 and 23 are a history of last fatal interrupt code (right just 0's)
24	R	*	Last fatal failure code for port A
25	R	*	Last fatal failure code for port B Items 24 and 25 are a history of the last fatal failure code (left just 0's)

Table 2-8 **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 available by the item CPU DIAG SERVICE error mode.

26	R	*	Command code is before execution or last error
27	R	*	Interrupt code is 6 bits right justified
30	R	*	Status 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.

			Register	Contents
31	R	*	0	Read write control
32	R	*	1	Read path diagnostic bits
33	R	*	3	Read path status
34	R	*	4	Read path CMD
35	R	*	5	A/V FIC
36	R	*	7	RC done
37	R	*	11	Illegal S4/
40	R	*	20	Mark 2
41	R	*	21	Bad mark
42	R	*	23	RC par bit
43	R	*	26	Postamble det
44	R	*	27	Data
45	R	*	30	CRC
46	R	*	31	Correct/ data
47	R	*	33	FCC status
50	R	*	40	Channel 1 TIF bus
51	R	*	41	Channel 1 TIF bus

*Item value is not initialized by enabling keypad.

Table 2-6 Parameter Items (Cont)

Item Number	Read/ Write	Initialized Value	Description	
			Register	Contents
58	R	*	12	Channel 2 TIP bus
59	R	*	13	Channel 3 TIP bus
54	R	*	44	Channel 4 TIP bus
55	R	*	45	Channel 5 TIP bus
56	R	*	46	Channel 6 TIP bus
57	R	*	47	Channel 7 TIP bus
58	R	*	50	Channel 8 TIP bus
61	R	*	60	TIP bus
62	R	*	104	ANTIF
63	R	*	100	Port Status
64	R	*	104	Read data
65	R	*	240	CA Status
66	R	*	241	CBUS status
67	R	*	300	DMA status
70	R	*	330	WMC status
71	R	*	320	TU select 0
72	R	*	321	TU select 1
73	R	*	322	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	Block counter <7:0>
101	R	*	326	Block counter <15:8>
102	R	*	330	DDR/MDD A
103	R	*	331	DDR/MDD B
104	R	*	332	WMC Error
105	R	*	340	Interrupt status
106	R	*	0	MIA status
107	R	*	1	MIA status A
110	R	*	2	MIA status B
111	R	*	3	Serial NRZI A
112	R	*	4	Serial NRZI B
113	R	*	5	TU diagnostics
114	R	0		Retry counter
			This item count of number of retry requests given. A zero means tape unit is not in error recovery.	
115	R	*	Retry success bits	

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 available Bit 3 – position command (NOP) 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 suppression 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 Mass bus register containing retry suppress, format, and skip count.
[illegible]	R	*	Keypad enable flag
			This item is nonzero when keypad is enabled.
122–139			Not used
140	R	*	MIA register 0, TL TS status
140	W	*	MIA register 0, TL CMD A
141	R	*	MIA register 1, MIA status A
141	W	*	MIA register 1, TL 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, TL diagnostics
145	W		Not used
146	–		Not used
147	R/W	*	MIA register 7, pattern generator data
148–157			Not used
			Items 140 – 147 are explained in Appendix C of the Technical Manual.

*Item value is not initialized by enabling keypad.

2.7.4 Maintenance Instructions

A table of the maintenance instructions may be assembled and run using the INP, STA and CON keys. Simple instructions may also be executed with the **PTP** and **REP** keys. The transport being exercised must be selected to port 03. Table 2-7 lists all available maintenance instruction codes, their description, and the parameter form 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 DX78 is off-line or on-line with the host CPU using another transport. However, privileged instructions (Group D) require that both ports of the DX78 be placed off-line.

Table 2-7 Maintenance Instruction Codes

Instruction Code	Description	Controlling Parameter Items (Table 2-6)
A. Tape Commands (Nonprivileged)		
7	Rewind and unload tape	0,1
9	Rewind tape	0,1
10	Write tape mark – PE	0,1,12
11	Write tape mark – GCR	0,1,12
13	Space one record forward	0,1,13,14
21	Space one record reverse	0,1,13,14
25	Space forward one record or file	0,1,...3,15
33	Space reverse one record or file	0,1,...3,15
45	Erase extended gap – PE	0,1
49	Erase extended gap – GCR	0,1
50	Loop write-read at TU port – PE	0,1,5
52	Loop write-read at TU port – GCR	0,1,5
57	Loop write-read at MIA	0,1,5
59	Loop write-read at MIA PCBA – GCR	0,1,5

Table 2-7 Maintenance Instruction Codes (Cont)

Instruction Code	Description	Controlling Parameter Items (Table 2-6)
62	Write data — PE	0,1,11,12,16,20
64	Write data — GCR	0,1,11,12,16,20
[illegible]	Read forward	0,1,11,13,14,17,21
[illegible]	Read reverse	0,1,11,13,14,17,21

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

Instruction Code	Description	Controlling Parameter Items (Table 2-6)
0	NO-OP	—
2	Halt	7
4	Increment counter +1	1,3
6	Decrement counter -1	1,3
10	Update parameter items 26 through 121 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 + s	Branch if error status	1,2
220 + s	Branch if no error status	1,2
240 + s	Branch if EOT detected	1,4
260 + s	Branch if no EOT detected	1,4
300 + s	Branch if tape mark detected	1,4
320 + s	Branch if no tape mark detected	1,4
340 + s	Branch if counter not zero	1,3
360 + s	Unconditional branch	1

* Refer to note on page 51.
s — Item number (0 to 17) of next instruction if branch condition is true.

Table 2-7 Maintenance Interaction Codes (Cont)

Instruction Code	Description	Controlling Parameter Items (Table 2-6)
47	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
43	Write 1.5 mm (0.5 in) record pattern generator PG	1,3,12,147
44	Write 1.5 mm (0.5 in) record using pattern generator = GCR	1,3,12,147
50	Privileged Instructions (UMTH must be off-line)	
26	Write continuously at 3200 FRPI in all tracks	0,17
40	Write continuously at 9042 FRPI in all tracks	0, 2
46	Write continuously using pattern generator PG	0,3,12,147
50	Write continuously using pattern generator = GCR	0,3,12,147

2.7.5 Sample Maintenance Routine

Figure 2-9 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	61 163)	Write PE (GCR)
3	240	If EOT, branch to start
4	214	If error, branch to save
5	77	Read reverse
6	311	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 to display
13	362	Branch to write
14	14	Save registers
15	2	Halt
16	363	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 17 – UNUSED
TP 15 – +5 V DC
TP 14 – LDIO
TP 15 – CLK B (100 KHZ)
TP 16 – LD2-2
TP 17 – UNUSED
TP 18 – NLDPI

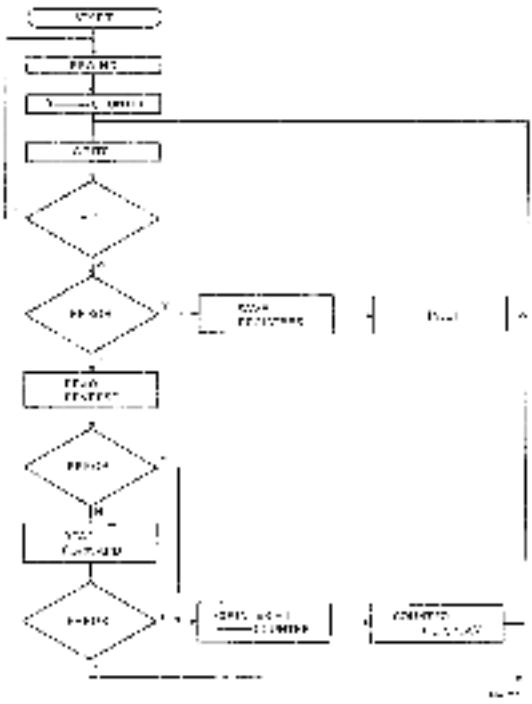


Figure 2-2 Sample Write/Read Routine

Control M2 PCBA

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

Control M2 PCBA

TP35 – 1 OF 3
TP36 – NBOT
TP37 – STL
TP38 – NTOT
TP39 – CLK C (10 KHZ)
TP40 – TACH AMP
TP41 – 1 OF 3
TP42 – LOF4
TP43 – LOW TAPE SENSOR
TP44 – NLIDS
TP45 – LIDS (LOAD FAULT SENSE)
TP46 – REW
TP47 – MR1
TP48 – ADP N/O
TP49 – GND
TP50 – GND
TP51 – NPOL
TP52 – DHO
TP54 – FC N/O
TP55 – CO N/O
TP56 – 13465 UNLD
TP57 – S LIMIT N/O
TP58 – NSMRL
TP59 – TOR N/O
TP60 – VAC N/O
TP61 – T LIMIT N/O
TP62 – NCNTLE
TP63 – NCOC (CLOSE CART CMD)
TP64 – SRF
TP65 – SRR
TP66 – TRF
TP67 – TRR
TP68 – TTIDS
TP69 – NCOC (CART OPEN CMD)
TP70 – NRSAC (RESET SERVO TNADD)
TP71 – PNU RST
TP72 – NXFR

Read PCBA

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

TP21 CLEAR
TP22 STU CLOCKS
TP23 UNUSED
TP24 UNUSED

Write PCBA

TP 1 CLK 3
TP 2 V PED
TP 3 V STEP
TP 4 V WRT
TP 5 CLK 1
TP 6 V PED AT Q27/28 WD1
TP 7-21 UNUSED
TP24 GTWR (9TWIND RAMP)

Capstan/Regulator PCBA

TP 1 GND
TP 2 GND
TP 3-9 UNUSED
TP10 +5 V DC
TP12 V SENSE
TP13 MOTOR CURRENT
TP14 UNUSED
TP15 +15 VDC
TP16 UNUSED
TP17 UNUSED
TP18 -15 VDC
TP19 MOTOR VOLTAGE
TP20-34 UNUSED
TP40 CAPSTAN GND
TP50 CAPSTAN GND
TP51 NPPT
TP52 ANALOG TACH
TP53 UNUSED
TP54 UNUSED
TP55 SPARE ST
TP56 CART SOL RET
TP57 VAC SOL RET
TP58 WP SOL RET
TP59 PRES SOL RET
TP60-64 UNUSED
TP65 6.3 VAC
TP66-69 UNUSED
TP70 POWRST
TP71 CART MTR (+)
TP72 UNUSED

Interconnect #1 PCBA

TP 1 S POS
TP 2 T POS 2
TP 3 TEF
TP 4 N PKSN
TP 5 LOT
TP 6 BOT
TP 7 GND

Head Servo PCBA

TP 1
TP 2
TP 4 +36 V (T)
TP 6 TM (+)
TP 5 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 55 +5 V (S) TO ALL ICS
TP54 UNUSED
TP55 TPOS
TP56 NTRKTD57 NTRF
TP58 SUM AMP OUT NDDA/B
TP59 SUM AMP OUT T/U LOOP COMP
TP60 NAE (REEL SERVO ENAB)
TP61 NTUNTLK
TP62 +15 V DC
TP62 UNUSED
TP64 -15 V DC
TP65 1.25 KHZ T-WAVE GEN
TP66 NPOS
TP67 01 DSET
TP68 SUM AMP OUT SUP LOOP COMP
TP69 NSRF 1
TP70 NSUR
TP71 SUM AMP OUT NSDA/B
TP72 NSRF 2

3 CHECKS AND ADJUSTMENTS

3.1 PARTS REPLACEMENT

Table 3-1 lists the corrective checks 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. Figures 3-1 and 3-2 show the location of various controls and switches on the TU78 PCAAs. Figure 3-3 shows the test points with their test points and adjustments.

Table 3-1 Checks/Adjustments When Replacing Parts

Part Replaced	Check or Adjustment	Paragraph
Read/write/erase head	Check tape/head Power	4.3.4*
	Capstan servo adjustment	5.5.1*
	Read/write amplifier adjustment	5.5.3*
		6.5.2*
Capstan motor	Speed control	6.5.1.1*
	Tension control	6.5.4.2*
	Head skew	6.5.5.1*
Supply and take-up	Supply reel motor speed	6.5.6.2*
	Tape loop position	6.5.5.4*

*TU78 Technical Manual (Vol II)

Table 6-1 Checks/Adjustments When Replacing Parts (Cont.)

Part Replaced	Check or Adjustment	Paragraph
Take-up reel motor	Take-up reel load speed	6.5.6.2
	Take-up loop position	6.5.6.4
AC Power	Vacuum/ pressure	6.5.3
Blower	System vacuum	6.5.6.1
	Take-up reel vacuum	6.5.6.2
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 current	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
Interface PCBA	EOT/BOT sensor	6.5.3
	Photo sensor	6.5.3
	Tape loop position	6.5.6.4

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

Part Replaced	Check or Adjustment	Paragraph
Main or auxiliary power supply	Keypad/display power on checks	3.3.1.3*
H7441	+5 V	3.7.9†
H7446	+15 V	3.7.8†
H7440	−5 V	3.7.5†

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

*TI 728 Technical Manual (Vol II)
†TM 8 Technical Manual

Table 3-2 Adjustment Specifications

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
EUT Supply Voltage				
15 V	15.15 Vdc, ±0.15 Vdc	Capacitor/regulator, TP11	Capacitor/regulator, R179	6-3
Tape Path Sensors				
LOAD/EOT sensor	0 Vdc, ±0.1 Vdc with LOAD/EOT not under sensor	Interconnect P1, TP5(+); TP5(−)	Interconnect P1, R22	6-5
Pack sense	0.5 Vdc max with tape not seated in VCR with cover	Interconnect P1, TP4(+); TP3(−)	Interconnect P1, R17	6-5.3

Table 3-2 Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Vacuum/Air Pressure				
Servo valve	24 inches of water with tape running (about 0.87 inch water)	Capstan reel port	Servo valve	6.5.4.1
Takeup reel vacuum	70 inches of water (2.5 inch water)	Takeup reel vacuum port	Vacuum valve Tachometer plate	6.5.4.2
Air bearing pressure	3.75 PSI (±0.25 PSI) with tape running forward	Air bearing pressure port	Pressure relief ARP screw	6.5.4.3
Thread block pressure	54 inches of water (1.9 inches of water)	Thread block pressure port	Thread block pressure adjustment screw	6.5.4.4
Cartridge pressure	3.5 inches of water (1.0.5 inches of water with tape threaded, should be greater than 0.0 inches of water)	Cartridge pressure port	Cartridge pressure screw	6.5.4.4

Table 3-2 Adjustment Specifications (Cont'd)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Capstan Servo				
Tape speed	Use TMS maintenance panel Keypad OP Code = 32 (REP) Display value = 0.00	–	Capstan/regulator, R7	6.5.4
Forward start ramp	Use TMS maintenance panel Keypad OP Code = 34 (REP) Display value = 0.00 ± 2		Capstan/regulator, R9	6.5.5
Forward stop ramp	Use TMS maintenance panel Keypad OP Code = 36 (REP) Display value = 0.00 ± 2	–	Capstan/regulator, R6	6.5.5

Table 3-2 Adjustment Specifications (Cont.)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Reverse stop ramp	Use TM78 Maintenance mode Keypad UP Code = 40 (REP) Display value = L00 ± 2	–	Capstan Angle Adj. R71	6.5.5
Reel Servo				
Servo offset	As a function of supply reel hub		Reel servo PCBA R76	6.5.5.1
Supply reel base speed	55 rpm (1.5 cps) Reel servo PCBA TP50 and TP69 to ground (TP49)	–	Reel servo PCBA R51	6.5.6.2

Table 3-7. Adjustment Specifications (Cont)

Procedure	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Tracking error final speed	180 rpm (LR mode) Read servo PCB1A TP60 and TP57 to ground (TP49)		Read servo PCBA R61	6.5.6.2
Tape loop position	Refer to procedure in TM	–	–	6.5.6.1
Read/Write	Clean tape path	–		6.3.4
Skew (azimuth)	Reading step width (using skew tape) — 1.2 Vss maximum. Adjust for minimum	Read PCB1A TP11	Head azimuth screw	6.3.7.1

Table 3-2 Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
Write current	Refer to Paragraph 3.3 in TM		-	6.3.7.2
PB gain	1.25 V P-P at Preamp output, resistor wiring all heads, standard tape	Preamp resistor upper lead	Head 1 PCBA Potentiometer	6.3.7.3
		R1	R706	
		R4	R906	
		R7	R906	
		R10	R906	
		R13	R906	
		R16	R906	
		R19	R906	
		R22	R906	
		R25	R906	

Table 3-2 Adjustment Specifications (Cont)

Parameter	Specified Value and Tolerance	Test Point	Adjustment	Adjustment Paragraph
TM878 Power				
+5 V (card path)	5 Vdc ±0.1 Vdc	A1toA2	A2422 Regulator 2	TM878 Tech Manual Table 5-10
15 V (write path and control)	± Vdc ±0.1 Vdc	A2toA2	H2422 Regulator 4	Table 5-10
5 V	5.0 Vdc, ±0.5 Vdc	A2toA2	H2422 Regulator 1	Table 5-10

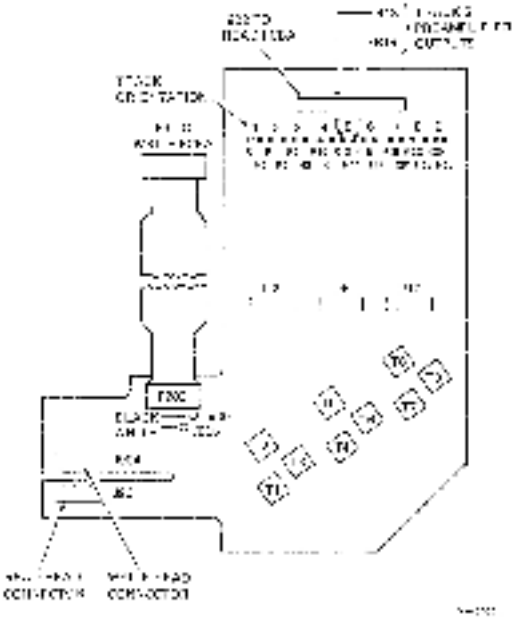


Figure 3-1. GCR/PE Preamp I PCBA Test Points

Figure 3-2 Interconnect EL PCBA
a. Early Model

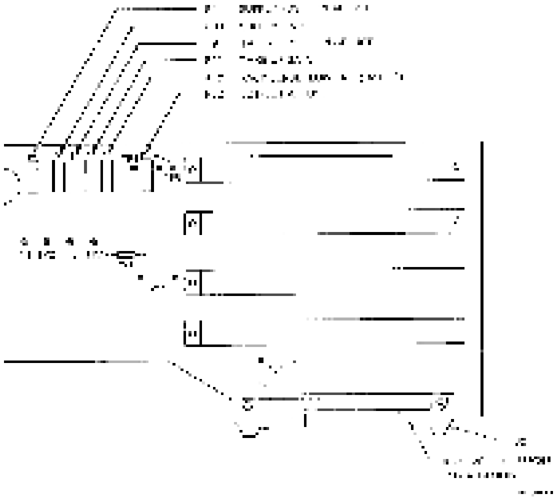
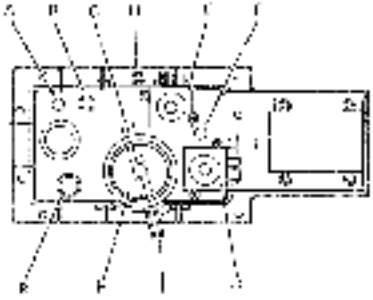
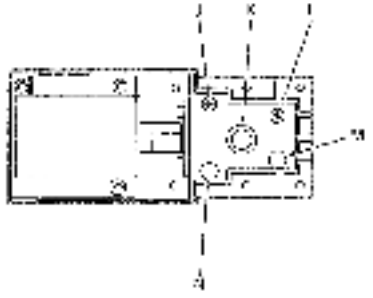


Figure 3-2 Interconnect EL PCBA
b. Current Model



VACUUM VALVE DETAIL



PRESSURE VALVE DETAIL

Fig. 3-31 Vacuum Valve and Pressure Valve

Table 3-3 Vacuum and Pressure Valve Components

Reference	Description
A	Air cleaner vacuum valve port
B	Reed switch connections
C	Butterfly valve adjust nut screw
D	Tapered reel vacuum adjustment screw
E	Vacuum pressure switch
F	Tapered 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 drive pressure adjust nut screw
M	Thread drive pressure port
N	Air bearing pressure port

4.3 WRITE CURRENT ADJUSTMENTS

1. Verify power supply voltages according to Paragraph 4.2.1.

2. Load any write enabled 2GB mini (6" x 2" x 1") tape to BOT. Leave the transport off-line.

3. Set the MIA switches as follows:

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

   Data pattern (UU96) equals all ones (all switches forward).

A. Phase Encoded Write Current Adjustments

1. Connect an oscilloscope to write PCBA (Figure 6-16) test points. Set the scope as follows:

   Vertical, ch 1 = 1.0 V/div ac (X 10 probe)
   Horizontal = 0.2 µs/div
   Sync = +, Ch 1, Int

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

3. Adjust write PCBA potentiometer R59 (PE 800 amp) for a 1.25 or 1.1 µs positive pulse width.

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

5. Move the scope probe to write PCBA TP2. Change the vertical setting to 2.0 V/div, ac.

6. Place transport on-line.

7. Adjust write PCBA potentiometer R10 (PE amp) for a 18.75 Vdc ±0.5 Vdc level.

9. Move the scope probe to write PCBA TP2.

10. Adjust write PCBA potentiometer R36 (PT pedestal) for a −6.2 Vdc (−6 Vdc level).

11. Place the transport in Fine and rewind the tape to BOT.

B. Group Coded Write Current Adjustments (Transport Offline, Loaded, And at BOT, Post Search to 0)

Figure 3-4 shows the correct waveform for the pedestal current and step current at the tape head. You may want to use this figure as a reference. The GCR write current adjustments involve potentiometers R29, R22 and R49 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 MLA switches S1, S2, S3, and S4 to the right. Data select (U1901) quads all ones (all switches forward).

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

3. Adjust R22 to set TP3 to 2 V.

4. Adjust R29 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 (R15) of the GCR/PE measure 1 PCBA (Figure 2-2).

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.

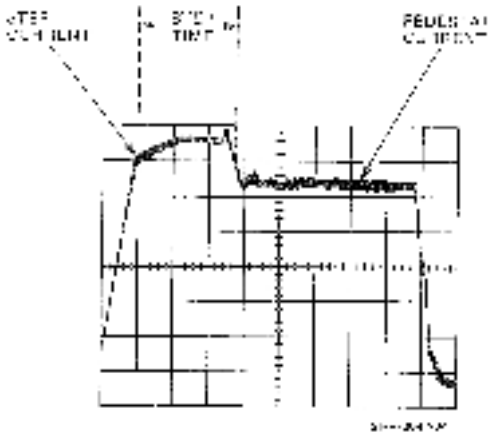


Figure 3-8. Write Head Current Waveform.

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

8. Measure and record the dc voltage at TP1.

9. Continue to adjust R39 CCW until the waveform amplitude begins to decrease. (This is the approximate 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 TP1 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 R69 CCW until the peak-to-peak amplitude across 75 ohms is about 105 percent to guarantee media saturation). Then measure and record the voltage at TP3.

15. Set TP3 back to the voltage calculated in step 14.

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 R29 until TP3 is at the voltage recorded in step 14. (The periodic lamp current is now set to about the 105 percent saturation point.)

19. Move the scope probe to TP6 on the write PCBA. Using R48 (OCR step time), set TP6 to 200 mV −10 percent at the 20 percent point.

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

If any value is outside the specified range, perform this entire ILST. If it cannot be met, the following field replaceable units should be suspected as being defective:

The Read/Write/Erase Head
The Write PCBA
The Read PCBA
The Preamp PCBA

APPENDIX A
SUBSYSTEM MASSBUS REGISTERS

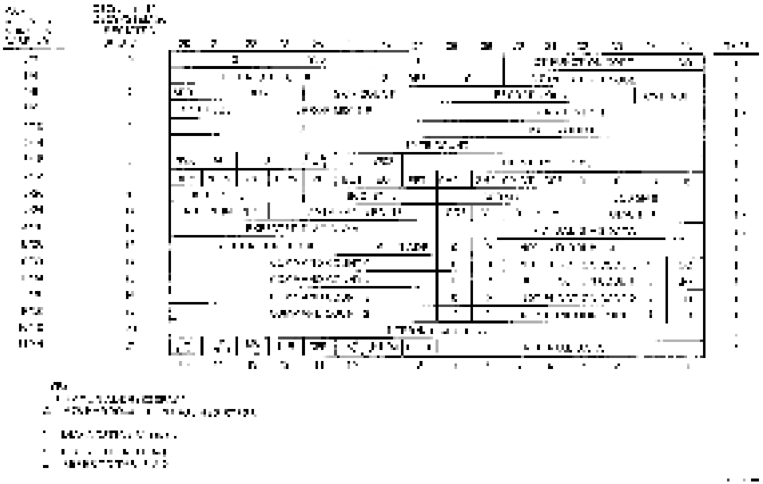


Figure A-1 RH20 and RH780 Addresses

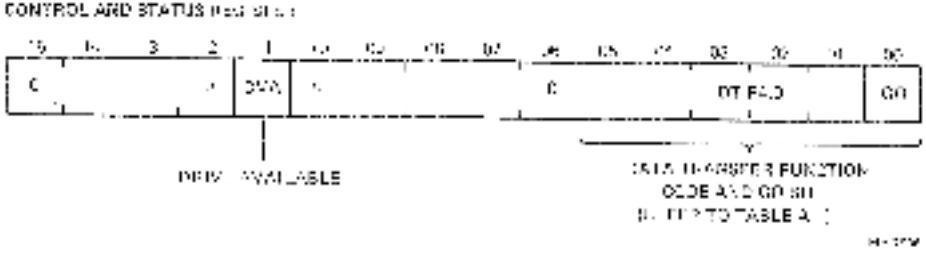


Figure A-7 Control and Status Register

Table A-1 Data Transfer Function Codes

Function Code (Co 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.
59	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
6A	WRITE GCR*	Write group coded records
71	READ FWD	Read records forward
7A	EXSNS	Read extended sense error log
79	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.

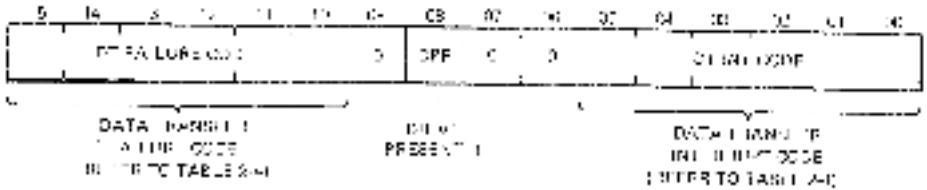


Figure A-4 Data Transfer Interrupt Register

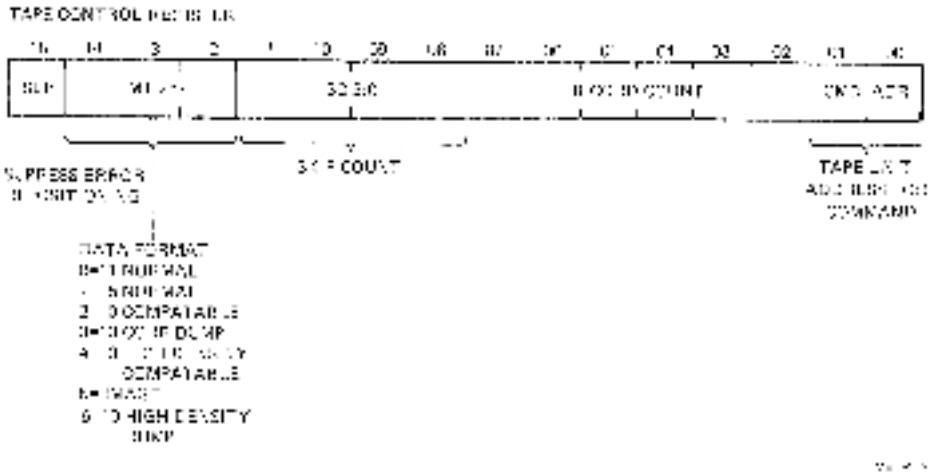


Figure A-4 Tape Control Register

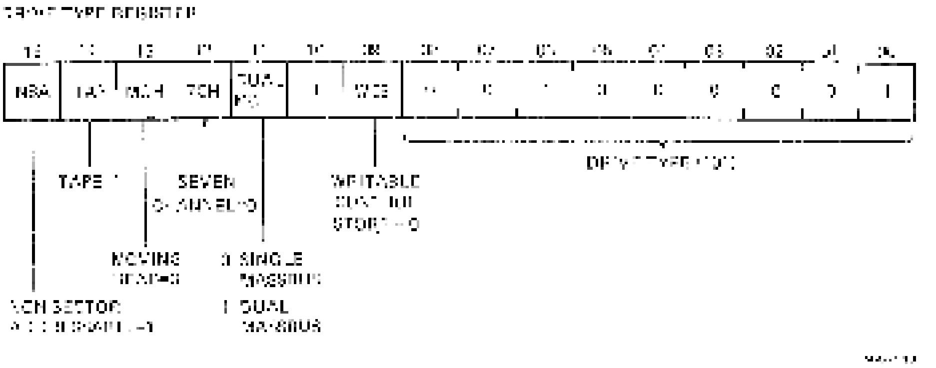


Figure A-5 Drive Type Register

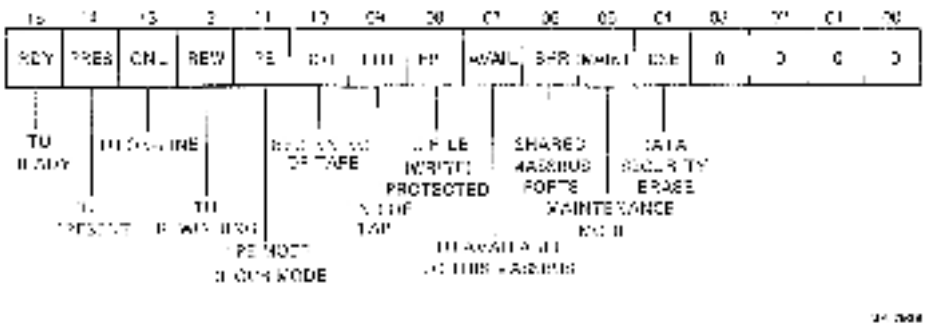


Figure A-6 Tape Unit Status Register

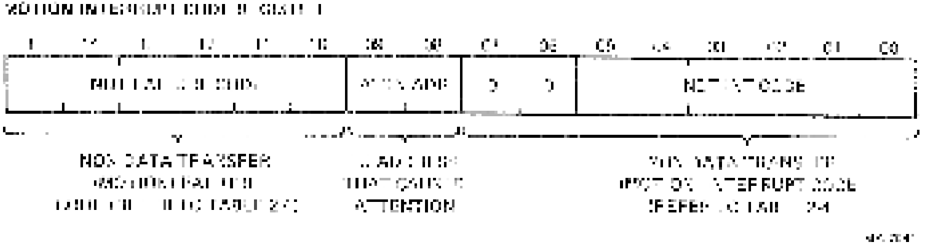
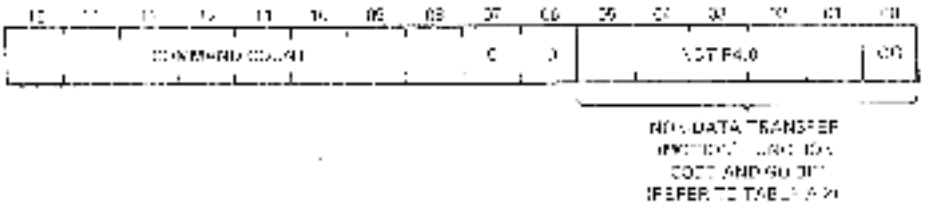


Figure A-7 Motion Interrupt Code Register



NOTE: THERE ARE FOUR MOTION COMMAND REGISTERS, ONE FOR
EACH MOTION UNIT.

Figure A-3 Motion Command Register

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	Status†	Data status is transferred into CAS
13	Data Security Erase†	Erases rest 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, adds PE

Table A-2 Nonlatch Transfer Function Codes (Cont)

Function Code (Octal Equivalent)	Name	Description
37	ERG GCR †	Erases 3.0 in (76.2 mm) 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 FIVE/LEOT ‡	Spaces forward to tape mark, steps if two successive tape marks (logical end of tape)

†Second use interrupts when forward space always interrupts after tape motion has stopped

‡Status registers are valid as long as the ATTN bit is set.

‖Erases at least 3.0 in (76.2 mm) 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 this only reverse operation the FWM may skip over an LEOT located where direction was reversed.

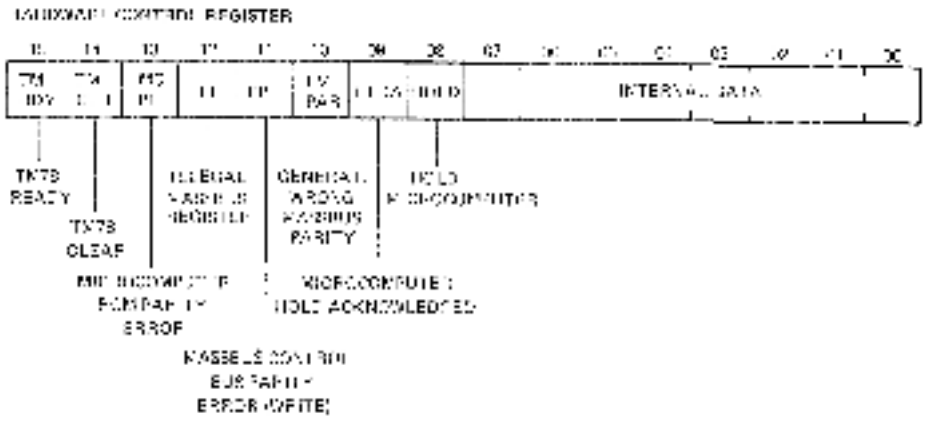


Figure A-9 Hardware Control Register

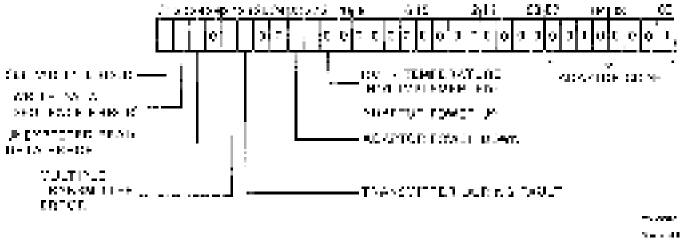


Figure A-30 Configuration/Status Register

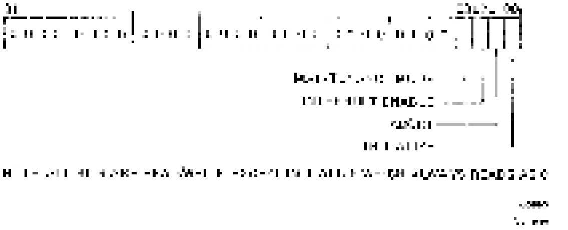


Figure A-[illegible] Control Register

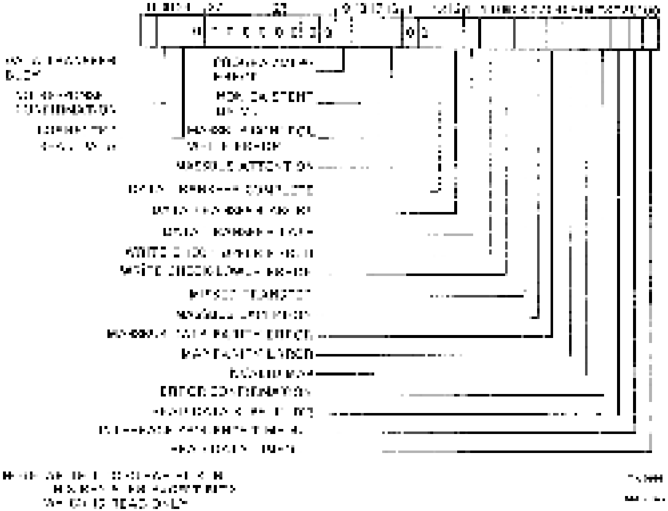


Figure A-12 Status Register

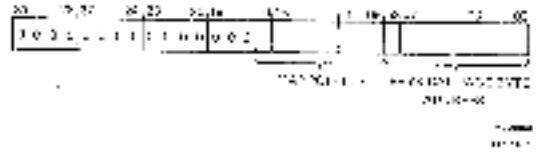


Figure A-13 Virtual Address Register

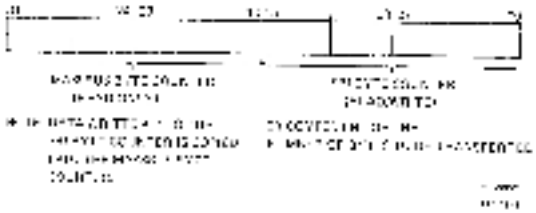


Figure A-14 Byte Counter Register

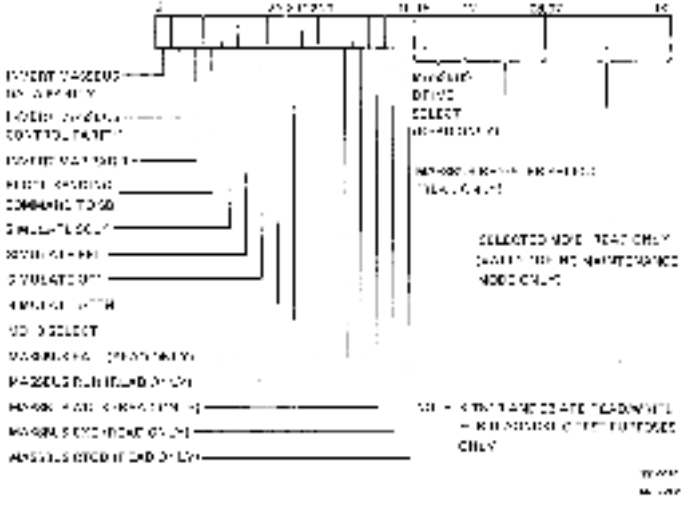


Figure A-15 Diagnostic Register

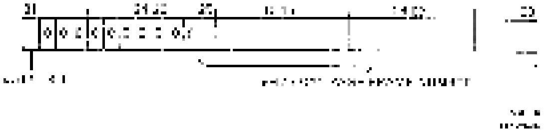


Figure A-6 Map Register

APPENDIX B
EXTENDED SENSE BYTES

Byte	Description
1	Command code being executed on last error
2	Tape unit 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-1)
8	Hardware register 20; AMTIT S (CH 7:0) loaded the status of the AMTIT lines from the tape drive. This is a dynamic read of the M8950 status bits by the M8953 read path microcontroller
9	Hardware register 21; RC FRONT (CH 7:0). This bit will be false if the associated M8950 has completed its assigned task
10	Hardware register 22: GCR illegal 5-1, PE code error such as no bit time phase transition

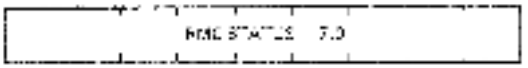


Figure B-1 Read Path Status Byte

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 M8950 self-test	
103	Read path passed self-test
104	Read path failed self-test
Status resulting from an M8950 self-test command	
105	[illegible] channel tests all passed
Status resulting from a electrical test command for velocity checking of drive by [illegible]	
[illegible]	First tach pulse
201	Last tach pulse (eleventh [illegible] spacer)
Status resulting from a sample density command	
2[illegible]0	NOT CAPABLE found
2[illegible]1	GCR ID found
2[illegible]2	PE ID found
Status resulting from a write test of IRG, PE ID, GCR ID, ARA ID, or ARA burst	
220	Bad status write test
Status resulting from a tape mark test command	
[illegible]	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
2[illegible]5	Read path fault, too many M8950s have been disabled to continue record processing

Table B-1 Read Microcontroller Abort Codes (Cont)

Status	Meaning
235	Read path fault 2; [illegible] ware M8950 BIOARIOS found illegal 5 to 4 translations.
74'	Unexpected TDC in data; probably caused tape [illegible] 7 or more AMTEI9 [illegible]
26.	Data table long
262	Data table short
377	OK

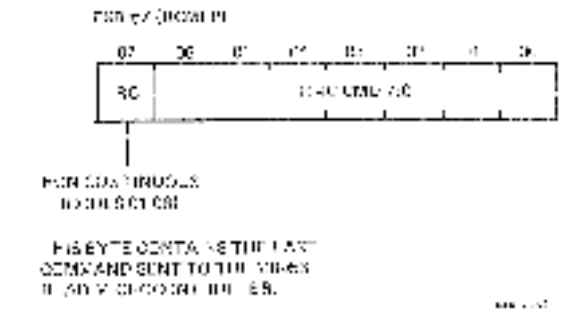


Figure B-7 Read Microcontroller Command Byte

Byte	Description
11	Hardware register 23; mask 2 (CH1 7:0 (MASK2)
12	Hardware register 24, read mask (CH 7:0-RPNT) for read channels location; M8950s
13	Hardware register 25; BC PAR bits (CH1 P) (Refer to Figure B-5)

Table B-2 Read Microcontroller Command Codes

CMD Code	Description
00	NOP
01	Interblock read
02	Test PE HD burst
03	Test GCR HD burst
04	Test ARA HD burst
05	Test tape mark
06	Test ARA burst
07	Normal NON-BOT read
10	Run BMC self-test
11	Test mark even HD burst
12	Run read channel microtest
13	Diagnostic read command
14	Run read channel self-test
15	Run clear all BMC test programs
16	Run ECC self test program
17	Find gap

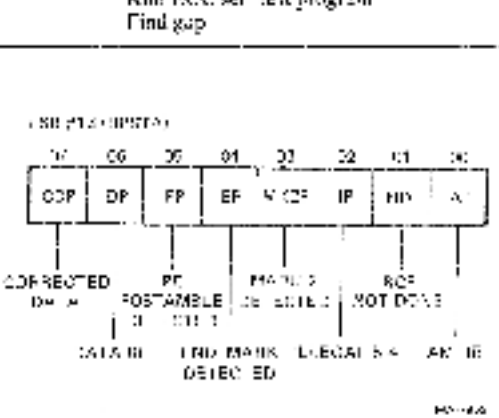


Figure B-3 Parity Read Channel Status Byte

Byte	Description
14	Hardware register 26: read channel PE postamble detect register (CH 7:0); location = M8959
15	Hardware register 27: data (CH 7:0) Data output from M8959 to FCC (M8961)
16	Hardware register 30; CRC word ECC checker output bits = location 8957

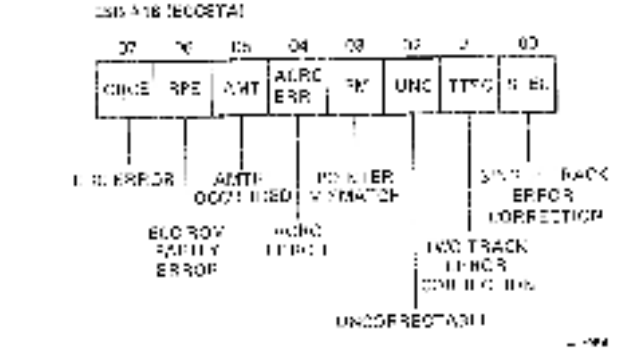


Figure B-4 ECC Status Byte

Byte	Description
17	Hardware register 31: ECCOR. Corrected data (CH 7:0) Corrected data output from M8951 to M8952
18	Hardware register 32; ECC status - 8951 (Refer to Figure B-4)
19	Hardware register 40, channel 0 TTE bus (Refer to Figure B-5)
20	Hardware register 41; channel 1 TTE bus (Refer to Figure B-5)
21	Hardware register 42: channel 2 TTE bus (Refer to Figure B-5)
22	Hardware register 43, channel 3 TTE bus (Refer to Figure B-5)
23	Hardware register 44; channel 4 TTE bus (Refer to Figure B-5)
24	Hardware register 45: channel 5 TTE bus (Refer to Figure B-5)
25	Hardware register 46, channel 6 TTE bus (Refer to Figure B-5)
26	Hardware register 47, channel 7 TTE bus (Refer to Figure B-5)
27	Hardware register 50; channel P TTE bus (Refer to Figure B-5)

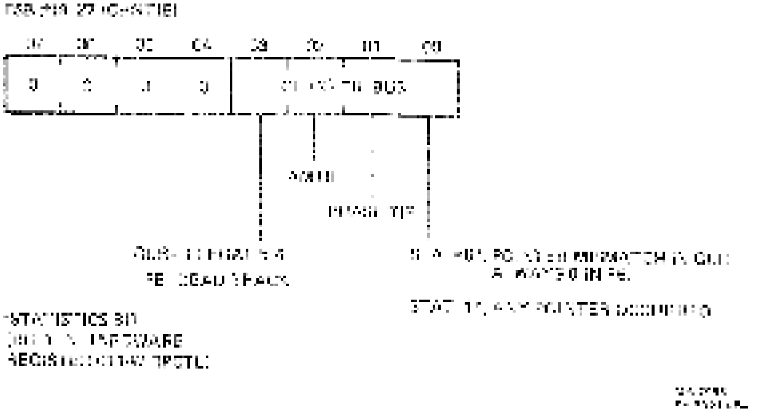


Figure B-3 Channel (N) Check-in Error Byte

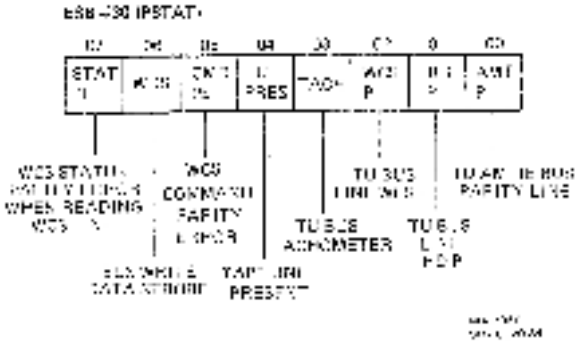


Figure B-6 TU Port Status Byte

Byte	Description
28	Hardware register 60; RIER. Read channel bypass for diagnostic purposes
29	Hardware register 104; TAMT. Diagnostic AMTIE loop register in 8955 module
30	Hardware register 130; PORT status (Refer to Figure B-6)
31	Hardware register 134
32	Hardware register 240; CAS status (Refer to Figure B-7)
33	Hardware register 241; CBUSSTA status (Refer to Figure B-8)
34	Hardware register 300; DBUSSTA status (Refer to Figure B-9)
35	Hardware register 320; WMC status. See Appendix B in maintenance manual for bit descriptions
36	Hardware register 321; TU select 0. (M8955 slot 8) See Appendix B in maintenance manual for bit descriptions
37	Hardware register 322; TU select 1. (M8955 – slot 9) See Appendix B in maintenance manual for bit descriptions
38	Hardware register 333; WRTDAT. Write microcontroller data – 8956 module.
39	Hardware register 321; BYTCN 1 <7:00>. Write byte count to word

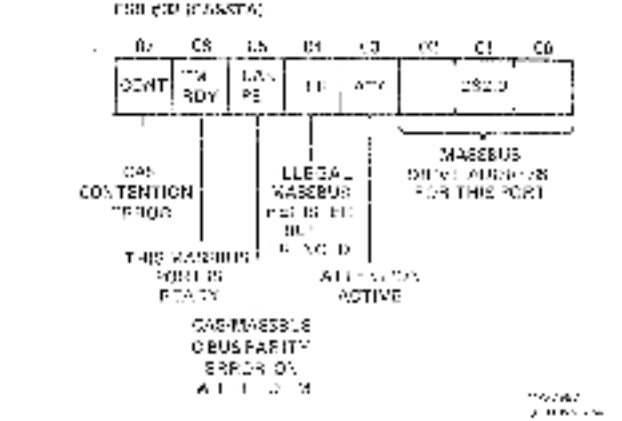


Figure B-7 CAS Port (N) Status Byte

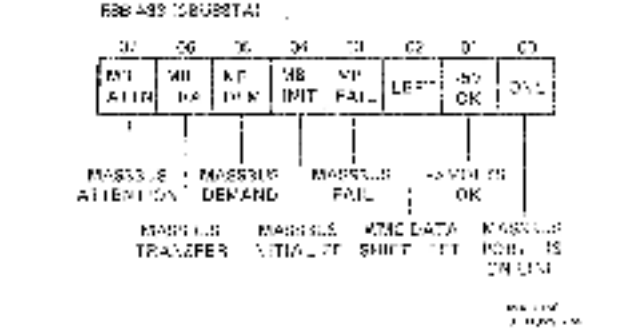


Figure B-8 MASSBUS Control Status Byte

Byte	Description
40	Hardware register 320: BYCNT <15:8>. Write byte count in word
41	Hardware register 320, PADCN <7:0>. Write twos complement assembly parity character counter in word
42	Hardware register 326: PADCNT <15:8>. Write twos complement assembly parity character counter in word
43	Hardware register 326: ERRCNT <7:0>. In word bits 8–15. Write twos byte assembly error count

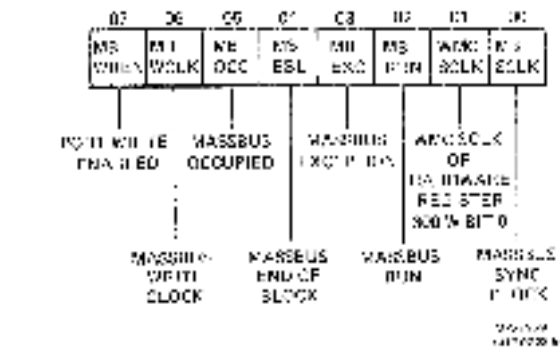


Figure B-9 MASSBUS Data Bus Status Byte

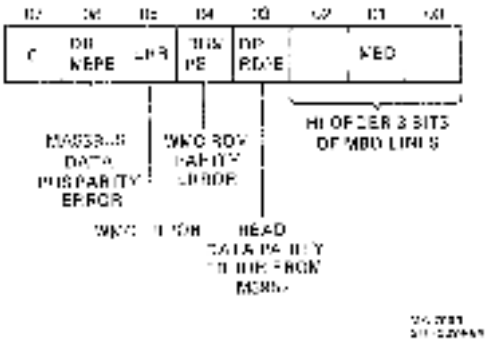


Figure B-10 Write Microcontroller Error Byte

Byte	Description
44	Hardware register 326: ERRCNT mode <15:8> word bits 0 – 17. Refer to Appendix B in maintenance manual for bit codes
45	Hardware register 320; DDR A diagnostic data register A used to test bus between M8956 and M8959
46	Hardware register 321; DDR B. Diagnostic data register B used to test bus between M8956 and M8959
47	Hardware register 340 WMCERR (Refer to Figure B-10)

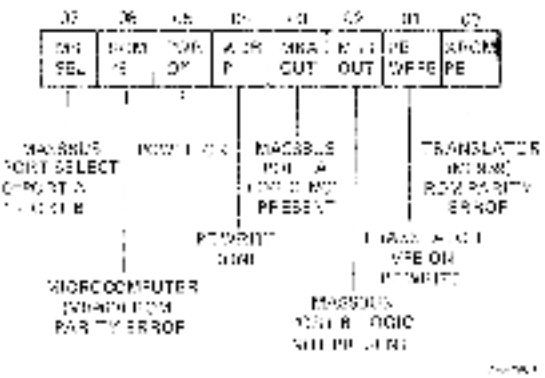


Figure B-1. Interrupt Status Byte

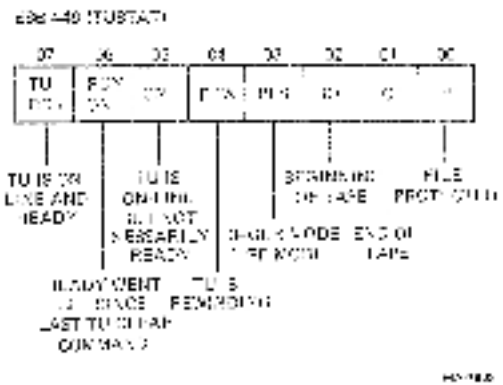


Figure B-2. TU Status Byte

Byte	Description
18	Hardware register 340: INTSTA (Refer to Figure B-1). Interrupt status byte on M3960
19	MIA register C. TU 0 status (Refer to Figure B-2)

Byte	Description
50	MIA register 1; MIA status A (Refer to Figure B-14)
51	MIA register 2; MIA status B (Refer to Figure B-14)
52	MIA register 3; SNTH Serial number – thousands and hundreds digits (BCD)
53	MIA register 4; SNTU serial number – tens and units digits (BCD).
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 commands to control error recovery. It is used on 9-track only when the retry counter (byte 55) is not zero. (Refer to Figure B-16)
57	TU software status (TUS) – 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 (XRbTRY). This byte contains the contents of the left half of the MASSBUS register (CAS register 2), which contains the SER (Suppress Error Report Interrupt) bit, format, and skip count.
60	Keypad enable flag (ENA=ON) – This byte is not zero when the keypad is enabled.

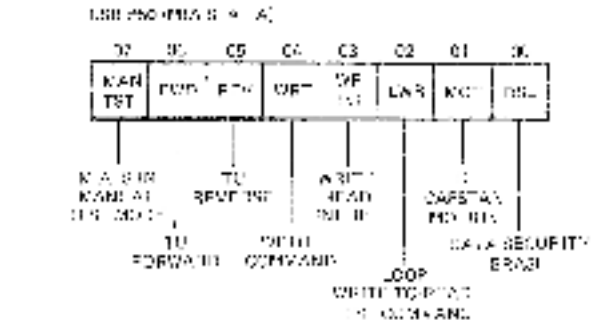


Figure B-17 MFA Status A Byte

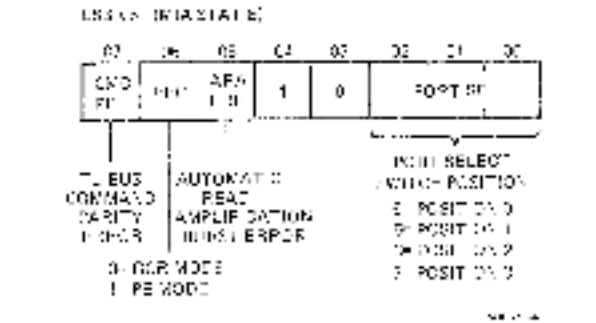


Figure B-18 MFA Status B Byte

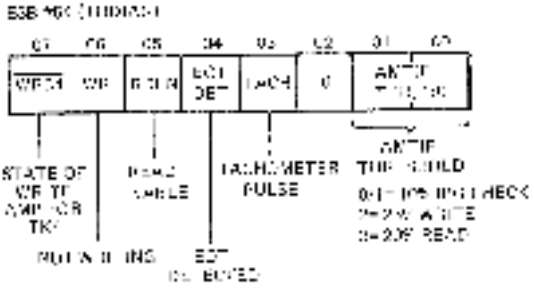


Figure B-15 MTA TU Diagnostics Byte

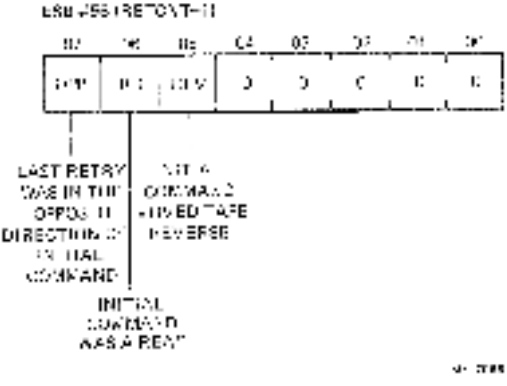


Figure B-16 Retry Control Byte

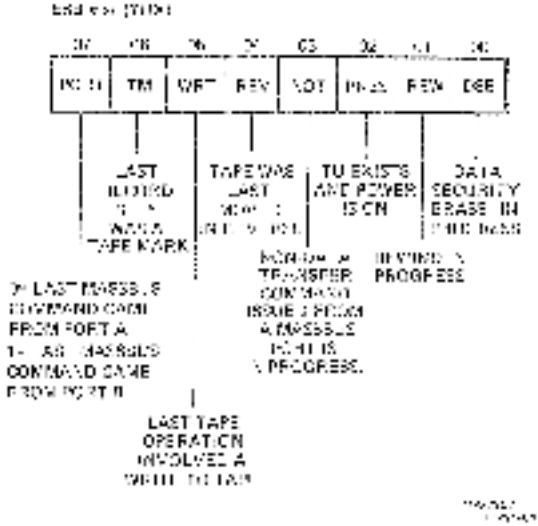


Figure 8-17 Unit Status Byte

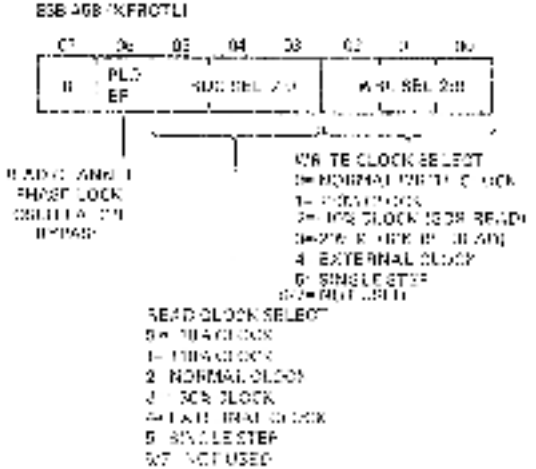
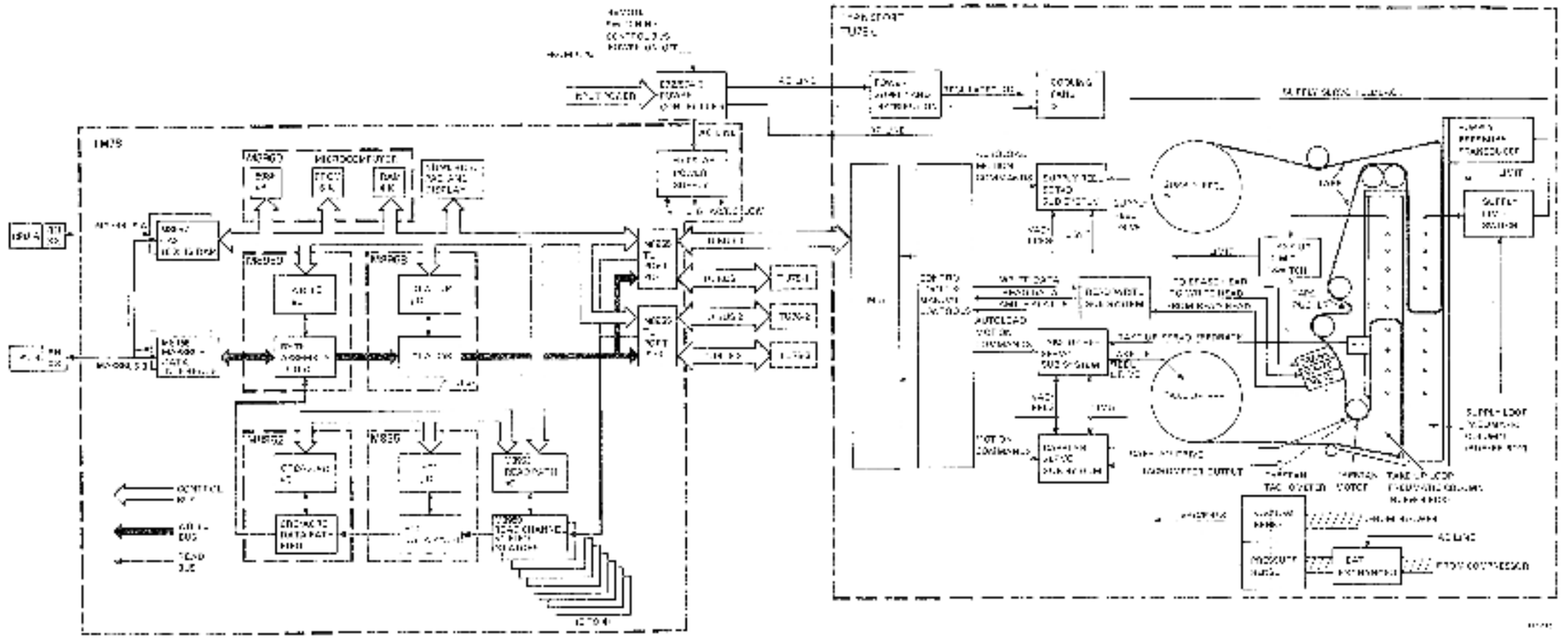
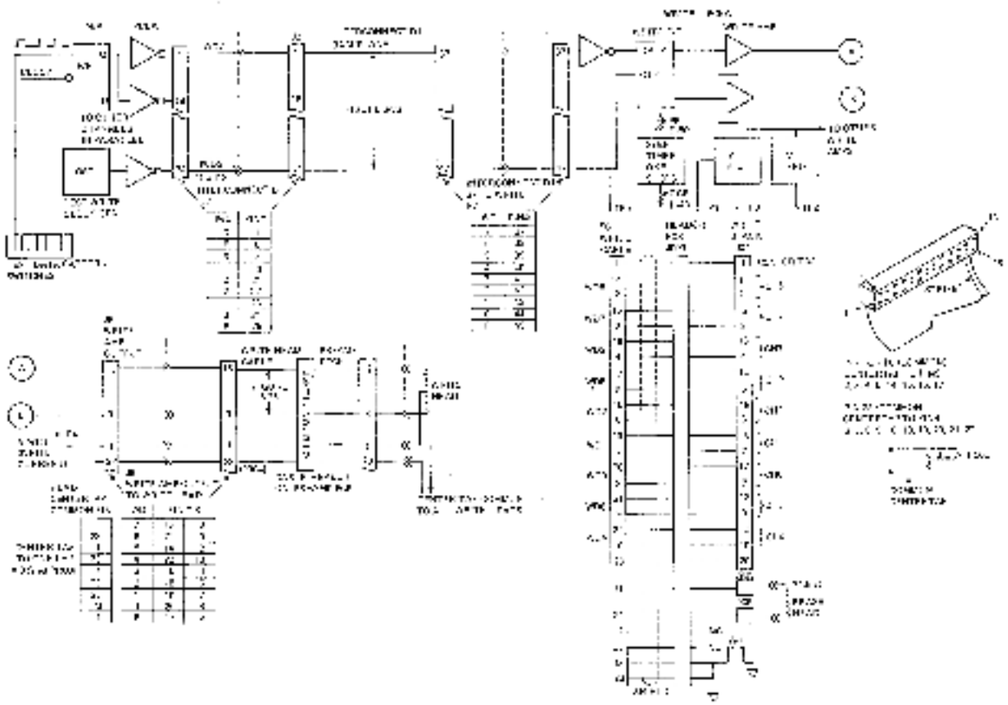


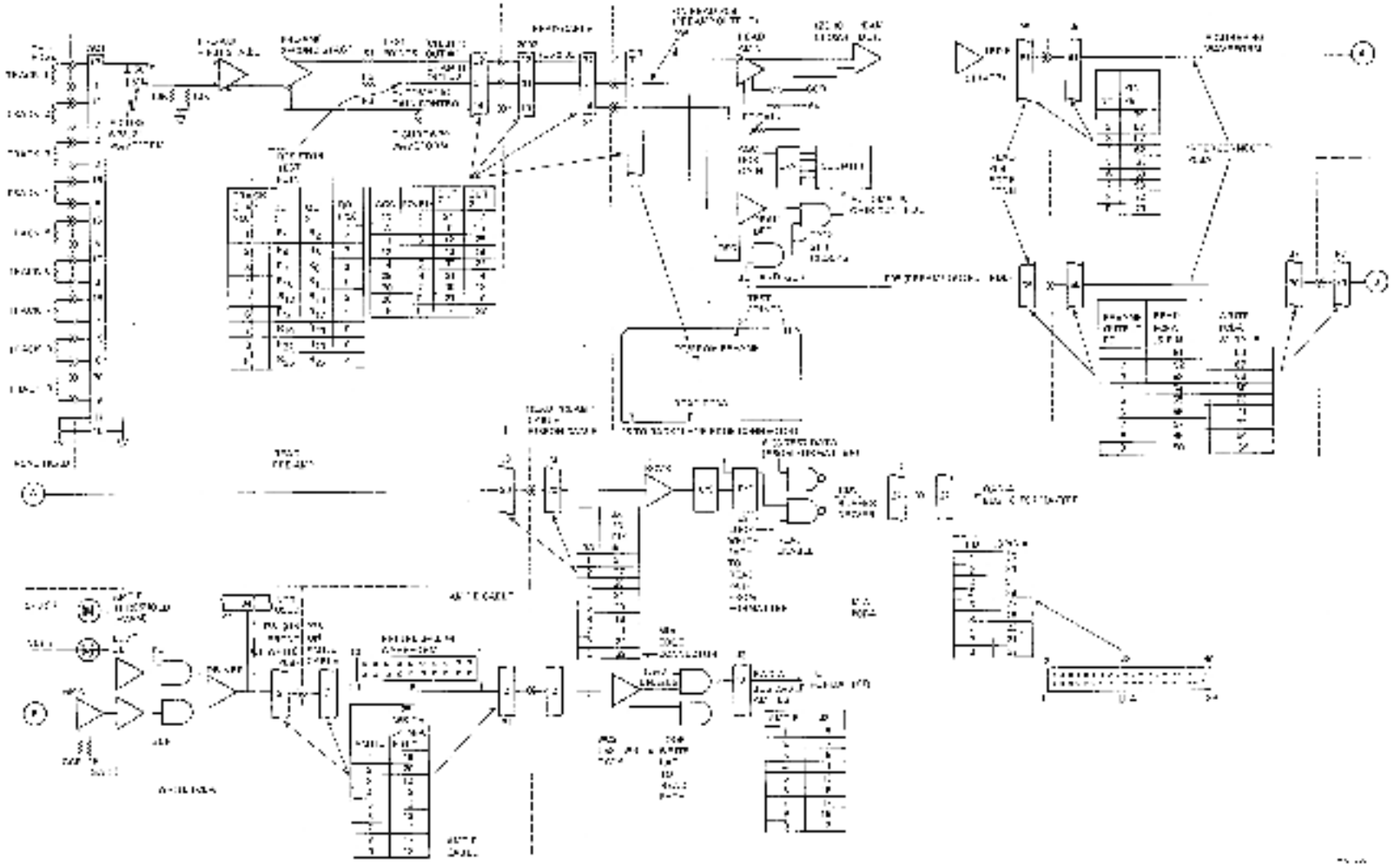
Figure 8-18 Transfer Control Byte



T-1070 Subsystem Detailed Block Diagram



Write Path Troubleshooting Diagram



Read Path Troubleshooting Diagram