M244X

Streaming Tape Drive
Customer Engineering Manual

FUJITSU

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CHAPTER 1 GENERAL DESCRIPTION

1.1 General Description

M244X series streaming Tape Drive is direct reel to reel servo type tape drive and consist of tape transport mechanism, tape motion control electronics, dual density read/write circuit and data formatter electronics which can read and write ANSI-standard nine track half inch magnetic tape in 6250 BPI (GCR mode) or 1600 BPI (PE mode).

M244X series has four modes as shown below.

Model	M2441A	M2442A	M2443A	M2444A
Form	Standalone	rack mount	Standalone	rack mount
Tape speed	12.5/100 IPS	12.5/100 IPS	25/75 IPS	25/75 IPS

1.2 Configuration

A maximum of four MTSs can be connected to the host controller with daisy chain connection as shown in Figure 1.2.1.

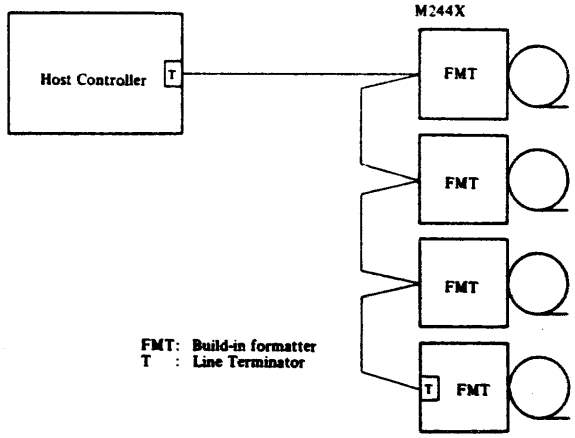


Figure 1.2.1 Maximum configuration

1.3 Specifications

1.3.1 Functional specifications

Table 1.3.1 Functional Specifications

Models		M2441A/M2442A		M2443A/M2444A	
Tape Speed and Mode		100 IPS Streaming	12.5 IPS Start/Stop	75 IPS Streaming	25 IPS Streaming
Recording Density	GCR	6250 BPI			
	PE	1600 BPI			
Data Transfer Rate	GCR	625 KB/sec	78 KB/sec	469 KB/sec	156 KB/sec
	PE	160 KB/sec	20 KB/sec	120 KB/sec	40 KB/sec
IBG	GCR	0.3 Inch	0.3 Inch	0.3 Inch	0.3 Inch
	PE	0.6 Inch	0.6 Inch	0.6 Inch	0.6 Inch
Access Time (Write)	GCR	166 ms	21 ms	126 ms	50 ms
	PE	170 ms	25 ms	130 ms	63 ms
Repositioning Time	GCR	792 ms	-	580 ms	176 ms
	PE	794 ms	-	582 ms	196 ms
Command Reinstruction Time (Write)	GCR	1.2 ms	-	1.7 ms	5.7 ms
	PE	4.2 ms	-	5.7 ms	17.7 ms
Rewind Time 2400 FT		136 sec			
Load Time		10 sec			
Tape Media		1/2 Inch Width Standard Tape for Computer 2400/1200/600/300 foot			

1.3.2 Physical specifications

Table 1.3.2 Physical specifications

Item		Operating	Not operating
Power requirement	Voltage	100~120V or 200~240V ±10%	
	Frequency	48~61 Hz	
	Phase	Single	
Power consumption		Max 0.8 KVA	0.4 KVA at 100~120V 0.5 KVA at 200~240V
Heat dissipation		Max 440 Kcal/Hour (1,750 BTU/Hour)	
Circuit breaker Capacity		20A	
Leakage current		Less than 1 mA	
Air flow		4 m^3/min	
Sound pressure level		max 52 dB	
Environment	Temperature	5~40°C (41~104°F)	0~50°C (32~122°F)
	Relative humidity	20~80% RH	8~90% RH
	Wet bulb	0~29°C (32~84°F)	
	Temperature changerate	15°C/Hour (27°F/Hour)	
	RH change rate	30%/24 Hours	
	Altitude	-609~3,048 m (-2,000~10,000 ft)	
	Vibration	max 0.25G	max 0.4G
Dimensions (Height x width x Depth)	M2441A/M2443A	1,000 mm x 500 mm x 700 mm (39.4 inch x 19.7 inch x 27.6 inch)	
	M2442A/M2444A	575 mm x 482 mm x 580 mm (22.6 inch x 19.0 inch x 22.8 inch)	
Weight	M2441A/M2443A	110 kg (242 lb)	
	M2442A/M2444A	90 kg (198 lb)	
Service clearances		Front: 1 m, Rear: 1 m Side : Not required	

1.3.3 Reliability and maintenablity

(1) Service life

More than five years or 40,000 hours.

(2) MTBF

More than 8,000 hours.

(3) MTTR

1 hour.

1.4 RECORDING METHOD

The Formatter provides the capability of recording and retreiving data in the Phase Encoded (PE) format or the Group Coded Recording (GCR) format. Each recording format is implemented in accordance with the ANSI standards. Track Assignments and Data Block Format are shown in Figures 1.4.1 and 1.4.2.

1.4.1 Phase Encoding format

In the Phase Encoding (PE) format each bit is recorded on tape as a flux transition at mid-cell-time. A ''0'' is represented by a transition away from the erase direction; a ''1'' by a transition made, if necessary, at the cell-boundary-time in order to allow the correct transition direction at the subsequent mid-cell-time.

Each track is therefore self-clocking, thus allowing a certain amount of skew between the bits of a byte. Deskewing is performed during read data recovery. Data errors caused by failure of a single track are corrected on the fly during read operations.

A block of data consists of a preamble, the data and a postamble. The preamble consists of 40 bytes of all "0's" followed by a byte of all "1's", while the postamble consists of a byte of all "1's" followed by 40 bytes of all "0's". The preamble and postamble are mirror image of each other, allowing the block to be read in reverse.

A tape Mark is special conbination of 64 to 256 flux transitions at 3200 FRPI in Tracks 1, 2, 4, 5, 7 and 8, and DC erasure in Tracks 3, 6 and 9.

When writing starts at BOT, the PE ID burst is written in the BOT area followed by a gap before the first data block. The ID burst is a single active track (Track 4) at 1600 RPI with the rest of the tracks DC erased.

1.4.2 Group Coded Recording format

In the Group Coded Recording format (GCR), the NRZI recording technique is used; i.e., each "1" recorded on tape is represented by a flux change and "0" is represented by no flux change. In order that each track may be self-clocking and thereby tolerate a considerable amount of skew, the write data is remapped such that 4 bytes of write data is transformed to 5 bytes of data written on the tape. This transformation is performed in such a way as to guarantee that no more than 2 consecutive "0's" will occur without an intervening "1". The user data is broken up into groups of 7 bytes. An 8th byte, the Error Correction Character (ECC) is calculated and added to the group. The data group of 8 bytes is devided into two subgroups of 4 bytes.

Each subgroup of 4 bytes is transformed from a 6-bytes subgroup of data written on tape in the manners at Table 1.4.1.

A block of data consists of a preamble, a Mark I subgroup, up to 158 data groups, an end mark subgroup, a residual group, a CRC go up, a Mark II subgroup, and a postamble. As in PE, the Mark II subgroup and the postamble are mirror images of the preamble and Mark I subgroup. The preamble consists of a beginning subgroup of a alternate "1's" and "0's", a second subgroup of one "0" and 4 "1's" followed by 14 subgroups of sync bytes, all "1's". If the user data creates more than 158 data groups a resync burst consisting of a Mark II, 2 sync subgroups and a Mark I is inserted every 158 data groups. The first 6 bytes of the residual group consists of the remainder of the write data bytes plus any required pad of data "0's". The 7th byte is an auxiliary CRC byte and the 8th byte is the ECC. The group is recorded in the same manner as a data group after 4 to 5 bit transformations.

The first byte of the CRC group is a data "0" if the number of preceding data groups is even or the CRC character if the number of preceding data groups is odd. The 2nd through 6th byte is the repeated CRC character. The 7th byte is a residual character which is related to the number of data bytes. The 8th byte is the ECC. The group is recorded in the same manner as a data group. Data errors caused by one or two track failures can be corrected on the fly.

In PE, the tape mark and ID burst at BOT are unique combinations of active and inactive tracks. The tape mark is the special combination of 250 to 400 flux transitions at 9042 FRPI in Tracks 1, 2, 4, 5 and 8, and DC erasure in Tracks 3, 6 and 9. The ID is a burst at 3014 FRPI in Track 6 only; the rest of the tracks are DC erased.

GCR has a GCR ID and an ARA (Automatic Read Amplification) burst followed by an ARA ID before the first data block. the ARA burst is used to automatically set the gain of the Read Amplifiers in each track to the optimum value for best reading. The ARA is recorded at 9042 FRPI in every track while the ARA is recorded at 9042 FRPI in Tracks 2, 3, 5, 6, 8 and 9 and DC erased in Tracks 1, 4, and 7.

Table 1.4.1 4 to 5 Bit Transformation

Data Subgroup	Storage Subgroup	Data Subgroup	Storage Subgroup
0000	11001	1000	11010
0001	11011	1001	01001
0010	10010	1010	01010
0011	10011	1011	01011
0100	11101	1100	11110
0101	10101	1101	01101
0110	10110	1110	01110
0111	10111	1111	01111

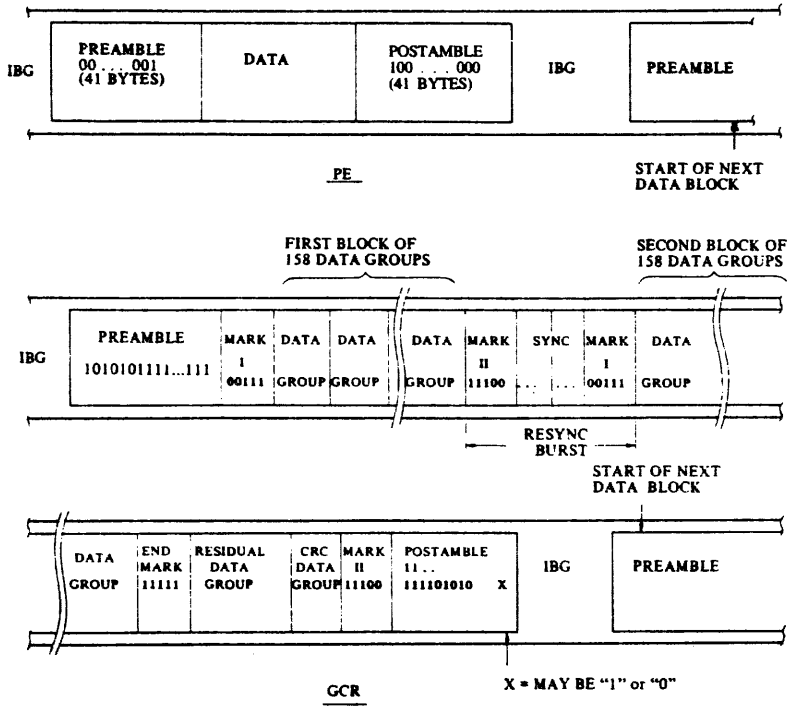
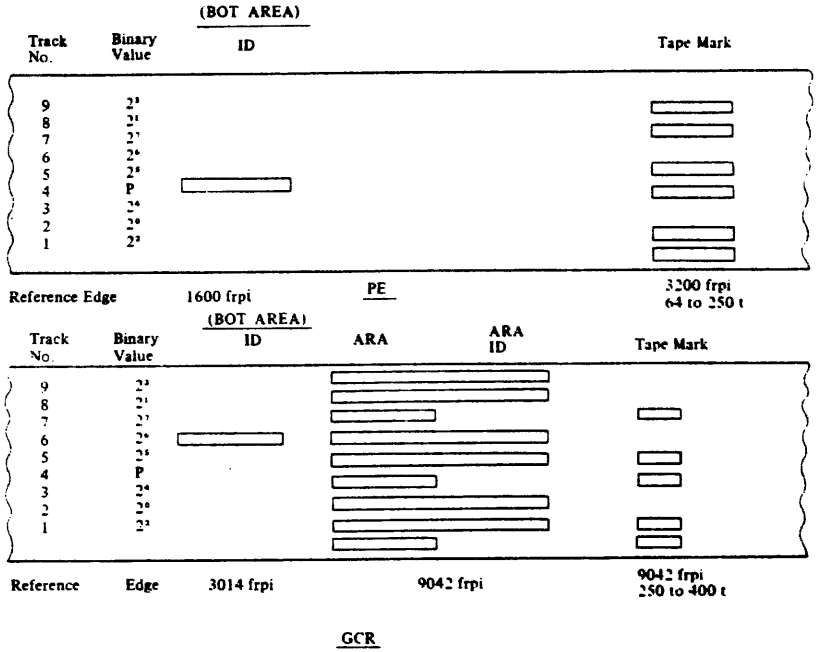


Figure 1.4.1 Data Block Format



* Tracks 1, 4, 7 may be either DC erased or recorded as shown.

Figure 1.4.2 Track Assignments

CHAPTER 2 INSTALLATION

2.1 Unpacking

CAUTION

Condensation may occur when the cabinet is transferred from a cold to a warm environment.
In order to avoid condensation, the cabinet should remain in an environment at the ambient temperature for at least 3 hours before unpacking.

2.1.1 M2441/M2443

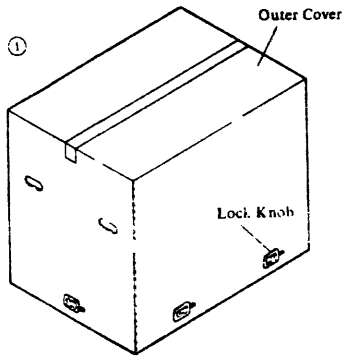
Refer to Figure 2.1.1 when tape model M2441 or M2443 is unpacked.

Reserved

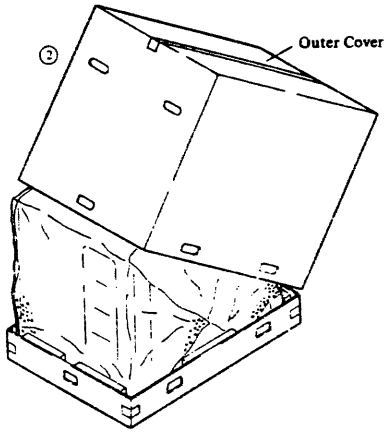
Figure 2.1.1 M2441/M2443 Unpacking

2.1.2 M2442/M2444

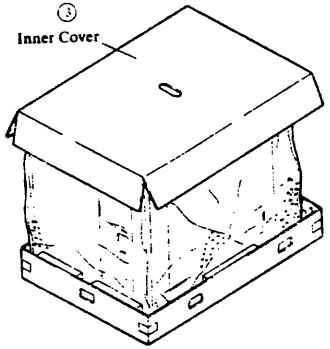
Refer to Figures 2.1.2 and 2.1.3 when tape model M2442 or M2444 is unpacked.



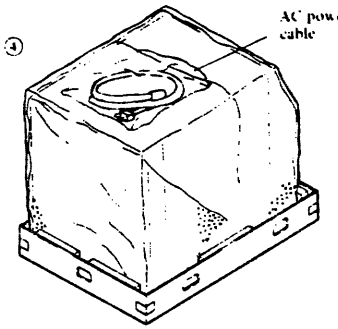
Remove six lock knobs on each side of the outer cover. For detailed removing lock knobs, see Figure 2.1.3.



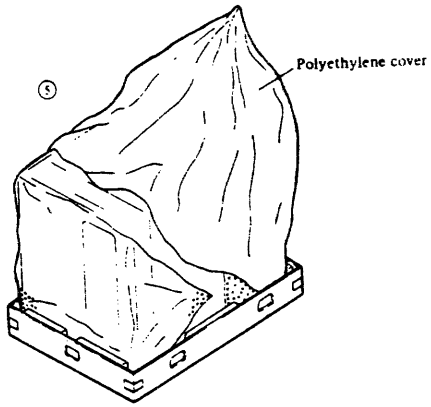
Remove the Outer Cover.



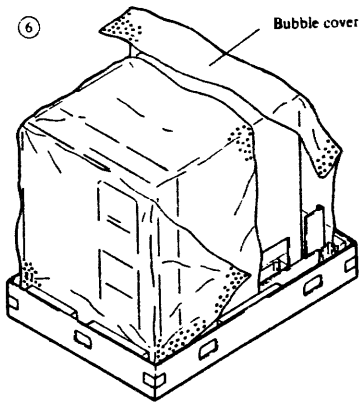
Remove the Inner Cover



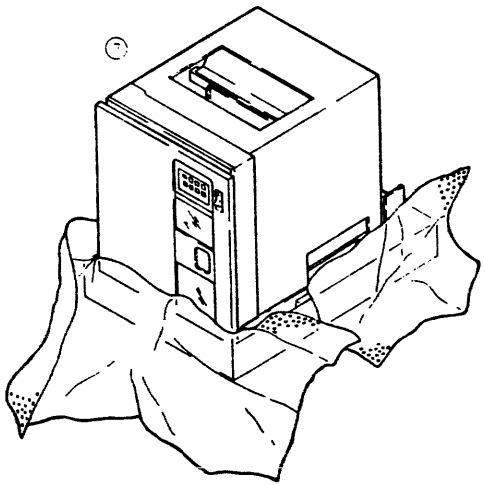
Remove AC power cable from top of unit.



Remove the polyethylene cover.



Remove the bubble cover.



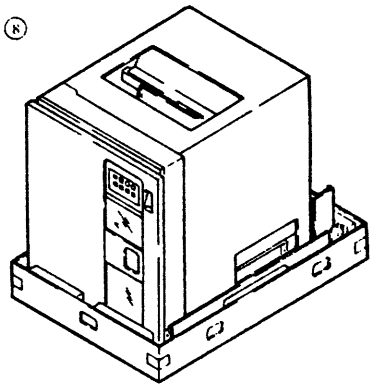


Figure 2.1.2 M2442/M2444 Unpacking

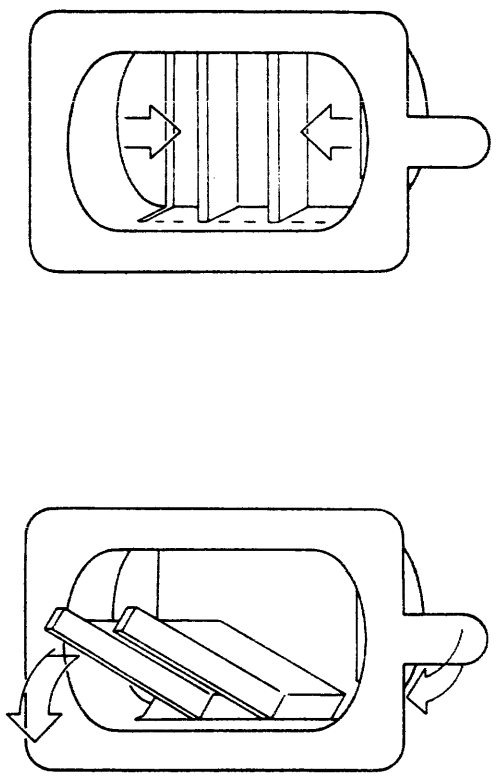


Figure 2.1.3 Lock knob removal

The Lock knob moving method is as follows:

1. Nip the two limbs and release latches (①).
2. Pull down the limb part (②).
3. Remove the knob from each side of outer cover (③).

2.2 Mechanical Installation

2.2.1 M2441/M2443 installation

This section is applied to the standalone type tape drive.

(1) Front cover/rear cover opening

The opening method of the front cover and the rear cover is the same.

First, open the top cover adequately. Then release the two latches by pushing down the each plate of latches through the hole using a screwdriver.

Figure 2.2.1 shows the front cover opening.
Figure 2.2.2 shows the rear cover opening.

After releasing the cover, disconnect the frame grounding wire from it by removing the screw. See Figure 2.2.3.

(2) Front cover/rear cover closing

Connect the frame grounding wire to the cover with the screw. Next fit the cover to the latches by pushing in on it.

(3) Adjustment of the leveling feet

To secure the M2441 or M2443 streaming tape unit, adjustment of the level feet as necessary.

Place the pads under the leveling feet and adjust the level by using a wrench. Adjust four leveling feet.

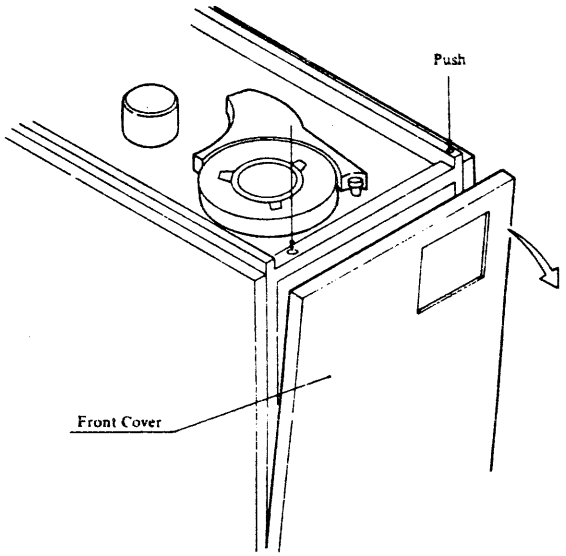


Figure 2.2.1 Top cover opening

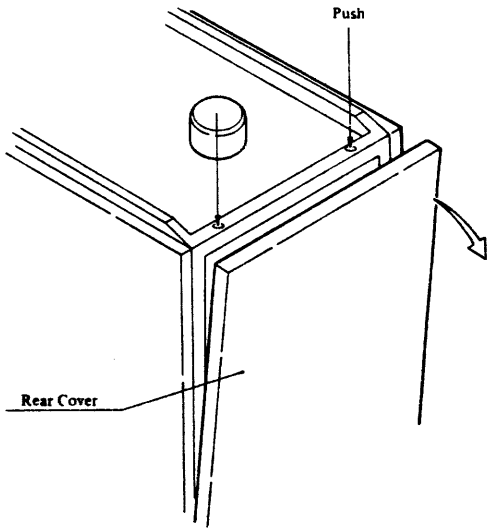


Figure 2.2.2 Rear cover opening

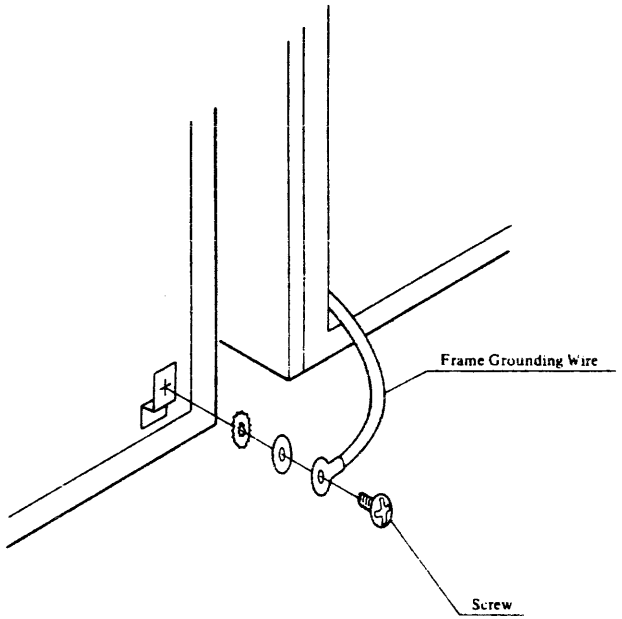


Figure 2.2.3 FG wire removing

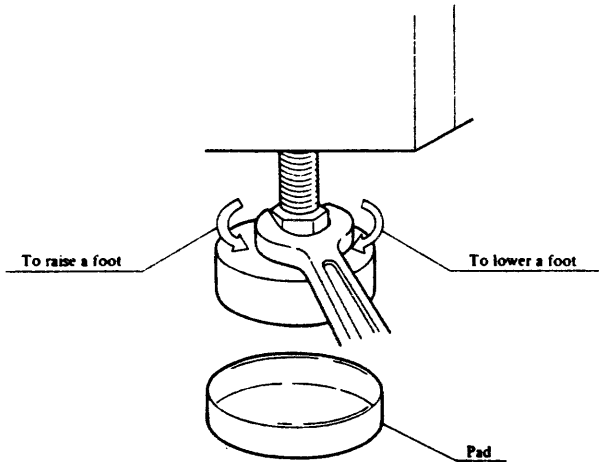


Figure 2.2.4 Leveling foot

2.2.2 M2442/M2444 installation

(1) Outside view

Figure 2.2.5 shows the outside view of the drive and Figure 2.2.6 shows the outside view of the rack.

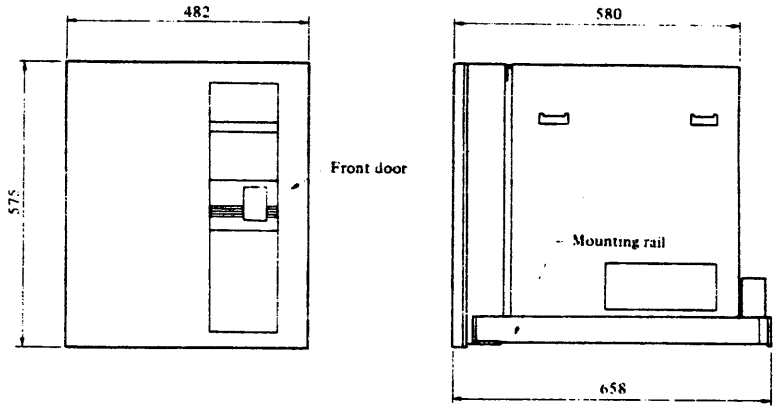


Figure 2.2.5 Outside view of the drive (rack mount type)

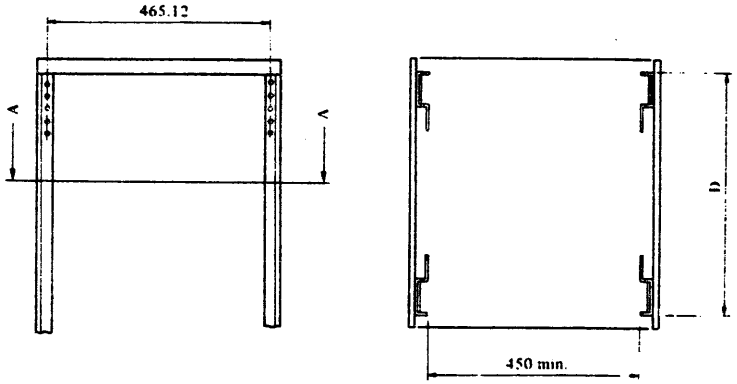


Figure 2.2.6 Outside view of the rack

(2) Mounting Method

a. The method of removing the pair of mounting rails attached to the unit.

Note: The Right Rail is shown in Figure 2.2.5 right side view. Each rail is fixed to the unit by two screws. The screws are located on the front and rear sides.

(a) Open the front door.

(b) Loosen the two screws A indicated in Figure 2.2.7 and open the casting panel.

Caution: The center of gravity moves to the front when the panel is opened. Care should be taken so the drive does not tip forward.

(c) Remove the philips type screw B indicated in Figure 2.2.8. Remove the left side screw in the same manner.

(d) Remove the philips type screw C indicated in Figure 2.2.9. Remove the left side screw in the same manner.

(e) Close the casting panel and fix the screw A, and close the front door to prevent the door from opening unexpectedly when sliding the unit on the rails.

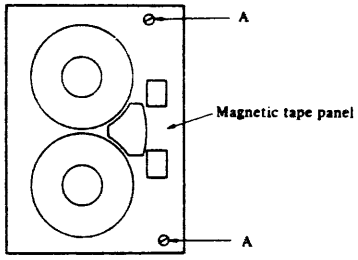


Figure 2.2.7 Mounting rails removal (1)

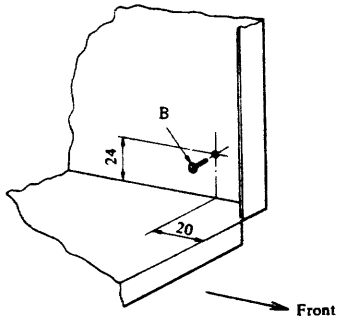


Figure 2.2.8 Mounting rails removal (2)

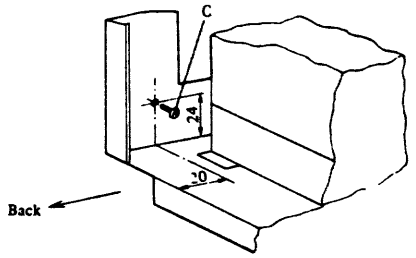


Figure 2.2.9 Mounting rails removal (3)

b. The method of mounting the rails to the rack

(a) **Remove all the A screws. (Refer to Figure 2.2.10)**

(b) Adjust the rails to the rack. (Refer to Figure 2.2.13)

As D=25": refer to Figure 2.2.10
As D=28" or 30": reassemble the rails indicated Figure 2.2.11 (for 28")
or Figure 2.2.12 (for 30").

Fix the screw B temporarily.

(c) Fix the rail to the rack using each 3 holes, one of which is the lowest hole of the 12th pitch and the rest are the top and next hole of the 13th pitch, i.e. the highest of these 3 holes is 520.7 mm from the top hole of the rack. (Refer to Figure 2.2.13)

(d) Fix the screws B which are fixed temporarily.

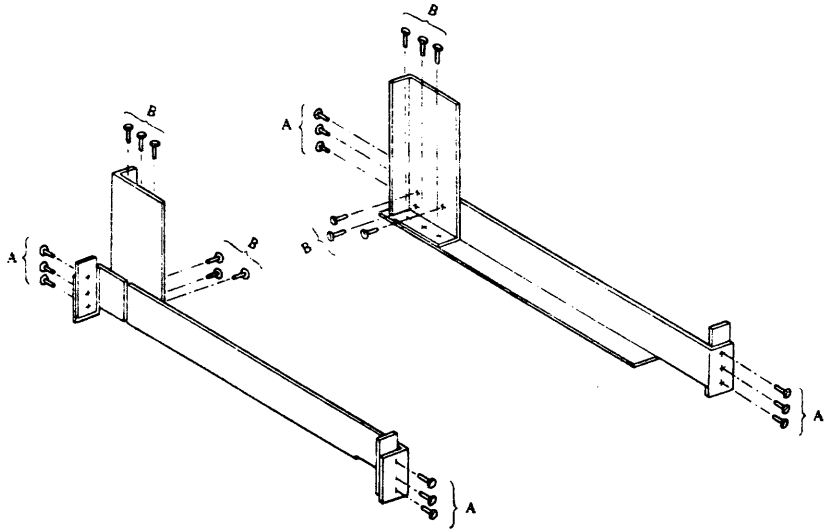


Figure 2.2.10 Rail mounting (1)

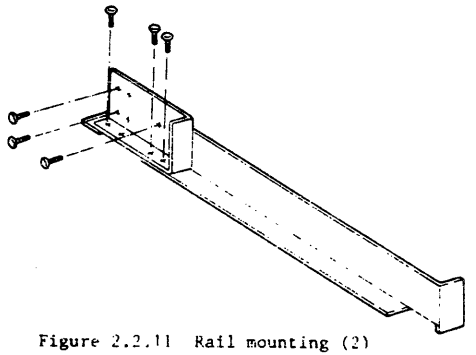


Figure 2.2.11 Rail mounting (2)

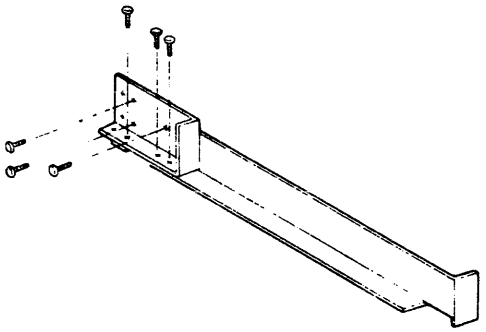


Figure 2.2.12 Rail mounting (3)

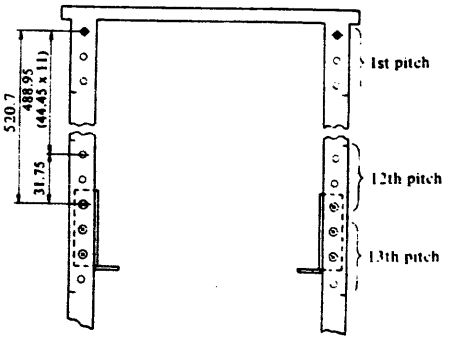


Figure 2.2.13 Rail mounting (4)

c. Mount the unit on the rail from front side

d. The method of the fixing the unit to the rail

Fix the screws in the reverse sequence as the method of removing. (Refer to Section 3.1)

Caution: Fix the back side screws for the first time. Never open the casting panel before fixing the back side screws to prevent the unit falling down front side because of unbalance.

e. Fix the screws indicated in Figure 2.2.7.

(3) The method of removing

Carry out in the reverse sequence of mounting.

2.3 Cable Connection

Interface cable and power cable

2.3.1 Confirm that the Interface cable A and B and AC power cable indicated in Figures 2.3.1

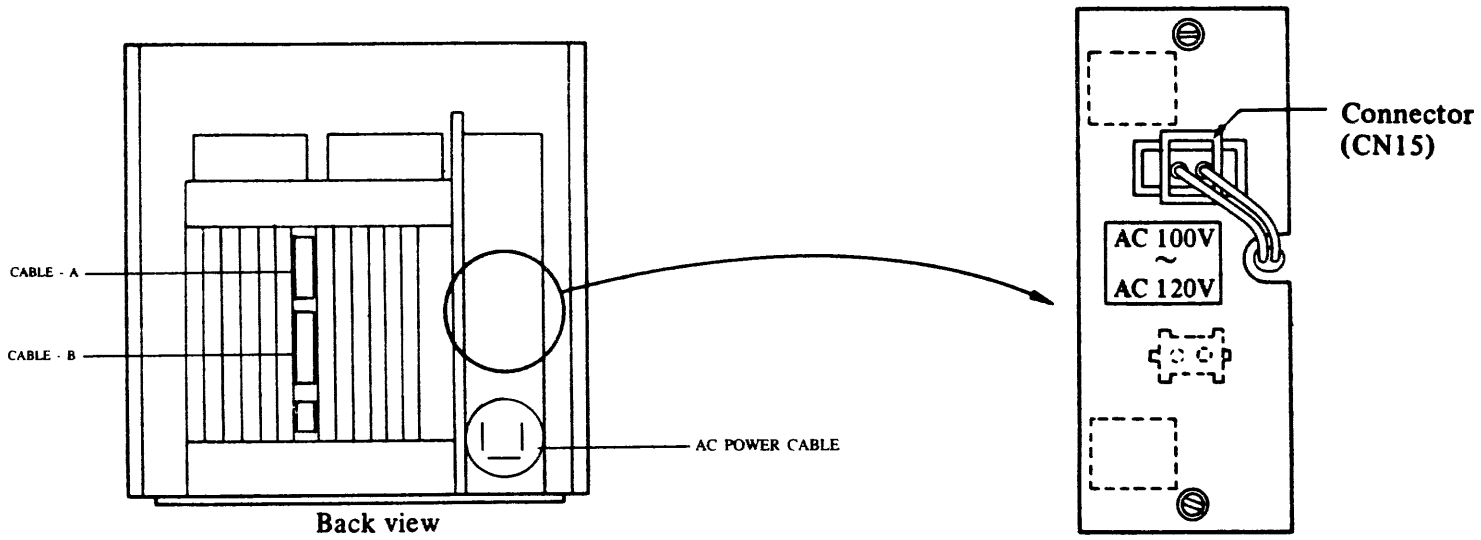


Fig 2.3.1

2.4 Checkout

Note: The location and the nickname of PCA is shown in Appendix. Please refer to the Appendix if necessary.

2.4.1 Input voltage setting

Note: This machine is set to 100~120 VAC.

(1) a Confirm that the connector (CN15) indicated in Figure 2.4.1 is plugged into the upper side of the power supply unit.

b In the case of 200~240 VAC
Confirm that the connector (CN15) indicated in Figure 2.4.1 is plugged into the upper side of the power supply unit.

(2) Input voltage changing method

a. Remove the connector (CN15).

b. Remove the two screws.

c. Reverse the plastic cover.

d. Confirm that the label on to the plastic cover indicates correct voltage.

e. Fix the plastic cover by two screws.

f. Plug the connector in to the jack.

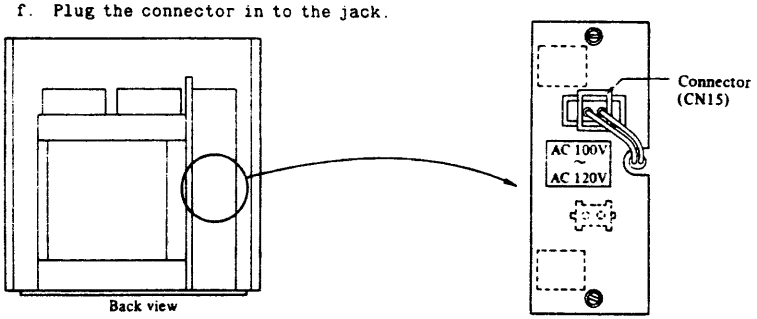


Figure 2.4.1 Input voltage setting

2.4.2 Device address & Write bus parity check setting.

(1) Device address setting.

The device address is determined by plugging the switch board located on PCA 'IFC'. The location on PCA is AA7. (See Figure 2.4.2)

The default address is #0. If the address of the device is #1~#3, change the plugging location. The address and the plugging pin meaning is shown in Table 2.4.1.

Table 2.4.1 MTU address and switch circuit

MTU Address	Connection of switch circuit			
	SWAD	SWAD1	SWAD0	
0	10-09	06-05	03-02	16 09 / 01 08
1	10-09	06-05	03-04	
2	10-09	06-07	03-02	PCA: 'IFC' IC location: AA7
3	10-09	06-07	03-04	

(2) Write bus parity check setting

This drive provides odd parity checking of write data bus.
If the write data from the host adaptor is not odd parity, change the plug location as follows.

Pin 12-13 (default: parity check) IC Location: AA7
Pin 14-13 (default: no check) PCA: 'IFC'

(3) Line terminators

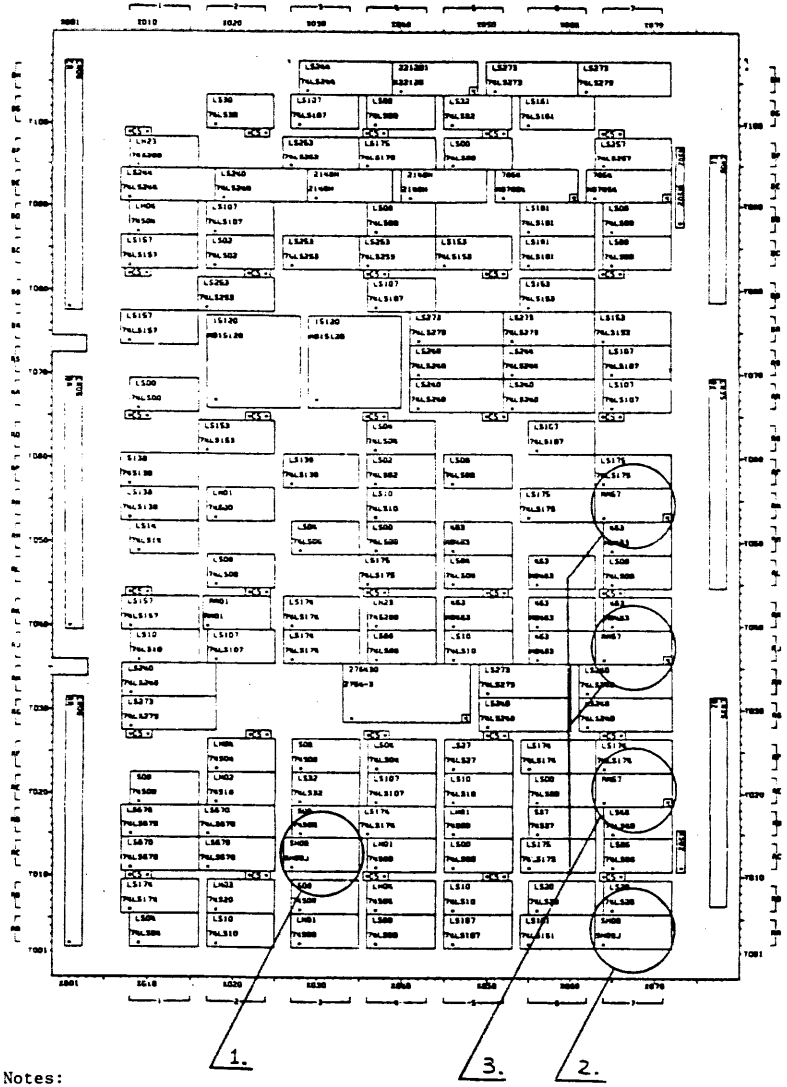
Every drive has 3 line terminators. These are located on PCA 'IFC'. (IC location: AE7, AJ7, AN7; See Figure 2.4.2)
If the drive is not the last one on the string remove the line terminators.

(4) Clock skew compensation circuit

To adjust the trailing edge of the formatter clock between LSI and SSI, compensation is neeeded and its circuit is located on PCA 'IFC'. (IC Location: AC3; See Figure 2.4.2) Confirm that pin 7 and pin 3 is connected.

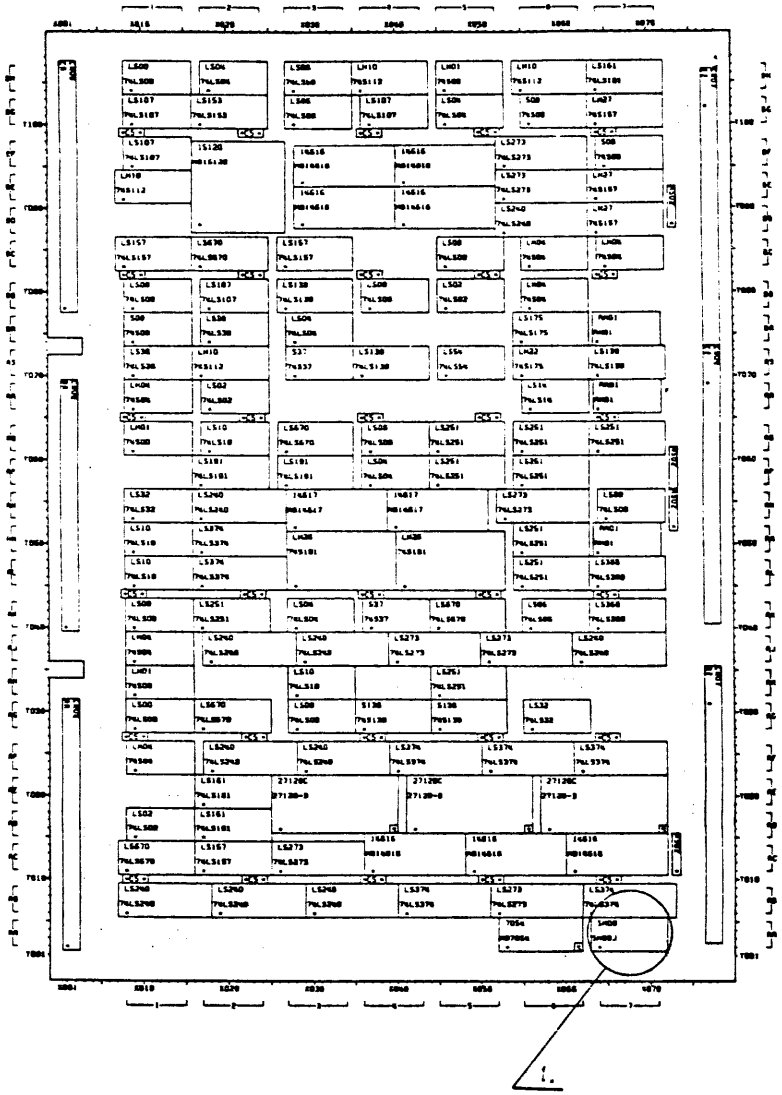
(5) Microprogram expansion feature

EPROM for the microprogram is MBM27128 (128K Byte).
In the future, if a larger program is needed, 256K Byte EPROM will be used. For this purpose, a switch is located on PCA 'IFC'. (IC Location: AA7; See Figure 2.4.3) Confirm pin-10-pin-11 is connected.



Notes:
1. Clock skew compensation for formatter
2. Address setting & write bus parity check setting
3. Three line terminators

Figure 2.4.2 Overview of PCA 'IFC'



Notes:
1. Microprogram expansion feature

Figure 2.4.3 Overview of PCA 'MPU'

2.4.3 Setting by Operator Panel

The interface of M244X is the standard Pertec interface. The M244X has three variations of Pertec. (See, section 4.2 and 4.3). The default of the interface mode is Mode A. If a change to another mode is needed, the setting can be changed by the Operator Panel.
The density select mode is changable by the Operator Panel. (See, Section 3.2). The default of the density after the power up sequence is 6250 bpi & Host Select mode. But it is selectable to other modes (i.e. 1600 bpi & not Host) by the Operator Panel.
The IBG Length Mode is also selectable. The default value of the IB is normal length, but if the variable IBG length mode is set, the IBG length will be expanded up to twice of normal IBG.

The method of these three functions is described in chapter 6, item 23200.

2.5 Diagnostics

For checking out the unit after the installation, the M244X has powerful offline diagnostic routines. These routines can be executed easily by the operator panel. The details are described in Appendix B.
Routine 01 should be executed for the purpose of complete check out. During diagnostics, the routine ID is displayed in the 7 segment LEDs. At the end of the diagnostics, '00' is displayed. But if some error is encountered, the Fault Symptom Code (FSC) is displayed in 7 segment LEDs and the Fault Location code (FLC) is displayed by an operation of the panel. (See Section 3.2 and Appendix B)
The detail description of Fault Symptom Code is explained in chapter 5.
during diagnostics, no retry will be executed. So the error as FSC E2xx, E3xx, D010 or D180 may be encountered because of not good tape media. In these case, however, the good quality media will fix the problem.

CHAPTER 3 OPERATION

3.1 Power ON/OFF switch

The power switch shown on the right side of Figure 3.1.1 is for the main AC line of the unit.
Power is supplied as ''1'' (upperside) is pushed, and cut off as ''0'' (lower side) is pushed.
When the power switch is turned on, all indicators of the operator panel are illuminated for one second during the indicator malfunction test. Power on diagnostics are automatically executed after all DC lines stable, then the 2-Digit indicator indicates a normal code ''00''. If the firmware detects an error, it indicates a Fault Symptom Code in the 7 segment L.E.D..

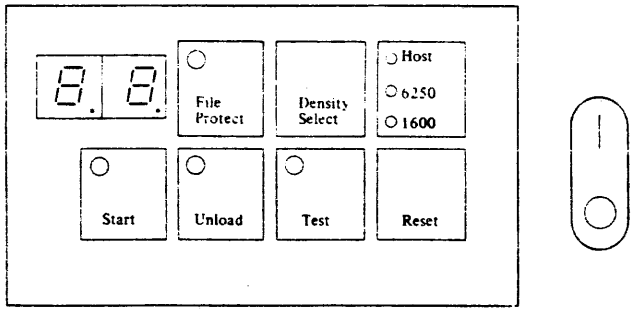


Figure 3.3.1 Operator Panel

3.2 Operator Panel

Figure 3.3.1 shows the operator panel which can be used in either normal operation or diagnostic mode. The key and indicator function for diagnostics are described in Appendix B.

3.2.1 Start kev and indicator

When tension is not applied to the tape (Servo off State), this switch initiates the load sequence. After the load sequence is completed, the unit becomes ready. The load sequence has two different sequences depending if tape has already advanced beyond BOT or not.

(1) If this key is pressed after the tape is mounted and wound on the machine reel, the tape is tensioned and moves forward to the BOT.

(2) If this key pressed when the tape has already advanced beyond BOT, the tape is tensioned and moves forward for 64 revolutions then rewinds to BOT at high speed.

(3) This key is effective only when the Start Indication is not illuminated.

(4) This indication is illuminated when the unit is ready and enabled to the controller.

(5) If the Reset key is pressed, this indication turns off. Pressing the Start Key, the unit becomes ready again after the completion of rewinding to BOT.

3.2.2 Unload key and indicator.

(1) This key is effective only when the unit is in not ready state. (Start indication is OFF.)

(2) Pressing this key rewinds the whole tape on to the supply reel.

(3) This indicator is lit during unload operation.

3.2.3 Test key and indicator

This key is used for diagnostics.

Refer Appendix B for details.

3.2.4 Reset key

(1) Pressing this key puts the unit in the offline mode (not ready state) and reset test mode if you are in diagnostics.

(2) Pressing this key during the execution of a tape motion command, the tape motion is terminated.

3.2.5 Density Select key

This key selects the write density mode (HOST/6250/1600) of the unit.

Pressing this key changes the write density mode in a cyclic way shown as follows.

HOST ——→ 6250 ——→ 1600 ↺

This key is ignored when the unit is online or in the diagnostic mode.

The density for reading depends on the written tape (6250 or 1600). the reading of tape does not cause any change of density mode indicator.

3.2.6 File protect indicator

(1) The indicator is illuminated when the Write Enable Ring is not mounted on the file reel.

(2) A write operation is inhibited if this indicator is illuminated.

3.2.7 Density indicators (HOST/6250/1600)

These LEDs indicate the density mode while writing the data to tape.

The LEDs do not indicate the reading density.

(1) HOST

This LED indicates that the unit can change the write density by Host command.

(2) 6250

This LED indicates that the write density mode of the unit is set to 6250 (GCR). When this LED is lit, the density change command from the Host is ignored.

(3) 1600

This LED indicates that the write density mode of the unit is set to 1600 (PE). When this LED is lit, the density change command from the Host is ignored.

3.2.8 2-Digit indicator

This indicator indicates the power-ON state or the details of unit errors.

(1) Normal Power ON State

"00" code is indicated.

(2) Error State 1 (Load Check Code)

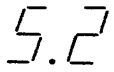
When a load failure occurs the two digit indicator on the operator panel blinks the load check code.

The code and meanings are:

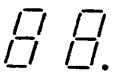
L1: Door opened
L2: Reel latch opened
L3: Tape loosened
L4: BOT marker not found
L5: Tape not in tape path

(3) Error State 2 (Fault Symptom Code)

When a hardware failure occurs the two digit indicator on the operator panel displays two bytes of FSC (Fault Symptom Code). The FSC shows the cause of the error and the index is in the maintenance section.



(a) Upper byte



(b) Lower byte

The above indications are changed for one second cyclically.

Figure 3.2.1 FSC Indication

(4) Diagnostic routines and error codes

When the unit is in Test (diagnostic) mode, these indicators display their test routine ID number and the results of test.

Refer to Appendix B for further details.

4.1 Mechanism

4.1.1 Tape drive mechanism

Figure 4.1.1 shows an outline.

All parts that form the tape path, such as reel hub, head unit, and machine reel, are mounted on the tape deck.

Tape passes over the tension sensor and the tape guides and is then wound on the machine reel via an idler.

The reel hub and machine reel are connected directly to a DC motors with a built-in tachometer.

A tension sensor detects the tape tension, and the idler sensor detects the tape speed and position by means of built-in tachometers.

An write enable sensor is attached close to the reel hub to detect whether a write enable ring is on the tape. This sensor also detects whether the reel is locked.

The head unit contains a tape cleaner, erase head, read/write head, and read/write circuit. A tape guide is attached on both sides of the head unit, and a shield block is installed facing the head.

A sheet-type operation panel is installed on the front door; it contains push buttons, LEDs, and an on/off switch.

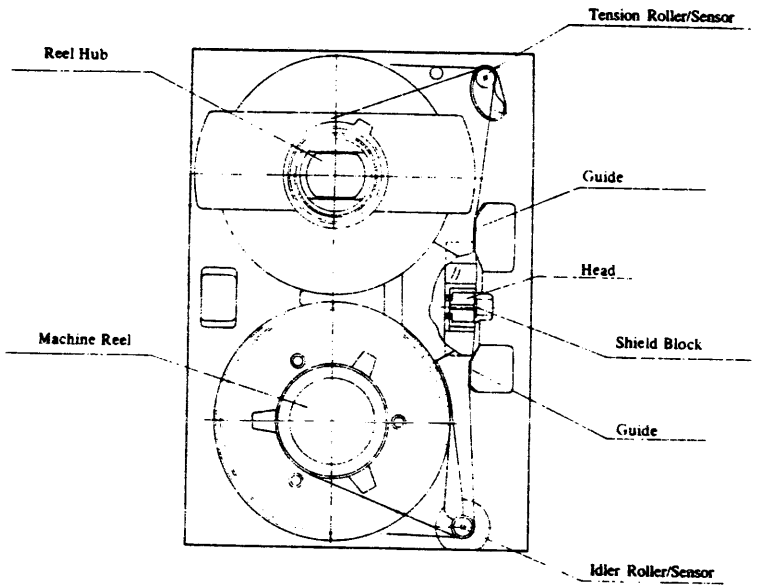


Figure 4.1.1 Tape drive mechanism

(1) Reel hub

The reel hub is operated manually. When the knob is pushed by hand, the cam is pulled to the reel boss by a link mechanism. Then a claw is pushed out to expand the rubber, and locks the reel in place. When the cam is pulled, the reel lock detection ring moves inside, which moves the shield (that covered the sensor) so that light passes through. This enables the mechanism to recognize that the reel has been locked.

(2) Enable sensor and reel lock sensor

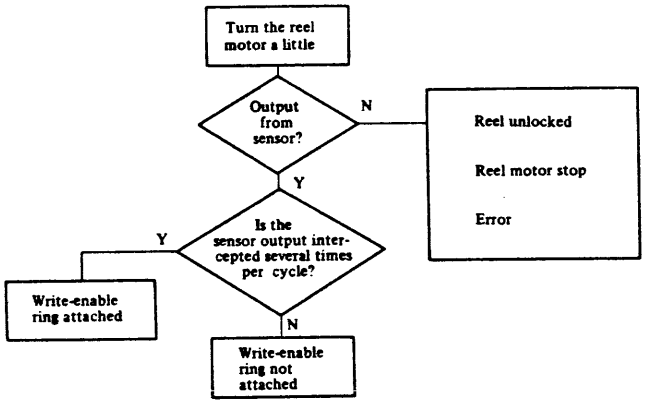
As shown in the figure, there are spaces for two types of shields: A shield for enable sense and a shield for reel lock sense. These shields are round springs, which return to the original position by means of elasticity.

The shields for sensor function as shown in the following table:

		Reel lock	
		Locked	Not locked
Write enable ring	Attached	Δ	X
	Not attached	o	X

X: No sensor output.
Δ: Sensor output repeats ON and OFF by file reel rotation.
o: Sensor output is always on.

The sensor operates in the following sequence:



(3) Tension sensor

A roller bearing is attached to an arm and a coil spring is attached to the arm changes in tape tension result in a change in the angle of arm. A tachometer disk with a slit is connected to the center shaft, changes in the arm angle will cause a change from the initial location. A dampening mass on the shaft protects the arm from resonance that may be caused when start/stop operations are repeated in certain regular intervals.

(4) Idler tachometer

A tachometer disk is attached to the other side of the roller guide detects the tape speed.

4.1.2 Quick loading

(1) Tape loading

Bring the beginning of the tape over the tension roller and thru the upper tape guide. Place the tape between the R/W head and the head shield and pull the tape thru the lower tape guide. Wrap the tape around the idler roller and on to the machine reel.

The tape is then pulled to the center of the machine reel by the vacuum of the machine reel fan.

Refer to the Figure 4.1.2.

After closing the front door, push the start switch on the operator panel.

The microprogram controls the load sequence and the tape is positioned at BOT followed by the start LED lighting.

NOTE: The load fan is kept running for five minutes if any of following occur:
(a) door oopening or closing
(b) idler rotation
(c) file reel rotation
(d) pushing the reset switch on the operator panel

(2) Loading failure recovery

When a tape fails to load, the character "L3" is displayed on the 2-digit indicator. In this case, push the reset switch in order to reset the error condition.

Perform the tape loading explained in the item (1) again.

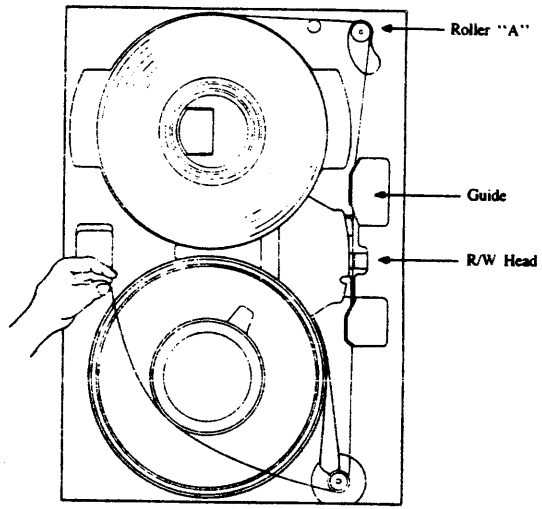


Figure 4.1.2 Quick loading

4.2 Interface

4.2.1 Introduction

This section describes the interface connections using two 50P flat cables. The host controller can be connected to a maximum of 4 MTUs in a daisy chain configuration. The drive has three types of industrial standard interface specifications. The interface specifications can be changed by the setting command on the PCA 'IFC'. As the result of this change, the specifications of five interface lines are changes as shown in Table 4.2.1. These differences of the specifications are explained in chapter 6.

All interface signals are negative logic. (True means low level)

Note: MODE A: CDC 92185 COMPATIBLE MODE
MODE B: CIPHER F880 COMPATIBLE MODE
MODE C: PERTEC FS1000 SERIES COMPATIBLE

Table 4.2.1 Signal and pin assignment

SIGNAL NAME (MNENONIC)			PIN LOCATION			DIRECTION		SIGNAL NAME (MNEMONIC)			PIN LOCATION			DIRECTION	
Mode A	Mode B	Mode C	CN	S	G	Host	MTU	Mode A	Mode B	Mode C	CN	S	G	Host	MTU
	FBSY		A	02	01	←			RDP		B	01	05	←	
	LWD			04	03	→			RDO			02		←	
	WD4			06	05	→			RD1			03		←	
	GO			08	07	→			LDP			04		←	
	WDO			10	09	→			RD4			06		←	
	WD1			12	11	→			RD7			08	07	←	
	UCK			14	13	←			RD6			10	09	←	
	Not Use			16	15				HER			12	11	←	
	REV			18	17	→			TMD			14	13	←	
	REW			20	19	→			ID			16	15	←	
	WDP			22	21	→			FEN			18	17	→	
	WD7			24	23	→			RD5			20	19	←	
	WD3			26	25	→			EOT			22	21	←	
	WD6			28	27	→			UNL			24	23	→	
	WD2			30	29	→			GCR			26	25	←	
	WD5			32	31	→			RDY			28	27	←	
	WRT			34	33	→			RWD			30	29	←	
LGAP	Not Use	HISP		36	35	→			FPT			32	31	←	
	EDIT			38	37	→			RSTR			34	33	←	
	ERASE			40	39	→			WSTR			36	35	←	
	WFM			42	41	→			DBSY			38	37	←	
Not Use		LGAP		44	43	→			HSPD			40	39	←	
	TADO			46	45	→			CER			42	41	←	
	RD2			48	47	←			ONL			44	43	←	
	RD3			50	49	←			TAD1			46	45	→	
									FAD			48	47	→	
CN; Connector, S; Signal Line, G; Ground Line								HISP		HID		50	49	→	

(Note) Three types of the interface modes, i.e. Mode A, Mode B and Mode C, can be set by using a Field Tester or the front panel to keep compatibility with each industrial standard. Refer to Chapter 6 Replace and Adjustment (2320).

4.2.2 Controller-to-MTU interface signals

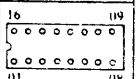
(1) Formatter Address (FAD) & Transport Address 0, 1 (TAD 0, 1)

These three address lines are used to select one of the MTUs which should execute the command issued by the controller or should output its status.

The MTU compares the address lines to MTU address set with switch circuits of the PCA, and if equal, the ouput signals of the MTU are presented on the interface lines within 150 nanoseconds after the address lines are switched.

In case of a command execution, these lines should be stable 90 nanoseconds prior to GO signal assertion and should remain stable till the trailing edge of DBSY signal. The decoded list of these address lines is shown in Table 4.2.2.

Table 4.2.2 Address lines decode

MTU Address	Connection of switch circuit			
	SWAD	SWADI	SWAD0	
0	10-09	06-05	03-02	 PCA: 'IFC' IC location: AA7
1	10-09	06-05	03-04	
2	10-09	06-07	03-02	
3	10-09	06-07	03-04	

(Note) 1. Signal level on the interface
0; False (High level +2.5 - +5.0V)
1; True (Low level 0 - +0.5V)
2. Switch circuit location
PCA; 'IFC'
IC Location; AA7

(2) Initiate command (GO)

This signal is used to initiate the command operation specified by the address lines and the command lines. This signal should be asserted for 500 nanoseconds or more as a pulse signal.

The MTU strobes the command lines at the trailing edge timing of this signal, and then FBSY signal is asserted by the MTU within 500 nanoseconds after this time. This signal should not be asserted while the MTU executes the command operation, i.e. the time duration from the trailing edge of GO signal till the trailing edge of DBSY signal.

(3) Rewind (REW)

This signal is used to initiate a Rewind command to the addressed MTU. This signal should be asserted for 500 nanoseconds or more as a pulse signal.

When this pulse signal is issued, the MTU asserts RWD signal within 500 nanoseconds after the trailing edge of this pulse as response to this initiation and starts rewinding operation. At this time either FBSY signal or DBSY signal is not asserted.

(4) Offline & Unload (UNL)

This signal is used to cause the MTU to go offline and initiate unload operation.

This signal should be asserted for 500 nanoseconds or more as a pulse signal. When this pulse signal is issued, the MTU resets RDY signal and ONL signal within 500 nanoseconds after the training edge of this pulse. If a tape is not positioned at BOT at this time, RWD signal is asserted by the MTU until a tape reaches at BOT. in this case either FBSY signal or DBSY signal is not asserted.

(5) Long Gap (LGAP)

This signal is used to set the MTU to long IBG (Inter Block Gap) mode when a write type command is issued.

According to the interface mode, the following line is used as this signal.

Mode A; CNA, Signal Pin 36
Mode B; Not used
Mode C; CNA, Signal Pin 44

This signal should be stable 90 nanoseconds prior to GO signal assertion and should remain stable more than 500 nanoseconds after the trailing edge of GO signal.

(6) High Speed (HISP)

This signal is used to set the MTU Tape speed mode when any command except density mode set commands and Sense command is issued.

According to the interface mode, the following line is used as this signal.

Mode A; CNB, Signal Pin 50
Mode B; CNB, Signal Pin 50
Mode C; CNB, Signal Pin 36

This signal should also be stable 90 nanoseconds prior to GO signal assertion and should remain stable more than 500 nanoseconds after the trailing edge of GO signal. When this signal is true, the MTU is set to 100/75 IPS streaming mode, and when false, the MTU is set to 25 IPS streaming mode, or 12.5 IPS start/stop mode.

(7) High Density (HID) (Mode C only; CNA signal Pin 50)

This signal is used to set the MTU density mode when any write type command such as WT, WTM, ERS or VERS is issued at BOT. This is valid in Mode C, the MTU ignores this signal in Mode A or B.
When this is true, the MTU is set to 6,250 BPI mode.
When this is false, the MTU is set to 1,600 BPI mode.

This should be stable 90 nanoseconds prior to GO signal assertion and should remain stable more than 500 nanoseconds after the trailing edge of GO signal.

(8) Formatter Enable (FEN)

This signal is used to reset the command operation except REW, UNL. This is also used to reset the formatter error status such as HER, CRT and UCK, when DBSY is false. This signal should be asserted for 1 microsecond or more.

(9) Write Data 0-7, P (WDO-7, P)

These lines are used as the Write Data Bus to transfer write data on to a tape.

These lines are strobed by the WSTR signal for each Write Data byte. In the case of modes A & B, the data to be written should be stable 300 nanoseconds prior to the trailing edge of WSTR and should remain stable till the trailing edge of WSTR.
In case of Mode C, the data should be stable 300 nanoseconds prior to the leading edge of WSTR and should remain stable till the leading edge of WSTR. Refer to Figure 4.2.1.

The most significant bit is WDO.

(10) Last Word (LWD)

This signal is used to inform the MTU of the last data byte to be transferred during write or Variable Length Erase command operation.

This signal should be strobed by WSTR at the same timing as those of WDO-7, P.

This signal is valid during the assertion of DBSY in Write or Variable Length Erase command.

(11) Other command lines

There are five signal lines, i.e. Edit (EDIT), Write (WRT), Write File Mark (WFM), Erase (ERS) and Reverse (REV) lines, to indicate the command operation with their combination at the time of GO signal assertion.

These signals should be stable 90 nanosecond prior to the trailing edge of GO signal and should remain stable more than 500 nanoseconds after the trailing edge of GO signal.

The command decode table is shown in Table 4.2.3.

Table 4.2.3 Command decode table

Combinations of command lines						Command (Mnemonic)		
EDIT	WRT	WFM	ERASE	REV	HEX	Mode A	Mode B	Mode C
0	0	0	0	0	00	Read (RD)		
0	0	0	0	1	01	Backward Read (BRD)		
0	0	0	1	0	02	Space (SP)		
0	0	0	1	1	03	Backspace (BSP)		
0	0	1	0	0	04	Space File with data (SFD)		Space File no data (SF)
0	0	1	0	1	05	Backspace File with data (BSFD)		Backspace File no data (BSF)
0	0	1	1	0	06	Space File no data (SF)		Space File w/ data (SFD)
0	0	1	1	1	07	Backspace File no data (BSF)		Backspace File w/ data (BSFD)
0	1	0	0	0	08	Write (WT)		
0	1	0	1	0	0A	Various Length Erase (VERS)		
0	1	1	0	0	0C	Write Tape Mark (WTM)		
0	1	1	1	0	0E	Fixed Length Erase (ERS)		
1	0	0	1	0	12	———	No Operation (NOP)	———
1	0	0	1	1	13	Sense (SNS)		
1	0	1	1	0	16	Set 1600 BPI (S1600)		No Operation (NOP)
1	0	1	1	1	17	Set 6250 BPI (S5250)		———
1	1	0	1	1	1B	Extended Sense (EXSNS)		
1	1	1	1	0	1E	Data Security Erase (DSE)		
1	1	1	1	1	1F	Loop Write-To-Read (LWR)		

(Note) 1. —— mark means "Not defined".
2. Other commands than the above described are "Not defined" and these are the cause of "Command Reject" in Sense Data.

4.2.3 MTU-to-Controller interface signals

(1) Formatter Busy (FBSY)

This signal is asserted by the MTU to indicate that the MTU is executing the command operation including the repositioning operation after a read/write operation in streaming mode. When the command is initiated by GO signal, the MTU asserts this signal as a response to the command initiation within 500 nanoseconds after the trailing edge of GO signal.

This signal is not asserted during a REW or UNL command.

(2) Data Busy (DBSY)

This signal is asserted by the MTU to indicate that the MTU is executing the actual command operation. After FBSY as a response to the command initiation is asserted and the MTU starts to execute the actual command operation, and then the MTU asserts the DBSY signal.

After the MTU completes the actual command operation checks the result and sets the participant status, the MTU resets this signal.

Therefore the controller shall issue a next command after this signal is reset even if FBSY is still asserted.

(3) Ready (RDY)

This signal indicates that tape is loaded and online.

When REW or UNL commands are issued this signal is reset.

(4) Online (ONL)

This signal indicates that the MTU is in online to the host controller.

(5) Rewinding (RWD)

This signal indicates that the MTU is rewinding to BOT. This signal is asserted within 500 nanoseconds after the trailing edge of the REW command pulse.

(6) File Protect (FPT)

This signal indicates that a write enable ring is off the file reel and the MTU cannot go in to write status.

(7) Load Point (LDP)

This signal indicates that a tape is positioned at Load Point (BOT).

When a command is executed at BOT, this signal remains true during positioning, because streaming operation requires long ramps and repositions.

(8) End of Tape (EOT)

This signal indicates that a tape is positioned on or past EOT marker.

In EOT area, the length where a read or write operation can be executed is approximately 3 meters.

If any forward command execution exceeds this limit, the tape may come off the file reel and the MTU goes offline.

(9) High Speed (HSPD)

This signal indicates that the MTU is in high speed mode.

(10) GCR

This signal indicates that the MTU is in GCR mode.

(11) Identification Burst (ID)

This signal indicates that the ID burst of PE or GCR is detected at BOT area of tape during read forward type command operation.

This signal is asserted when the ID burst is detected and is reset when the MTU starts to read or space the first block.

(12) Tape Mark Detected (TMD)

This signal indicates that a tape mark block was detected.

(13) Hard Error (HER)

This signal indicates that some error was detected during the command operation.

The details of this error can be transferred to the host by issuing a Sense or Extended Sense command.

(14) Unit check (UCK)

This signal indicates that an equipment check was detected during the command operation.

In this case, tape positioning may be lost and care should be taken in the recovery of this type of error.

The details of this error are in the sense date byte.

(15) Corrected Error (CER)

This signal indicates the following.

(1) One track error correction was performed during a GCR write operation or PE read operation.

(2) One or two track error correction was performed during a GCR read operation.

However HER may be also asserted in spite of the above error correction.

(16) Write Strobe (WSTR)

This signal is used to request the write data byte and to strobe the write data byte on Write Data Bus.

This signal is asserted by the MTU for 1/3 bitcell (GCR) or 1/6 bitcell (PE) duration.

Time relation to WD0-7, P is explained in section (9).

Time chart of write data transfer is shown in Figure 4.2.1.

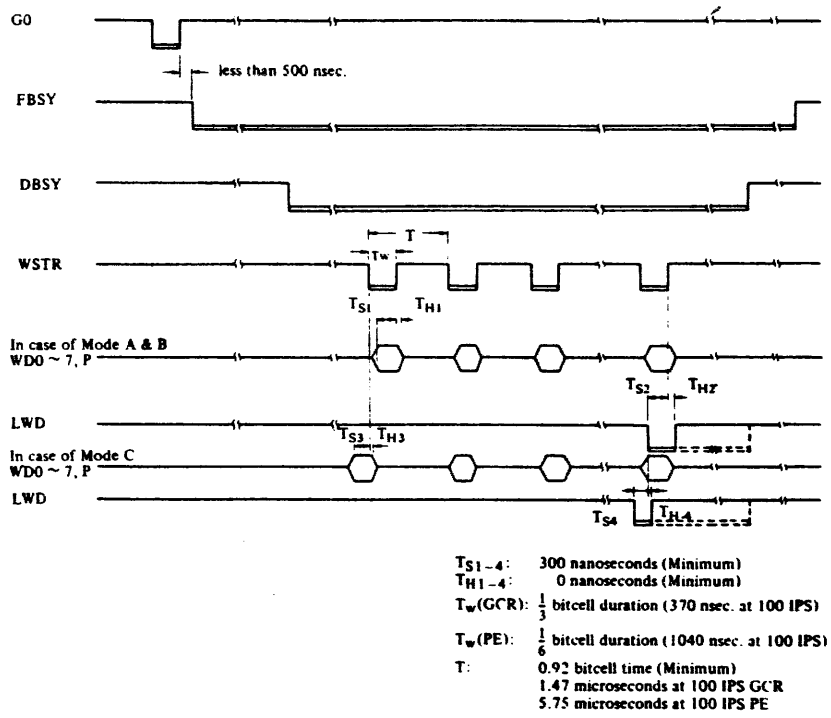


Figure 4.2.1 Time chart of write data transfer

(17) Read Data 0-7, P (RD 0-7, P)

These lines are used as the Read Data Bus to transfer read data read from the tape and sense data from the sense register.

Since these lines are strobed by RSTR signal, the data byte to be transferred is stable 150 nanoseconds prior to the leading edge of RSTR and remains stable 250 nanoseconds after the trailing edge of RSTR.

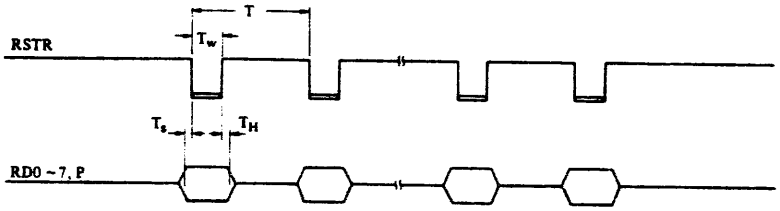
The most significant bit is RD0.

(18) Read Strobe (RSTR)

This signal is a to request to transfer read data or sense data to the Controller and to strobe it on Read Data Bus.

This signal is asserted by the MTU for 1/3 bitcell (GCR) or 1/6 bitcell (PE).

Timing chart of read data transfer is shown in Figure 4.2.2.



T_S: 150 nanoseconds (Minimum)
T_H: 0 nanoseconds (Minimum)
T_w(GCR): $\frac{1}{3}$ bitcell duration (370 nsec. at 100 IPS)
T_w(PE): $\frac{1}{6}$ bitcell duration (1040 nsec. at 100 IPS)
T(GCR): 0.75 bitcell time (Minimum) (1.2 microseconds at 100 IPS)
T(PE): 0.5 bitcell time (Minimum) (3.125 microseconds at 100 IPS)

Figure 4.2.2 Timing chart of read data transfer

4.2.4 Physical interface

(1) Connector requirements

The specification of two 50-pin connectors for this interface should be as follows or equivalent.

- Connector 3M No. 3425-6050 or Equivalent
- Strain Relief 3M No. 3448-3050 or Equivalent

(2) Cable requirements

The conditions of the interface cables are as follows.

- Maximum length ; 20 Ft
- 50-pin flat Cable for Rack-mount type

(3) Driver, receiver and terminator

Driver, Receiver and Terminator for this interface should be used as Figure 4.2.3.

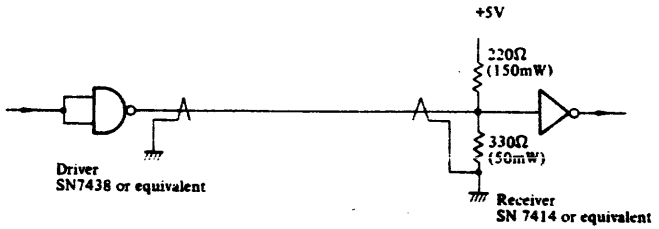


Figure 4.2.3 Driver, receiver and terminator

(4) Phisical voltage

All interface signal levels should be as follows.

True; 0V to +0.5V
False; +2.5V to +5.0V

(NOTE) The assertion of the interface signals means true.

4.3 Command Operation and Sense Byte

4.3.1 Command description

Commands other than REW and UNL commands are initiated with the trailing edge of GO asserted by the Controller while the MTU is in Online and Ready status and is not executing any command operation.

The MTU responds to this initiation with FBSY asserted within 500 nanoseconds after the trailing edge of GO. The MTU decodes the command and starts to execute the specific command operation. When the MTU starts to execute the actual command operation, DBSY signal is asserted by the MTU. After the MTU completes the command operation and sets the status as a result of the command operation, FBSY and DBSY are reset. However at this time FBSY may remain asserted in streaming mode as a result of a reposition. The Controller can issue the next command after DBSY is reset. The Controller should issue the next command within the reinstruction time to keep the streaming operation.

The command reinstruction times are shown in Table 4.3.1.

If the Controller can not issue the within next limits command, the MTU executes a repositioning operation automatically and these then executes the next operation.

If an error occurs during the command operation, the Controller should issue SNS command to get the detail error information, the Controller should then issue error recovery routine.

The status lines as a result of the command operation are reset when any new command is issued.

When SNS or EXSNS command is issued, the above status lines are reset but the actual sense data is not reset.
Sense data is reset by the initiation of commands other than SNS and EXSNS commands.

REW command is initiated with the trailing edge of REW signal asserted by the Controller.

The MTU responds to this initiation asserting RWD within 500 nanoseconds after the trailing edge of the REW signal. If a tape is positioned at BOT, the MTU ignores this command.

UNL command is initiated with the trailing edge of UNL signal asserted by the Controller.

If a tape is not positioned at BOT, the MTU responds to this initiation by resetting ONL and RDY and asserting RWD within 500 nanoseconds after the trailing edge of the UNL signal until a tape reaches BOT.

If a tape is positioned at BOT, the MTU responds by resetting ONL and RDY and then starts the unload operation.

Table 4.3.1 Reinstruction time table

Model	Tape Speed	Density Mode	IBG Mode	Reinstruction Time (msec)	
				Write	Read
M2441A M2442A	100 IPS	GCR	Normal (0.3")	1.2	2.7
			Long (0.6")	4.2	5.7
		PE	Normal (0.6")	4.2	5.7
			Long (1.2")	10.2	11.7
M2443A M2444A	75 IPS	GCR	Normal (0.3")	1.7	3.7
			Long (0.6")	5.7	7.7
		PE	Normal (0.6")	5.7	7.7
			Long (1.2")	13.7	15.7
	25 IPS	GCR	Normal (0.3")	5.7	11.7
			Long (0.6")	17.7	23.7
		PE	Normal (0.6")	17.7	23.7
			Long (1.2")	41.7	47.7

4.3.2 Command operation at BOT (Load Point)

(1) **The followings are executed in a write type command (WT, WTM, VERS, ERS and DSE).**

a When the above write type commands are issued at BOT, the MTU writes the ID burst in the density mode according to setting of Density Select Switch on the operator panel.

Host Select

The MTU writes the ID burst according to the last state of the density memory.
This density memory is set to GCR mode on power up and is updated by the mode set command, i.e. S6250 and S1600.

6250 BPI Select

The MTU always writes GCR ID burst in spite of contents of the density memory.

1600 BPI Select

The MTU always writes PE ID burst in spite of contents of the density memory.

The above explanation is only applied at BOT.

b If a GCR ID burst is written, an ARA burst is written and setting of the read amplitude (SAGC operation) is automatically performed as a part of the command operation.

SAGC operations are executed in both low speed mode and high speed mode sequencially.

c If the ID burst and ARA burst cannot be correctly written or setting of read amplitude fails, the command operation terminates abnormally with HER asserted.
ID Burst Error and Unit Check sense bits are set at this time.

In this case, the tape stops on the way to ID burst or ARA burst, and neither data block nor tape mark block is written.

(2) **The followings are executed in a forward read type command (RD, SP, SF and SFD)**

a. After the MTU reads the ID burst, the MTU sets its density mode according to ID burst.
If a GCR tape is read, setting of read amplitude is performed using the ARA burst.

b. If an ID burst is not found in the BOT area, i.e. data written in NRZI mode, the command operation terminates abnormally with HER asserted after the assertion of DBSY.

In this case, the Not Capable sense bit is set and no data is tranferred to the controller.

c. If the SAGC operation fails in GCR mode, the command operation terminates abnormally with HER asserted.

At this time ID burst error sense bit is set and no data is transferred to the controller.

On a RD command, HER is posted after reading first block. Data check of sense data is set.

On other commands the operation terminates normally.

(3) **Relations between BOT and backward type command except REW and Unload command (BRD, BSP, BSF and BSFD)**

a. When any backward type command is initiated at BOT, the command operation is rejected and terminates abnormally with HER assertion.

In this case, Command Reject and BOT sense Bits are set.

b. During executing these commands, when a tape reaches BOT, the command operation terminates abnormally at BOT with HER assertion.

In this case, Unit Check and BOT sense bits are set.

4.3.3 Command operation in EOT area

EOT signal indicates a tape is positioned on or past the EOT marker.

The software handling in this area is critical as described in item 4.2.3 (8)

4.3.4 Illegal IBG

In a RD, SP, SF or SFD command, when IBG exceeds the specific limit before a data block or tape mark is detected, the command operation terminates abnormally with HER asserted.

In this case Unit Check and Data Not Found sense bits are set.

4.3.5 Read (RD)/Backward Read (BRD)

RD or BRD command causes the tape to be moved in the forward or backward direction and next block is read.

Data read from the tape is transferred to the controller byte by byte.

In the case of a tape mark, no data is transferred to the controller and TMD signal is asserted for 10 microseconds or prior to the trailing edge of DBSY signal.

4.3.6 Space (SP)/Backspace (BSP)

SP or BSP command causes the tape to moved in the forward or backward direction and next first block is skipped without data transfer. In the case that a tape mark is detected, TMD signal is asserted for 10 microseconds or more prior to the trailing edge of DBSY signal.

4.3.7 Space File without data (SF)/Backspace File without data (BSF)

SF or BSF commands causes the tape to be moved in the forward or backward direction until the first tape mark block is detected. These commands do not transfer data to the controller.

After the tape mark is detected, the tape stops. In this case, TMD signal is asserted for 10 microseconds or more prior to the trailing edge of DBSY signal.

4.3.8 Space File with data (SFD)/Backspace File with data (BSFD)

SFD or BSFD command causes the tape to be moved in the forward or backward direction. Data is read and transferred to the controller until a tape mark block is detected. After the tape mark block is detected, the tape stops. In this case TMD signal is asserted in the same manner as SF/BSF command operation.

4.3.9 Write (WT)

WT command causes the tape to be moved in the forward direction, and after the velocity of tape transportation reaches the specified speed and the IBG following the previous block is generated, one data block begins to be written. The data transferred from the controller is encoded and composed in data block format. The data written on the tape is read back for checking. After all data and postamble signals have been written. The IBG is generated and the tape stops. The density mode is designated by the setting of Density Select Switch and the density memory at BOT. (Refer to section 4.3.2(1) a.)

The first WSTR signal appears 40 microseconds (minimum) of DBSY signal assertion. The controller must present stable write data by this time.

4.3.10 Write Tape Mark (WTM)

WTM command causes the tape to be moved in the forward direction, and a tape mark block is written after erasing 3.5 inches.

The tape mark block in GCR mode is composed of 370 flux reversal transitions at 9042 FRPI in tracks 1, 2, 4, 5, 7 and 8 and DC erasure in tracks 3, 6 and 9. The tape mark block in PE is composed of 250 flux reversal transitions at 3200 FRPI in tracks 1, 2, 4, 5, 7 and 8 and DC erasure in tracks 3, 6 and 9.

4.3.11 Erase

(1) Fixed Length Erase (ERS)

ERS command is used to erase the tape in a forward direction for 3.5 inch in GCR mode or 3.8 inch in PE mode.
During erasing, the MTU verifies that erasure is successful. If some noise is detected in this read-after-erase check, EQC, Unit Check and Noise of sense data is set. In this case the command terminates abnormally with HER assertion.

(2) Variable Length Erase (VERS)

VERS command is used to erase the tape in a forward direction for the length designated by LWD response to WSTR pulses. The MTU performs the same read-after-erase check as ERS command.

(3) Data Security Erase (DSE)

DSE command is used to erase the tape from the current position till approximately 1 meter after EOT marker at 200 IPS tape speed.
Read-after-erase check is not performed in this command . This command teminates in the EOT area.

4.3.12 Rewind (REW)

This command is initiated by REW signal assertion and is used to rewind a tape to BOT. The MTU responds to REW signal assertion asserting RWD signal. The MTU resets RDY signal and starts the rewind operation. If a tape is positioned at BOT, the MTU ignores this command initiation.

4.3.13 Unload (UNL)

This command is initiated by UNL signal assertion and is used to unload a tape until all tape is wound onto the supply reel. The MTU responds to UNL signal assertion resetting RDY and ONL signals and then starts the unload operation.

4.3.14 Set GCR Mode (S6250)

This command is used to change the density memory of the MTU to GCR mode. This command is valid only when the tape is positioned at BOT and Density Select Switch is set to Host Select mode.
In case that the tape is not positioned at BOT or Density Select Switch is not set to Host Select mode, no operation is performed in this command.

A write type command issued by the controller at BOT is executed in the density mode specified by the density memory.

4.3.15 Set PE Mode (S1600)

This command is used to change the density memory of the MTU to PE mode. This command is valid only when the tape is positioned at BOT and Density Select Switch is set to Host Select mode.

4.3.16 Loop Write-To-Read (LWR)

This command is used to verify the data path of the MTU and does not initiate tape motion. This command sequence is the same as a WT command without tape motion.

The data transferred from the controller is encoded, formatted, bypassed from the input of Write Amplifiers to the output of Read Amplifiers, deformatted, decoded and checked in the current density mode and speed mode of the MTU.

4.3.17 Sense (SNS)

This command is used to send 8 bytes of detail error information to the controller. These sense data is set when the MTU recognizes an error and is reset when any command except SNS and EXSNS is issued. Sense data table is shown in Table 4.3.2 and the details of the sense data is described in subsection 4.3.20.

4.3.18 Extended Sense (EXSNS)

This command is used to send 27 bytes of detailed error information to the controller the first 8 bytes of the sense data is the same data sent in SNS command. The set/reset conditions of the EXSNS data is the same in the SNS command.

Sense data table is shown in Table 4.3.3 details are described in subsection 4.3.20.

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Table 4.3.2 Sense Data Table

BYTE	BIT 0	1	2	3	4	5	6	7
0	Command Reject (U)	Intervention Required (U)	Drive Type.	Data Check (U)	Equipment Check (U)	Command Overrun (U)	Unit Check	Corrected Error
1	Last Command REV	WRT	EDIT	WFM	ERS	HISP	—	LGAP
2	Ready Status	Online Status	Rewinding Status	File Protect Status	GCR Mode	High Speed Mode	BOT	EOT
3	Tape Mark Detected	Illegal Command (C)	Not Capable (U)	Device Check (E)	Operator Failure (E)	Write Bus Parity Error (D)	No Block Detected (E)	—
4	Data Not Found (U)	Noise (E)	ID Burst Drror (U)	Uncorrect-able Data (D)	Format Error (D)	Multi-Track Error (D)	No Track Pointer (D)	Error Track Pointer P
5	Error Track Pointer 0	1	2	3	4	5	6	7
6	Fault Symptom Code (Upper)							
7	Fault Symptom Code (Lower)							

(U) causes Unit Check, (C) causes Command Reject, (E) causes Equipment Check, (D) causes Data Check.

Table 4.3.3 Extended sense data

BYTE	BIT 0	1	2	3	4	5	6	7
0 7	Same as Sense Data 0-7							
8	Sub-Fault Symptom Code (Most Significant Byte)							
9	Sub-Fault Symptom Code							
10	Sub-Fault Symptom Code							
11	Sub-Fault Symptom Code (Least Significant Byte)							
12	Servo Error State							
13	Device Error State							
14	Start Read Check (F)	End Data Check (F)	Postamble Error (F)	Crease Detected (F)	IBG Detected (F)	Early Begin Read Back Check (F)	Slow Begin/ End Read Back Check (F)	SAGC Check (NOTE 3)
15	VRC Error (UCE)	CRC Error (UCE)	Sker Error/WTM Error (NOTE 4)	Miscellaneous Error (UCE)	Write Trigger VRC (UCE)	Write Data Parity Check (UCE)	Velocity Change (UCE)	Envelope Check
16	File Reel diameter							
17	Machine reel diameter							
18	Device command code							
19	Present device microprogram state							
20	Tacho counter (high order)							
21	Tacho counter (low order)							
22	DVREQ register							
23	Reserved							
24	MECHSNS register							
25	DVTYPE register							
26	ECLVL register							

(NOTE) 1. (F) means the cause of Format Error in Sense Byte 4.
2. (UCE) means the cause of Uncorrectable Error in Sense Byte 4.
3. In Write command
This is the cause of ID burst Error in Sense Byte 4.
In Read command
This is the cause of Data Check or Equipment Check.
4. In Write Tape Mark command
This indicates WTM Error.
In Write command
This indicates Skew Error and the cause of Uncorrectable Error.
5. As for the other Extended Sense Data, refer to CE Manual.

B03P-5325-0100A...01A

4.3.19 Sense byte

The M244X series has 27 bytes of sense data which indicate the detail error conditions. These sense bits are set in Sense Byte registers when the MTU detects an error.

Eight bytes of sense data shown in Table 6.1 are sent to the controller in SNS command and 27 bytes of sense data including the above 8 bytes of sense data are sent in EXSNS command. The sense data is reset when commands other than SNS and EXSNS are initiated and are not reset by the execution of SNS or EXSNS command.

The 8 bytes of sense data sent in SNS command are useful for Field Engineers to maintain this MTU. The other 19 bytes of sense data is useful for Field Engineer to investigate a trouble in the MTU.

4.3.20 Description of each sense byte

(1) Sense byte 0

a. Bit 0 Command Reject (CRJ)

This is set in the following cases.
- When any write type command is initiated to a file-protected MTU.
- When any backward type command except RWD and UNL is initiated to the MTU when a tape position is at BOT.
- When a undefined command is issued.

b. Bit 1 Intervention Required (IRQ)

This indicates intervention should be required for this recovery, and is set in the following cases.
- When the MTU is in offline.
- When the MTU goes offline during the command operation.

c. Bit 2 Device Type

This indicates the MTU has GCR mode capability and is always true in this MTU.

d. Bit 3 Equipment Check (EQC)

This indicates the command operation is initiated by incomplete because an error condition. In this case the position sensing may be lost, i.e. the stop position may be in a data block or in an incorrect IBG position.

This is set in the following cases.
- When bit 3 Device Check, bit 4 Operator Failure or bit 6 No Block Detected in Sense Byte 3 is set.
- When bit 1 Noise in Sense Byte 4 is set in an erase operation.
- When the MTU goes offline in the command operation.
- When the MTU goes File Protected in the write type command operation.

e. Bit 4 Data Check (DCK)

This is set in the following cases.
- When bit 5 Write Bus Parity Error in Sense Byte 3 is set.
- When bit 3 Uncorrectable Data, bit 4 Format Error, bit 5 Multi-track Error or bit 6 No Track Pointer in Sense Byte 4 is set.

f. Bit 5 Command Overrun (COVR)

This indicates the command operation was interrupted by the next command initiation.
In this case the command operation may not be completed.

g. Bit 6 Unit Check (UCK)

This is always set in the case of HER assertion and indicates the MTU has sense data.
This is set in the following cases.
- When bit 0 Command Reject, bit 1 Intervention Required, bit 3 Data Check, bit 4 Equipment Check or bit 5 Command Overrun in Sense Byte 0 is set.
- When bit 2 Not Capable in Sense Byte 3 is set.
- When bit 0 Data Not Found or bit 2 ID Burst Error in Sense Byte 4 is set.
- When BOT is detected in the backward command operation without REW and LINL.

The details of the above error are indicated in other sense bytes. Fault Symptom Code in Sense Byte 6 and 7 are useful for analyzing the cause of the error.

h. Bit 7 Corrected Error (COR)

This is set in the following cases.
- One track error correction was performed during GCR write operation or PE read operation.
- One or two track error correction was performed during GCR read operation.

This is not the cause of HER, but HER may be also asserted in spite of the above correction.

(2) Sense byte 1

This Sense Byte indicates the last command. (Bit 6 is not yet defined.)

(3) Sense byte 2

This Sense Byte indicates the current MTU status, and all bits are the same signals as interface lines.

a. Bit 0 Ready Status (RDYS)

This indicates the addressed MTU is in ready and online status.

b. Bit 1 Online Status (ONLS)

This indicates the addressed MTU is in online status.

c. Bit 2 Rewinding Status (RWDS)

This indicates the addressed MTU is rewinding.

d. Bit 3 File Protect Status (FPS)

This indicates Write Enable Ring is removed from the back of the file reel and any write operation cannot be performed.

e. Bit 4 GCR Mode (GCRM)

This indicates the addressed MTU is in GCR mode.

f. Bit 5 High Speed Mode (HSPM)

This indicates the addressed MTU is in high speed mode.

g. Bit 6 BOT (Beginning Of Tape)

This indicates the tape is positioned at BOT.

h. Bit 7 EOT (End Of Tape)

This indicates the tape is positioned on or past EOT marker.

(4) Sense byte 3

a. Bit 0 Tape Mark Detected (TMD)

This indicates a tape mark block has been detected.

b. Bit 1 Illegal Command (ILGC)

This is set in the following cases, and in this case, CRJ and UCK in Sense Byte 0 are also set.
- When a backward type command except REW and UNL is initiated at BOT.
- When a write type command is initiated to the file protected MTU.

c. Bit 2 Not Capable (NCP)

This is set when the tape written in NRZI mode has been read. In this case, UCK is also set.

d. Bit 3 Device Check (DVCK)

This indicates the transport controller in the MTU detected an error. The details are indicated in Fault Symptom Code of Sense Byte 6 and 7. In this case, EQC and UCK are also set.

e. Bit 4 Operator Failure (OPF)

This indicates some manual intervention has been performed in the command operation or load sequence.
In this case, EQC and UCK are also set.

f. Bit 5 Write Bus Parity Error (WBPE)

This indicates a parity error was detected in the Write data sent from the controller. In this case DCK and UCK are also set. This bit will not be set if no parity checking is jumpered.

g. Bit 6 No Block Detected (NBLK)

No data block was detected after writing a data block in WT command mode. In this case EQC is also set.

h. Bit 7 Not used

(5) Sense byte 4

a. Bit 0 Data Not Found (DTNF)

This indicates neither data block nor tape mark block has been detected through more than 4.5 m at GCR or more than 7.6 m at PE in a forward read type command such as RD, SP, SF and SFD.
In this case, UCK is also set.

b. Bit 1 Noise (NOIS)

This indicates some noise was detected in an erase operation. In this case, EQC and UCK are also set.

c. Bit 2 ID Burst Error (IDBE)

This indicates ID burst and ARA burst (GCR) was not correctly written at BOT in a write type command operation. At this time UCK is also set. For this error recovery, the same command should be again issued after REW command is issued and completed.

d. Bit 3 Uncorrectable Data (UCD)

This indicates the data could not be correctly read and is in a uncorrectable condition. The details are indicated in Fault Symptom Code. In this case, DCK and UCK are also set.

e. Bit 4 Format Error (FMTE)

This indicates preamble, postamble or other format signal of data block could not be correctly detected. The details are indicated in Fault Symptom code and in Sense Byte 14. In this case, DCK and UCK are also set.

f. Bit 5 Multi-Track Error (MLTE)

This indicates two or more error track pointers were detected during PE read/write operation or GCR write operation. In this case, DCK and UCK are set. This also indicates three or more error track pointers were detected during GCR read operation.
In this case, neither DCK or UCK may be set.

g. Bit 6 No Track Pointer (NPTR)

This indicates a data error was detected but no error track pointer could be detected at that time.
In this case, UCE, DCK and UCK are also set.

h. Bit 7 Error Track Pointer P (ETP)

This indicates a data error or hardware pointer such as phase error, drop-out and excessive skew is detected in Parity Track.

(6) Sense byte 5

This sense byte indicates error track pointer 0-7 correspoinding to each bit.

(7) Sense byte 6 and 7

These sense bytes indicate two bytes of Fault Symptom Code. Details of Fault Symptom Code are shown in Chapter 5.

(8) Sense byte 8-11

These sense bytes indicate four bytes of the Sub-Fault Symptom Code. In the case that EOC is set and upper four bits of Fault Symptom Code is '1100', this indicate a Fault Location Code. In another case, these indicate the contents of the registers corresponding to the error as error informations.

(9) Sense byte 12

This sense byte indicates a Servo Error which is in the sequence ID of the microprogram servo control at the time of the error occured.

(10) Sense byte 13

This sense byte indicates a Device Error which is in the sequence ID of the microprogram device control at the time of the error occured.

(11) Sense byte 14

Each bit of this sense byte indicates main details of the FMTE. When any of these bits except bit 7 is set, FMTE, DCK and UCK are also set.

a. Bit 0 Start Read Check (SRDC)

This indicates the beginning mark of the preamble could not be correctly detected after detecting the data block in read/write operation.

b. Bit 1 End Data Check (EDC)

This indicates the IBG could not be detected within the specific limit after detecting the beginning of postamble.

c. Bit 2 Postamble Error (POSE)

This indicates abnormal format data was detected in the postamble.

d. Bit 3 Crease Detected (CRSD)

This indicates IBG or drop-outs in five tracks or more were detected before detecting the postamble in read operation.

e. Bit 4 IBG Detected (IBGD)

This indicates IBG or drop-outs in five tracks or more were detected when writing data.

f. Bit 5 Early Begin Read Back Check (EBRC)

This indicates the beginning of the data block was read back prior to the specific limit after starting to write data.

g. Bit 6 Slow Begin/End Read Back Check

This indicates the beginning or the end of data block was not read back within the specific limit after the end of writing data.

h. Bit 7 SAGC Check

This indicates the read amplitude setting using ARA burst failed or ARA burst could not be correctly written. In case of write type command IDBE and UCK are also set.
In case of read type command DCK and UCK or EQC and UCK are also set.

(12) Sense byte 15

Each bit of this sense byte indicates mainly parts of the cause of UCE. When any of these bits except bit 2 and bit 7 is set, UCE, DCK and UCK are also set.

a. Bit 0 VRC Error (VRCE)

This indicates parity error of data was detected and could not be corrected.

b. Bit 1 CRC Error (CRCE)

This indicates error of CRC (Cyclic Redanduncy Check) character generated with data was detected during read/write operation.

c. Bit 2 Skew Error (SKWE)/Write Tape Mark Error (WTME)

This indicates an excessive skew of data was detected in WT command operation. In this case, UCE, DCK and UCK are also set.
This also indicates WTM command operation failed. In this case, DCK and UCK are also set.

d. Bit 3 Miscellaneous Error (MSCE)

This indicates parity error of data through read/write data path was detected during read/write operation.

e. Bit 4 Write Trigger VRC (WVRC)

This indicates the write triggers have incorrect parity during write operation.

f. Bit 5 Write Data Parity Error (WDPE)

This indicates parity, a error of input data was detected during write operation.

g. Bit 6 Velocity Change (VLCG)

This indicates the tape speed tolerance exceeded the specified limit during write operation.

h. Bit 7 Envelope Check (ENVC)

This indicates drop-out in one track was detected during read/write operation. This does not cause any error.

(13) Sense byte 16 ∿ 26

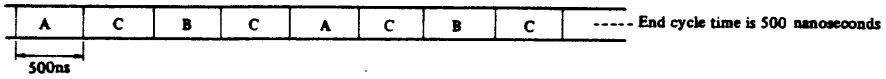
These bytes describe the state of the internal registers.

4.4 Microprogramming

4.4.1 General description

The microprogramming in this unit consists of four divisions.
They are:
1. Device control program (0000-0FFF, phase A)
2. Formatter control program (1000-1FFF, phase A)
3. Servo control program (2000-2FFF, phase B)
4. Interface control program (3000-3FFF, phase C)

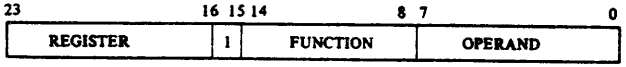
Each address range is 4K words (12KB).
They are time shared programs that run the following phase sequence: Each cycle time is 500 nanoseconds. A, C, B, C, A, C, B, C, ...



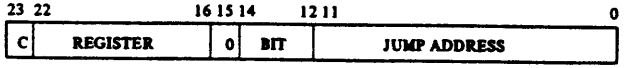
The device control and formatter control program are switched alternatively by the software themselves.
The program is written in three 128KB-EPROMs.

4.4.2 Micro instructions

The instruction of this unit consists of the calculation and conditional jump type command.
Each of the instructions is 24 bits long.



Calculation type command



Conditional jump type command

4.4.3 Interrupt processing

The interrupt of each phase is available from hardware and another phase software.

1. Phase A: Device/Formatter control program
   Software interrupts are caused from the Interface program as a command and from the servo program as a fault of servo control.

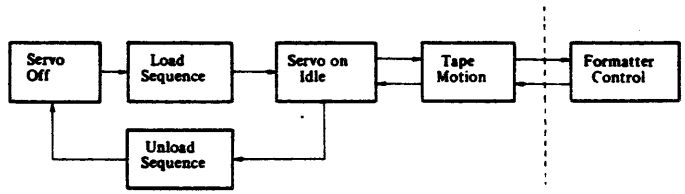
2. Phase B: Servo control program
   Hardware interrupts are caused from idler tachometer pluses to measure duty cycle for tape speed. Software interrupts occur from phase A to display a fault symptom code.

3. Phase C: Interface program
   Hardware interrupts are caused from interface signals and CE tester panel.

4.4.4 Sequence control

The sequence control program controls the tape motion for read/write control, receives a device command from the interface program and sends servo commands to the servo program to move tape.

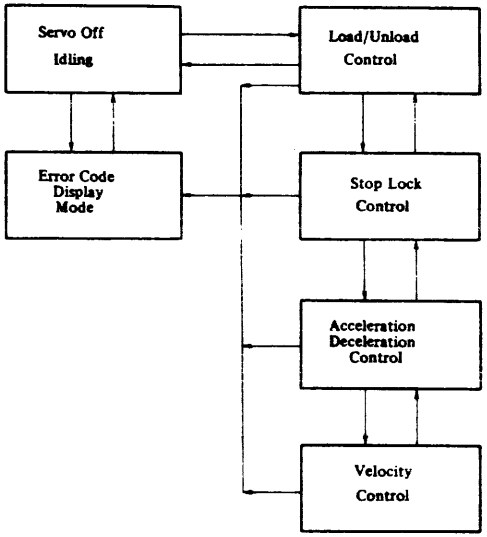
This program also operates the loading, Rewinding and Unloading sequences. It switches to the formatter program after the tape position and tape speed are correct in a read or write type command.



General flow of the sequence control program

4.4.5 Servo control

The servo control program receives a servo command from the sequence control program, then it controls reel motor currents to give correct tape tension, position, speed, and acceleration.
It also displays error codes to 2 digit-LEDs on the operator panel. General flow is as follows..



4.4.6 Formatter control

(1) Introduction

The microprogram will jump into the formatter control from the sequence control after tape speed reaches the specified speed. The sequence control program decides the routine to jump to by the command. There are several routines (shown below) in the formatter control program.
- BOT routine (Write/Read)
- Write block routine
- Write tape mark erase routine
- Loop write to read routine
- Read, space and space file routine
- Some diagnostic routines

The formatter control program makes the formatter hardware and VFO start. During the command execution, the timing of formatter control signals and the format signals which are generated from the read data are checked. After the detection of IBG, the errors checked by the hardware are checked by the program and if any error occur, the Fault Symptom Code is generated.
After all errors are checked, the microprogram returns to the sequence control routine to stop the tape motion.

(2) BOT routine

(a) Write type command

When the write type command except loop write to read is issued at BOT, the density identification burst (ID-burst) is written at the BOT area. The density is determined by the density select mode of the densitory memory.
If the density indicates 6250 bpi by command or the panel, the automatic read amplification burst (ARA-burst) is written after ID-burst. During writing ARA-burst, the gain for each track is adjusted by the output level of read head.
Two sets of read amplifier gain counters are provided because of dual speed. At 6250 bpi mode, ID and ARA-burst are written twice. When the speed is low speed, the ID and ARA-burst are written at high speed and the tape is rewound to BOT. The speed is set to low and again the ID and ARA-burst are written. After the operation the ID and the ARA-burst, the initial IBG (about 15cm: GCR, about 45cm: PE) is generated and the data block or tape mark is written. If the command is data security erase, ID or ARA-burst are written like a write command.
If the ID-burst length is not enough, HER is asserted and ID-burst error is set in the sense byte. If the gain control of the read amplifier at ARA-burst is incomplete, HER and ID-burst error are set.

(b) Forward read type command

When the forward read type command is issued at BOT, the density identification burst will be checked to adjust the control signals of the formatter or VFO to the density of the tape. Even if the density mode of the operator panel indicates 6250 mode, the tape written at PE mode can be read.
If no ID-burst is detected, HER is asserted with UCK and not capable bits in the sense byte. When the GCR ID-burst is detected, then ARA-burst is read and SAGC operation is done as in the write operation. ID and ARA-burst are read in both speed same as in the write operation. After the operation in the BOT area the next data block will be read.
If the gain control of the read amplifier was incomplete, HER is asserted and EQC and SAGCE are set in the sense byte.

(3) Write routine

At the start of this routine, DBSY is asserted. The microprogram initiates the hardware to start the data transfer. After a few bytes of data were transferred, the data is written. The microprogram checks many kinds of timings such as early begin, slow begin or slow end read back check and also checks format errors that are detected by the hardware.
After the IBG is detected, errors detected by the read after write hardware are checked and if any errors occur, HER is asserted and a sense bit is set in the sense byte.
If the command is loop write to read, tape does not move and early begin, slow begin read back and tape speed are not checked.

(4) Write tape mark and erase routine

(a) Erase

When write tape mark or erase fixed length command is issued, the tape is moved in the forward direction about 10 cm (3.5 inches) long. Data on the tape is erased by the erase and write heads. When an erase variable length command is issued, the micro program and write fomatter hardware will perform the same as in write a operation. But no data is written on the tape and the erase length is controlled by the LAST WORD signal.

(b) Write tape mark

After a fixed length erase operation, the tape mark pattern is written on the tape and checked by the read circuit.

(5) Read, space, space file routine

(a) Read

The microprogram makes the read formatter and VFO ready to read and waits for the beginning of the data block or tape mark block. If any data or tape mark block is not detected in about 4.5 meter (GCR) or 7.6 meter (PE) long, HER is asserted and UCK and data not found bit are set in the sense byte.
When the beginning of a data block is detected, the program waits for the end of the preamble, the beginning of postamble and the IBG. At the end of preamble, the slice level of the read amplifier is set to 0% and at the beginning of postamble it is returned to the normal read level.
During the process of the data block transfer, the microprogram checks for format errors. When a IBG is detected, the errors which were detected by the hardware are checked by the program. If any error occur, HER is asserted and, the FSC sense bits are set in the sense byte.

(b) Space

On this command, the microprogram waits for the beginning of a data block or tape mark block. Long IBG is checked, if the block is detected, it is skipped without any data transfer.

(c) Space file

On this command, the microprogram repeats a space operation until the tape mark is detected.
If the command is space file with data, the microprogram repeats the read operation in stead of the space operation.
During the space file with data operation, HER or CER is set and reset by every data block.
When the tape mark is detected, File Mark signal is asserted and TMDET bit is set in the sense byte.

(d) Backward read type

If the command is the backward read type command, the microprogram waits for the beginning of the data or tape mark block or BOT or ARA, ID-burst. Long IBG is not checked.

4.4.7 Interface control

(1) Introduction

The interface control microprogram is composed of four parts.

- Power On diagnostics
- Interface support
- Field Tester support
- Operator panel diagnosis support

(2) Power on diagnostic routine

When the power is turned on and the hardware goes active, the power up diagnostics are initiated.
The microprocessor and some interface control registers are checked. If any error is detected, FSC is displayed on the operator panel. At this time, if the RESET key is pressed, the power on diagnostics is rerun. If an error is not detected, the microprogram jumps to the idle loop of the interface support routine and will wait for a tape to be loaded.

(3) Interface support routine

In this routine, the program waits for the command initiation. If the initiate command (GO) pulse is detected, the command is decoded and checked. If the command is Sense, the interface control program executes the sense operation. If the command is mode set command such as set high speed or set 6250 rpi, the control bit in the work register is set. In the case of the other command, the code is converted to the other code which is used between the interface and sequence control program.
If the command is a read, write or motion command, the converted code is transfered to the sequence control and the interface control waits for the command completion.

(4) Field Tester support

When the field tester is connected, the program is trapped in the mode change from online to offline.
The program looks at the SSS switch and when it is pushed, the code of switch 0 ∿ 7 is converted as the interface support routine.
At the normal command, the statical records are stored in the work register.

(5) Operator panel diagnosis routine

Refer to Appendix B.

4.5 Circuit Description

Note: The location and the nick name of printed circuit assembly is shown in Appendix C. Please refer to the Appendix if necessary.

4.5.1 PCA 'MPU' --- Microprocessor

This device contains a microprocessor. The tape drive and interface devices are controlled by firmware.

(1) Configuration

Figure 4.5.1 shows the configuration of the microprocessor. The control program for the microprocessor is stored in ROMs (Read Only Memory). The ROM can store 16K words. (One word size is 24 bit.)

The micro instructions are all one word size. Micro instructions are read one by one controlled by the address counter and set in the read register.

The micro instructions are classified by arithmetic instructions and branch instructions. Branch instructions change the address counter contents depending upon the value of the external register. When the prescribed condition for an external register is met, the address counter value is changed depending upon the external registe value.

When a branch instruction is set in the ROM Read register, the contents of the specified external register is read (the register is selected by the external register bus); the value is then set in the first register. The address control circuit referencing the contents of the register determines whether to branch or not. When branching, the address control circuit sets a destination address for jumping; when not branching, it increments the address counter by one.

When executing an arithmetic instruction, a specified register pointed by the read register is selected from the group of external registers and then the content is stored in the first operand register.

Similarly, another specified register pointed by the read register is selected from the group of external registers, and the content is stored in the second operand register. The eight-bit arithmetic and logical unit (ALU) then performs operation on the data in the first and second operand registers, and stores the operational result in an external register. The type of arithmetic operation (logical sum, addition, etc.) is selected by the 8 bits of the read register.

The output of ALU is stored to the same external register that had been selected as a first operand.

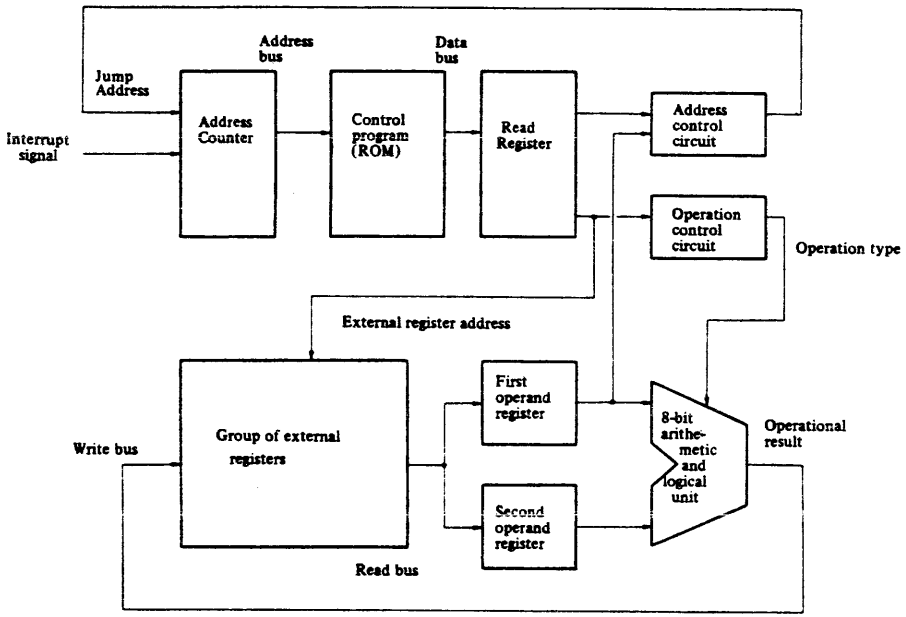


Figure 4.5.1 Microprocessor configuration

(2) External registers

The external registers occupy 256 bytes of memory and consist of registers, counters, input ports, and RAM.

The microprocessor can access the external registers byte by byte using the register selection address.

The register output are sent to interface circuits and motor drive circuit as the output port of the microprocessor. The input port are connected to various sensor signals and switch signals from the operator panel.

The field tester allows observation of a specific byte of the external registers. (Set the register selection address in switches 0 to 7, and press the CNT key; the content of the specified byte will be displayed on LEDs 0 to 7.)

(a) Idler tachometer circuit

The idler tachometer generates two-phase tachometer pulses. When the tape is running in the forward direction, tachometer pulse A is in the leading phase, and when the tape is running in the reverse direction, pulse A is in the lagging phase.

The idler tachometer circuit, receiving the two-phase tachometer pulses, generates QTP (quarter tachopulse) and BKROT (backward rotation) signals. The QTP signal is generated at every transition of the tachometer pulse: the signal is used to measure the distance of tape movement.

The BKROT signal indicates the direction of tape transport. (See Figure 4.5.2)

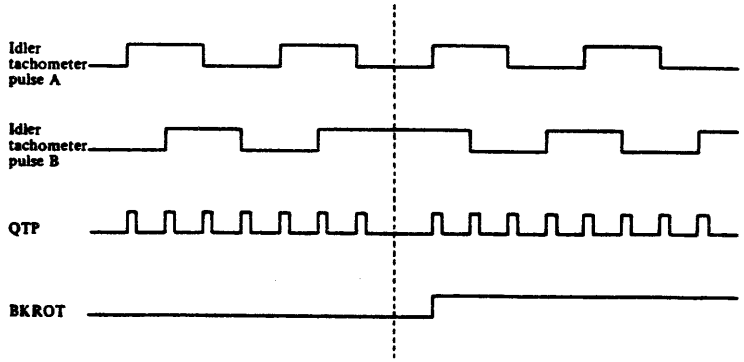


Figure 4.5.2 Idler tachometer circuit

(b) Q counter

The Q counter, a 16-bit reversible binary counter is used to count QTP pulses. Since the BKROT signal changes the polarity of the Q counter from''counting up'' to ''counting down'' and vice versa the counter can be used to measure the distance a tape moves. The Q counter is preset to X'8000' when the block read operation is complete.

(c) F/M counter

This counter, a 16-bit reversible binary counter, counts QTP pulses. The counter changes its polarity from ''counting up'' to ''counting down'' and vice versa on a BKROT signal. The F counter is preset at every transition of the file reel tacho pulse, and the M counter is reset at every transition of the machine reel tacho pulse. The F/M counter value immediately before resetting is sampled by the microprocessor, and used to calculate the diameter of the tape on both reels.

(d) A/B counters

The A/B counters, eight-bit binary counters, are used for counting clock pulses and thus function as a timer. A pair of A/B counters are allocated for each of IF, DV, and SV phases.

These counters are preset by the microprocessor to a certain value, and incremented by one at each clock pulse. When the counter value becomes X'FF', the overflow flag is set and counting stops.

(e) Parameter tables

A 64K-bit ROM and a nonvolatile RAM are referred by the microprocessor. The 64K-bit ROM is used by the servo program as a ''look-up table'' to calculate reel motor current. The nonvolatile RAM is used to store the gain of the read circuit, the slice level of the BOT/EOT sensor, etc. These parameters are held when the power is turned off.

(f) RAM

A total of 448 bytes of RAM is used as external registers for the microprocessor. The register address locations X'40' through X'7F' are shared by all of the IF, DV and SV phases. Any of these phases can write into or read from these locations. Address locations X'80' through X'FF' are provided independently for each phase (IF, DV, or SV phase); an address location written/read by the IF phase, for example, cannot be written/read by the DV phase. (See Figure 4.5.3.)

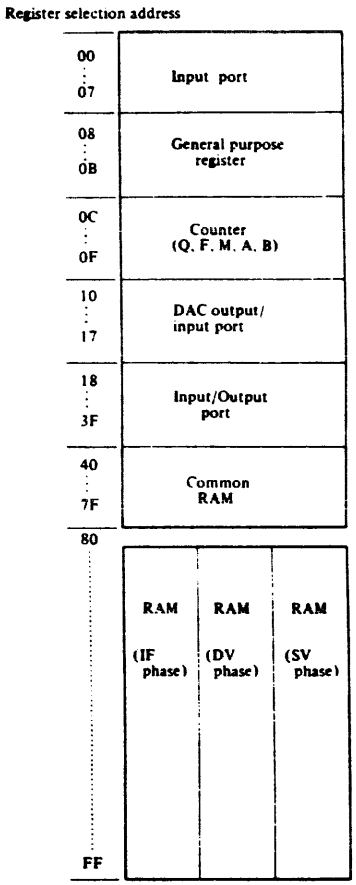


Figure 4.5.3 Configuration of external registers

(3) Execution cycle

The microprocessor concurrently execute the IF, DV, and SV phases through time-sharing. The IF phase processes the interface control with the host system and executes a diagnostic program in offline mode. The IF phase program is approximately 4K words in size, and 1.0 µsec/word in execution speed.

The DV phase receives commands from the IF phase, controls read/write circuit, and instructs the SV phase the execution of tape operation. The DV phase program is approximately 8K words in size, and 2.0 µsec/word in execution speed.

The SV phase receives signals from sensors and the operator control panel, and controls the reel motor via a servo circuit. The SV phase program is approximately 4K words in size, and 2.0 µsec/word in execution speed.

Figure 4.5.4 shows the relationship of the phases and control blocks.

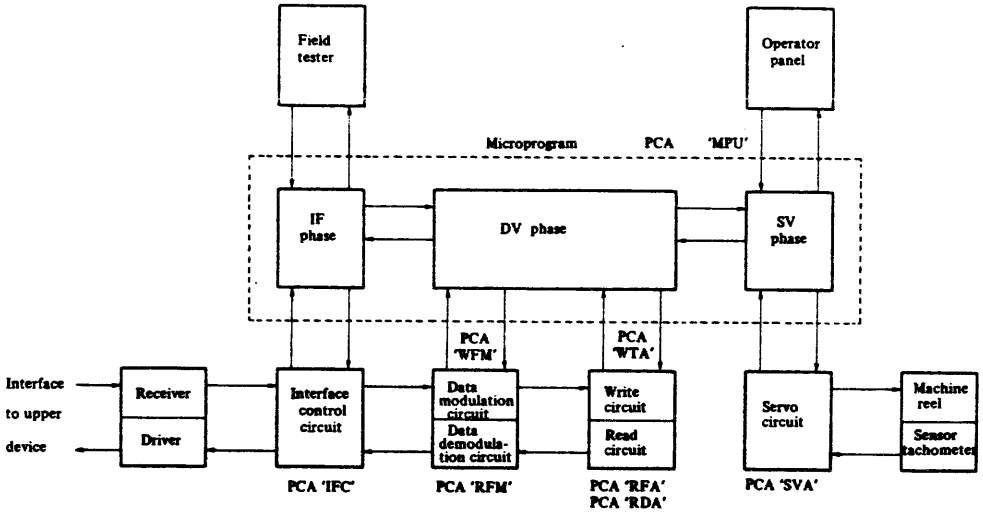


Figure 4.5.4 Microprogram and control block

4.5.2 Interface

(1) Introduction

The interface hardware has two functions. One is the control function, for the interface protocol, and another is the data transfer control function.

(2) Hardware about the protocol

i) Formatter address, transport address 0, 1

These signals are compared with the value of the switch setting located on PCA 53248IU, IC location AA7.
The drive address is determined by these three signals.

ii) Command pulse and status control

The initiate command, rewind and offline pulses are latched by the hardware. Formatter busy status is asserted when the initiate command pulse is received and command code is latched. Rewinding status is asserted and ready status is reset when the rewind pulse is received.

When the offline pulse is received, rewinding status is set and ready status and online status are reset.
The ready status and online status are set and the rewinding or the formatter busy status are reset by the microprogram.
The corrected error status is generated by the formatter when the 1 or 2 track correction is detected.
The other status are set or reset by the microprogram.

(3) Data transfer control

When the microprogram initiates the data transfer and the formatter is ready to transfer, Write Strobe or Read Strobe is generated and transferred to the host adaptor.
The interval between strobes is limited. If the command is a write operation, minimum interval of the Write Strobe is 4 clocks of the formatter clock. (ex. 1.47 µs at GCR 100 ips)
The data tranfer is ended by the last word signal in the write operation. In the read operation it is ended by detecting the block end signal.

4.5.3 Formatter

(1) Write control

(a) Format/Deformat clock

As shown in Table 4.5.1 the clock cycle of the format/deformat circuit varies with the tape speed and recording density. The number of clocks per bit cell are 3 in 6250 mode, 6τ in 1600 mode.

Table 4.5.1 Format/Deformat Clock

Speed (IPS)	Mode (RPI)	Full Clock (ns)	Half Clock (ns)
100	6250	368	184
	1600	1041	521
12.5	6250	2944	1472
	1600	8328	4170

Timing is controlled by the C and D counters. The relation-ship between C, D counters and bit cells is shown in Figures 4.5.5 and 4.5.6. The C-counter is operational during idle scan status also.

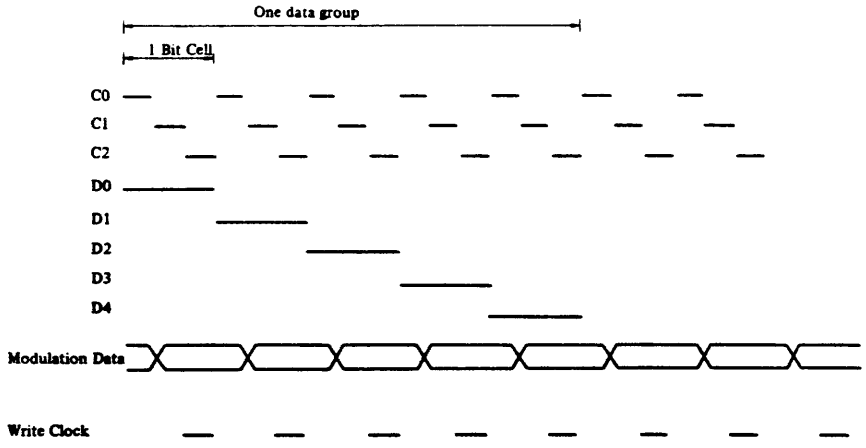


Figure 4.5.5 C, D counters in 6250 mode

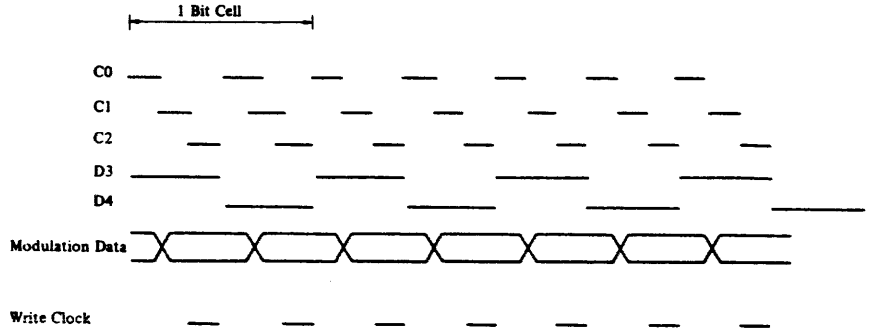


Figure 4.5.6 C, D counters in 1600 mode

(b) Start write operation

Write processing is started when the MP sets a Write OK signal (WOKA). As soon as the WOKA sdignal is set, the WOKD signal is synchronized with the formatter clock. The D counter starts as soon as WOKD signal is set. At this stage, the format counter starts. The Write format is controlled by this format counter. Now WOKDD signal is set as in D4 (D Counter) timing as follows: FC0 (Format in 6250 mode), FCI (in 1600 mode). The Write clock sent to write amplifier is gated by WOKDD signal.

(c) Format control

Write operation of preamble, postamble and data field are controlled by the format counter and the group counter and is used to count data groups.

Table 4.5.2 Format counter

Format Counter	6250	1600
FC 0	TERM	PREA ALL"0" x 1
FC 1	SECOND	PREA ALL"0" x 1
FC 2	SYNC	PREA ALL"0" x 38
FC 3	MARK1	PREA ALL"1"
FC 4	DATA GROUP	DATA
FC 5	MARK2	-
FC 6	END MARK	POSA ALL"1"
FC 7	RESIDUAL A	POSA ALL"0" x 1
FC 8	RESIDUAL B	POSA ALL"0" x 1
FC 9	CRC A	POSA ALL"0" x 1
FC10	CRC B	POSA ALL"0" x 1
FC11	MARK2	POSA ALL"0" x 1
FC12	SYNC	POSA ALL"0" x 32
FC13	SECOND	POSA ALL"0" x 1
FC14	TERM	POSA ALL"0" x 1
FC15	(WOK RESET)	POSA ALL"0" x 1

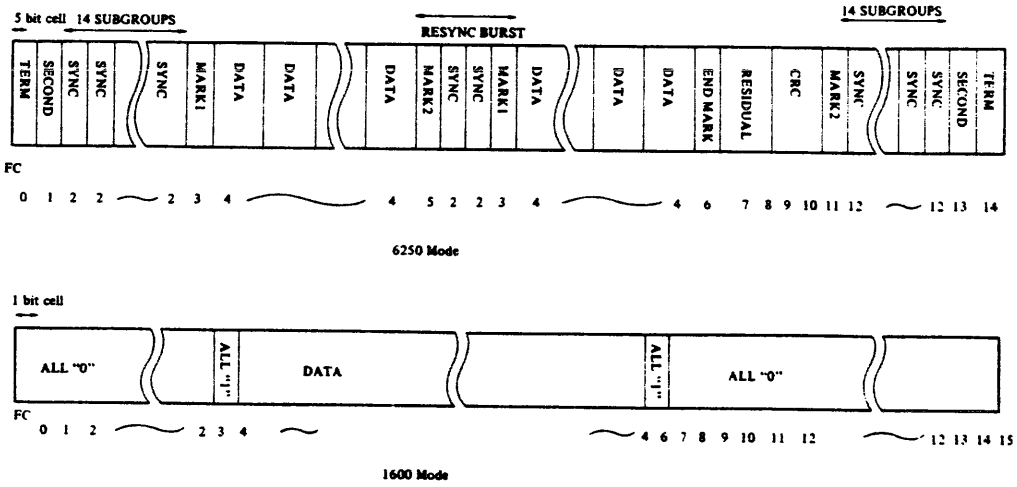


Figure 4.5.7 Data format

(d) Data bus

The Write data received from the channel is entered into the transfer buffer when the WTXB signal obtained by delaying DXFP signal by 1τ is set ON. First DXFO signal is set by the microprogram, and after data is stored in the transfer buffer and the WOK signal is set. Only then the write operation is started. First preamble is written, and data is read out from the buffer at C2 timing after format counter becomes ''4'' and RO + IW signal becomes ''1''. The data read out from the buffer is entered into CRC LSI.

In CRC LSI the data passes through Write Bus Multiplexor. Here ECC characters, padding characters etc. are added and is output from the LSI on the bi direction bus. The relationship between Selector signals WBSL1, 2, 4 on Write Bus Multiplexor and WDAT0 8 signals is shown in Table 4.5.3.

When WBSL1, 2, 4 are all '1', CRC Check circuit status passes through Write Bus Multiplexor instead of Write data.

The parity bit of Write data obtained from Write Bus Multiplexor output is compared with the parity bit from the buffer out register. If they do not match, the Write Bus Out Check signal (WTBOC) is set to '1'.

Table 4.5.3 Write bus selection

WBSL 421	Input data	WDATX Description
000	"0"	Padding Character
001	XBOx (Transfer Buffer Output)	Data Character
010	ECC Register	ECC Character
011	CRC Register	Aux, CRC Character
100	WCRC Register	CRC Character
101	MD7, MD32 Register	Residual Character
110	"1"	1600 mode Preamble, Postamble All '1'
111	CRC Check Circuit Error	Data Sensed by the Microprogram, CRCST Register

Transfer Buffer input data is subject to parity check in CRC LSI. Parity bit is not generated but bit 8 in Bus Out register (BO reg.) is entered to the transfer buffer.

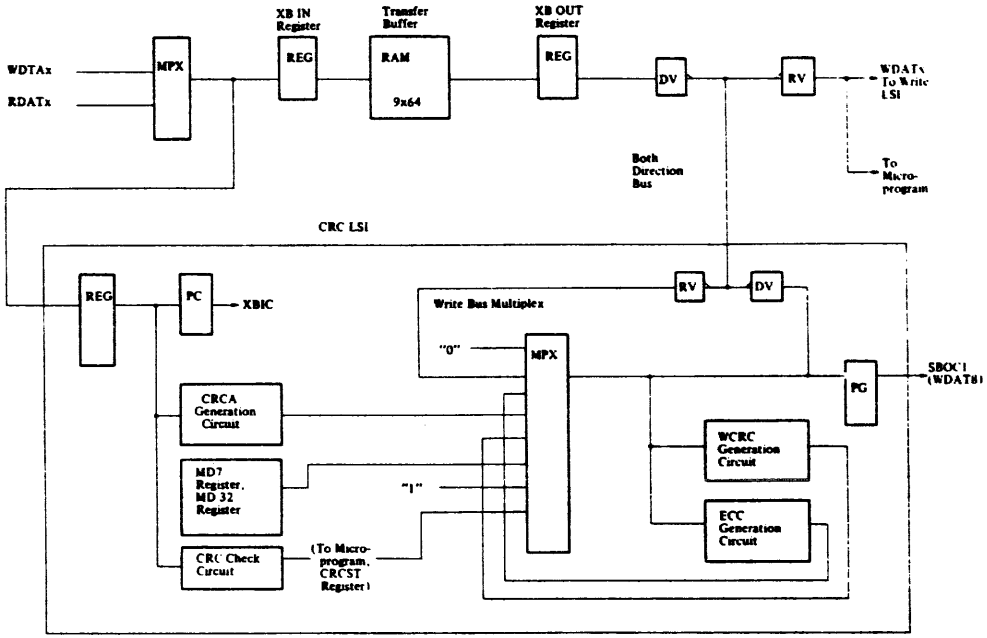


Figure 4.5.8 Transfer buffer and write bus selection

(e) Write modulation circuit

In 6250 Bpi mode, the data output from the Write Bus Multiplexor is fed to WRT LSI. The first four bits is one subdata group and are set in the sub-group register. The four bit data is converted into five bits and is sent in parallel to the five-bit shift register.
The data is then read out serially and fed to the modulation register. The data from the modulation register, is placed in a JK flip flop, the JK flip flop generates NRZi data.

The MSEL signal is set to '1' for Writing SYNC, MARK1, MARK2, TERM, SECOND and END MARK. In this case the FM0∿4 signal is preset in the shift register instead of 4-5 conversion data.

INHGC signal in the data field is set ('1') when DMW mode is specified. At this stage, subgroup register bits 1, 2 (CVR1, 2) are also set to '1' simultaneously. All '0' is set in the serializer to inhibit entry of a subdata group. If INVLD signal is ON under the above conditions, all '1' is preset and invalid code of All '1' is entered in its subdata group.

When a Mask is specified, the modulation register output is gated and All '0' is entered.

If inhibit preamble or inhibit postamble is specified, the IHAMB signal is set to '1' during preamble or postamble processing and the modulation register output is gated as in Mask processing.

In 1600 Bpi mode, MSEL signal is set to '1' when the format counter is between 0∿2 or 7∿15. When the counter is 3 or 4, '1', '1' is set in the lower two serializer bits. MSEL signal is '0' when the format counter is 3, 4, or 6. At this stage the data from Write Bus Multiplexor is set in the subgroup register, bits 3 4 are subjected to PE conversion and are set in the lower two serializer bets if D4 signal is '1'.

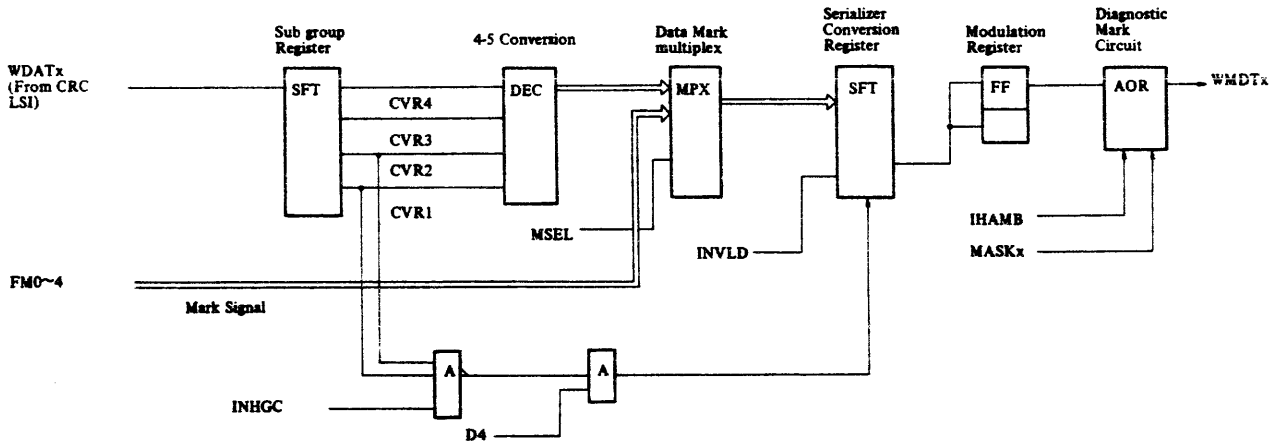


Figure 4.5.9 Write modulation circuit (one track)

(f) Write VRC check

Parity check on Write Modulation Waveform is carried out when the Write Pulse is '2' (WRPL signal) and ALlWT signal is '0'.

In 6250 mode, the 9 track parity at the end of NRZI subdata group (D4 signal = '1') comforms with predetermined conditions. The subdata groups of residual data and CRC data have Odd parity. While the subdata group of the data has even parity. SYNC in the Mark field is a repeatation of Even and Odd parities. Other Mark fields may have uniform parity depending how they are entered.

In 1600 rpi mode, when, the subdata group of the data is transferred, a check is executed to confirm Odd parity after inverting the phase. At PE Mode, data is '1' when Write Modulation Wave change to '0' from '1'. So, data '1' is checked to be level '1'.

(g) Read control

Read Command will be described in this section, Read Backward command and Read after Write check. The Bus In Data (RDDT0∿8) passes through the analog circuit, and is converted into Modulated Data (DEMD0∿8), Read Clock (SRIC0∿8), Phase Error (PHE0∿8) and Peak Pulse (AMPS0∿8) signals respectively.

As shown in Figure 4.5.10, the signals are transfer to Read Circuit for detection of blocks, format check, modulate, data check data and error correction.

The Mark detection circuit, Skew detection circuit and 5–4 conversion circuit correspond to three tracks each for and are made up of 3 LSIs.

Pointer circuits are made of three LSIs (3 tracks) while the error correction and detection circuits consist of one LSI each.

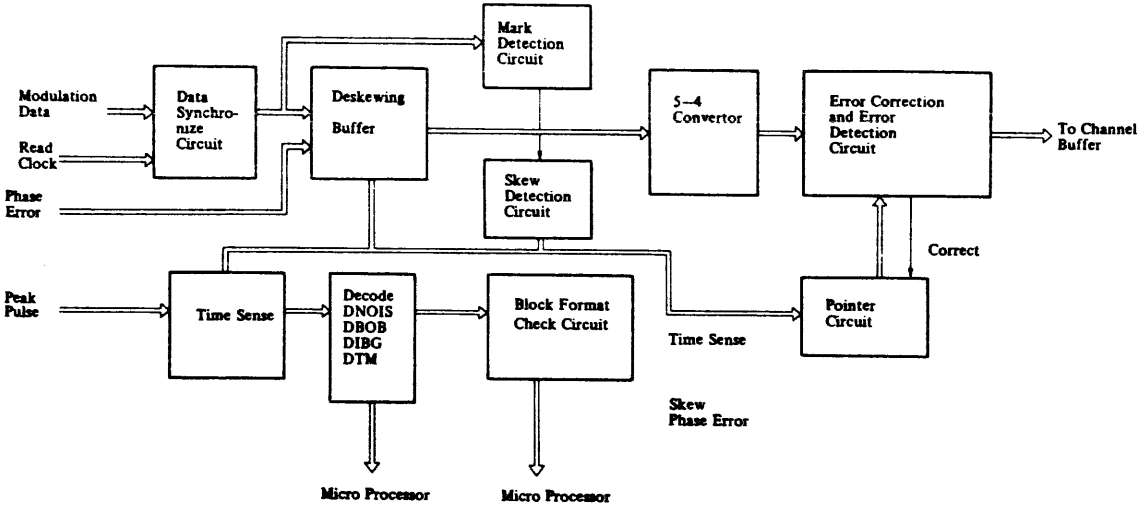


Figure 4.5.10 Read block diagram

(h) Time sense

As soon as the Read OK signal (ROK) is set, the Peak Pulse signal (PEKP0∿8) which is the differential signal from the Bus (DVBI0∿8) is generated.
In the 6250 mode, if the peak pulse is detected for ten bit cells period, Time Sense signal (TSNS0∿8) is set. On the other hand, if the peak pulse is not detected for 5 bit cells period, the Time Sense signal is reset. In 1600 rpi mode, the time period for setting Sense signal is 5 bit cells and for resetting is 2.5 bit cells.
The time sense values of each tracks are decoded to generate Clock Detection (DB0B), IBG Detection (DIBG) or Tape Mark Detection signals (DTM). Signal detection logic is shown below in the form of a logical equation.

TSNS0 ∿ 8 shows 0 ∿ 8.

$$DBOB = (4.1.3+6.2.7+0.8.5).(4+1+3).(6+2+7).(0+8+5)$$

$$DIBG = \overline{0}.\overline{1}.\overline{2}.\overline{3}.\overline{4}.\overline{5}.\overline{6}.\overline{7}.\overline{8}$$

$$DTM\ (For\ Write) = 0.\overline{1}.2.\overline{3}.\overline{4}.5.6.7.8$$

$$DTM\ (For\ Read\ in\ 1600\ rpi\ mode) = \overline{1}.\overline{3}.\overline{4}(2.6.7+0.5.8)$$

$$DTM\ (For\ Read\ in\ 6250\ rpi\ mode) = 1.3.4\ \{2.6.7.(0+5+8)+(2+6+7).0.5.8\}$$

$$DARA\ (For\ Write) = \overline{0}.1.2.3.\overline{4}.5.6.7.\overline{8}$$

$$DARA\ (For\ Read) = \overline{0}.\overline{5}.\overline{8}\ \{1.3.4(2+6+7)+(1+3+4).2.6.7\}$$

$$DNOIS = 0.4.6+1.2.8+3.5.7+(0+4+6)(1+2+8)(3+5+7)$$

(i) Block format check

The following will be described in this section:

a) HNIS signal for identifying a block in Write mode, and Back Read type command after Write command.
b) HBLK signal for detecting a block in Read type command.
c) HTM signal for detecting a Tape Mark.
d) EPOSA signal that resets the PHOK signal.
e) End Data Check Counter.
f) Start Read Check Counter.
g) Slip Check Counter.
h) Noise Check Counter.

When the DB0B signal is set to '1' upon decoding the time sense, it is counted and WOS1 signal set to '1' upon decoding the time 6250 BPI mode and 1 bit cycle in 1600 BPI. As soon as a carry is generated at 12th clock time HBLK signal is set along with PHOK signal.

The Read circuit is activated as soon as the PHOK signal is set to '1'. The PHOK signal is reset and the Read circuit is cleared when the bit cell count shown in Table 4.5.4. is completed after post amble is detected and EPOSA signal is set to '1'.

Just as the HBLK signals etc, HNIS, HTM, EDDCK, STRDC, NOISC and SLIPC signals are counted by WOS1 ∿ WOS16 signals. They are reset by bit cells shown in Table 4.5.4.

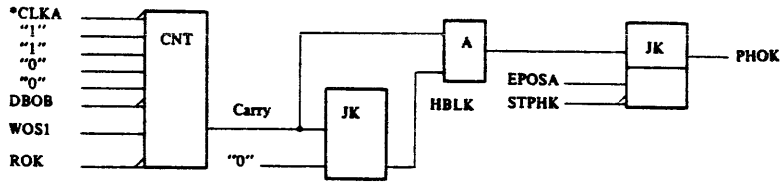
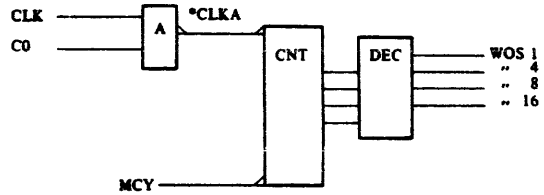


Figure 4.5.11 HBLK and PHOK signal



Unit: bit cell

	6250 Mode	1600 Mode
C0	1	1/2
WOS1	2	1
WOS4	4	2
WOS8	8	4
WOS16	16	8

Figure 4.5.12 Check count values of block format

Table 4.5.4 Check values of block format

HNIS	GCR	Write Read	46 ± 2 22 ± 2	Counts DNOIS signal
	PE	Write Read	23 ± 1 11 ± 1	
HBLK	GCR	-	25 ± 1	Counts DBOB signal
	PE	-	12.5 ± 0.5	
HTM	GCR	Write Read	304 ± 8 42 ± 2	Counts DTM signal
	PE	Write Read	84 ± 4 21 ± 1	
EPOSA	GCR	Write Read	34 ± 2 6 ± 2	Set if POSA are detected in series for the bit cells on the left.
	PE	Write Read	31 ± 1 21 ± 1	
EDDCK	GCR	Write Read	88 ± 8 248 ± 8	Set if DIBG signal is not turned ON upon expiration of the bit cell period (mentioned on left) after starting EPOSA Count.
	PE	Write Read	20 ± 4 36 ± 4	
STRDC	GCR	Write Read	120 ± 8 168 ± 8	Set if PREA signal is not detected upon expiration of the bit cell period (Noted on the left) after detecting HBLK.
	PE	Write Read	52 ± 4 63 ± 4	
NOISC	GCR	-	1084 ± 4	Set if DBOB is detected with the bit cell period (noted on the left) after WOK signal
	PE	-	192.5 ± 0.5	
	-20% for RW Head Gap			
SLIPC	GCR	-	1448 ± 4	Set if DNOIS signal is not detected within the bit cell period (noted on the left) after WOK signal.
	PE	-	268 ± 0.5	
	+7% for RW Head Gap			

(j) Deskewing buffer

Modulation data is set in the deskewing buffer after synchronization with the formatter clock. Phase Error Detection signal is stored at the same time as the data.

Data is entered into the buffer trackwise. However, it is read out simultaneously. The buffer capaicty is equivalent to 32 bit cells.

The Read In Cycle signal (RICY) will be set after mark '1' is detected after a series of '1's (for 10 bit cells) in 6250 mode, or if 00001 pattern is detected in 1600 rpi mode.
When data is detected after RICY signal has been set, the Read In Counter is advanced and the CMP signal of the track is reset. CMP signal is reset as soon as the Dead Track Pointer is set. Read Out Counter is activated as soon as the CMP signals of all the tracks are reset.

(k) Skew control

Pointer and skew errors are set in the up.down counter used for indicating the volume of data in the deskewing buffer.

a. Pointer in 6250 Mode Read Mode

The Dead Track Pointer for indicating skew of less than 2 bits is set if a track with skew in excess of 26 bits (STMP signal: '1') and seven tracks with skew of more than 4 bits (LAG signal: '1') are detected. If less than 6 tracks are involved (LED: 1), the Dead Track Pointer for skew in excess of 26 bits is sets.

b. Pointer in 1600 mode Read Mode

Dead Track pointer indicating skew of under 2 bits is set if a track with skew exceeding 14 bits and more than 7 tracks with skew exceeding 4 bits are detected. Dead Track Pointer indicating skew of over 26 bits is set if less than 6 tracks are involved.

c. Skew error

Skew Error is set in the following cases:

1600 mode Write: over 2 bits.
6250 mode Write: over 14 bits.
When skew margin has been specified skew error is set under the following conditions:

1600 mode Read: over 4 bits
1600 mode Write: over 1 bit
Skew margin is invalid in 6250 mode.

(1) Error correction

In 6250 mode, error correction is determined with reference to Syndrome 1 (S1), Syndrome 2 (S2) and the number of pointers.

As shown in Figure 4.5.13, S1 indicates parity check status of each byte. S2 is generated by logic similar to that used to generate the ECC bytes. S2 byte is generated from data byte 7 and the ECC byte.

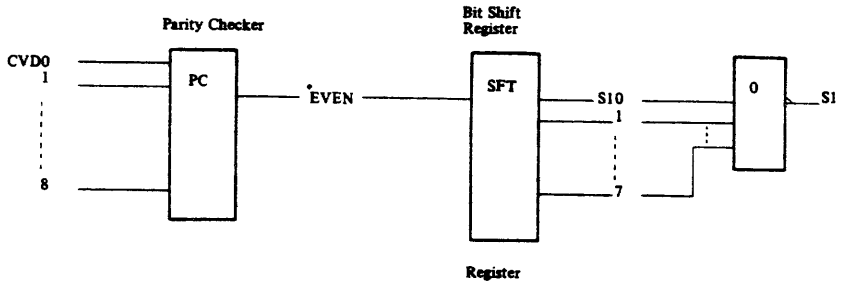


Figure 4.5.13 S1 Generation circuit

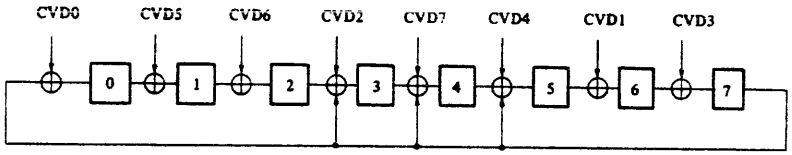


Figure 4.5.14 S2 Generation circuit

S1 and S2 registers are shifted (S1SFT, S2SFT) in synchronization with the convention buffers. All the pointers related to the data group are sampled, if the SETPT signal (for pointer set timing) is '1'. Now, S1, S2 and pointers are checked when CKCOR signal used for decision on error correction is '1'. Error correction conditions are listed next.

a. Write command

It is not error when S1 and S2 are simultaneously '0'. However, if the pointer indicates more than two tracks, Multi-Track Error is indicated.

When $S1 \neq 0$, $S2 \neq 0$ and only the parity track pointer is ON, only the parity track is corrected.

When $S1 \neq 0$, $S2 \neq 0$ and the pointer of only one track (other than parity track) is ON, S2 is shifted by an amount determined by reference to the pointer track. Then correction is executed when S1 = S2. However if $S1 \neq S2$, VRC Error is indicated.

In cases other than the above, data check is executed assuming it to be a VRC error. In this case the number of pointers is 0 or 1, VRC Error is set. If more than 2 pointers are involved, Multitrack error and VRC error are set.

b. Read command

It is no error if both S1 and S2 are '0'. If more than 3 track pointers are set, a Multitrack error is assumed to have occured. This does not result in data check.

Two track error correction is executed if S1 = 0, $S2 \neq 0$ and two pointers are ON.

Parity track correction is carried out in the following cases.

(i) $S1 \neq 0$, S2 = 0, No pointer
(ii) $S1 \neq 0$, S2 = 0, One pointer
(iii) $S1 \neq 0$, S2 = 0, Two pointers (including parity track).

Two track error correction is executed if $S2 \neq 0$, S2 = 0 and 2 track pointers are set (excluding parity track).

If $S1 \neq 0$, $S2 \neq 0$ and pointers are 0 or 1, S2 is shifted till S1 = S2. Error track is then identified from the number of shift operations and one track error correction is executed. If $S1 \neq S2$ after 8 shift operations, VRC error is set.

If $S1 \neq 0$, $S2 \neq 0$ and two pointers are set, error correction is executed for the pointer track. If the pointer is 0 or 1 in cases other than the above, VRC error is set. If more than three track pointers are set, VRC Error and Multi-track Error are set.

(m) Pointer

a. 1600 mode

There are two types of pointers in 1600 rpi mode. They are Dead Track and Valid Track Ponters.

Dead Track Pointer

- Track in which the time sense signal has been reset while PHOK signal is '1'.
- Track with excessive skew.
- Track (read only) subjected to 8 bytes serial correction with reference to the valid pointer data (this correction is carried out after the valid pointer has been set).

If any of the above three conditions are set, they will not be reset during the processing.

Valid Pointer

Normally this pointer is set in a track in which a phase error has been detected and is set unconditionally in Write operation. It is set during preamble and postamble in Read operation. It is also set unconditionally if other track pointers have been set, but it may only be set in data if parity error has been detected.

Once the valid pointer is set, it may only be reset if 8 bytes (or more) serial error correction is not executed and the data is changed from 0 to 1 or 1 to 0 (in read only).

b. 6250 mode

There are three types of pointers, Dead Track Pointer, Valid Pointer and ECC Group Buffer Pointer in 6250 mode.

Dead Track Pointer

The condition for setting this pointer are the same as that in 1600 mode. In Read Operation if the time sense is '1' when resynchronous burst is detected, this dead track pointer is reset.

Valid Pointer

- Track subjected to error correction.
- A track in which invalid data pattern and mark is not detected in the mark field.

This pointer is set if a phase error is detected in a data group is to be processed. If dead or valid track pointers of more than three tracks have been set, the ECC group buffer pointer is not employed as a pointer.

ECC Group Buffer Pointer

This pointer is set if an phase error is detected in a data group to be processed. If dead or valid track pointers of more than three tracks have been set, the ECC group buffer pointer is not employed as a pointer.

In Read operation, this pointer is reset upon detection of resynchronous burst and upon completion of processing of a data group.

(n) Data flow

The data deskewed at the deskewing buffer (PD0 ∿ 8) is set in the sub group buffer when the ROC+D signal (which is a step delayed from ROC+1) is set ('1'). As soon as the five bit data counted by the group counter is set in the buffer, the group buffer full signal (GBFUL) is set.

The five bit output from the group buffer is subjected to 5-4 conversion to obtain 4 bit data.

At this stage, Mark 1, Mark 2 or All 1 mark is detected. The 5-4 conversion data is preset in the conversion buffer at SECTV '1' timing when GBFUL signal is '1' and conversion buffer busy signal (VBBSY) is '0'.
The data from the conversion buffer shift signal (VBSFT) is output serially by the conversion buffer shift signal.
This CVD0 ∿ 8 output data is stored in the ECC buffer by the S1SFT signal (S1 register shift timing signal). This buffer is made of 8 bit serial in/serial out register. The ECC register output data is subjected to error correction and then set in the ECC buffer out register. The output data (E00 ∿ 8) from this register, is set in the transfer buffer as Read Data when STRIN signal is '1'.

Read system data flow is shown in Figure 4.5.15.

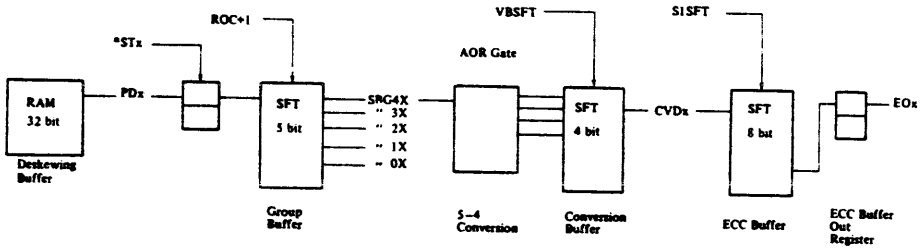


Fig. 4.5.15

(o) CRC check

The following data check circuits are provided: CRCA, CRCB, CRCC, CRCD and CRC. CRCA is generated from the transfer buffer input data.

CRCB is generated from the transfer buffer output data.
CRCC is generated from the data and Aux-CRC byte.
CRCD is generated from Aux-CRC byte.

CRC is generated from data, padding characters, Aux CRC byte and one CRC byte.

Details on checks in each mode are given in Table 4.5.5.

Table 4.5.5 CRC check

		6250	1600
		WT RD BR	WT RD BR
CRCA ≠ CRCB	Transfer Buffer Input/Output does not match	o o o	o o o
CRCB ≠ CRCC	Write Data and Read after write Data do not match		o
CRCB ≠ CRCD	R/W data and the Aux-CPC Data read out do not match	o o	
Unmatch CRC	Required pattern not obtained in Read data CRC Check.	o o o	
Unmatch CRCC	CRCC generated from Read data does not have the required pattern	o	

4.5.4 PCA 'WTA' --- Write circuit

(1) Configuration

The Write circuit consists of a file protect circuit, write voltage generator circuit, erase circuit, write control circuit, and write current control circuit. Figure 4.5.16 shows the configuration of the Write circuit. As shown in the figure, a write current control circuit is provided for each of the nine tracks, but the other circuits are shared by all tracks.

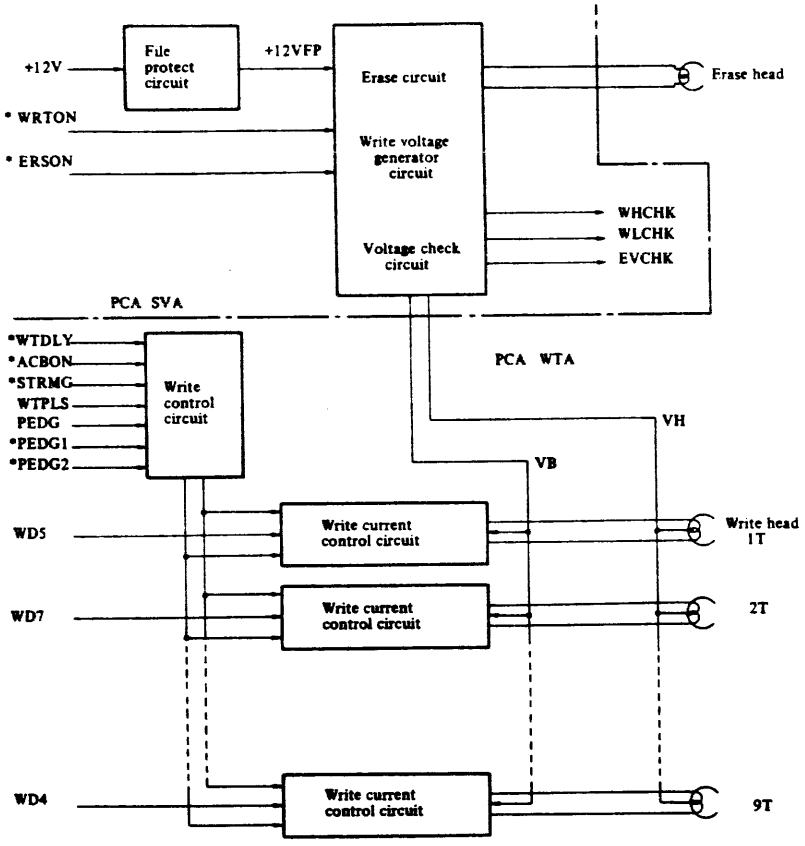


Figure 4.5.16 Write circuit configuration

(a) File protect circuit

The file protect circuit protects the magnetic tape from inadvertent erasure or write-over. Files are protected under the following condition:

i) Write enable ring is not attached to the file reel.

The FILE PROTECT LED lights when the unit is write protected. This circuit is on PCA 'SVA'.

(b) Write voltage generator, erase, and voltage check circuit

The write voltage generator controls the generation of write voltage. The write voltage is set to a value suitable for the tape speed and recording density by microprocessor. After the end of the write operation, the circuit generates an attenuating voltage for degaussing the write head.

The erase circuit supplies current to the erase head at the erase control signal.

The voltage check circuit checks the write head voltage and erase head current.

This circuit is on PCA 'SVA'.

(c) Write control circuit

This circuit is composed of:
- A circuit that changes the GCR/PE mode.
- An AC bias oscillator, and
- A write clock setting circuit for generating a step wave form for write current.

(d) Write current control circuit

This circuit controls the current that flows into the write head. In the PE mode, the waveform of the write current is rectangular. In the GCR mode, AC bias current is superimposed over the step waveform. The write current is greater in the PE mode than in the GCR mode.

(2) I/O signal lines for the write circuit

The functions of the I/O signals shown in Figure 4.5.16 are described below:

(a) Input signal --- PCA 'SVA'

*WRTON: Signal for controlling the write voltage
*ERSON: Signal for controlling the erase current

(b) Input signals --- PCA 'MTA'

*ACBON: Signal for controlling the AC bias current in the GCR mode
*STRMG: Signal for changing the AC bias frequency and the step width of the step waveform.
WTPLS: Clock signal for synchronizing the write data with the signal.
PEDG, *PEDG1, *PEDG2: Signals for setting the current control circuit in the PE mode
WD0 to 8: Write data bits 0 to 8

(c) Output signals --- PCA 'SVA'

WHCHK: During write operations, this signal confirms that the value of 12 VFP is as prescribed.
WLCHK: During read operations, this signal varifies that the write voltage circuit is not operating.
EVCHK: During erase operation, this signal confirms that the erase current is as prescribed.

(3) Write sequence and current waveform

Figure 4.5.17 shows the write sequence and write current waveform. First, the *ERSON signal activates the erase circuit, which in turn supplies current to the erase head. When it is confirmed that the current is correct, EVCHK is issued.

The write operation is initiated by activating the write voltage generator circuit with *WRTON; the circuit then applies the write voltage to the write head. If the voltage is correct, WHCHK is issued.

Write data bits WD0 through WD8 (= 9 bits) are written on the tape, synchronized with the write clock (WRPLS). As described in the section for the write control circuit, the waveform of the write current is rectangular for the PE mode and step waveform superimposed over an AC bias.

When the write operation is completed and the *WRTON signal goes away, the write circuit starts a degauss operation: The write voltage decreases gradually, and the write current control circuit, in response to the degaussing pulses, reverses the polarities of the current that flows into the head in regular intervals. The write sequence is completed when the degaussing is finished.

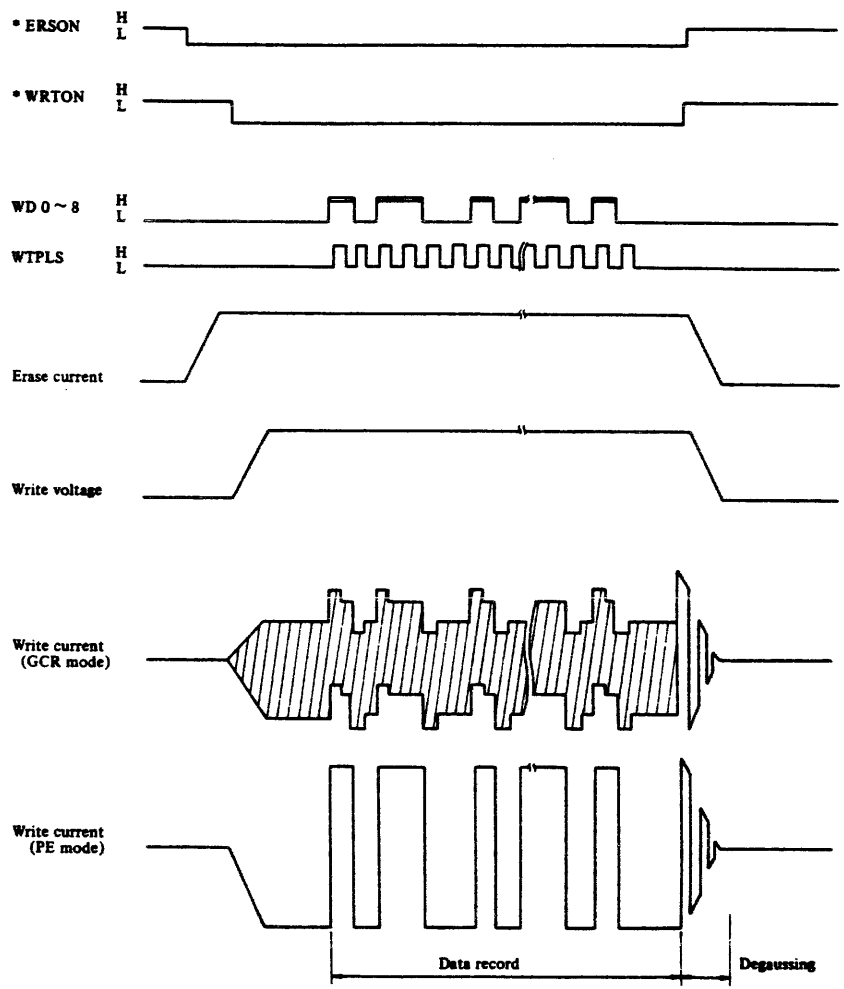


Figure 4.5.17 Write sequence

4.5.5 PCA 'RPA' -- Read pre-amplifier circuit

PCA 'RPA' is composed of pre-amplifiers, tension sensor, idler tachometer, and reel tachometer.

(1) Pre-amplifier circuit

Each head output signal is amplified by the pre-amplifier. Three pre-amplifiers are packaged in one integrated circuit: so there are three integrated circuits on PCA 'RPA'.

(2) Tension sensor circuit

The tension sensor circuit senses the output of the photo sensors with two hybrid ICs. Variable resistors adjust the phase and duty between two sensor outputs.

(3) Idler tachometer circuit

This circuit senses the two phase outputs of the idler tachometer photo sensors with two hybrid ICs.
Two variable resistors are used for adjusting the phase and duty of the output of the tachometer.

(4) Reel tachometer circuit

Each circuit of machine reel tachometer and file reel tachometer is composed of the same kind of hybrid ICs.

4.5.6 PCA 'RDA' --- Read circuit

(1) Configuration

The read circuit amplifies the head output, detects peak points which are information recorded on the tape, converts the read data into pulses, and sends the resulting pulses to the demodulator circuit.

Figure 4.5.18 shows the configuration of the Read circuit. The circuit consists of:

Pre-amplifier, differentiator, gain switching circuit, register circuit, filtering amplifier, peak point detector circuit, amplitude check circuit, standard voltage generator, and read control circuit.

The standard voltage generator circuit and the read control circuit are shared by all of the nine tracks.

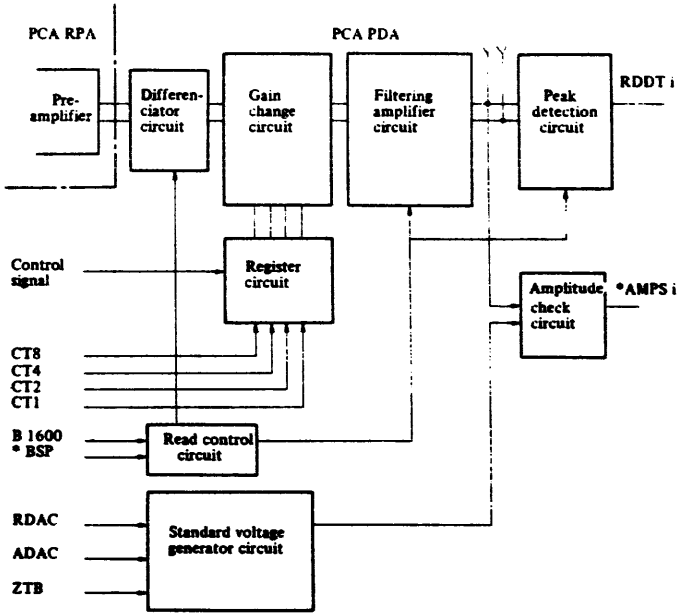


Figure 4.5.18 Read circuit configuration

(a) Pre-amplifier circuit -- (Only the pre-amplifier circuit is on the PCA RPA.)

The pre-amplifier circuit amplifies the head output to an adequate level.

(b) Differentiator circuit

The differentiator circuit differenciates the pre-amplifier output into a signal suitable for peak point detection. The band is changed depending on whether the unit is in the streaming mode or start/stop mode.

(c) Gain switching circuit

The gain switching circuit, with its four-bit signal line, changes the gain. The gain can be chosen from the 16 steps available.

(d) Filtering amplifier

The filtering amplifier consists of two amplifier ICs, and IC for input switching, and an IC for voltage gain regulation, all mounted in one package.

The amplifier together with external registers, capacitors and transistors makes up an active filter, which is used both in the streaming mode and in the start/stop mode. The characteristic of this filter is changed depending on the mode (GCR or PE).
Output voltage; 2Vpp (from the ground)

(e) Peak points detector circuit

Because the differentiated signal indicates peak points at 0V, this circuit detects the zero-crossing points of the signal, and outputs peak pulses.

(f) Amplitude detection circuit

The amplitude detection circuit detects when the input amplitude is less than a prescribed value. When the amplitude of the analog signal from the filtering amplifier is as prescribed or more, the signal is then sent to the formatter.

In the GCR mode, the output from this circuit is used in gain setting in the ARA area through an SAGC operation. Moreover, the circuit is also used in setting the read gain in the PE mode.

(g) Standard voltage generator circuit

The standard voltage generator circuit applies voltage to the amplitude detection circuit. The voltage is controlled by a microprogram, supplied to the DAC of PCA SVA, and processed appropriately by the read circuit, which then generates a suitable voltage.

(h) Read control circuit

The read control circuit changes the filtering band of the differentiator and filtering amplifier, and the time constant of the peak point detector circuit.

(2) I/O signal lines of the read section

(a) Input signals (The following lists only the principal signals.)

B1600: Signal for switching from PE to GCR mode, vice versa
*HSP: Signal that indicates the unit is in the streaming mode
RDLWR: This signal is set during loop write to read.
RDAC: Input voltage for the standard voltage generator circuit
ADAC: Input voltage for the standard voltage generator circuit

(b) Output signals

*AMPS0 to 8: Output signal from the amplitude detection circuit. This signal is output when the amplitude is greater than the prescribed.
*RDDT0 to 8: Indicates peak point detection signal.

(3) SAGC operation

The SAGC operation, performed in the GCR mode, automatically adjust the gain. Details are described below:

With a magnetic tape recorded in the GCR mode, an amplitude standard signal (ARA) is recorded immediately after the BOT. The read circuit adjusts the gain according to the ARA value prior to tape read operation. Figure 4.5.19 shows the SAGC operation.

(a) SAGC operation 1

When SAGC is initiated, the gains of all tracks are decreased to the minimum (step 0). After a certain period, the read circuit increases the gains at regular intervals. When the output from the filtering amplifier becomes the prescribed value, the register circuit is fixed. When the gains for all tracks become suitable values, TSNS 0 through 8 become active. The microprogram, confirming this, finishes the SAGC operation. The process up to this point is called "SAGC operation 1".

(b) SAGC operation 2

If any of outputs from the filtering amplifiers does not attain the prescribed value after reaching the prescribed gain value, the slice level is lowered. If the TSNS signal is activated at this point, the SAGC operation is terminated just as in SAGC operation 1. This operation is called "SAGC operation 2".

(c) SAGC operation error

If the SAGC operation is not terminated in SAGC operation 2, an SAGC operation error occurs.

(5) Oscillator circuit

This package contains the following three oscillators:

(a) Main clock for the microprocessor

(b) Write clock for PE mode

(c) Write clock for GCR mode

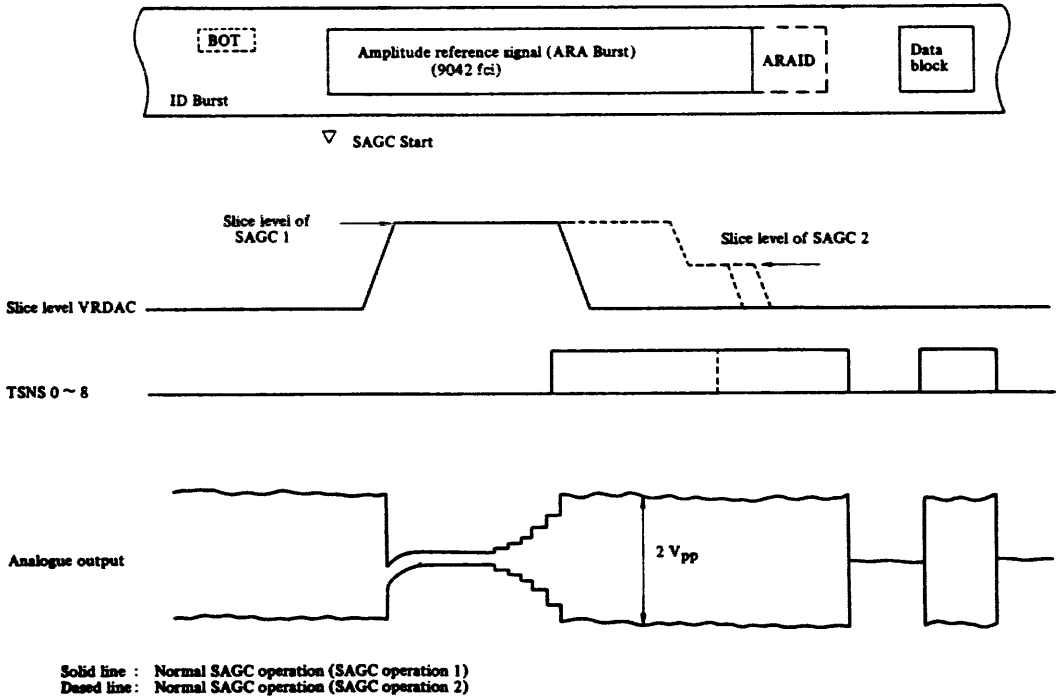


Figure 4.5.19 SAGC operation

4.5.7 Demodulator circuit

(1) Principle

The peak signal, which detects the peak of the signal reproduced via the read head, is sent to the demodulator circuit.

A reference signal is obtained by inputting the peak signal to a variable frequency oscillator (VFO). The reference signal thus obtained is compared with the peak signal in terms of phase; data bits are determined to be either "1" or "0" depending upon whether the phase between the two signals match or not.

Figure 4.5.20 shows the block diagram of the demodulator circuit and Figures 4.5.21 and 4.5.22 shows the timing chart for the PE mode and GCR mode, respectively. The numbered signal names on the timing charts correspond to the numbers on the block diagram.

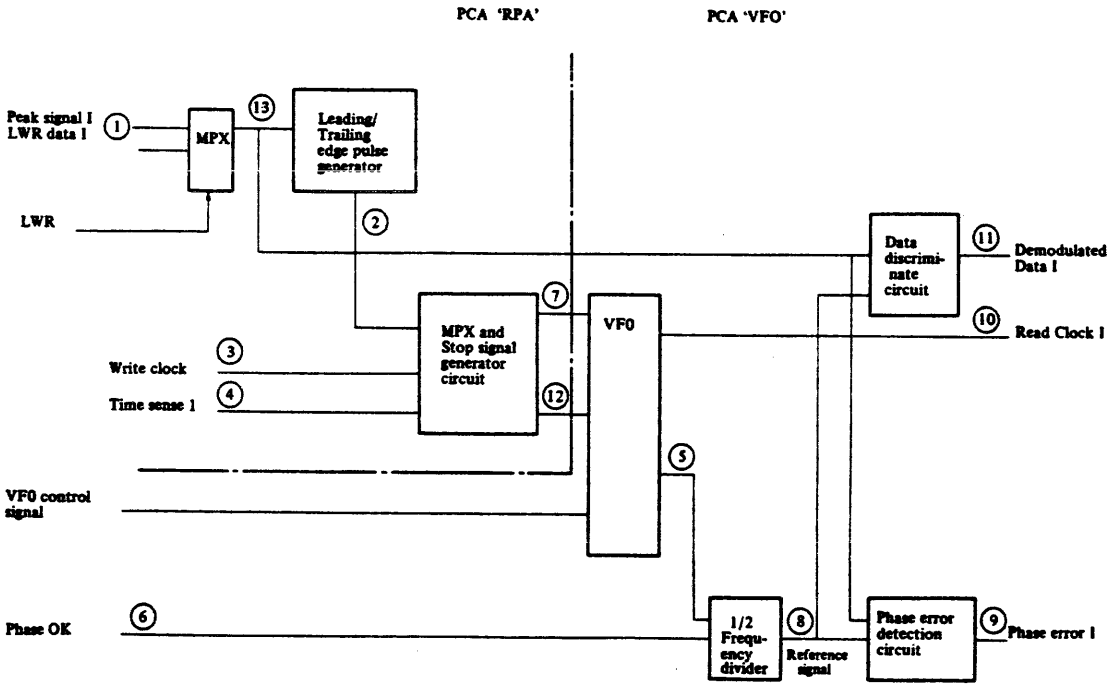


Figure 4.5.20 Block diagram of GCR and PE demodulator circuit

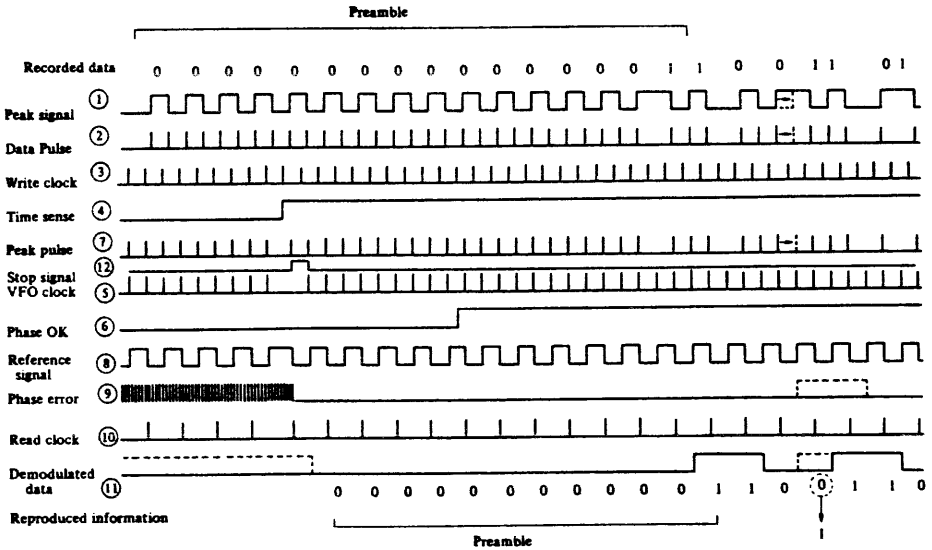


Figure 4.5.21 PE demodulation timing

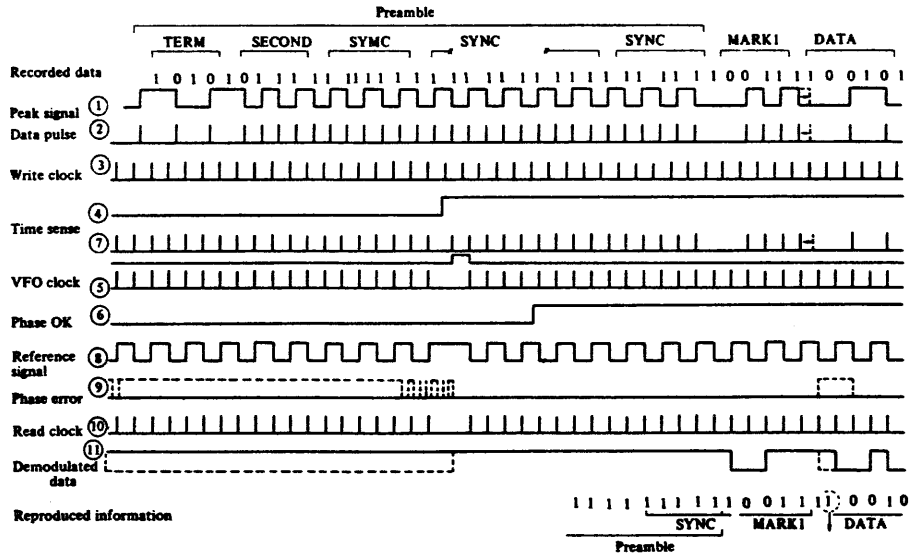


Figure 4.5.22 GCR demodulation timing

(2) Signals in the demodulator circuit

① Peak signal (0 to 8)

The peak signal of the data read from the magnatic tape.

② Data pulse (0 to 8)

Leading and trailing edges of the peak signal ① .

③ Write clock

Standard clock for holding the VFO in the standard state.

④ Time sense (0 to 8)

This signal changes its state from low to high when the peak pulse lasts for a specified time period. This signal changes the input signal to the VFO.

⑤ VFO clock (0 to 8)

VFO output clock which is synchronized with peak pulse ⑦ as the VFO input.

⑥ Phase OK

Demodulated data and phase error become valid after this signal is issued.

⑦ Peak pulse

VFO input pulse signal obtained by multiplexing the differential pulse ② and the write clock signal ③.

⑧ Reference signal (0 to 8)

Signal obtained by frequency-dividing the VFO clock signal ⑤.

⑨ Phase error (0 to 8)

This signal is activated when a peak pulse is not received or when the phase of a peak pulse remarkably differs from that of the reference signal ⑧.

⑩ Read clock (0 to 8)

Clock signal for reading demodulated data ⑪ .

⑪ Democulated data (0 to 8)

Collection of data bits ("1" or "0") obtained through demodulation.

⑫ Stop signal

Signal for temporarily stopping the VFO at the leading edge of the time sense signal ④.

⑬ Read data

Input signal or the demodulator circuit during read/write operations.

(3) PE demodulation

In the 1600 Bpi mode, data is recorded on magnetic tape in the PE mode.

To allow automatic adjustment of the free-running frequency while data blocks are not inputted, the VFO of the demodulator circuit is connected to the write clock signal ③.

When a data block is detected, the signal ⑦ is shaped into data pulses by leading and trailing edge generators. In this way, a time sense signal ④ is generated at the time sensor. The peak pulse signal ⑦ is switched from the write clock signal ③ to the data pulse signal ② the VFO, which has been synchronized with the write clock signal ③ outputs a VFO clock signal that is synchronized with the peak pulse signal ⑦ This VFO clock signal is frequency-divided to produce a reference signal ⑧ The value (''1'' or ''0'') of each data bit is determined by comparing the peak signal ① and the reference signal ⑧ in terms of phase. Data is reproduced by sampling the demodulated data produced at each read clock pulse.

The phase error signal ⑨ is generated when the phases of the peak signal ① and the reference signal ⑧ differ due to peak shift or bit drop.

(4) GCR democulation

In the 6250 Bpi mode, data is GCR converted and recorded on the magnetic tape through NRZI method. In the NRZI method, ''1'' is recorded as flux reversal, and ''0'' is recorded as no flux reversal.

Similar to the PE mode, the VFO generates VFO clock pulses ⑤ which are synchronized with the peak pulse signal.

The value ("1" or "0") of each data bit is determined by comparing the peak signal ① and the reference signal in terms of phase for the interval between the center of the bit cell to the center of the next bit cell. The demodulated data ⑪ is sampled at each read clock pulse ⑩ , reproducing the recorded data.

The phase error signal ⑨ is generated when the phases of the peak signal ① and the reference signal ⑧ differs due to, peak shift.

4.5.8 PCA 'SVA' --- Tape motion and other circuits

This package consists of the following cirucits

- DAC circuit
- Servo amplifiers for both reel motor
- +12V circuit for write amplifier
- Sensor circuit
- Power supply control circuit

(1) DAC Circuit

The PCA SVA has eight channels of DACs, which converts 8-bit digital signal sent from the microprocessor into an analog signal. These DACs are used as follows:

1) FDAC -- For driving the file reel motor.
2) MDAC -- For driving the machine reel motor.
3) BDAC -- For setting the slice level of the BOT sensor.
4) EDAC -- For setting the slice level of the EOT sensor.
5) TDAC -- For tension feedback
6) SDAC -- For setting the slice level of the sensor.
7) RDAC -- For sensing the amplitude of the read analog signal.
8) ADAC -- For setting the write head current.

In the actual circuit, one DAC is time-shared, and the DAC outputs are held by capacitors. In Figure 4.5.23, one of the switches SW0~7 turns on, and one byte in the 2-port RAM is selected at a time.

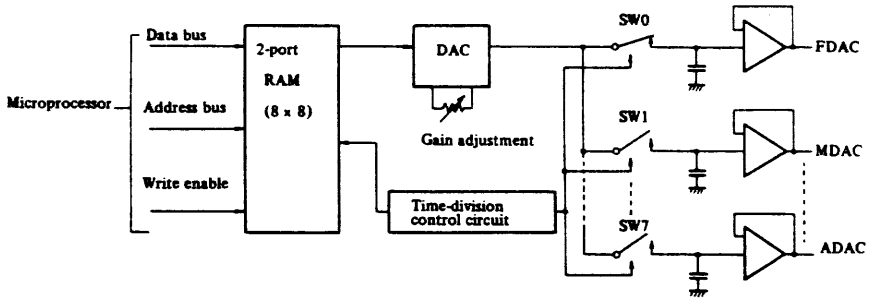


Figure 4.5.23 DAC circuit

(2) Servo amplifier circuits

Figure 4.5.24 shows the file reel motor driver circuit.

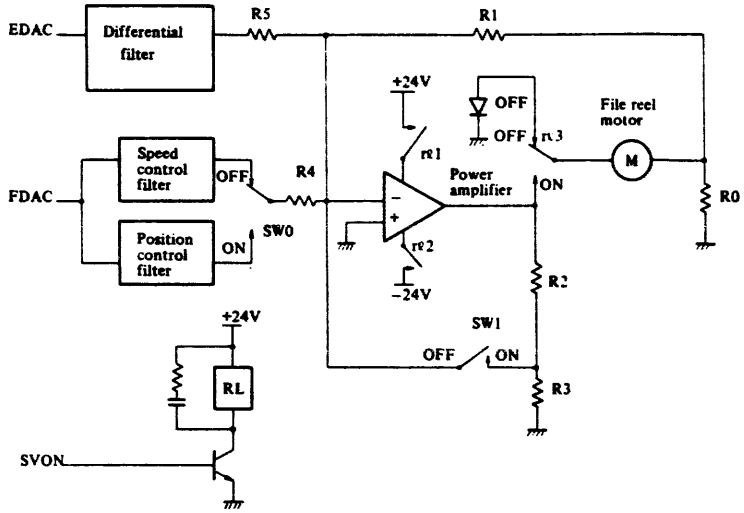


Figure 4.5.24 File reel motor driver circuit

When SVON (the signal for activating the servo circuit) is a low level, the relay (RL) is off, and contact points rl 1 through rl 3 are open. In this state, power is not supplied to the power amplifier, and the file motor is dynamicly braked by a diode. When SVON becomes high level, the power amplifier is activated, and the reel motor is connected to the power amplifier output. At this stage, the reel motor is controlled by the values of TDAC and FDAC. The following three operation modes are available:

- Speed control mode (SW0: off; SW1: off)
  Because current feedback via R0 and R1 is enabled, tape speed can be regulated by controlling the motor current with FDAC. when the tape tension changes, the change is reflected in TDAC, which makes up a tension feedback loop through a differential filter.

- Position control mode (SW0: on; SW1: off)
  The speed control filter is altered for position control. In this mode, FDAC is controlled so that the tape position may be constant.

- Voltage feedback mode (SW0: off; SW1: on)
  Because the power amplifier output voltage is fed back via R2 and R3, the motor terminal voltage can be controlled with FDAC. This operation mode is used while loading and unloading.

The machine rool motor driver circuit is the same as Figure 4.5.24 except that it does not include the tension feedback by TDAC.

(3) **+12V circuit**

The +12V circuit provides the write current in write operations, and checks the +12V with its internal circuit. Because the +12V power is shut off by a relay in the file protect mode, the data on the tape cannot be written over or erased.

(4) **Sensor circuit**

Figure 4.5.25 shows the schematic diagram of the BOT/EOT sensor circuits. In the normal mode except for diagnostics, the BDAC for the BOT sensor supplies about −1.0V and the SDAC supplies about 0.0V. Because the photo-transistor output current is less than the sink current of the transistor Tr1 when the BOT marker is not detected, the Tr1 become a saturation state. As this result, the voltage of Tr1 collector becomes negative and the output of comparator (*BOTMK signal) becomes high level. When a marker is detected, the output current of photo-transistor increases over the sink current and *BOTMK signal becomes low level. In the diagnostics, mode the BDAC (EDAC) and SDAC are varied for a measure of the sensor current, and are set to the optimized value which is calculated by the microprocessor.

The write enable sensor is the similar to Figure 4.5.25, but because of the contrast in the sensor area the circuit is connected to −6V instead of the BDAG output.

The sensor circuit also includes a over-current detection circuit and saturation detection circuit for the power amplifier. This allows early detection of a tape drive circuit malfunction, protecting the tape from damage.

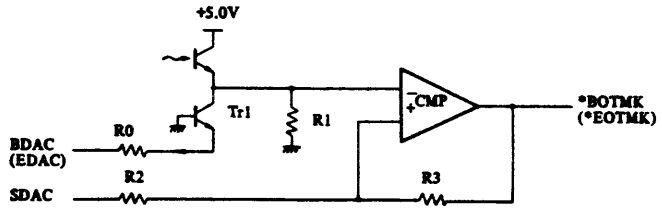


Figure 4.5.25 BOT/EOT sensor circuit

(5) **Power supply control circuit**

In the control circuit several signals are transferred between the microprocessor and the power supply. The microprocessor sends the PWOFF signal to the power supply to shut it off; this signal is useful to shut the power off after taking protective measures for the media when an alarm situation such as ''fan alarm'' occurs.

The PWOK signal indicates that the power supply is ready. Tape drive operations are enabled when this signal goes high.

The PWALM0 and PWALM1 signals informs the power supply of alarm conditions such as temperature alarm, fan alarm, and motor over-current. The alarm LEDs are lighted depending upon the alarm code. The LED display remains on even after the power is shut off.

(5) Demodulator interface

The demodulator circuit is contained partly in the read circuit, and the rest of the circuit is contained in another printed circuit assembly. As shown in Figure 4.5.20, the differential pulse generator, MPX and stop signal generator are contained in PCA 'RDA', and the VFO, 1/2 frequency divider, bit value determiner circuit, and phase error detector circuit are contained in DEIA.

Table 4.5.6 lists the input signals to PCA 'RDA' (i.e., signals to the demodulator).
Table 4.5.7 lists the signals transferred from PCA 'RDA' to PCA 'VFO'.
Table 4.5.8 lists the other input signals to PCA 'VFO'.
Table 4.5.9 lists the output signals from PCA 'VFO'.

Table 4.5.6 Input signals to PCA 'RDA'

Item	Signal name	Description
1	LWR data (WMDT0 to 8)	Data at LWR time
2	Time sense (TSNS0 to 8)	Signal for detectin the block of each track
3	VFO start (*VFOS)	Signal for resetting and then starting the VFO
4	Write clock (*WTOSC)	Basic frequency clock signal
5	Backward (BWD)	Indicates the tape direction.
6	Read loop, write read RDLWR	Indicates the LWR mode.

Table 4.5.7 Signals between PCA 'RDA' and 'VFO'

Item	Signal name	Description
1	Peak pulse (PEKP0 to 8)	Rising and falling edge pulses of the peak signal.
2	Stop signal (STOP0 to 8)	Signal for stopping the VFO at TSNS change
3	Peak signal (RDDT0 to 8)	Signal that indicates the peak points of the signal wave read from the tape.

Table 4.5.8 PCA 'VFO' input signals

Item	Signal name	Description
1	VFO start (*VFOS)	Signal that resets and then starts the VFO
2	Speed signal (*HSP)	Control signal that indicates the tape speed
3	1600 signal (B1600)	Control signal that indicates the recording density
4	High gain signal (*HIG)	Signal for changing the VFO gain
5	Phase OK (PHOK)	Signal for starting data demodulation

TAble 4.5.9 PCA 'VFO' output signals

Item	Signal name	Description
1	Read clock (*SRIC0 to 8)	Clock signal for sampling the demodulated signal
2	Demodulated data (*DEME0 to 8)	Data in binary format (i.e., "1" or "0")
3	Phase error (PHE0 to 8)	Phase error detection signal

(2) DC output

The following table lists the DC voltage sgenerated by the power supply unit:

DC output (V)	Output voltage precision (V)	Load capacity (A)	Protection circuit exists (o) does not exist (x)		
			over current	over voltage	low voltage
+ 5.0	+4.75 ∿ +5.25	17 ∿ 22	o	o	o
+ 6.0	-5.58 ∿ -6.42	1.0 ∿ 1.5	o	x	o
+12.0	+11.0 ∿ +15.0	0 ∿ 1.0	o	x	o
- 5.2	-4.94 ∿ -5.46	4.0 ∿ 6.0	o	o	o
+24.0	+22.08 ∿ +26.40	0.9 ∿ 4.8	o	x	o
-24.0	-22.08 ∿ -26.4	0.1 ∿ 6.0	o	x	o

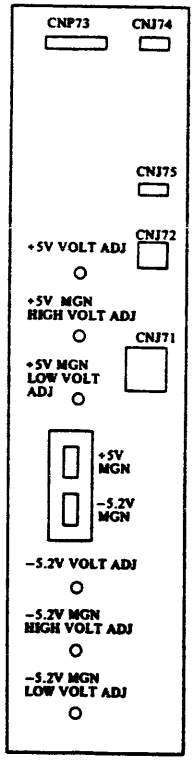
4.6 POWER SUPPLY UNIT

4.6.1 Outline

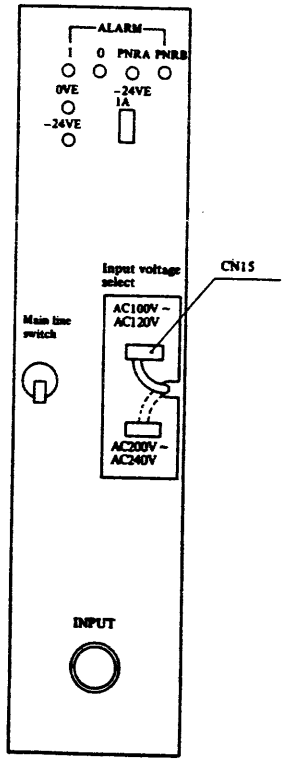
The power supply unit receives single-phase 100-120Vac or 200-240Vac, and delivers DC power necessary to operate the system. This power supply unit has the following three features:

(1) The use of switching control allows stable DC current to be supplied to the load.
(2) Over-voltage and over-current detector circuits are provided to protect the load and the power supply.
(3) A control circuit is provided for sequenced operation at the rising and falling edges of each DC power output and for displaying abnormal conditions.

The operator panel is shown below:



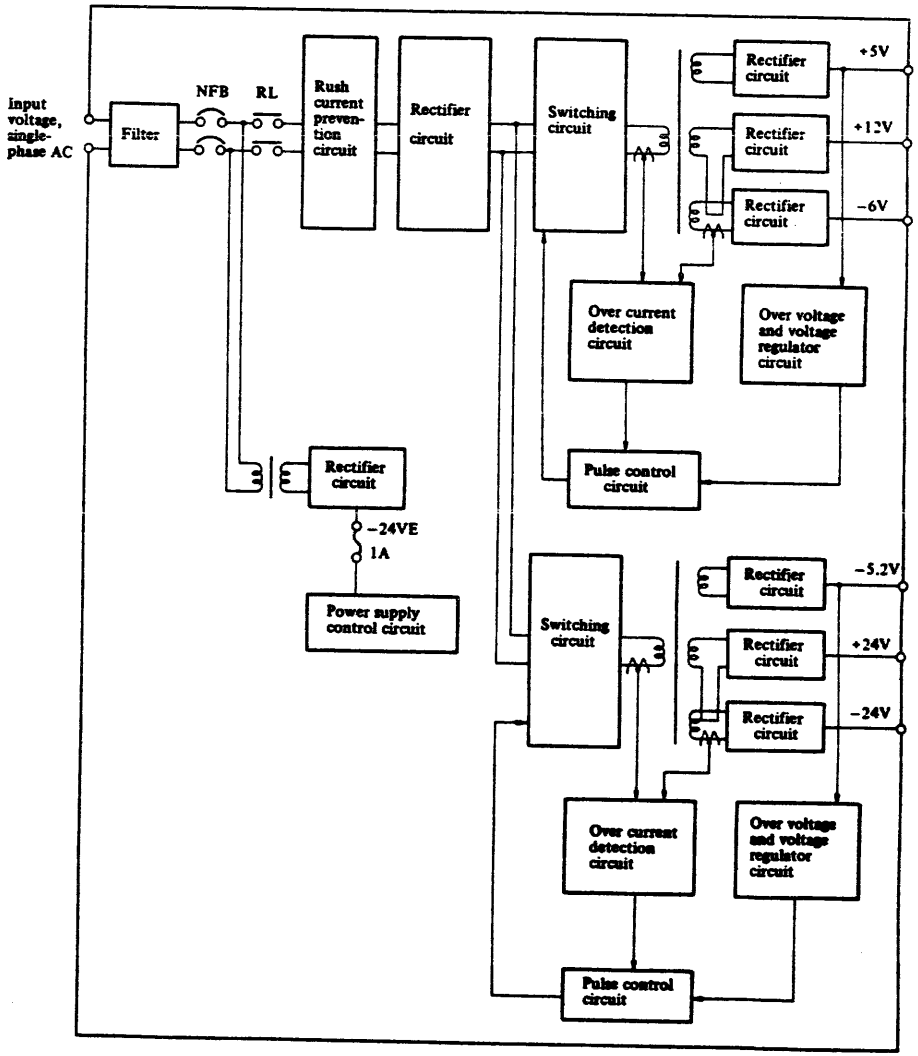
Front view



Rear view

4.6.2 Configuration

(1) Block diagram



4.6.3 Operations

(1) Turning power on/off

Power is turned on/off by the I/O switch on the front panel:
I position --- Power is on.
O position --- Power is off.

(2) Abnormal conditions

When the power supply or the load becomes abnormal, the power supply is shut off immediately, and one of the alarm LEDs lights. The alarm LEDs are:

(a) ALARM PWR A, B: Lighted when the power supply becomes abnormal.
(b) ALARM 1, 0: Lighted when locations other than the power supply become abnormal. The display indicates the alarm code.

The following table describes the meanings of the alarms:

Alarm				Description
1	0	PWRA	PWRB	
		X		(1) +5V over-voltage or over-current (2) -6V over-current (3) +12V over-current (4) Abnormal temperature in the +5V, -6V, or +12V circuit
			X	(1) -5.2V over-voltage or over-current (2) +24V over-current (3) -24V over-current (4) Abnormal temperature, the -5.2V, +24V, or -24V circuit (5) Abnormal high temperature at the rush current prevention resistor
	X			Abnormal temperature is detected (THS1) due to the stoppage of FAN1 (further away from the power supply).
X				Abnormal temperature is detected (THS2) due to the stoppage of FAN2 (closer to the power supply).
X	X			Abnormally high temperature in the power amplifier of the servo circuit.

Note: "X" indicates that the LED is lighted.

Perform power shut-off procedure before turning the power on again. Be sure that the cause of the alarm has been removed.

(3) Changing input voltages

This power supply unit can operate at either 100 to 120Vac or 200 to 240Vac. The switching is done by changing the location of connector CN15. See the operator panel view for the correct location of connector CN 15.

4.6.4 Voltage adjustment

The +5V VOLT ADJ knob adjusts the output voltage of the +5V. Turning this knob clockwise increases the absolute value of the voltage.

The -5.2V VOLT ADJ knob adjust the output voltage of the -5.2V. Turning this knob clockwise increases the absolute value of the voltage.

Note: Do not turn the following adjustment knobs; they are already adjusted before shipment:

① +5V MGN HIGH VOLT ADJ.
② +5V MGN LOW VOLT ADJ
③ -5.2V MGN HIGH VOLT ADJ.
④ -5.2 MGN LOW VOLT ADJ

4.7 CONVERSION INSTRUCTION (M244XA=›M244XAC)

4.7.1 Interface line terminator

Remove the line terminators on PCA:C16B-5327-0060#U (IC location: AE7, AJ7, AN7), when the buffer adaptor is installed.
(refer to section 2.4.2)

Also check the line terminators on PCA:B17B-0160-0010#U, remove if the drive is not located at the end of the daisy chain. (see. Figure 4.7.1.1)

4.7.2 Drive address & bus parity check setting

The setting of the drive address and the write bus parity check mode is located in PCA:C16B-5327-0060#U. It is same as M244XA. (refer to section 2.4.2)
The setting of the write bus parity check is for the drive itself and should be set to check parity because the parity of the write data between the buffer adaptor and the drive should be valid.
The write bus parity check mode for the adaptor is described section 4.

4.7.3 PCA location and cable connection

PCA parts number is B17B-0160-0010A#U and its location in the PCA shelf is 1A05. Remove two dummy board (1A04,1A05) and install the adaptor board into slot 1A05. Connect two internal cables between the buffer adaptor and the drive. Figure 4.7.2.1 shows the cable connection.

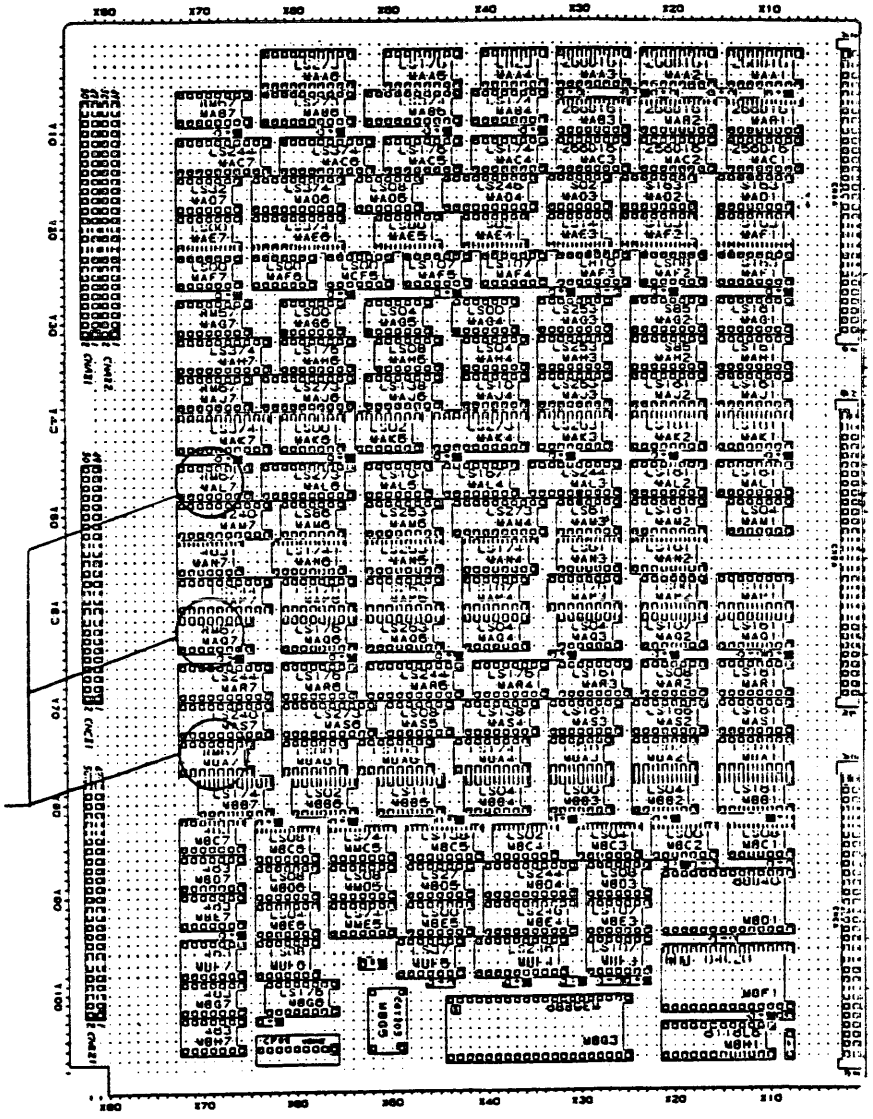
4.7.4 Buffer parameter setting

There are eight parameters for the buffer adaptor.
Table D.1 shows the parameters.

These settings can be executed by the offline diag. of the operator panel. This is nearly same as device type setting. (refer to Chapter 6, REP 2320)

(1) Set the drive to offline and servo off state.
(2) Do the items as shown in Table 4.8.
    Item 28, 29 are for the write operation into non-volatile memory.
    If it is not necessary to write into non-volatile, these items can be passed.

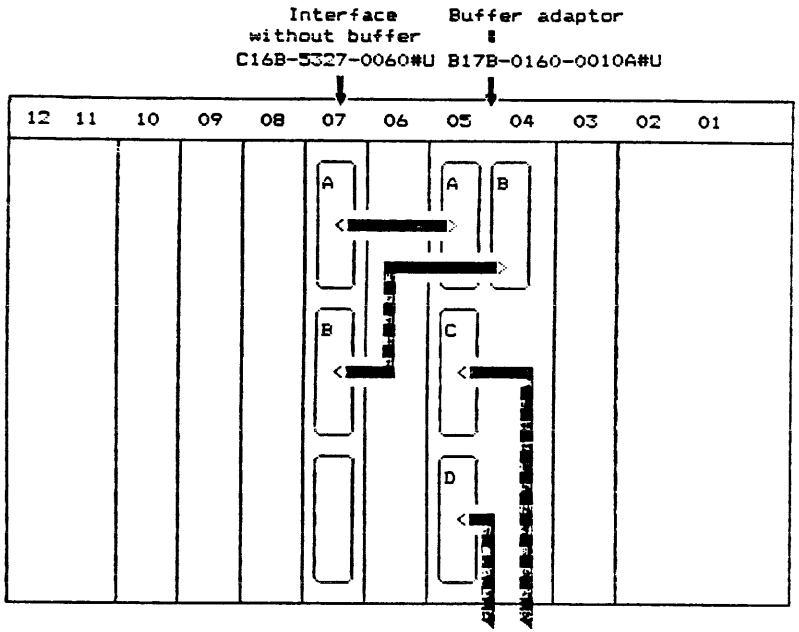
Figure 4.7.1 Overview of PCA 'BUF'



Note: 1. Three Line Terminators. (parts. NO. RM 57) (on the IC socket)

Figure 4.7.1.1.

Figure 4.7.2 Cable connection between buffer and drive



4.8.2 Theory of Operation of the Buffer Adapter

Models		M2441AC/M2442AC	M2443AC/M2444AC
Tape speed and mode		100 IPS Streaming	75 IPS Streaming
Recording density (BPI)	GCR	6250	
	PE	1600	
IBG Length (Inch)	GCR	0.3	
	PE	0.6	
Data transfer rate (KB/sec)		60 - 1,000	
Access time (write) (msec)		0.2 - 5.0 (emulated)	
Buffer size (KB)		256	
Maximum block size (KB)		64	

Note: Refer to section 2.3 for other specifications.

The buffer adapter is placed between host controller and M244XA interface. The buffer adapter can reduce restrictions on command reinstruct time and repositioning time.

In write a operation, the data transfer will start without physical tape motion and can end before the actual tape operation starts. The buffer adapter will issue write commands to the drive after data is stored in the buffer adapter. During the transferring data to the drive, the buffer adapter can accept new write commands. If the data transfer of the next command is completed before the last write command is transferred to the drive, the buffer adapter will issue the next write command within a drive reinstruct time so that the drive can maintain the streaming operation.

If the host system has a low average transfer rate, repositioning may occur. The buffer adapter will accept commands during repositioning.

In read mode, when the buffer adapter detects the read command, the adapter issues the read command to the drive and accepts the data from the drive. After a complete block of data is stored in the buffer it is then transferred to the host controller. During the transfer to the host, the adapter will prefetch data blocks so to fill the data buffer. The data which has been already stored in the buffer will be transferred to the host when the next read command is issued.

The buffer adapter can achieve the nearly same performance as the host system but the maximum performance is limited by the drive specification.

4.8.2.2 Buffer adapter features

(1) 256 Kbytes data buffer

The 256 Kbytes of buffer is used in both read and write.

(2) Partitioning of the data buffer

The data buffer is divided into 1 Kbyte segments (256 1K). The data block may share several segments.

(3) Maximum block size and buffer overwrite

The buffer adapter can handle up to 64 Kbytes for each data block. If the block length exceeds 64 Kbytes, the buffer adapter will post HER to the host in read or write or write mode.

Inside the adapter, there are some limitation to control the data buffer. Minimum 8 Kbytes, maximum 64 Kbytes are limitations. This limitation is used only in the buffer full state. There is a setting whether new data will start to transfer or not. One of the setting is that the data transfer will wait until the buffer has space for one complete block. The other option is to allow data transfer if there is 1 Kbyte or more available in the buffer. This setting is named buffer overwrite mode. (Refer to section 10.7.)

Internal limitation is automatically expanded up to 64 Kbytes, if the block length exceeds 8 Kbytes.

(4) Hardware error recovery

The adapter will try to recover by itself when the recoverable error is encountered.

In a write operation, when the adapter detects HER the same from the drive, the logical and physical head positions may not be the same so that a software recovery procedure is not practical. So the recovery is done by the adapter.
When the retry out is encountered, HER is posted to the host controller when the next command is received.
Variable length erase command is used to erase the error block in a retry operation. The adapter checks the total IBG length as a result of the retry and controls the retry limit not to exceed 3.5 m (11.5 feet) in GCR and 5 m (16 feet) in PE.
Also the adapter checks the retry times which are selectable. (Refer to section 10.7)

In a read operation, when the retry out is encountered, HER is posted to the host and software recovery is available because the logical and physical head position are the same in a read operation.
If the software tries to recover, then the retry times may be equal to (hardware retry) times (software retry).

There are 4 options (16, 8, 4, 0 times) for the retry modes which are selectable to fit the user requirements. The number of retries should be set within the timer timeout of the host controller or the operating system. During a Write retry sequence, the adapter can accept other commands.

(Note) The Total time of retry is calculated as follows;

T = (Repo. time x 1.3 + (data bytes x N) / (density x speed)) x (number of retry)

T: Total time, N: 4 (write), 2 (read)

If the retry time is specified to ''0'', the adapter will not try to recover. The recovery should be done by the operating system. In this case, every command is executed in a non-buffered mode.

EOT area

In the tape early warning area, every command will be executed with non-buffered mode.

(5) Read prefetching and the early warning area

In read type operation, if the adapter receives two consecutive read commands, the adapter will try to fill the data buffer with up to 64 blocks.

Early warning area & Logical EOT mode

The early warning area is a caution area near the EOT. It starts about 80 feet before the EOT marker.

When the adapter detects this area during a write operation, the adapter starts to measure the total length written from the beginning of the early warning area. The adapter has a setting to support logical EOT mode. If this mode is set, the adapter will post the EOT signal to the host controller when it reaches about 50 feet from the beginning of the early warning area. Before the logical EOT, up to 64 write commands will be buffered. (Refer to section 10.7 for logical EOT setting.)
If the logical EOT mode is not set, the number of blocks which can be stored in the data buffer is decreased gradually to 16, 8, 4, 2 blocks. This is done because when the adaptor finds the EOT sticker with 256 Kbytes in the buffer, it takes about 13 feet (4 m) of tape at 1600 BPI without any retry.
Table 10.2 shows the number of write commands that can be buffered. Also the retry number will be reduced to 4 with variable length erase.

In the read type operation, the adapter ignores early warning, the prefetching of the data is continued until the physical EOT. When the EOT marker is detected prefetching of the data is stopped.

Table 4.8.2 Write command buffering in early warning area of non logical EOT mode

Maximum block size	Number of commands that can be buffered	
	6250 BPI	1600 BPI
1 B - 8 KB	16	8
8 KB - 16 KB	8	4
16 KB - 32 KB	4	2
32 KB - 64 KB	2	2

(6) The head position synchronization between buffer and drive

Write operation

For the purpose of the data integrity, whole data blocks which are stored in the buffer will be written on tape prior to the execution of that command. In this case, the command which causes the synchronization of host and drive will not terminate until the complete data buffer is written to the tape. When Write Synchronize command (WSYNC) or a backward type command is issued, synchronization is executed.

There are two selectable conditions about the write tape mark command.
a. Consecutive write tape mark command are issued.
b. A write tape mark command is issued.

(Refer section 10.7 setting of buffer parameter (P5)).

Read operation

During prefetching the data from the tape, if EOT, BOT or HER from the drive is encountered, synchronization will occur. Also when the adapter receives a space file command or a command to change the direction, synchronization will occur. Also a write command issued after a read type command causes synchronization.

There are two selectable condtions about tape mark.
a. Consecutive tape marks are detected
b. A tape mark is detected

(Refer section 10.7 setting of buffer parameter (Q5)).

(7) Transfer rate

The adapter has the ability to transfer data to or from the host controller at variable transfer rates that is independent from the drive rate.
The transfer rate should not be set to exceed the maximum average transfer rate of the host controller.
There are 16 selectable rates from 60 Kbytes to 1 Mbyte. (Refer section 10.7 buffer parameter setting (P0)).

(8) Ramp delay emulation

The purpose of this feature is for the host controller to prepare the write data in its FIFO or data buffer.
There are 4 selectable setting from 0.2 msec to 5.0 msec. (Refer section 10.7 (P1)).

(9) Speed and IBG length control

The high speed select and the long gap select signal is neglected by the buffer adapter. The adapter sets the drive in high speed and ignores the LGAP signal.

4.8.3 Interface

4.8.3.1 Interface signal pin assignment

Interface signals are shown in table 10.3.

4.8.3.2 Difference between M244XAC and M244XA interface signals

(1) Signals not to be used in M244XAC model

There are three signals which are not used in the buffer adapter. The buffer adapter sets the drive to high speed, so HISP and LGAP signals are not used.

Not used signals: connector C, line 36—LGAP
connector D, line 50—HISP

(Note) If the interface mode is set to mode C (refer to Chapter 5), HISP signal means density select.

(2) Hard error (HER)

In M244XA model, hard error signal is asserted when the any error is encountered, even if it is recoverable.
In M244XAC mode, the buffer will retry by itself if a simple data check is encountered. HER is asserted only in the cases below.

a. Retry out of Data check

When a retry for a data check exceeds the limit of setting, the buffer adapter will post the HER to the host controller.
If this occures in a write operation, recovery by software is not suitable because the logical and physical records are not the same. In the case of a read operation, HER is asserted when the retry out is encountered, software recovery is available because the physical and logical record is the same.

b. Write bus parity check

When the buffer adapter detects a parity error on the write data bus, HER is posted to the host controller. In this case the previous transferred data was written on tape so software recovery can be available.

c. Buffer overwrite

When the buffer is nearly full and if new write data will exceed the rest of the buffer, HER will be posted to the host controller. In this case software recovery is also available.
If the buffer parameter is set not to post HER, the buffer adapter stops the data transfer until free space is available in the buffer and restart the data transfer.

d. Illegal command, invalid command

If the command code is illegal such as a write command in file protect status or a command code is not identified, HER is posted to the host controller.

e. Invalid sequence of interface

If the buffer detects the new go pulse during data busy, HER is posted and the last command is terminated. If the rewind or unload command is issued during data busy, HER is also posted and the last go command is terminated and then rewind or unload command will be executed.

f. Drive is offline when go pulse is issued

If the go, rewind or unload pulse is detected in the offline state, HER is posted to the host controller. Only sense command is available if the drive is in the offline state.

g. Equipment malfunction

If the buffer adapter detects a equipment malfunction of the drive of buffer itself, HER is asserted to the host controller.

h. Software will try to write or read over 64 Kbytes

If the buffer detects that the length of the data to be written or read is over 64 Kbytes, HER is posted. The buffer adapter can not handle over 64 Kbytes.

i. Not capable is detected

j. Long IBG detected

IBG should be less than 15 feet at GCR mode and less than 25 feet at PE mode.

k. Back into Load Point

(3) Corrected error (CER)

CER is not asserted usually, but can be posted with HER.

(4) Read/write strobe (RSTR/WSTR)

The pulse width is 500 nsec. The interval of the strobe varies from 1 µsec to 16.6 µsec, because the transfer rate is available from 1 Mbyte to 60 Kbytes.
Data setup and hold timing between strobe and bus is the same as the M244XA models.

4.8.3.3 Command code

Command codes are indicated by five signals lines, i.e. Edit, Write, Erase, Write file mark, Reverse.
The command decode table is shown in Table 10.4.

4.8.4 Command Operation

In this section, the difference from M244XA model is described. Basically the command operations are the same as the M244XA. (Refer to Chapter 6.)

(1) Write synchronize (WSYNC)

This command causes the adapter to synchronize the physical head position to the logical position. This means that the data to be written in the buffer will be written on the tape, one for one.
FBSY and DBSY signal are active until the complete data block in the buffer is written on the tape.

4.8.5 Sense Byte

4.8.5.1 Introduction

M244XAC has 27 bytes of sense data which indicates the error conditions. First 8 bytes of Table 10.5 are transferred to the host controller when the SNS command is received and 27 bytes are transferred for EXSNS command.
SNS or EXSNS command is very helpful for the field engineer to maintain this MTU. The operating system should issue these command to gather the error logging data when the buffer adapter posted the HER.
Also it is helpful to issue an EXSNS command at the job end, because data checks are automatically retried by EXSNS by the buffer and information regarding media quality can be transferred.

4.8.5.2 Description of the differnce from M244XA

(1) Sense byte 3, bit 7-Buffer installed

This bit is for the identification flag for M244XAC

(2) Sense byte 16, 17, 18-Sequence number of error block from BOT

These three bytes are the sequence number of the error block from BOT when the buffer adapter posted HER signal.

(3) Sense byte 19-Remaining blocks in buffer

This byte shows the remaining data blocks in the data buffer when the write retry out was encountered.
Data of remaining blocks should be lost.

(4) Sense byte 20, 21-Read retry count

These two bytes indicate the number of hardware retries for read errors.

(5) Sense byte 22, 23—Write retry count

These two bytes indicate the number of hardware retries for write error.

(6) Sense byte 24, 25—Buffer parameter

These two bytes indicate the buffer parameter which are set in non volatile memory of the drive.

(7) Sense byte 26—Device type

This byte is same as sense byte 25 of M244XA.

Table 4.8.3 Interface signals

Signal name		Pin location			Direction	
		CN	S	G	Host	MTU
Formatter busy	(FBSY)	C	02	01	←	
Last word	(LWD)	C	04	03	→	
Write data bit 4	(WD4)	C	06	05	→	
Initiate command	(GO)	C	08	07	→	
Write data bit 0	(WD0)	C	10	09	→	
Write data bit 1	(WD1)	C	12	11	→	
Unit check	(UCK)	C	14	13	←	
not used		C	16	15	→	
Reverse	(REV)	C	18	17	→	
Rewind	(REW)	C	20	19	→	
Write data parity	(WDP)	C	22	21	→	
Write data bit 7	(WD7)	C	24	23	→	
Write data bit 3	(WD3)	C	26	25	→	
Write data bit 6	(WD6)	C	28	27	→	
Write data bit 2	(WD2)	C	30	29	→	
Write data bit 5	(WD5)	C	32	31	→	
Write	(WRT)	C	34	33	→	
not used		C	36	35	→	
Edit	(EDIT)	C	38	37	→	
Erase	(ERASE)	C	40	39	→	
Write file mark	(WFM)	C	42	41	→	
not used		C	44	43	→	
Transport address 0	(TAD0)	C	46	45	→	
Read data bit 2	(RD2)	C	48	47	←	
Read data bit 3	(RD3)	C	50	49	←	
Read data parity	(RDP)	D	01	05	←	
Read data bit 0	(RD0)	D	02	05	←	
Read data bit 1	(RD1)	D	03	05	←	
Load point	(LDP)	D	04	05	←	
Read data bit 4	(RD4)	D	06	05	←	
Read data bit 7	(RD7)	D	08	07	←	
Read data bit 6	(RD6)	D	10	09	←	
Hard error	(HER)	D	12	11	←	
Tape mark detected	(TMD)	D	14	13	←	
Identification burst	(ID)	D	16	15	←	
Formatter enable	(FEN)	D	18	17	→	
Read data bit 5	(RD5)	D	20	19	←	
End of tape	(EOT)	D	22	21	←	
Offline & unload	(UNL)	D	24	23	→	
GCR mode	(GCR)	D	26	25	←	
Ready	(RDY)	D	28	27	←	
Rewinding	(RWD)	D	30	29	←	
File protect	(FPT)	D	32	31	←	
Read strobe	(RSTR)	D	34	33	←	
Write strobe	(WSTR)	D	36	35	←	
Data busy	(DBSY)	D	38	37	←	
High speed	(HSPD)	D	40	39	←	
Corrected error	(CER)	D	42	41	←	
Online	(ONL)	D	44	43	←	
Transport address 1	(TAD1)	D	46	45	→	
Formatter address	(FAD)	D	48	47	→	
High speed select	(HISP)	D	50	49	→	

Table 4.8.4 Command decode table

Interface signals					Command (Mnemonic)		
EDT	WRT	WFM	ERS	REV	Mode A	Mode B	Mode C
0	0	0	0	0	Read (RD)		
0	0	0	0	1	Backward read (BRD)		
0	0	0	1	0	Space (SP)		
0	0	0	1	1	Backspace (BSP)		
0	0	1	0	0	Space file with data (SFD)		Space file no data (SF)
0	0	1	0	1	Backspace file with data (BSFD)		Backspace file no data (BSF)
0	0	1	1	0	Space file no data (SF)		Space file with data (SFD)
0	0	1	1	1	Backspace file no data (BSF)		Backspace file with data (BSFD)
0	1	0	0	0	Write (WT)		
0	1	0	0	1	———	Set 6250 BPI (S6250) *4	———
0	1	0	1	0	Variable length erase (VERS)		
0	1	1	0	0	Write tape mark (WTM)		
0	1	1	1	0	Fixed length erase (ERS)		
1	0	0	1	0	Write synchronize (WSYNC)		
1	0	0	1	1	Sense (SNS)		
1	0	1	1	0	Set 1600 BPI (S1600)		No operation
1	0	1	1	1	Set 6250 BPI (S6250)		———
1	1	0	1	1	Extended sense (EXSNS)		
1	1	1	1	0	Data security erase (DSE)		
1	1	1	1	1	Loop write-to-read (LWR)		

Notes: 1. Mode A, B or C is selectable by the offline diag. Refer to CE manual APPENDIX.
2. —— mark means "Not defined".
3. Other commands than the above described are "Not defined" and the cause of "command reject" in sense data.
4. This command is used to set PE 3200 on other tape drives This command will set GCR mode in the M244X MTU.

Table 4.8.5 Sense byte of M244XAC

Byte	bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
0	Command reject (U)	Intervention required(U)	Device type (=1)	Equipment check (U)	Data check (U)	Command overrun (U)	Unit check	Corrected error
1	Reverse	Write	Edit	Write Tapemark	Erase	High speed	RTH2	Long gap
2	Ready status	Online status	Rewinding	File protect	GCR mode	High speed	BOT (U)	EOT
3	Tape mark detect	Illegal command (C)	Not capable (U)	Device check (E)	Operator failure (E)	Write bus parity error (D)	No (E) block detect	Buffer install
4	Data not (U) found	Noise (E)	ID burst error (U)	Uncorrectable data (D)	Format error (D)	Multi track error (D)	No (D) track pointer	EFT 4 bit P
5	ETP 7 bit 0	ETP 6 bit 1	ETP 5 bit 2	ETP 3 bit 3	ETP 9 bit 4	ETP 1 bit 5	ETP 8 bit 6	ETP 2 bit 7
6	Fault symptom code (upper byte)							
7	Fault symptom code (lower byte)							
8	Sub fault symptom code (most significant byte)							
9	Sub fault symptom code							
10	Sub fault symptom code							
11	Sub fault symptom code (least significant byte)							
12	Error servo state							
13	Error device state							
14	Start read check (FMTER)	End data check (FMTER)	Postamb error (FMTER)	Crease detect (FMTER)	IBG detect (FMTER)	Early begin (FMTER)	Slow end /begin (FMTER)	SAGC check (Note 3)
15	VRC error (UCE)	CRC error (UCE)	Skew error/ WTM error (Note 4)	MISC error (UCE)	Write trigger VRC(UCE)	Write data parity check (UCE)	Velocity change (UCE)	Envelop check

Table 4.8.5 Sense byte of M244XAC - continued

Byte	bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
16	Sequence number of error block from BOT (high order byte)							
17	Sequence number of error block from BOT (mid order byte)							
18	Sequence number of error block from BOT (low order byte)							
19	Remaining blocks in buffer to be writen on tape when retry out							
20	Read retry count (most significant byte)							
21	Read retry count (least significant byte)							
22	Write retry count (most significant byte)							
23	Write retry count (least significant byte)							
24	Buffer parameter byte 0							
25	Buffer parameter byte 1							
26	Device type							

Notes: 1. (FMTER) means the cause of format error in sense byte 4.
2. (USE) means the cause of uncorrectable error in sense byte 4.
3. In write type command, this is the cause of ID burst error in sense byte 1.
In forward read type command, this is the cause of data check or equipment check.
4. In write tape mark command, this indicates write tape mark error.
In write command, this indicates skew error.
Both case, this bit is the cause of uncorrectable error in sense byte 4.

4.8.6 Error Recovery

4.8.6.1 Procedure by using sense bytes

The operating system should check the validity of the operation with HER signal. If HER signal is asserted, the system program should issue SNS or EXSNS command to classify the error and to determine the recovery procedure. Sense bytes should be stored in the error logging file for the purpose of the maintenance. Error bits of sense bytes should be checked in the following order.

1. Equipment check
2. Command overun
3. Command reject
4. Not capable
5. Data not found
6. BOT during backward type operation except rewind or unload
7. Intervention required
8. Data check

The recovery procedure is the same for the M244XA's. (Refer to section 9.4)

4.8.6.2 Procedure by using only HER signal

The action of an abnormal condition of the buffer adapter is described in this section so that the recovery procedure should be known without using the sense command.

(1) GO pulse except sense command is accepted in intervention required state

-‹interface response›- Post HER, UCK.
-‹display of panel ›-
-‹expected action of operator›- Load a tape.
-‹expected action of software›- Retry the job.

(2) Invalid or illegal command was issued

-‹interface response›- Post HER, UCK.
-‹display of panel ›-
-‹expected action of operator›- Set the write enable ring if needed.
-‹expected action of software›- Retry the job.

(3) Not capable if detected. No hardware retry.

-‹interface response›- Post HER, UCK when the software will try to read the error block.
-‹display of panel ›-
-‹expected action of software›- Recoverable by the software but should not retry.
-‹expected action of operator›- Exchange a tape to correct one.

After this sequence;
Read or back read, back space command is acceptable.
The tape is automatically rewound to BOT and the ID burst will be written when the write command is accepted.

(4) Data not found (too long IBG). No hardware retry.

-‹interface response›- Post HER, UCK when the software will try to read the error block.
-‹display of panel ›-
-‹expected action of software›- Recoverable by the software but should not retry.
-‹expected action of operator›- Exchange a tape to correct one.

After this sequence;
Read or back read, back space command is acceptable.
The tape is automatically back spaced and spaced and normal IBG will be generated when the write command is accepted.

(5) Back into load point. No hardware retry.

-‹interface response›- Post HER, UCK and LDP.
-‹display of panel ›-
-‹expected action of software› abnormal E.O.J. if not intended.
-‹expected action of operator›

(6) Write data check

When a write command data check is detected with 0 retry or in the tape early warning area, no hardware retry is performed. In this case, the software can recover it.

-‹interface response›- Post HER, UCK.
-‹display of panel ›-
-‹expected action of software›- Issue back space and erase and reissue command.
-‹expected action of operator›-

(7) Read data check

The data check retry out on read commands is encountered the software can recover it.

-‹interface response›- Post HER, UCK.
-‹display of panel ›-
-‹expected action of software›- Issue reposition command such as back space and reissue command.
-‹expected action of operator›-

(8) GO command after write retry out

When the retry out for write data check is encountered, the software can not recover it because the software can not reposition correctly.

-‹interface response›- Post HER, UCK.
-‹display of panel ›-
-‹expected action of software›-
-‹expected action of operator›-

After this sequence, new GO pulse is accepted because of the software retry.

-‹interface response›- Post HER, UCK.
-‹display of panel ›- ''88'' ''20''
-‹expected action of software›- Job abnormal end. Issue REW or UNL command and retry the job after the tape is exchanged.
-‹expected action of operator›- Reset the drive and exchange the tape.

(9) REW or UNL command after write retry out

When the retry out for write data check is encountered, the buffer cannot post HER because of REW or UNL command is issued.

-‹interface response›- Reset READY, ONLINE and REWINDING. REW or UNL command is not executed.
-‹display of panel ›- ''88'' ''20''
-‹expected action of software›- Abnormal E.O.J. Retry the job after the tape is exchanged.
-‹expected action of operator›- Reset the drive and exchange the tape.

(10) Equipment check detected by drive

-‹interface response›- Post HER, UCK.
-‹display of panel ›- ''Cx'' ''xx'' (FSC of drive) or ''88'' ''3x''
-‹expected action of software›- abnormal E.O.J. If the FSC of display is ''88'' or ''3x'', retry the job after changing a tape.
-‹expected action of operator›- Reset the drive and exchange tape, if FSC is ''883x''. Otherwise call a field engineer.

(11) Buffer overwrite detected

-‹interface response›- Post HER, UCK.
-‹display of panel ›-
-‹expected action of software›- Retry the command after reposition a block.
-‹expected action of operator›-

(12) Write data check/buffer

When the write bus parity check or buffer data parity error is detected, data check or equipment check is set. If the data check is set, the software can recover it.

-‹interface response›- Post HER, UCK.
-‹display of panel ›- ''88'' ''51'', if the buffer data parity error of the write data is detected.
-‹expected action of software›- Retry the command if FSC is not indicated at the panel.
Abnormal E.O.J. drive. Retry the job after changing a tape.
-‹expected action of operator›- Reset the drive and exchange tape, if FSC is ''8851''.

(13) Equipment check of the buffer adapter is detected

—‹interface response›— Post HER, UCK.
—‹display of panel ›— ''88'⟷''7x''
''88'⟷''8x''
''88'⟷''Ax''
''88'⟷''Bx''
—‹expected action of software›— Abnormal E.O.J.
—‹expected action of operator›— Call a field engineer.

4.8.7 Buffer Parameter and Drive Address Setting

4.8.7.1 Drive address and bus parity check setting

The setting of the drive address and write bus parity check mode is located in PCA:C16B-5327-0060#U. It is same as the M244XA. (Refer to subsection 5.2.1.) The setting of write bus parity check is for the drive itself and should be set to check parity because the parity of the write data between the buffer adapter and the drive should be valid.
The write bus parity check mode for the adapter is described in the next section.

4.8.7.2 Buffer parameter setting

There are eight parameters for the buffer adapter.
Table 10.6 shows the parameters.

This setting can be executed by the offline diag. of the operator panel through parameter #97. (Refer to CE Manual: Adjustment.)

(1) Set the drive to offline and servo off state (the tape should be unloaded).

(2) Perform the items as shown in Table 10.7.
Item 28, 29 are for the write operation into non-volatile memory.
If P0 thru P7 has not been changed it is not necessary to write into non-volatile memory, in this case items 28 and 29 should be ignored.

Table 4.8.6 M244XAC Buffer parameter setting

Parameter & meaning	Setting	Contents
P0: Data transfer rate	00	1 MB/S
	01	888 KB/S
	02	800 KB/S
	03	727 KB/S
	04	666 KB/S
	05	615 KB/S
	06	571 KB/S
	07	533 KB/S
	08	500 KB/S
	09	470 KB/S
	0A	400 KB/S
	0B	320 KB/S
	0C	250 KB/S
	0D	200 KB/S
	0E	160 KB/S
	0F	60 KB/S
P1: Ramp delay emulation	00	0.2 msec.
	01	1.2 msec.
	02	3.0 msec.
	03	5.0 msec.
P2: Write retry times by buffer adapter	00	16 times
	01	8 times
	02	4 times
	03	0 times (always sync. soft retry OK.)
P3: Read retry times by buffer adapter	00	16 times
	01	8 times
	02	4 times
	03	0 times (soft retry OK.)
P4: Buffer overwrite Logical/Physical EOT mode	00	Stop data transfer & wait for available buffer space & Logical EOT mode
	01	Post hard error & expect soft retry buffer space & Physical EOT mode
	02	Stop data transfer & wait for available & Physical EOT mode
	03	Post hard error & expect soft retry & Physical EOT mode
P5: Buffer synchronizing	00	Write: double write tape mark command : or write sync command : direction change command - from host Read : double tape mark, EOT or BOT : or direction change command - from host
	01	Write: a write tape mark command : or write sync command : or direction change command - from host Read : single tape mark, EOT or BOT : or direction change command - from host
P6: Read strobe in write command	00	Strobe issued in write mode
	01	No read strobe during write mode
P7: Write bus parity check mode	00	Check write bus parity
	01	No check

Table 4.8.7 Buffer parameter setting procedures

Item	Switch to be pressed	7 segment	Other LED
1	TEST & START	00	TEST, HOST ON
2	UNLOAD till 7 segment LEDs indicate ''97''	00 → 97	
3 4 5	TEST & DENSITY SELECT RESET START or UNLOAD if necessary	P0 Contents UP/DOWN	6250, 1600 ON
6 7 8	TEST RESET START or UNLOAD if necessary	P1 Contents UP/DOWN	
9 10 11	TEST RESET START or UNLOAD if necessary	P2 Contents UP/DOWN	
12 13 14	TEST RESET START or UNLOAD if necessary	P3 Contents UP/DOWN	
15 16 17	TEST RESET START or UNLOAD if necessary	P4 Contents UP/DOWN	
18 19 20	TEST RESET START or UNLOAD if necessary	P5 Contents UP/DOWN	
21 22 23	TEST RESET START or UNLOAD if necessary	P6 Contents UP/DOWN	
24 25 26	TEST RESET START or UNLOAD if necessary	P7 Contents UP/DOWN	
27 28	TEST UNLOAD till 7 segment LEDs indicate "94"	00 00 → 94	6250, 1600 OFF
29	TEST & DENSITY SELECT	00	
30	RESET	00	TEST OFF

CHAPTER 5 TROUBLE SHOOTING

OUTLINE

The trouble procedure is described below. The trouble is classified into two classes. One is the power on, the other is trouble in an operation.

After turning on the power switch, the MTU power up diagnostics will take about three seconds. If there is no error, the 2 digit indicator will display ''00''. If not, pursue the troubleshooting flowchart shown in Figure 5.1.1.

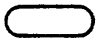
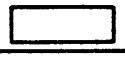
When an error occurs in the MTU operation, follow the troubleshooting flow as in Figure 5.1.2.

Note 1: It is recommended that before any replacement, or adjustment is performed chapter 6 should be read (Replacement/Adjustment) carefully and fully understand the details of the procedures and tools required.

Note 2: The location and the nicknames of printed circuit assembly (PCA) are shown in Appendix C. Refer to the Appendix if necessary.

Note 3: The following symbols shown in Table 5.1.1 are used throughout flowcharts.

Table 5.1.1 Symbol in Flowchart

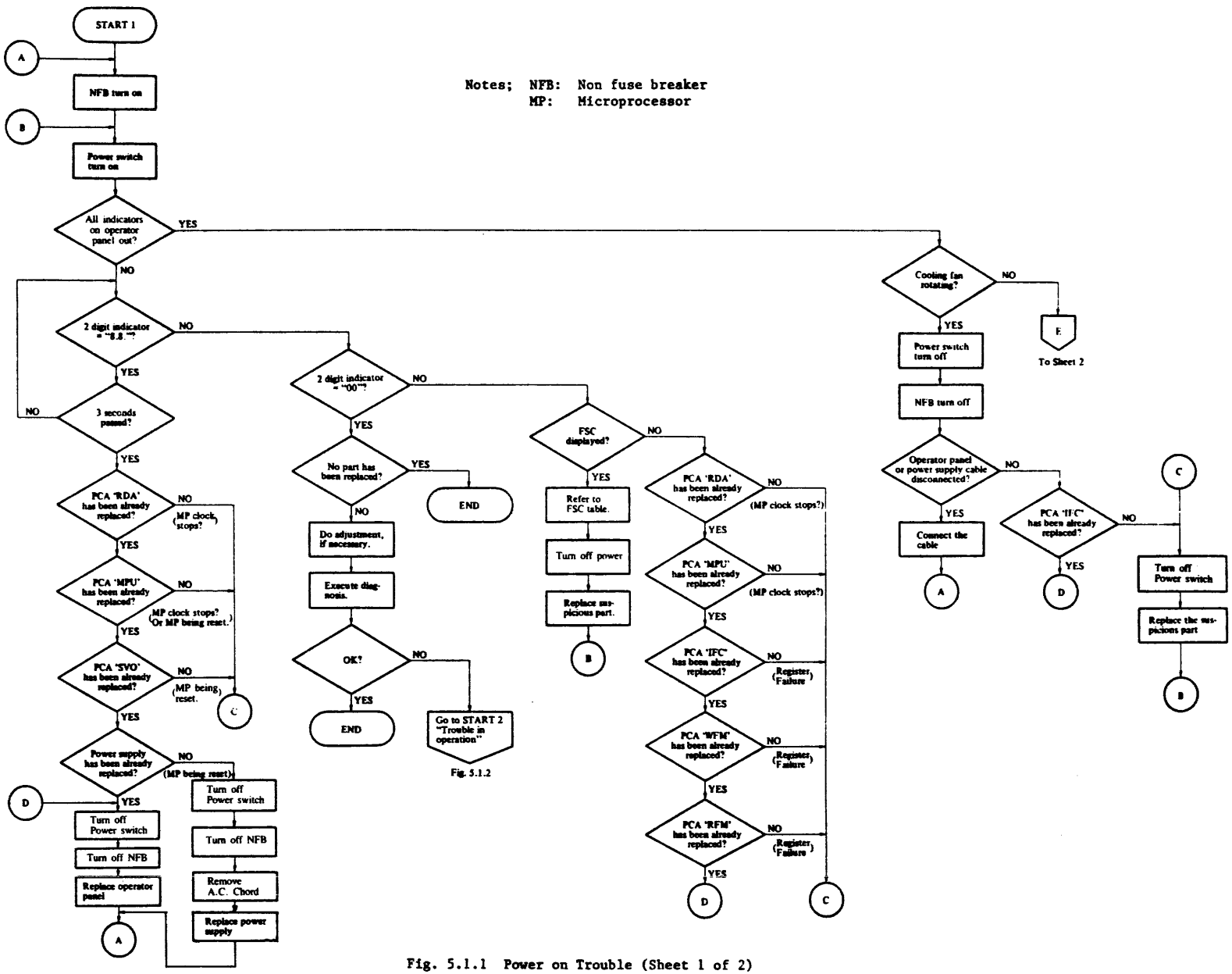
Symbol	Description
	Terminals Starting point of the trouble.
	Decision, go ahead according to YES or NO.
	Connector, go ahead same-numbered symbol in same sheet.
	Connector, go ahead same-numbered symbol in another sheet.
	Process

The detail of fault symptom code (FSC) is described after the flowcharts.

Note 4: The symbol used in the table of the FSC has the meanings as shown in Table 5.1.2.

Table 5.1.2 Symbol in FSC

Symbol	Description
●	The most suspicious part of location.
○	More suspicious part or location.
△	Suspicious part or location.



Notes; NFB: Non fuse breaker
MP: Microprocessor

Fig. 5.1.2

Fig. 5.1.1 Power on Trouble (Sheet 1 of 2)

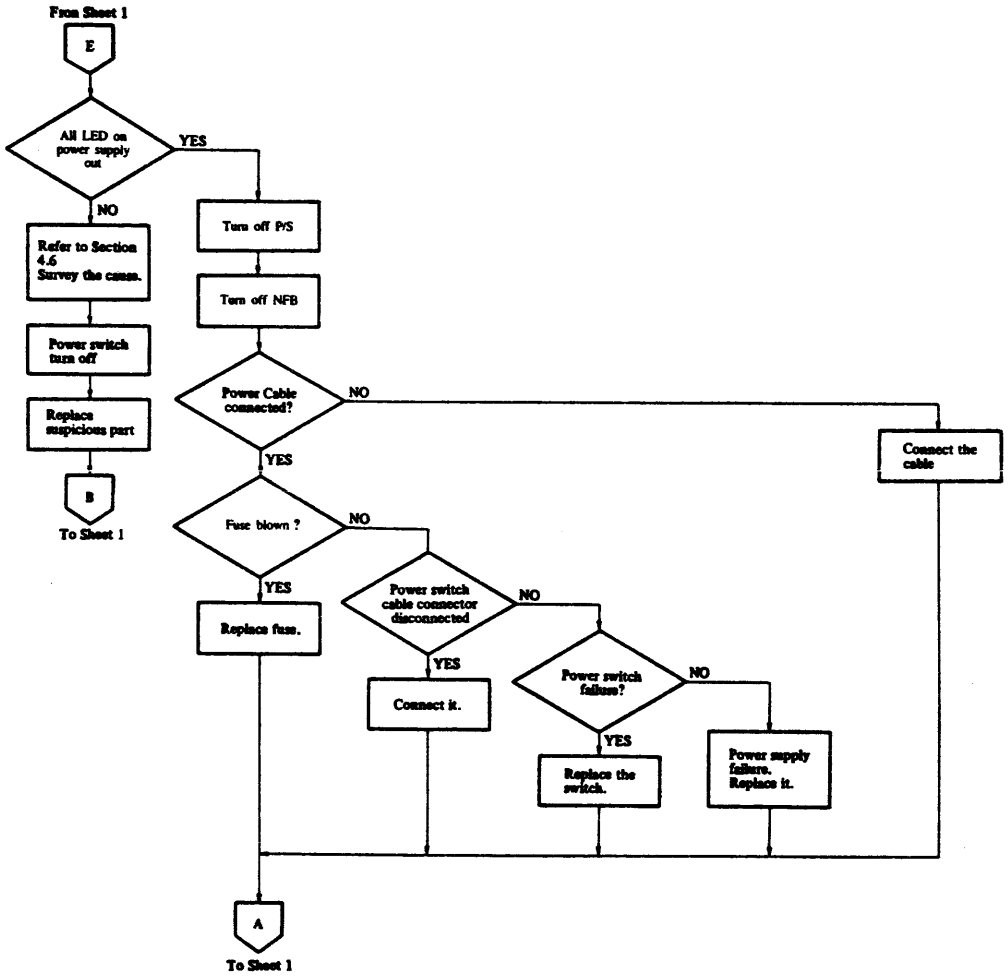


Fig. 5.1.1 Power on Trouble (Sheet 2 of 2)

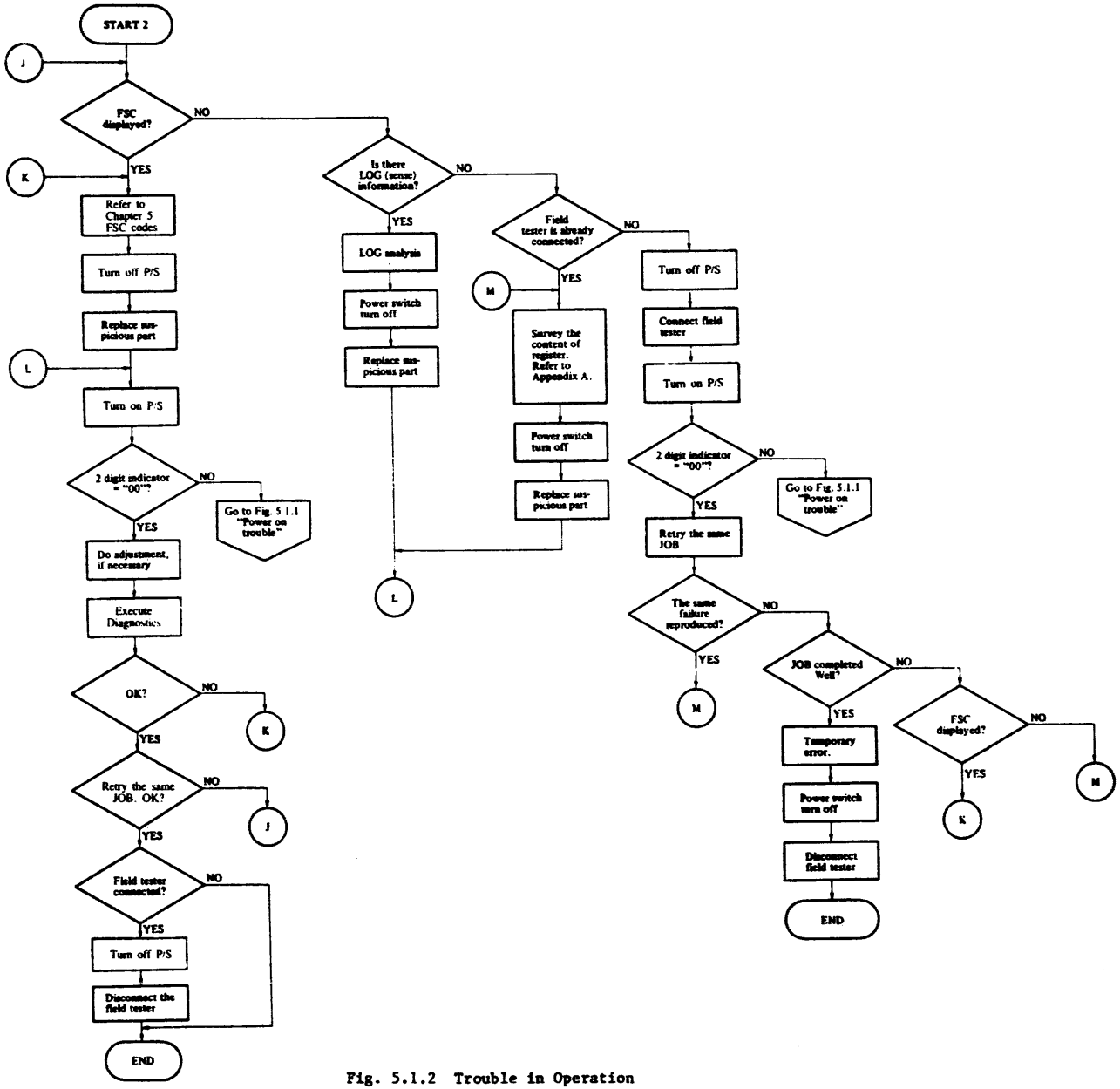


Fig. 5.1.2 Trouble in Operation

Load check code L1 to L4	CODE MAP FSC

M2441A/M2442A DLMT	MAP 1100

Load check codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
L1	◎ Operation mistake		-		Door was opened when servo was on, or when start or unload button was pushed.	
	○ Door switch		-			
	○ PCA "SVA"		-			
	△ PCA "MPU"					
L2	◎ Operation mistake		-		Reel latch was unlocked.	
	○ Write enable sensor (Reel hub lock sensor)		-			
	○ PCA "SVA"		-			
	△ PCA "MPU"		-			
L3	◎ Operation mistake		-		Tape was loose. (could not built up tension)	
	◎ Tension sensor assembly		1410			
	◎ PCA "RPA"		1110			
	○ PCA "SVA"		-			
	○ PCA "IFC"		1130			
	○ PCA "MPU"		-			
L4	◎ Magnetic tape (no BOT marker)		-		BOT marker was not found.	
	◎ BOT/EOT Sensors or adjustment		1400			
	○ Tension sensor assembly		1410			
	○ PCA "RPA"		1110			
	○ PCA "SVA"		-			
	○ Idler tachometer		1420			
	○ Reel hub assembly		1310			
	△ PCA "IFC"		1130			
	△ PCA "MPU"		-			
L5	◎ Operation mistake		-		Tape not in path. (BOT and EOT are sensed when start or unload button was pushed.)	
	◎ BOT/EOT Sensors or adjustment		1400			
	○ Magnetic tape		-			
	○ PCA "SVA"		-			
	△ PCA "RPA"		1110			
	△ PCA "MPU"		-			
	△ PCA "IFC"		1130			

M2441A/M2442A DLMT	MAP 1110

8010 to 9040	CODE MAP FSC	M2441A/M2442A DLMT	MAP 1110

Load check codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
8010	◎ PCA BUFF		-		Buffer Ram Error	
8020	◎ PCA BUFF		-		Buffer Timer Error	
8020	◎ PCA BUFF		-		Buffer W/R compare error	
8800	◎ PCA IFC o PCA BUFF		-		Command accepted in offline state	
8801	◎ Operation Error o PCA IFC o PCA BUFF		-		Command reject, Write operation in file protect state, BWD command at B.O.T.	
8802	◎ PCA BUFF o PCA WTA		- -		Data Check/Buffer Data Check/Buffer	
9000	◎ PCA BUFF		-		Timeout of BFRDY or SPCCMD	
9010	◎ PCA BUFF		-		BFRDY & SPCCMD Asserted	
9020	◎ PCA BUFF		-		SPCCMD not reset after BFTST	
9030	◎ Cable between BUFF and IFC o PCA BUFF		-		Check cable between BUFF and IFC	
9040	◎ PCA BUFF		-		Command code during MSG phase.	

Fault Symptom Codes A100	CODE MAP FSC

M2441A/2442A DLMT	MAP 1200

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
A100	◉ Host adaptor ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Command other than sense was accepted in an intervention required status.	

M2441A/2442A DLMT	MAP 1200

Fault Symptom Codes B100 to B420	CODE MAP FSC

M2441A/2442A DLMT	MAP 1210

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
B100	◎ Host adaptor ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Command reject Undefined command was issued.	
B210	◎ Host adapter ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Interface sequence error GO pulse was issued in data busy status.	
B220	◎ Host adaptor ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Interface sequence error REW pulse was issued in data busy status.	
B230	◎ Host adaptor ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Interface sequence error OFL pulse was issued in data busy status.	
B240	◎ Host adaptor ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Interface sequence error Undefined pulse was issued in data busy status.	
B310	◎ Host adapter ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Command reject Backward read type command was issued at load point.	
B320	◎ Host adapter ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Command reject Write type command was issued in file protect status.	
B420	◎ Host adapter ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Formatter address or transport address was changed in data busy was active.	

M2441A/2442A DLMT	MAP 1210

Fault Symptom Codes C002 to C114	CODE MAP FSC

M2441A/2442A DLMT	MAP 1220

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
C002 C004	◎ Fan or fan rotation detect sensor ○ Fan cables or cable assy of fan rotation detect sensor		1340 -		C002 Fan alarm 0 was detected. The fan that is further away from the power supply unit. C004 Fan alarm 1 was detected. The fan that is close to the power supply unit.	
C008	◎ PCA "SVA" △ Fan cables or cable assy of fan rotation detect sensor		- -		Thermal alarm of power amplifiers in UNIDMU was detected.	
C110	◎ Idler tachometer ◎ PCA "RPA" △ PCA "MPU" △ Poor media or soil of Read/Write head and/or transport. △ Cables between PCA "RPA" and sensors.		1420 1110 - - 1110		Missing pulses of idler tachometer	
C112	○ PCA "MPU" ○ PCA "RPA" △ Idler tachometer △ Cables between PCA "RPA" and sensors. △ Poor media or soil of Read/Write head and/or transport.		 1110 1120 1110 -		No connection between drive instruction and expected motor rotating direction	
C114	○ PCA "RPA" ○ Idler tachometer △ PCA "MPU" △ Cables between PCA "RPA" and sensors. △ Poor media or soil of Rread/Write head and/or transport.		1110 1420 - - -		Intervals of the idler tachometer pulses incorrect	

M2441A/2442A DLMT | MAP 1220

Fault Symptom Codes C120 to C208	CODE MAP FSC

M2441A/2442A DLMT	MAP 1230

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
C120 C124	◎ Sensor in the file reel tachometer ○ File reel motor ○ PCA "RPA" △ PCA "MPU" △ Idler tachometer △ Reel hub △ BOT/EOT sensor △ Cables between PCA "RPA" and sensors △ Poor media or soil of Read/Write head and/or transport.		1330 1300 1110 - 1420 1310 1400 - -		C120 Diameter of the file reel tape winding that was calculated using the output pulses of the file reel tachometer increased more than prescribed diameter increment. C124 Diameter of tape winding or the file reel that was calculated using the output pulses of the file reel tachometer was less than prescribed one.	
C122	◎ Sensor in the file reel tachometer ○ File reel motor ○ PCA RPGMU △ PCA "MPU" △ Idler tachometer △ Cables between PCA "RPA" and sensor △ Poor media or soil of Read/Write head and/or transport.		1330 1300 1110 - 1420 - -		The measured value of tape volume wound on the file reel decreased abnormally. A decrement value of diameter of tape on file reel was greater than prescribed.	
C140	◎ Sensor in the machine reel tachometer ○ Machine reel motor ○ PCA "RPA" △ PCA "MPU" △ Idler tachometer △ Cables between PCA "RPA" and △ Poor media or soil of Read/Write head and/or transport.		1330 1300 1110 - 1420 - -		C140 Diameter of the machine reel tape wound that was calculated using the output pulses of the machine reel tachometer increased more than prescribed diameter increment. C142 A decrement value of a diameter of tape wound on the machine reel was greater than prescribed. C144 A diameter of tape wound on the machine reel was less than prescribed.	
C208	◎ PCA "SVA" ○ Machine reel motor ○ Poor media or soil of Read/Write head and/or transport. △ PCA "MPU"		- 1300 - -		Amplifier saturation of the file reel motor drive circuit	

Fault Symptom Codes C210 to C400	CODE MAP FSC

M2441A/2442A DLMT	MAP 1240

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
C210	◎ PCA "SVA" ○ File reel motor ○ Poor media or soil of Read/Write head and/or transport. △ PCA "MPU"		- 1300 - -		Amplifier saturation of the machine reel motor drive circuit	
C220	◎ PCA "SVA" ○ Idler tachometer ○ File reel motor ○ Machine reel motor		- 1420 1300 1300		Over current of the reel motor drive circuit	
C240	◎ PCA "MPU" ○ PCA "IFC"		- 1130		Overflow of servo current calculation	
C281	◎ Tension sensor assembly ○ PCA "SVA" ○ PCA "RPA" ○ Idler tachometer ○ Reel hub assembly △ PCA "IFC" △ PCA "MPU" △ Poor media or soil of Read/Write head and/or transport △ Operation mistake		1410 - 1110 1420 1310 1130 - - -		Loss of tape tension during servo on	
C400	◎ PCA "SVA" ○ PCA "MPU" ○ Operation mistake △ PCA "IFC"		- - - 1130		Stop-failure of servo position	

M2441A/2442A DLMT	MAP 1240

Fault Symptom Codes C410 to C804	CODE MAP FSC

M2441A/2442A DLMT	MAP 1250

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
C410	◎ Idler tachometer		1420		Incorrect time/motion in starting or stopping	
	○ File reel motor		1300			
	○ Machine reel motor		1300			
	○ PCA "RPA"		1110			
	○ Cables between PCA "RPA" sensors		-			
	△ PCA "MPU"		-			
	△ PCA "SVA"		-			
	△ Poor media or soil of Read/Write head and/or transport		-			
C801	◎ Sensor in the file reel tachometer		1330		The file reel motor rotated too much in a tape load operation	
	○ Idler tachometer		1420			
	○ File reel motor		1300			
	○ PCA "SVA"		-			
	○ PCA "RPA"		1110			
	△ PCA "IFC"		1130			
	△ PCA "MPU"		-			
	△ Poor media or soil of Read/Write head and/or transport		-			
	△ Operation mistake		-			
C802	◎ Idler tachometer		1420		QTP counter count down at load operation	
	◎ PCA "RPA"		1110			
	○ PCA "SVA"		-			
	○ PCA "MPU"		-			
	△ Machine reel motor		1300			
C803	◎ Idler tachometer		1090		QTP counter did not count at load operation.	
	◎ PCA "RPA"		1110			
	○ PCA "SVA"		-			
	○ PCA "MPU"		-			
C804	◎ Machine reel tachometer		1330		Machine reel diameter not detected.	
	○ PCA "RPA"		1110			
	○ PCA "MPU"		-			
	△ Idler tachometer		1420			

M2441A/2442A DLMT	MAP 1250

Fault Symptom Codes C805 to C820	CODE MAP FSC

M2441A/2442A DLMT	MAP 1260

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
C805	◎ File reel tachometer ○ PCA "RPA" ○ PCA "MPU" △ Idler tachometer		1330 1110 - 1420		File reel diameter not detected.	
C807	○ Operation mistake ○ Machine reel tachometer ○ File reel tachometer ○ PCA "RPA" ○ PCA "MPU" △ Idler tachometer		 1330 1330 1110 - 1420		Reel size error	
C808	◎ File reel tachometer ○ Idler tachometer ○ File reel motor ○ PCA "SVA" △ PCA "MPU"		1330 1420 1300 - -		The file reel motor turned too fast in a tape load operation.	
C810	◎ Idler tachometer ◎ Tension sensor ○ PCA "SVA" ○ PCA "IFC" ○ PCA "MPU"		1420 1410 - 1130 -		Tape velocity check in a tape load operation	
C820	◎ Machine reel tachometer ○ Idler tachometer ○ Machine reel motor ○ PCA "SVA" △ PCA "MPU"		1330 1420 1300 - -		The machine reel motor turned too fast in a tape unload operation.	

M2441A/2442A DLMT	MAP 1260

Fault Symptom Codes C840 to C9E4	CODE MAP FSC	M2441A/2442A DLMT	MAP 1270

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
C840 ~ C85F	◎ BOT/EOT sensor ○ PCA "RPA" ○ PCA "SVA" ○ PCA "IFC" △ PCA "MPU"		1400 1110 - 1130 -		Abnormal gain of BOT/EOT sensor C84X: BOT C85X: EOT	
C870	◎ Idler tachometer ○ PCA "RPA" ○ PCA "SVA" ○ PCA "IFC"		1420 1110 - 1130		Tape speed is too slow in a load operation.	
C880 ~ C884	◎ PCA "IFC" ◎ PCA "SVA" ○ PCA "MPU" ◎ Operation mistake		1130 - - -		Data of nonvolatile memory error C880: access error C881: device identification error not establish data or converted model C882: check sum error C883: unexpected EC level is set.	
C89F	◎ Operation mistake △ PCA "IFC" △ PCA "MPU"		- 1130 -	Appendix A	ROM write command was issued without issue of set factory use command.	
C9E1	◎ Operation mistake ○ Operator panel △ Cable to operator panel △ PCA "IFC"		- 1430 - 1130		On-line mode was changed forcedly to off-line mode by pushing reset key.	
C9E2	◎ Operation mistake ◎ Door switch ○ PCA "SVA" △ PCA "MPU" △ Poor media or soil of Read/Write head and/or transport.		- 1210 - - -		Door was opened at servo on.	
C9E3	◎ Operation mistake		-		Tape load or unload operation was excuted as door in open.	
C9E4	◎ Operation mistake ○ Write enable (or Reel hub lock) sensor		- 1390		Load check Tape load operation was excuted as reel hub was unlocked.	

M2441A/2442A DLMT | MAP 1270

Fault Symptom Codes C9E7 to CA7X	CODE MAP FSC	M2441A/2442A DLMT	MAP 1280

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
C9E7	◎ Operation mistake		-		Tape was not wound on the machine reel or it was too loose.	
	◎ Tension sensor assembly		1410			
	◎ PCA "RPA"		1110			
	○ PCA UIDMU		-			
	○ PCA "IFC"		1130			
	○ PCA "MPU"		-			
CA0X CA1X	◎ PCA "MPU"		-		Tape ran away. Q-counter overflows.	
	○ PCA "RPA"		1130			
	△ PCA "SVA"		-			
CA2X CA3X	◎ Poor media or soil of Read/Write head and/or transport		-		Tape was faster or slower than standard speed. (start end velocity check)	
	○ Idler tachometer		1420			
	○ Tension sensor assembly		1410			
	△ PCA "IFC"		1130			
	△ PCA "MPU"		-			
	△ PCA "SVA"		-			
	△ Power supply unit		1500			
CA4X ~ CA7X	○ PCA "MPU"		-		CA4X, CA5X Early stop check CA6X, CA7X Late start check	
	○ PCA "SVA"		-			
	○ PCA "RPA"		1110			
	○ File reel motor		1300			
	○ Machine reel motor		1300			
	○ File reel tachometer		1330			
	○ Machine reel tachometer		1330			
	○ Operation mistake		-			
	○ Poor media or soil of Read/Write head and/or transport		-			
	○ Cable between PCA "SVA" and PCA "WTA" or between PCA "SVA" PCA "RPA"		-			
	○ Cables between PCA "RPA" and sensors		-			

M2441A/2442A DLMT	MAP 1280

Fault Symptom Codes CA8X to CD20	CODE MAP FSC

M2441A/2442A DLMT	MAP 1290

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
CA8X ∼ CAFX	◎ PCA "SVA" ○ PCA "WTA" ○ Read/Write head		- 1120 1240		Incorrect write or erase status	
CC0X	◎ Operation mistake △ PCA "IFC" △ PCA "MPU"		- 1130 -	Appendix A	Undefined servo command was issued.	
CC2X ∼ CC7X	◎ PCA "IFC" ◎ PCA "MPU"		1130 -		CC2X, CC3X A command was issued to the MTU in a not ready state CC4X, CC5X A command was issued to the MTU without BOT status. CC6X, CC7X A write command was issued to the MTU while not write enable.	
CC8X ∼ CCFX	◎ PCA "IFC" ◎ PCA "MPU"		1130 -		CC8X, CC9X An undefined command was issued. CCAX, CCBX Command was reissued on executing last one. CCCX, CCDX Microprogram out of sequence CCEX, CCFX A write command was issued to the MTU while being file protected.	
CD00 ∼ CD02	◎ PCA "MPU" ○ PCA "RDA" ○ PCA "VFO" ○ PCA "RFM" ○ PCA "WFM" ○ PCA "IFC"		- 1140 - - - 1130		Microprogram self-diagnostic error	
CD03 ∼ CD1F	◎ PCA "MPU"		-		Microprogram self diagnostic error	
CD20	◎ PCA "IFC" ○ PCA "MPU"		1130 -		RAM failure	

M2441A/2442A DLMT	MAP 1290

Fault Symptom Codes CD30 to CE2D	CODE MAP FSC

M2441A/2442A DLMT	MAP 1300

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
CD30 ∿ CD32	◎ PCA "MPU"		-		Q-counter failure	
CD33	◎ PCA "MPU" ○ PCA "IFC"		- 1130		Q-counter or register failure	
CD34 ∿ CD5F	◎ PCA "MPU"		-		Q-counter or A-counter or B-counter failure	
CD7A	◎ PCA "IFC" ○ PCA "MPU"		1130 -		MP Interrupt circuit failure	
CE01 CE02	◎ PCA "MPU" ○ PCA "RDA" ○ PCA "VFO" ○ PCA "RFM" ○ PCA "WFM" ○ PCA "IFC"		- 1140 - - - 1130		Microprogram self diagnostic error	
CE03 ∿ CE18	◎ PCA "MPU"		-		Microprogram self diagnostic error	
CE1D CE1E	◎ PCA "SVA" ○ PCA "MPU" ○ Cable between back panel and power supply unit		- - -		Register failure of power supply control	
CE1F	◎ PCA "SVA" ○ PCA "MPU" ○ Power supply unit or Fuse		- - 1500		Power supply control failure	
CE20	◎ PCA "IFC" ○ PCA "MPU"		1130 -		RAM failure	
CE21 ∿ CE23	◎ PCA "RDA" ○ PCA "MPU"		1140 -		Register failure in read circuit	
CE24 CE25	◎ PCA "MPU" ○ PCA "SVA"		- -		Register failure in write circuit	
CE29 ∿ CE2D	◎ PCA "IFC" ○ PCA "MPU"		1130 -		Register failure in servo circuit	

M2441A/2442A DLMT | MAP 1300

Fault Symptom Codes CE31 to CE41	CODE MAP FSC

M2441A/2442A DLMT	MAP 1310

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
CE31 ∿ CE33	◎ PCA "SVA" ○ PCA "MPU" ○ PCA "WRA" △ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and "RPA" △ Cable between PCA "SVA" and "WRA" or between PCA "SVA" and PCA "RPA"		- - 1120 - -		Write circuit or erase circuit failure CE31: EVCHK CE32: WLCHK CE33: WHCHK	
CE34	◎ PCA "SVA" ◎ BOT/EOT sensor ○ PCA "MPU" ○ PCA "RPA" △ Cable between PCA "RDA" and PCA "RPA" △ Cable between PCA "MPU" and PCA "RPA"		- 1400 - 1110 - -		BOT sensor or sensor circuit failure	
CE35	◎ PCA "SVA" ◎ BOT/EOT sensors ○ PCA "MPU" ○ PCA "RPA" △ Cable between PCA "RDA" and PCA "RPA" △ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" PCA "RPA"		- 1400 - 1110 - -		EOT sensor or sense circuit failure	
CE38 CE39	◎ PCA "SVA" ○ PCA "MPU"		- -		Servo amplifier failure CE38: File reel CE39: Machine reel	
CE40	◎ BOT/EOT sensors ◎ Fan alarm cable		1400 -		Cable check from back panel to power supply unit or from back	
CE41	◎ Cable between PCA "SVA" and PCA "RPA" ◎ Cable between PCA "SVA" and PCA "WRA"		-		Cable check between PCA "SVA" and PCA "RPA" or between PCA "SVA" and PCA "WTA"	

M2441A/2442A DLMT	MAP 1310

Fault Symptom Codes CE42 to CEE5	CODE MAP FSC

M2441A/2442A DLMT	MAP 1320

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
CE42	◎ Cable between PCA "SVA" and PCA "RPA" ◎ Cable between PCA "RPA" and sensors		-		Cable check between PCA "SVA" and PCA "RPA" Cable check between PCA "RPA" and sensors	
CE43	◎ Cable between PCA "MPU" and PCA "WTA"		-		Cable check between PCA "MPU" and PCA "WTA"	
CE44	◎ Cable between PCA "MPU" and PCA "RPA"		-		Cable check between PCA "MPU" and PCA "RPA"	
CE45	◎ Cable between PCA "RDA" and PCA "RPA"		-		Cable check between PCA "RDA" and PCA "RPA"	
CE49	◎ Cable between PCA "IFC" and operator panel		-		Cable check between PCA "IFC" and operator panel	
CE50	◎ PCA "IFC" ○ PCA "MPU"		1130 -		Servo table input or output failure	
CE51	◎ PCA "SVA" ○ PCA "IFC" ○ PCA "MPU"		- 1130 -		Write current control circuit failure	
CE54 ≀ CE58	◎ PCA "IFC" ○ PCA "MPU"		1130 -		Servo table read out failure	
CE70 ≀ CE9F	◎ PCA "IFC"		1130		Tension counter failure	
CEE1	◎ PCA "SVA"		-		Unsuitable PCA "SVA", refer to appendix C	See Append. C
CEE2	◎ PCA "RDA"		1140		Unsuitable PCA "RDA"	"
CEE3	◎ PCA "VFO"		-		Unsuitable PCA "VFO"	"
CEE4	◎ PCA "WTA"		-		Unsuitable PCA "WTA"	"
CEE5	◎ PCA "BUF"		-		Unsuitable PCA "BUF"	"

M2441A/2442A DLMT	MAP 1320

Fault Symptom Codes CF01 to CF73	CODE MAP FSC	M2441A/2442A DLMT	MAP 1330

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
CF01 ∼ CF0F	◕ PCA "MPU"		-		Power on diagnosis error CF01 Branch test error or ALU test error CF02 Test bit branch error CF03 AND immediate error CF04 EOR " CF05 OR " CF06 ADD " CF07 SUB " CF08 AND error CF09 OR " CF0A EOR " CF0B SUB " CF0C ADD " CF0D NAND/LSHIFT error CF0E NOR error CF0F JUMP ON register error	
CF20	◉ PCA "IFC" ○ PCA "MPU"		1130 -		Power on diagnosis error RAM test error	
CF30 ∼ CF3A	◕ PCA "IFC" ○ PCA "MPU"		1130 -		Power on diagnosis error Register set or reset test error CF30 TEST MODE bit error CF31 DTXFR register error CF32 DTXFR register clear CF33 TPSIG register set error CF34 TPSIG register reset error CF35 BUS IN register set error CF36 BUS IN register reset error CF37 IFSIG register set error	
CF40 ∼ CF45	◉ PCA "WFM" ○ PCA "IFC"		- 1130		LSI scan test error	
CF48 ∼ CF4D	◕ PCA "RFM" ○ PCA "IFC"		- 1130		LSI scan test error	
CF70 ∼ CF73	◕ PCA "MPU" ○ PCA "IFC"		- 1130		Counter test error	

M2441A/2442A DLMT	MAP 1330

Fault Symptom Codes D010 to D022	CODE MAP FSC	M2441A/2442A	MAP 1340

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
D010	◎ Poor media or soil of Read/Write head and/or transport		-		No block detected in the write command	
	○ Read/Write head		1240			
	○ PCA "WTA"		1120			
	○ PCA "RPA"		1110			
	○ PCA "SVA"		-			
	○ Cable between PCA "RDA" and PCA "RPA"		-			
	△ PCA "RDA"		1140			
	△ PCA "RFM"		-			
	△ PCA "WFM"		-			
	△ Cable between PCA "MPU" and PCA "WRA" or between PCA "MPU" PCA "RPA"		-			
D018	◎ Read/Write head		1240		Noise data detected during erase operation	
	◎ Shied Block		1370			
	○ PCA "WTA"		1120			
	○ PCA "RPA"		1110			
	○ Cable between PCA "RDA" and PCA "RPA"		-			
	△ PCA "SVA"		-			
	△ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and PCA "RPA"		-			
D020	◎ PCA "IFC"		1130		Write bus parity check at write data transfer.	
	△ Interface cable		-			
	△ Host adapter		-			
D022	◎ PCA "WFM"		-		Parity error of X-buffer BUS IN register	
	○ PCA "RFM"		-			
	○ PCA "IFC"		1130			

Fault Symptom Codes D024 to D220	CODE MAP FSC

M2441A/2442A DLMT	MAP 1350

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
D024	◎ PCA "WFM" ○ PCA "RDA" ○ PCA "VFO" ○ PCA "RFM" △ PCA "RPA" △ Poor media or soil of Read/Write head and/or transport		- 1140 - - 1110 -		CRCA was not equal to CRCB.	
D026	◎ PCA "WFM" ○ PCA "IFC"		- 1130		Parity error of X-buffer BUS OUT register	
D028	◎ PCA "WFM" ○ PCA "RPA" ○ PCA "VFO" ○ PCA "IFC"		- 1140 - 1130		Write trigger VRC error	
D110	◎ PCA "RFM" ○ PCA "RDA" ○ PCA "VFO"		- 1140 -		Control error of deskewing buffer	
D180	◎ Poor media or soil of Read/Write head and/or transport ◎ PCA "RDA" ◎ PCA "VFO" ○ PCA "RFM" ○ PCA "RPA" △ Cable between PCA "RDA" and PCA "RPA"		- 1140 - - 1110 -		VRC error	
D220	◎ Programming mistake or operation mistake ○ PCA "MPU" △ PCA "SVA" △ Read/Write head		- - - 1240		Load point was detected during BWD read type operation. BWD read type command was issued on the load point.	

M2441A/2442A DLMT	MAP 1350

Fault Symptom Codes D222 to D420	CODE MAP FSC	M2441A/2442A DLMT	MAP 1360

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
D222	◎ BOT/EOT sensor ○ Poor media or soil of Read/Write head and/or transport ○ PCA "RDA" ○ PCA "RFM" ○ PCA "IFC"		1400 - 1140 - 1130		Load point was not detected after ARA-ID detection during BWD read type operation.	
D2F0	◎ BOT/EOT sensor ○ PCA "IFC" operation mistake		1400 1130		EOT marker was detected during diagnostic forward command.	
D410	◎ Poor media or soil of Read/Write head and/or transport ○ Read/Write head ○ PCA "RPA" ○ PCA "RDA" ○ PCA "RFM" △ PCA "MPU" △ Cable between PCA "RDA" and PCA "RPA"		- 1240 1110 1140 - - -		IBG (Inter Block Gap) was not detected after identification burst detection.	
D420	○ PCA "RPA" ○ PCA "RDA" ○ PCA "RFM" △ PCA "MPU" △ Read/Write head △ Poor media or soil of Read/Write head and/of transport △ Cable between PCA "RDA" and PCA "RPA"		1110 1140 - - 1240 - -		IBG (Inter Block Gap) was not detected after tape mark detection.	

M2441A/2442A DLMT | MAP 1360

Fault Symptom Codes D480 to D840	CODE MAP FSC	M2441A/2442A DLMT	MAP 1370

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
D480	◎ Operation mistake		-		Data was not found in the prescribed tape length during FWD read type command operation.	
	○ Poor media or soil of Read/Write head and/or transport		-			
	△ Read/Write head		1240			
	△ PCA "RPA"		1110			
	△ PCA "RDA"		1140			
	△ PCA "RFM"		-			
	△ PCA "MPU"		-			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
D810	○ Tape (Media)				Tape stopped in a shorter distance than the prescribed one in the crease detection routine during a read type command operation.	
	○ Idler tachometer		1420			
	○ File reel motor		1300			
	○ Machine reel motor		1300			
	△ Tape cleaner		1230			
D820 D880	○ Idler tachometer		1420		D820 Tape speed out of the tolerance during identification burst write operation. D880 Tape speed out of the tolerance during write operation.	
	○ Tension sensor assembly		1410			
	○ File reel motor		1300			
	○ Machine reel motor		1300			
	○ PCA "SVA"		-			
	○ Cable between PCA "SVA" and PCA "WTA"		-			
	△ Cables between PCA "RPA"		-			
	△ Tape cleaner		1230			
D840	○ Idler tachometer		1420		Start velocity check occured during write operation	
	○ Tension sensor assembly		1410			
	○ File reel motor		1300			
	○ Machine reel motor		1300			
	○ PCA "SVA"		-			
	○ Cable between PCA "SVA" and PCA "WRA" or between PCA "SVA" and PCA "RPA"		-			
	○ Cables between PCA "RPA" and sensors		-			
	△ Tape cleaner		1230			

M2441A/2442A DLMT	MAP 1370

Fault Symptom Codes E002 to E204	CODE MAP FSC	M2441A/2442A DLMT	MAP 1380

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E002	◎ Program mistake or operation mistake		-		Tape mark was detected in read, space, or backspace command operation.	
E080	○ Magnetic tape		-		Data Overrun	
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	○ PCA "IFC"		1130			
E204	◎ Poor media or soil of Read/Write head and/or transport		-		Identification burst write error occured.	
	○ PCA "RDA"		1140			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	○ PCA "SVA"		-			
	○ PCA "WTA"		1120			
	○ PCA "RPA"		1110			
	○ Read/Write head		1240			
	○ Shield block		1370			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
	△ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and PCA "RPA"		-			

M2441A/2442A DLMT	MAP 1380

Fault Symptom Codes E205 to E206	CODE MAP FSC	M2441A/2442A DLMT	MAP 1390

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E205	◎ Poor media or soil of Read/Write head and/of transport		-		SAGC check occured in write type command.	
	○ PCA "RDA"		1140			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	○ PCA "SVA"		-			
	○ PCA "WTA"		1120			
	○ PCA "RPA"		1110			
	◌ Read/Write head		1240			
	△ Shield block		1370			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
	△ Cable between PCA "MPU" and PCA "WRA" or between PCA "MPU" PCA "RPA"		-			
E206	◎ Poor media or soil of Read/Write head and/or transport		-		ARA identification burst write error occured.	
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ PCA "RDA"		1140			
	△ PCA "SVA"		-			
	△ PCA "WTA"		1120			
	△ PCA "RPA"		1110			
	△ Read/Write head		1240			
	△ Shield block		1370			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
	△ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and PCA "RPA"		-			

Fault Symptom Codes E208 to E20C	CODE MAP FSC	M2441A/2442A DLMT	MAP 1400

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E208	○ Adjustment (Azimuth)		1110		Skew error occured in a write command.	
	○ Poor media or soil of Read/Write head and/or transport		-			
	○ PCA "WTA"		-			
	○ PCA "RPA"		1120			
	○ PCA "RDA"		1110			
	○ PCA "VFO"		1140			
	○ PCA "RFM"		-			
	△ Read/Write head		1240			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
	△ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and PCA "RPA"		-			
E20A E20C	◎ Poor media or soil of Read/Write head and/or transport		-		Write Tape Mark Error E20A Tape mark was not written correctly. E20C IBG after tape mark was not detected.	
	○ PCA "WTA"		1120			
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ Read/Write head		1240			
	△ Shield block		1370			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
	△ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and PCA "RPA"		-			

M2441A/2442A DLMT | MAP 1400

Fault Symptom Codes E210 to E21C	CODE MAP FSC	M2441A/2442A DLMT	MAP 1410

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E210	◎ Poor media or soil of Read/Write head and/or transport		-		Multi track error in write command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	△ Read/Write head		1240			
	△ Shield block		1370			
	△ PCA "WTA"		1120			
	△ PCA "SVA"		-			
	△ PCA "RFM"		-			
	△ PCA "WFM"		-			
	△ Adjustment (Azimuth)		2110			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
	△ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and PCA "RPA"		-			
E218 E21A E21C	◎ Poor media or soil of Read/Write head and/or transport		-		E218 IBG was detected at preamble in write command operation. E21A IBG was detected at postamble in write command operation. E21C IBG was detected after block format error occured in write command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	△ PCA "RFM"		-			
	△ PCA "WRM"		-			
	△ Read/write head		1240			
	△ Shield block		1370			
	△ PCA "SVA"		-			
	△ PCA "WTA"		1120			
	△ Adjustment (Azimuth)		2110			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
	△ Cable between PCA "MPU" and PCA "WTA" or between PCA "MPU" and PCA "RPA"		-			

M2441A/2442A DLMT	MAP 1410

Fault Symptom Codes E220 to E242	CODE MAP FSC	M2441A/2442A DLMT	MAP 1420

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E220	◎ Poor media or soil of Read/Write head and/or transport		-		Drop out was detected in the write command operation.	
	○ PCA "RDA"		1140			
	△ Adjustment (Azimuth)		2110			
E240	◎ Poor media or soil of Read/Write head and/or transport		-		Start read check occured in write command operation.	
	○ Idler tachometer		1420			
	○ Tension sensor assembly		1410			
	○ Adjustment (Read gain)		2330			
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ Read/Write head		1240			
	△ PCA "IFC"		1130			
	△ PCA "SVA"		-			
E241 E242	○ Shield block		1370		Early begin read back check was detected in write command operation	
	○ PCA "WTA"		1120			
	○ PCA "RPA"		1110			
	○ Adjustment (Read gain)		2330			
	○ PCA "RDA"		1140			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ Read/Write head		1240			
	△ PCA "MPU"		-			
	△ PCA "SVA"		-			

M2441A/2442A DLMT | MAP 1420

Fault Symptom Codes E244 to E282	CODE MAP FSC	M2441A/2442A DLMT	MAP 1430

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E244	◎ Poor media or soil of Read/Write head and/or transport		-		Slow begin read back check Beginning of data was not detected within the specified time.	
	○ Idler tachometer		1420			
	○ Sensor in the file reel tachometer		1330			
	○ Sensor in the machine reel tachometer		1330			
	○ File reel motor		1300			
	○ Machine reel motor		1300			
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	○ Read/Write head		-			
	△ PCA "IFC"		1130			
	△ PCA "MPU"		-			
	△ Tension sensor assembly		1410			
E260 E262 E264	○ Poor media or soil of Read/Write head and/or transport		-		E260 CRC error was detected in the write command operation. E262 CRCB was not equal to CRCD in GCR mode in a write command operation. E264 CRCB was not equal to CRCC in PE mode in a write command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WRM"		-			
	△ Read/Write head		1240			
	△ Adjustment Azimuth)		2110			
	△ Adjustment (Read gain)					
E280 E282	○ Poor media or soil of Read/Write head and/or transport		-		E280 End data check was detected in the write command operation. E282 Postample error was detected in the write command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ Adjustment (Read gain)		2330			

M2441A/2442A DLMT	MAP 1430

Fault Symptom Codes E284 to E310	CODE MAP FSC	M2441A/2442A DLMT	MAP 1440

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E284	○ Poor media or soil of Read/Write head and/or transport		-		Slow end read back check was detected in the write command operation.	
	○ Idler tachometer		1420			
	○ Sensor in the file reel motor		1330			
	○ Sensor in the machine reel motor		1330			
	○ File reel motor		1300			
	○ Machine reel motor		1300			
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "RFM"		-			
	△ BOT/EOT sensor		1400			
	△ PCA "MPU"		-			
	△ PCA "SVA"		-			
	△ Adjustment (Read gain)		2330			
E302 E305	◎ Operation mistake		-		E302 Not capable in read or space command operation (The cause is the recorded density on tape differs from what the host expected.) E305 SAGC check was detected in read, space, or space file command.	
	○ Poor media or soil of Read/Write head and/or transport		-			
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "RFM"		-			
	○ Read/Write head		-			
	○ Cable between PCA "RDA" and PCA "RPA"		-			
E310	◎ Poor media or soil of Read/Write head and/or transport		-		Multi-track error was detected in read command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	△ Read/Write head		1240			
	△ PCA "RFM"		-			
	△ PCA "WFM"		-			
	△ Adjustment (Read gain)		2330			
	△ Cable between PCA "RDA" and PCA "RPA"		-			

M2441A/2442A DLMT | MAP 1440

Fault Symptom Codes E318 to E31C	CODE MAP FSC	M2441A/2442A DLMT	MAP 1450

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E318	◎ Poor media or soil of Read/Write head and/or transport		-		IBG was detected before preamble was recognized in read command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	○ PCA "MPU"		-			
	△ PCA "SVA"		-			
	△ Read/Write head		1240			
	△ Adjustment (Read Gain)		-			
	△ Idler tachometer		-			
	△ File reel motor		-			
	△ Machine reel motor		-			
E31A E31C	◎ Poor media or soil of Read/Write head and/or transport		-		E31A IBG was detected before postamble was recognized in read command operation. E31C IBG was detected before the correct length of postamble was detected.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ Adjustment (Read Gain)		2330			
	△ Read/Write head		1240			
	△ Cable between PCA "RDA" and PCA "RPA"		-			

M2441A/2442A DLMT	MAP 1450

Fault Symptom Codes E320 to E368	CODE MAP FSC	M2441A/2442A DLMT	MAP 1460

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E320	◎ Poor media or soil of Read/Write head and/or transport		-		Skew error was detected in read command operation.	
	◎ PCA "RDA"		1140			
	◎ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "RPA"		1110			
	○ Adjustment (Azimuth)		2110			
	△ Cable between PCA "RDA" and PCA "RPA"		-			
E340	○ Poor media or soil of Read/Write head and/or transport		-		Start read check occured in read command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	△ Adjustment (Read gain)		2110			
	△ PCA "MPU"		-			
	△ PCA "SVA"		-			
	△ Idler tachometer		1420			
	△ File reel motor		1300			
	△ Machine reel motor		1300			
E360 E362 E368	○ Poor media or soil of Read/Write head and/or transport		-		E360 CRC error was detected in read command operation. E362 CRCB was not equal to CRCD in read. E368 CRCC was irregular in read.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ Read/Write head		1240			
	△ Adjustment (Azimuth, Read gain)		2110			

Fault Symptom Codes E380 to E41C	CODE MAP FSC	M2441A/2442A	MAP 1470

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E380	○ Poor media or soil of Read/Write head and/or transport		-		End data check was detected in read command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ Adjustment (Read gain)		2110			
	△ Read/Write head		1240			
	△ PCA "MPU"		-			
	△ PCA "SVA"		-			
E382	○ Poor media or soil of Read/Write head and/or transport		-		Postamble error was detected in read command operation.	
	○ PCA "RPA"		1110			
	○ PCA "RDA"		1140			
	○ PCA "VFO"		-			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	△ Adjustment (Read gain)		2110			
E408 E410 E418	◎ PCA "RDA"		1140		Error in loop-write-to-read E408 Skew error occured. E410 Multi-track error occured. E418 Start read check (IBG was detected before preamble was recognized.)	
	◎ PCA "RFM"		-			
	◎ PCA "WFM"		-			
	○ PCA "VFO"		-			
E41A E41C	◎ PCA "VFO"		-		Error in loop-write-to-read E41A IBG was detected in data area. E41C IBG was detected after block format error occured.	
	◎ PCA "RFM"		-			
	◎ PCA "WFM"		-			
	○ PCA "RDA"		1140			

M2441A/2442A DLMT	MAP 1470

Fault Symptom Codes E420 to E4E9	CODE MAP FSC

M2441A/2442A DLMT	MAP 1480

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
E420	◎ PCA "RDA" ◎ PCA "RFM" ◎ PCA "WFM"		1140 - -		Drop out was detected in loop write to read command operation.	
E440 ~ E482	◎ PCA "VFO" ◎ PCA "RFM" ◎ PCA "WFM" ○ PCA "RDA"		- - - 1140		Error in loop-write-to-read E440 Start read check occured. E460 CRC error E463 CRCB was not equal to CRCD in GCR mode. E464 CRCB was not equal to CRCC in PE mode. E480 End data check was detected. E482 Postamble error was detected.	
E484	◎ PCA "RDA" ◎ PCA "RFM" ◎ PCA "WFM" ○ PCA "VFO"		1140 - - -		Error in loop-write-to-read Slow end read back check was detected.	
E4E0 ~ E4E9	◎ PCA "RDA" ◎ PCA "RFM" ◎ PCA "VFO" ○ PCA "WFM" ○ PCA "IFC" ○ PCA "MPU"		1140 - - - 1130 -		Error in operator panel diagnostics E4E0: Time sensor error (some track is set.) E4E1: Time sensor error (time sensor is not set.) E4E2: DIBC is not set before testing. E4E3: DBOB is not set. E4E4: DNOIS is not set. E4E5: HBLK is not set. E4E6: HNOIS is not set. E4E7: DTM is not set. E4E8: HTM is not set. E4E9: DARA is not set.	

M2441A/2442A DLMT | MAP 1480

Fault Symptom Codes F001 to F200	CODE MAP FSC

M2441A/2442A DLMT	MAP 1490

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
F001 ↓ F003	◎ PCA "IFC" ◎ PCA "MPU"		1130 -		Error in operator panel diagnostics F001: Time out trap enable of DVC before CMISSU F002: Time out of command acceptance from IFC to DVC F003: Time out of reset acceptance of DVC	
F110	◎ PCA "RDA" ◎ PCA "RFM" ◎ PCA "VFO" ○ PCA "WFM" ○ PCA "IFC" ○ PCA "MPU"		1140 - - - 1110 -		Unmatch error track at LWR mask test	
F120 ↓ F130	◎ Magnetic tape ◎ Tape path ○ PCA "RDA" ○ PCA "RFM" ○ PCA "WTA" ○ PCA "VFO" ○ Head assembly △ PCA "WFM" △ PCA "IFC" △ PCA "SVA" △ Cable between PCA "RDA" and PCA "RPA" △ Cable between PCA "MPU" and PCA "WRA" or PCA "MPU" and PCA "RPA"		- - 1140 1120 1110 - 1240 - 1130 - - -		Error detection or correction test F120: Unmatch error track F122: One or two correction is not set. F123: Data check is not set. F124: Data check is set. F125: Multi-track error is not set. F130: WTM error is not set.	
F200	◎ PCA "MPU" ○ Idler tachometer assembly ○ PCA "RPA" ○ PCA "IFC" ○ Cable PCA "MPU" and PCA "WTA" or PCA "MPU" and PCA "RPA" ○ Cable PCA "RPA" and sensors		- 1420 - 1110 -		Tacho counter overflow error	

M2441A/2442A DLMT	MAP 1490

Fault Symptom Codes F300 to FF00	CODE MAP FSC

M2441A/2442A DLMT	MAP 1500

Fault symptom codes	Suspected faulty location	Go to			Explanation	Other unit MAP No.
		MAP No.	REP No.	TEST No.		
F300	◉ Magnetic tape		-		Write SAGC error in Read level test	
	◉ Wear of tape path		-			
	○ PCA "RDA"		1140			
	○ PCA "WTA"		1120			
	○ PCA "RPA"		1110			
	○ Head assembly		1240			
F310	◉ Magnetic tape		-		Read level is not enough.	
	○ Wear of tape path		-			
	○ PCA "RDA"		1140			
	○ PCA "RPA"		1110			
	○ Head assembly		1240			
F320	◉ Tape path (shield block)		1370		Feed through test error	
	◉ Head assembly		1240			
	◉ PCA "RDA"		1140			
	◉ PCA "WTA"		1120			
	○ PCA "RDA"		1110			
	○ PCA "RFM"		-			
	○ PCA "WFM"		-			
	○ Magnetic tape		-			
	○ Wear of tape path		-			
F340	◉ Tape path		-		PE read amplifier gain adjustment error (gain too high)	
	◉ Wear of tape path		-			
	◉ Magnetic tape		-			
	◉ Head assembly		1240			
	○ PCA "RDA"		1140			
	○ PCA "RPA"		1110			
FF00	◉ Operation mistake		-		Already in test mode by field tester	
	△ PCA "MPU"		-			
	△ PCA "IFC"		1130			

M2441A/2442A DLMT	MAP 1500

CHAPTER 6 MAINTENANCE

REP 1000	REPLACEMENT, CHECK AND ADJUSTMENT

General

REP 1010	GENERAL PRECAUTIONS

Replacement

REP 1050	MAGNETIC TAPE PANEL OPENING/CLOSING
REP 1100	PCA REPLACEMENT (GENERAL)
REP 1110	PCA 'RPA' REPLACEMENT
REP 1120	PCA 'WTA' REPLACEMENT
REP 1130	PCA 'IFC' REPLACEMENT
REP 1140	PCA 'RDA' REPLACEMENT
REP 1150	PCA 'SVA' REPLACEMENT
REP 1200	POWER SWITCH REPLACEMENT
REP 1210	DOOR SWITCH REPLACEMENT
REP 1220	ROLLER CATCH REPLACEMENT
REP 1230	TAPE CLEANER REPLACEMENT
REP 1240	READ/WRITE HEAD REPLACEMENT
REP 1300	REEL MOTOR ASSEMBLY REPLACEMENT
REP 1310	REEL HUB ASSEMBLY REPLACEMENT
REP 1320	MACHINE REEL REPLACEMENT
REP 1330	REEL TACHO REPLACEMENT
REP 1340	RIGHT/LEFT FAN REPLACEMENT
REP 1350	GUIDE REPLACEMENT
REP 1360	UPPER/LOWER FLANGE REPLACEMENT
REP 1370	SHIELD BLOCK REPLACEMENT
REP 1380	LOADING FAN REPLACEMENT
REP 1390	WRITE ENABLE SENSOR REPLACEMENT
REP 1400	BOT/EOT SENSOR ASSEMBLY REPLACEMENT
REP 1410	TENSION SENSOR ASSEMBLY REPLACEMENT
REP 1420	IDLER TACHO ASSEMBLY REPLACEMENT
REP 1430	OPERATOR PANEL REPLACEMENT
REP 1440	FILTER REPLACEMENT
REP 1500	POWER SUPPLY REPLACEMENT

Check and Adjustment

REP 2010	OUTPUT VOLTAGE CHECK AND ADJUSTMENT
REP 2110	AZIMUTH CHECK AND ADJUSTMENT
REP 2210	TENSION SENSOR CHECK AND ADJUSTMENT
REP 2220	IDLER TACHO CHECK AND ADJUSTMENT
REP 2310	BOT/EOT GAIN ADJUSTMENT
REP 2320	DEVICE TYPE/EC LEVEL/BOT GAIN/EOT GAIN
REP 2330	PE READ GAIN SETTING

REP 1010	GENERAL PRECAUTIONS

General Precautions

1. The power must be turned off before replacing part.
2. Correctly calibrated tools must be used.
3. Be careful not to lose any removed screws, washers and nuts.
4. Any part that falls into the equipment must always be removed.
5. Remember the conditions prior to replacement for the convenience of checking parts and performance.
6. When the part listed below table is replaced, it affects the machine revision, thereby checking the part revision and rewriting the machine revision. (IE IC. LEVEL REP 2320-1)

REP 1050	MAGNETIC TAPE PANEL OPENING/CLOSING

1. M2441/M2443

(A) Opening the magnetic tape panel

Open the top cover.

Loosen the screw A.

While pushing pin B on the left side of frame, pull up the magnetic panel until it is held by a latch.

(B) Closing the magnetic tape panel

While pushing pin B on the left side of frame, push down the magnetic tape panel.

Fasten the screw A.

Close the top cover.

2. M2442/M2444

(A) Opening the magnetic tape panel

Open the front cover.

Loosen the two screws A.

Pull the magnetic tape panel by the handle.

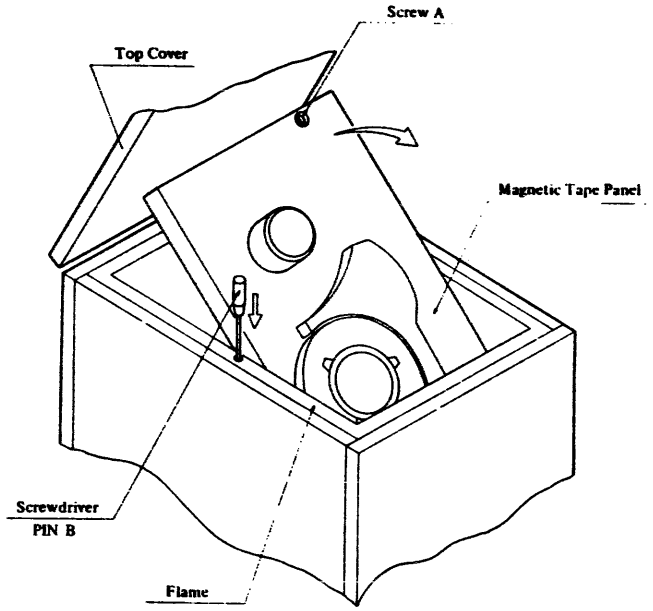
(B) Closing the magnetic tape panel

Push the magnetic tape panel with the handle.

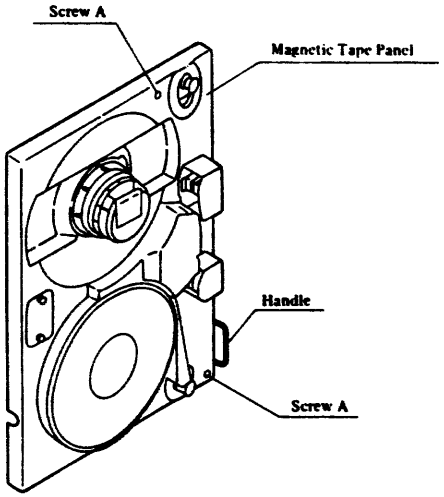
Fasten the screws A.

Close the front door.

M2441/M2443



M2442/M2444



REP 1100	PCA REPLACEMENT (GENERAL)

Note 1; **This section is applieded to each printed circuit assembly (PCA) located in shelf.**
Note 2; In the case of the standalone. it is necessary to open the rear cover. The method is shown in the chapter 2. Fig. 2.2.2

Removal

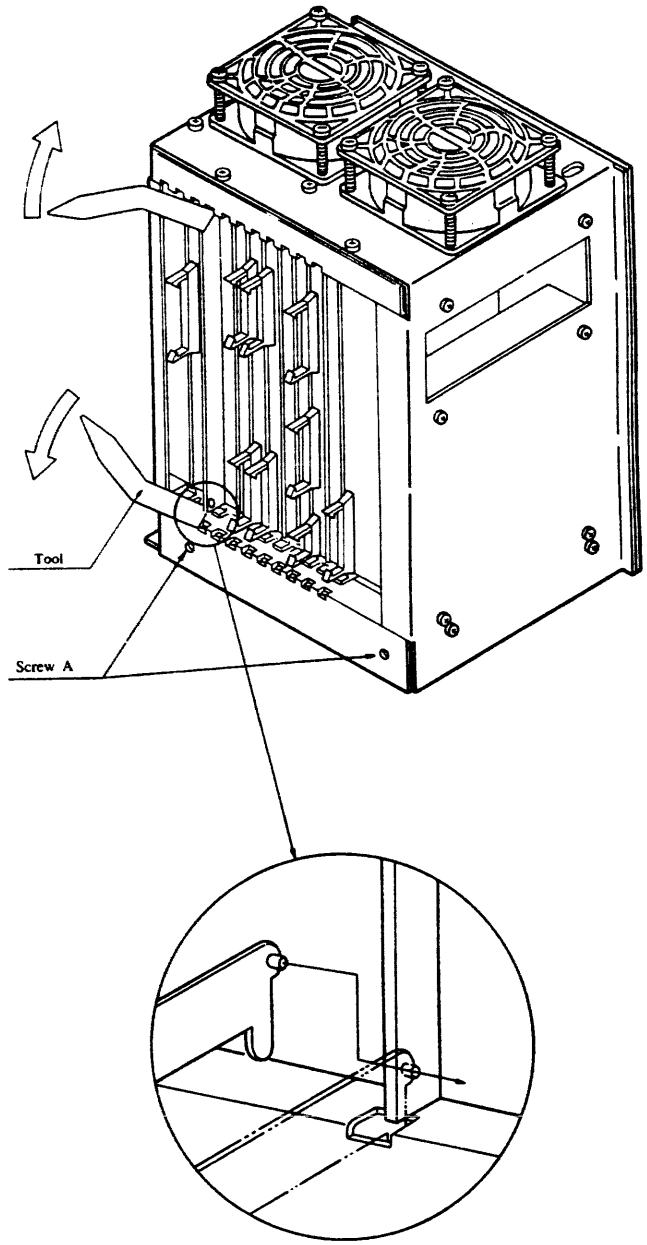
1. Loosen screw 'A' and lower card guide plate
2. Disconnect all the connectors attached to the PCA.
3. Extract the PCA using the tool.

Replacement

1. **Insert the PCA by sliding in the upper and lower grooves.**
2. **Insert firmly by using the tool.**
3. **Connect all the connectors attached to the PCA.**
4. Raise card guide plate and secure screws 'A'.

Check and Adjustment

Some PCAs require checks/adjustments
Look at the specified section/instructions.



REP 1110	PCA 'RPA' REPLACEMENT

Removal

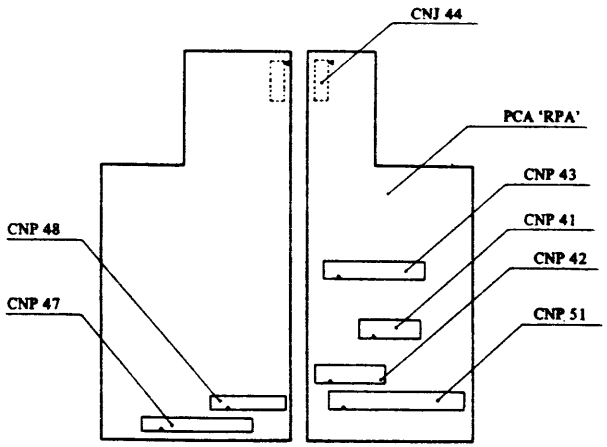
1. Disconnect all the connectors CNJ41, 42, 43, 47, 48, 51 on PCA 'RPA' and 'WTA'.
2. Remove four screws 'A' which fasten the head block, then detach the head assembly including the read/write head, 'RPA', 'WTA' and bracket.
3. Remove the 'SG' (signal ground) wire which connects between PCA 'RPA' and read/write head, detaching screw 'B'.
4. Release the two nylon latches that support 'RPA', and then disconnect the connector CNJ44 located on PCA 'RPA' from read side head connector.
5. Remove the 'RPA' from the bracket.

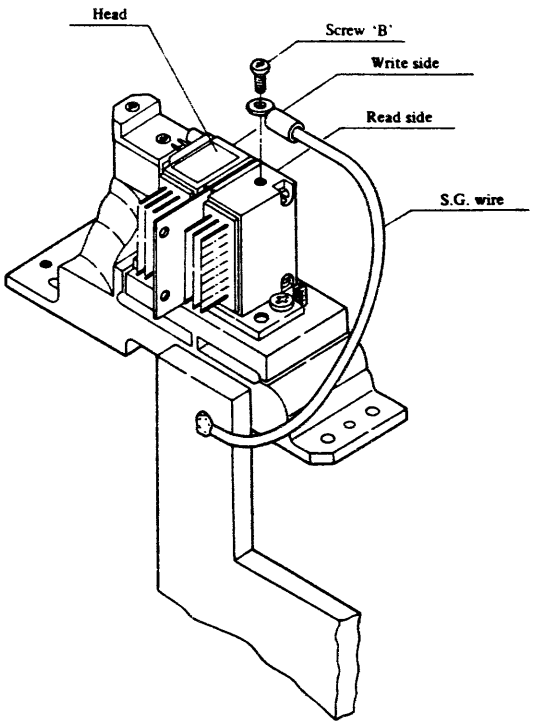
Replacement

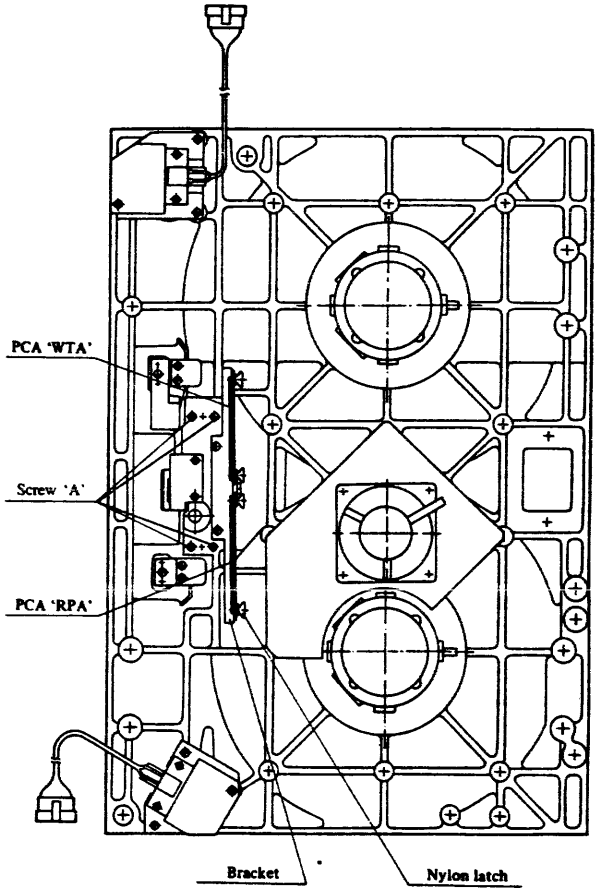
1. Insert the connector CNJ44 into the read side head connector.
2. Attach the PCA 'RPA' to the bracket and fasten the nylon latches.
3. Connect the 'SG' wire to the read/write head with the screw 'B'.
4. Attach the head assembly to the casting panel and fasten the four screws 'A' tightly.
5. Connect all the connectors CNJ 41, 42, 43, 47, 48, 51 to the PCA 'RPA' and to the PCA 'WTA'.

Check and adjustment

After this replacement, check and adjustment is required.
Refer to the REP 2110, 2210, 2220, 2330.







REP 1120	PCA 'WTA' REPLACEMENT

Removal

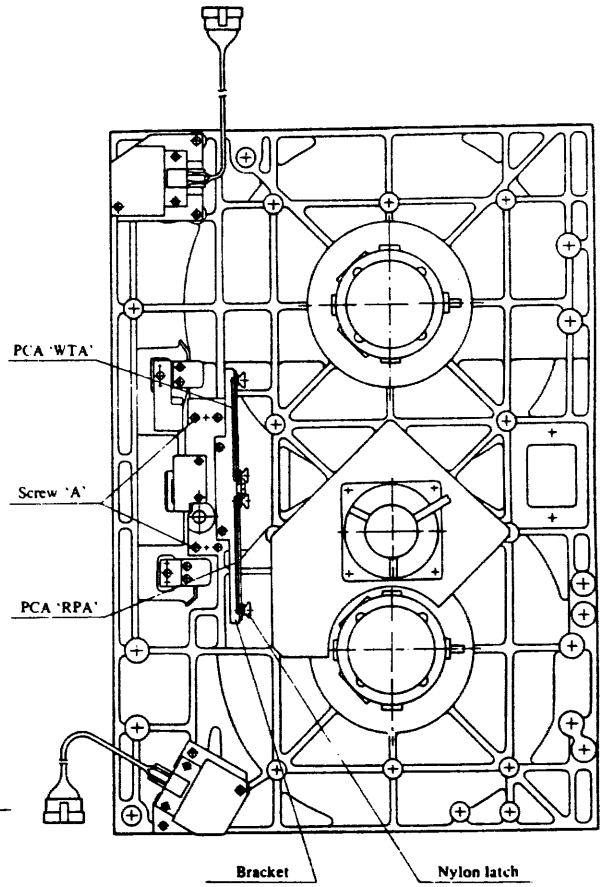
1. Disconnect all the connectors CNJ41, 42, 43, 47, 48, 51 on PCA 'RPA' and 'WTA'.
2. Remove four screws 'A' which fasten the head block, then detach the head assembly including the read/write head, the 'RPA', the 'WTA' and the bracket.
3. Release the two nylon latches that support 'WTA', and then disconnect the connector CNJ45 located on PCA 'WTA' from write side head connector. Disconnect the connector CNJ46 connected to erase head.
4. Remove the 'WTA' from the bracket.

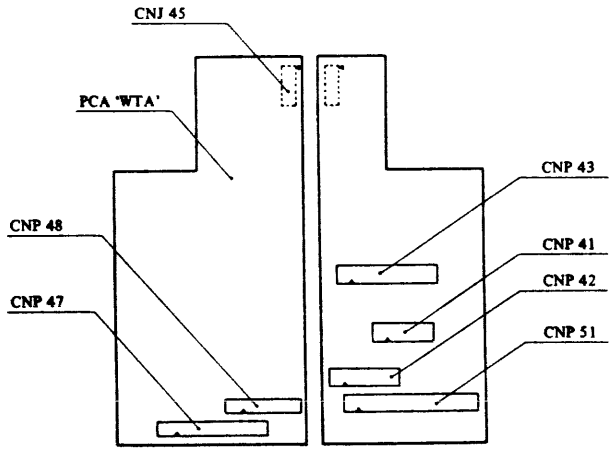
Replacement

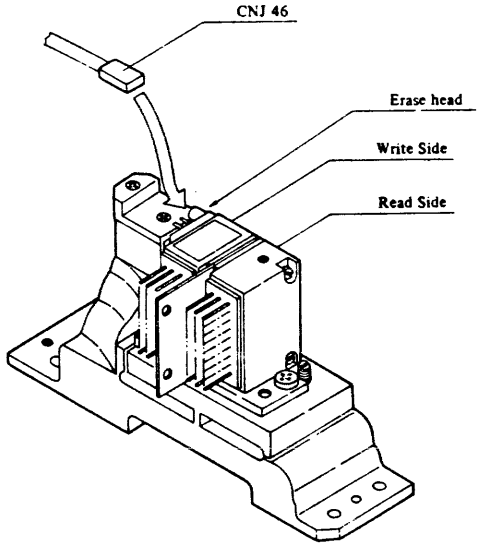
1. Connect the write head connector CNJ45 into the write side head connector and the erase head connector CNJ46.
2. Attach the PCA 'WTA' to the bracket and fasten the two nylon latches.
3. Attach the head assembly to the casting panel and tightly fasten the four screws to mount head block.
4. Connect all the connectors CNJ41, 42, 43, 47, 48, 51 to the PCA 'RPA' and the PCA 'WTA'.

Check and Adjustment

After this replacement, check and adjustment is required.
Refer to the REP 2110, 2330.







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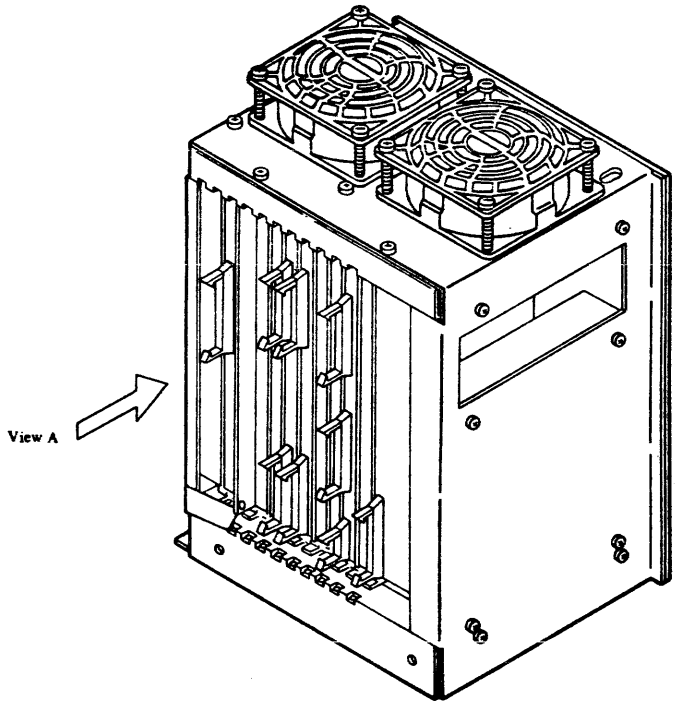
REP 1130	PCA 'IFC' REPLACEMENT

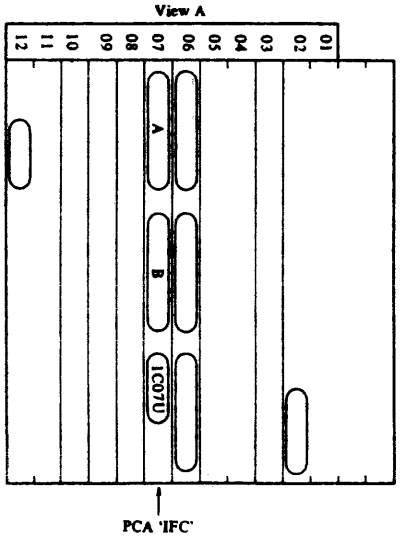
Removal

1. Separate connectors ''A'' and ''B'', and ''1C07U'' form the PCA 'IFC'.
2. Remove the PCA 'IFC' from the slot number 1A07.
   Refer to the REP 1100.

Replacement

1. Set device address and write bus parity check function on the new PCA.
   Refer to the Fig. 2.4.2.
2. Insert the new PCA in the slot number 1A07.
   Refer to the REP 1100.
3. Attach the connectors to the PCA.





REP 1150	PCA 'SVA' REPLACEMENT

Removal

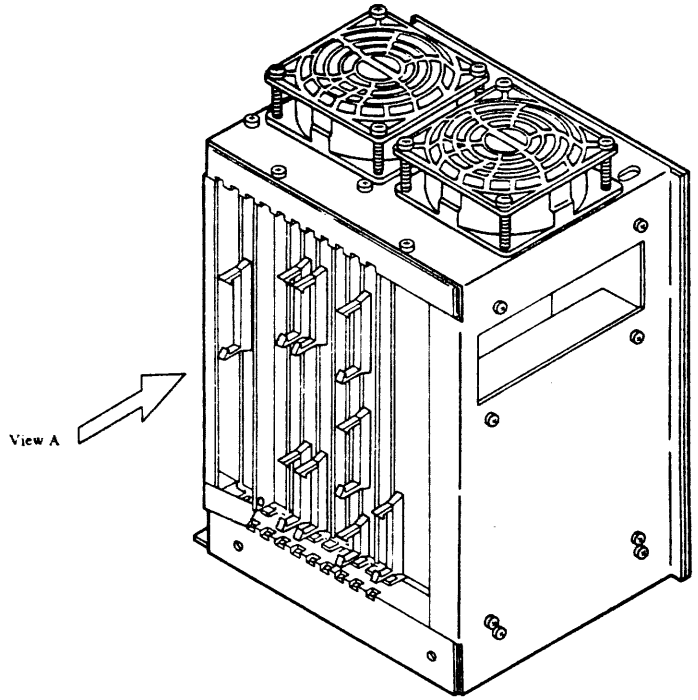
1. Separate connector CNJ11 from the PCA 'SVA'.
2. Remove the PCA 'SVA' from slot number 1A02.
   Refer to the REP 1100.

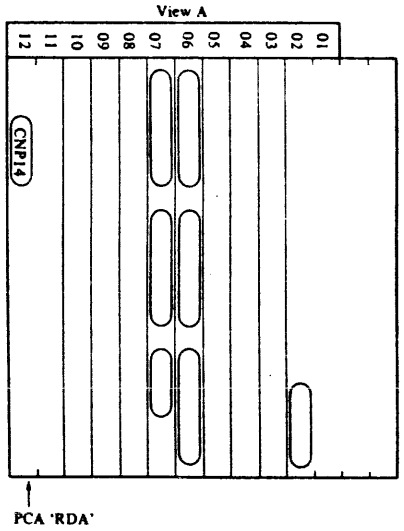
Replacement

1. Insert the new PCA in the slot number 1A02.
   Refer to the REP 1100.
2. Attach the connector to the PCA.

Check and Adjustment

After this replacement, check and adjustment is required.
Refer to the REP 2310.





REP 1200	POWER SWITCH REPLACEMENT

Precaution

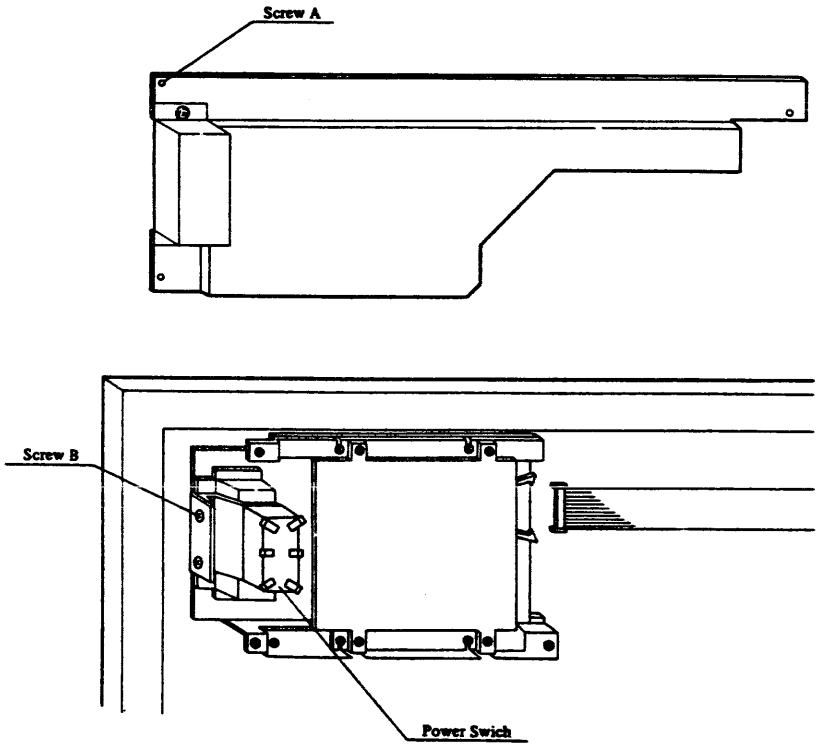
Turn off the power supply. Turn off the non-fuse-breaker.

Removal

1. Open the front door.
2. Remove the cover with three screws A.
3. Separate fasten terminals from each tab.
4. Remove the power switch with two screws B.

Replacement

1. Attach the power switch with the screws B.
2. Connect the fasten terminal corresponding to the tab numbers.
3. Attach the cover with the screws A.
4. Close the front door.



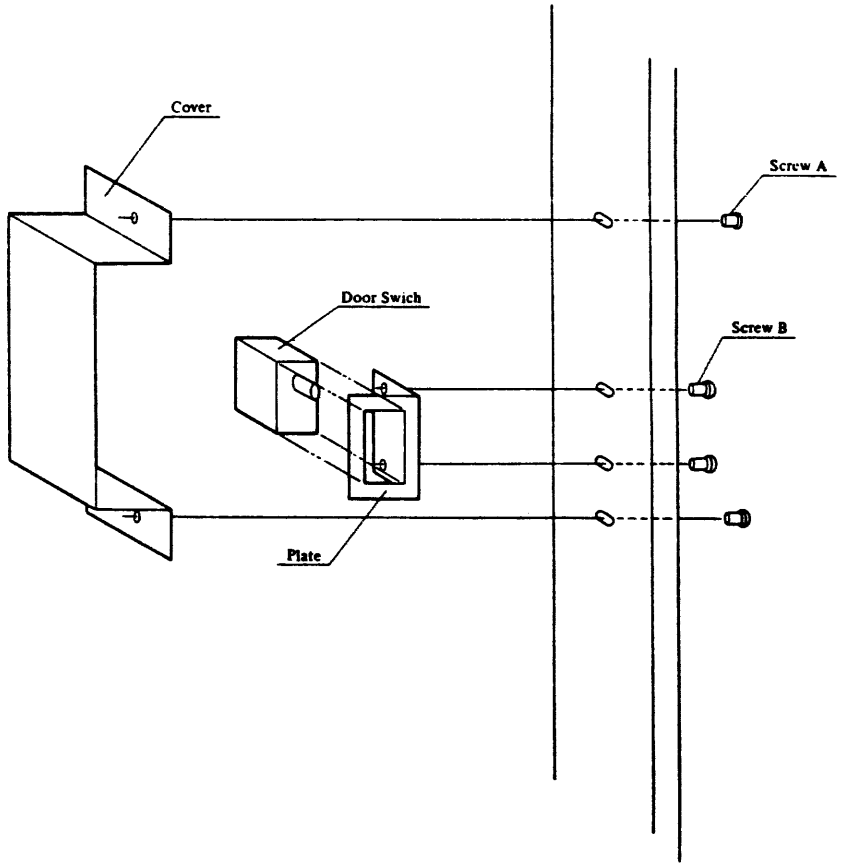
REP 1210	DOOR SWITCH REPLACEMENT

Removal

1. Open the front door.
2. Remove the cover with two screws A.
3. Separate each fasten teminal from tab.
4. Remove the door switch with two screws B.

Replacement

1. Attach the door switch with the screws B.
2. Connect the fasten terminals corresponding to the tabs.
3. Attach the cover with the screws A.
4. Close the front door.



REP 1220	ROLLER CATCH REPLACEMENT

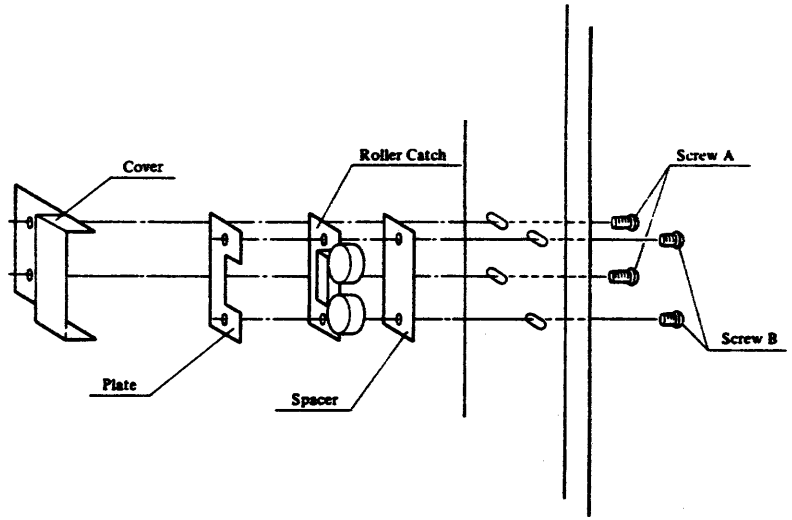
Note; When replacing roller catch, position adjustment is necessary.

Removal

1. Open the magnetic tape panel. Refer to the REP 1050.
2. Open the front door.
3. Remove the cover with two screws A.
4. Remove a plate, a roller catch and a spacer with two screws B.

Replacement

1. Temporarily fasten the plate, the roller catch, and the spacer with the screws B.
2. Attach the cover with the screws A.
3. Close the front door and insert the latch into the roller catch.
   Adjust the position of the roller catch so that the front cover shuts completely.
   Then fasten the screws B tightly.
4. Close the magnetic tape panel. Refer to the REP 1050.



REP 1180	TAPE CLEANER REPLACEMENT

Precaution of Replacement

1. Turn off the power supply.

Removal

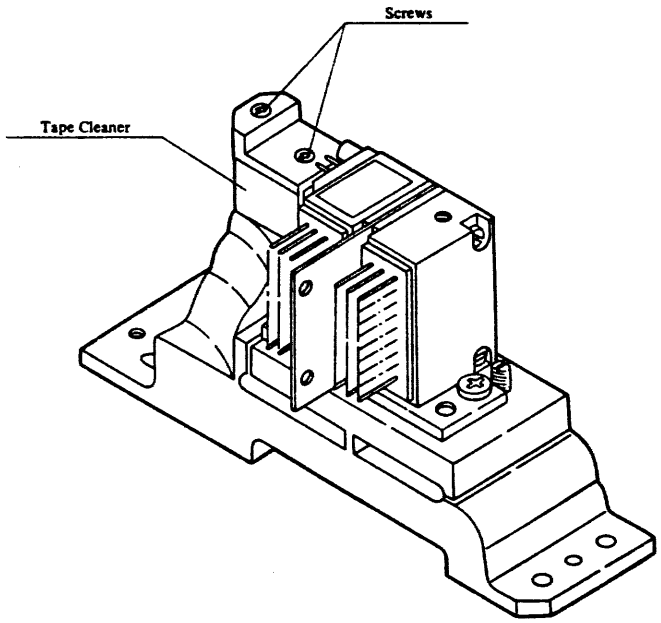
1. Remove the head block in accordance with the procedure of read/write head replacement. Refer to the REP 1240.
2. Remove the tape cleaner from the head block with two screws.

Replacement

1. Mount the cleaner to the head block by the screws.
2. Mount the head block to the magnetic tape panel in accordance with the procedure of mounting of read/write head replacement. Refer to the REP 1240.

Cehck and adjustment

After this replacement, check and adjustment is required.
Refer to the REP 2110.



REP 1240	READ/WRITE HEAD REPLACEMENT

Before replacing the head, the following tests should be performed for decision of head replacement.

1. Backward/Forward head output ratio test: field tester command code ''5A''. Look at Appendix A. Table A.1.
2. **Digital Gain Control (DGC) step test: field tester command code "57", and evalute the DGC step value.**
   Nominal value of the step is about from 4 to 7.
   To execute the code, look at the Appendix A, Table A.1.
   To check the step, refer to the REP 2330.

   Note: The above result is reference only, it is not always the absolute criteria for replacement.

Precaution of Replacement

1. Wind the tape to the file reel if tape is loaded.
2. Be careful not to strike the read/write head against other objects.
3. Use two pins located on the head block for accurate positioning of the head.

Removal

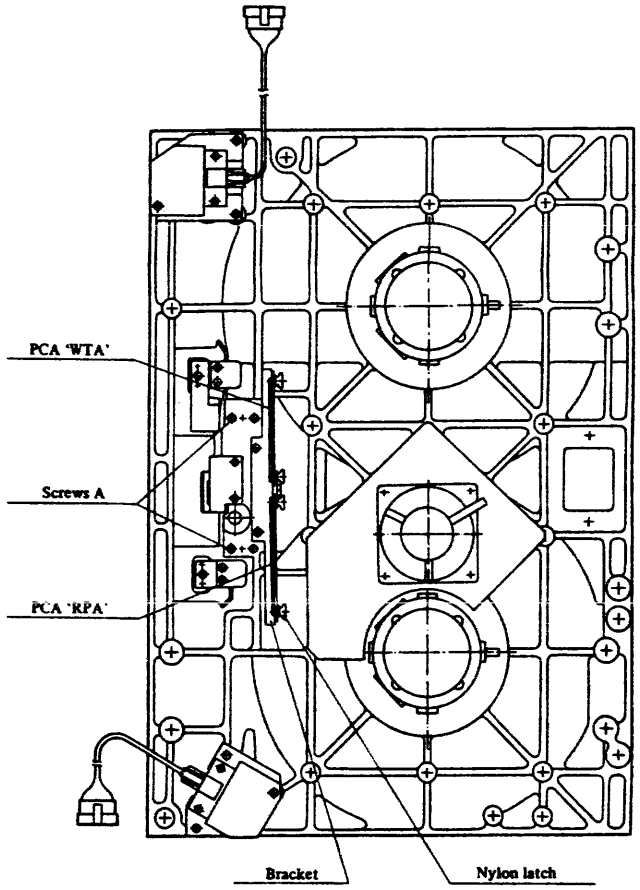
1. **Remove PCA 'RPA' and 'WTA' in accordance with procedure of their removal. Refer to the REP 1110, 1120.**
2. Remove the read/write head from head block with two screws 'B'

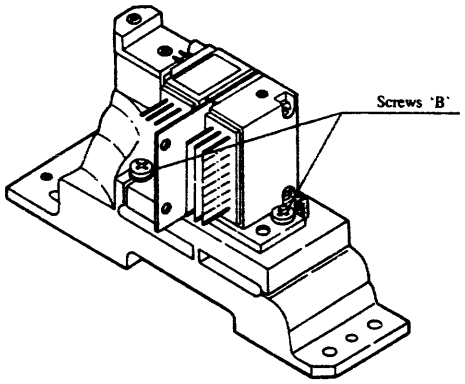
Mounting

1. Attach the read/write head to the head block by two screws 'B'.
2. **Attach the PCA 'RPA' and the PCA 'WTA' to the bracket. Then attach the head block to the casting panel. See REP 1110, 1120.**

Adjustment

After this replacement, check and adjustment is required. Refer to the REP 2110, 2330.





REP 1300	REEL MOTOR ASSEMBLY REPLACEMENT

Precaution of Replacement

The replacement procedure for both file and machine reel motor assembly is the same.

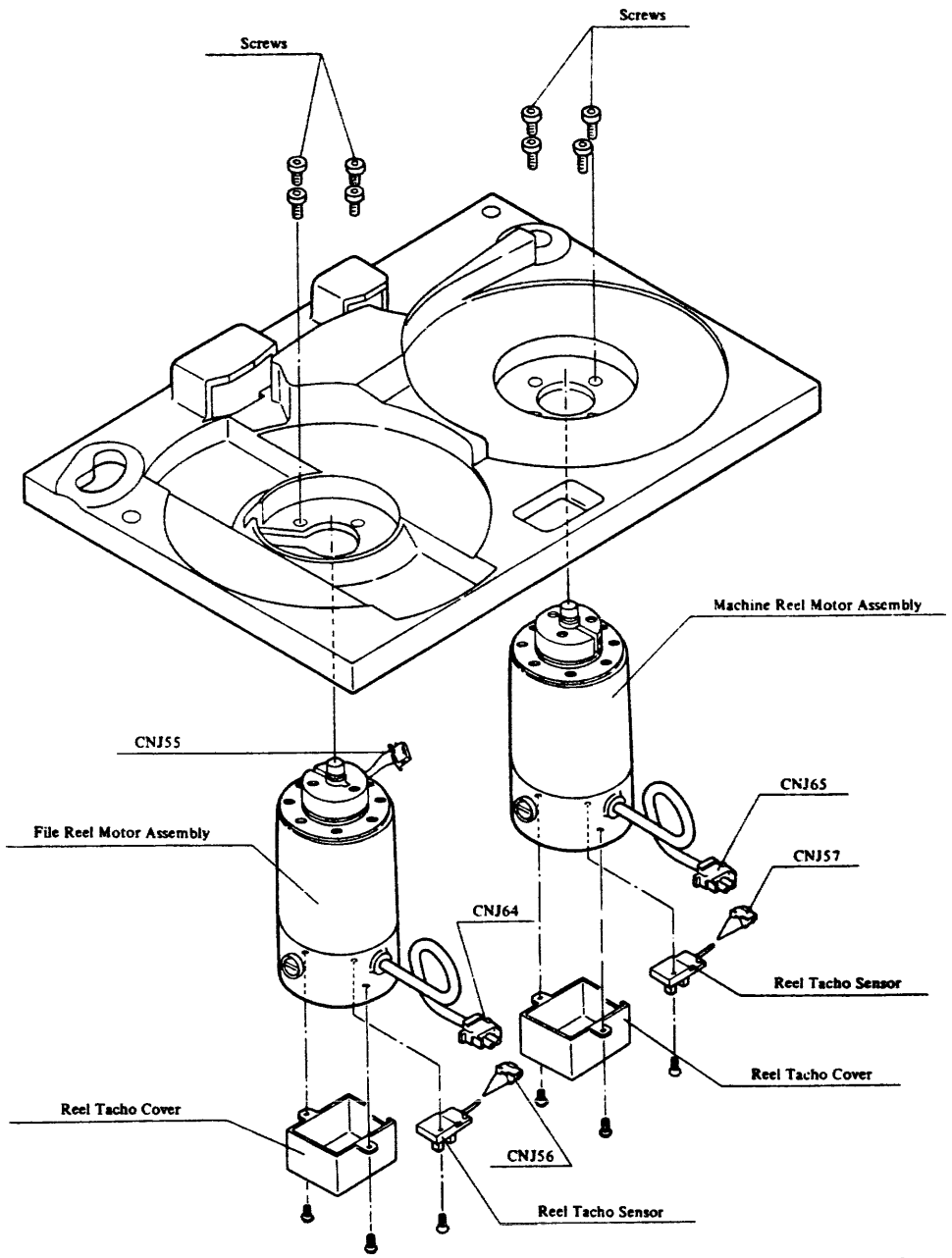
Turn off the power supply.

Removal

1. In the case of the file reel motor assembly replacement, remove the reel hub first.
   Refer to the REP 1310.
   Or in the case of the machine reel assembly replacement, remove the machine reel first.
   Refer to the REP 1320.

Mounting

1. **Attach the motor to the magnetic tape panel with screws.**
2. Connect the reel motor cable, CNJ64 or CNJ65.
3. **Attach the reel tacho sensor.**
   Refer to the REP 1330.
4. **Mount the reel hub in the case of the file reel motor assembly was replaced.**
   Refer to the REP 1310.
   Or mount the machne reel in the case the machine reel motor assembly was replaced.
   Refer to the REP 1320.



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REP 1310	REEL HUB ASSEMBLY REPLACEMENT/ADJUSTMENT

Precaution of Replacement

1. Wind the tape to the file reel completely.
   And remove the file reel.
2. Turn off the power supply.

Removal

1. Loosen two screw A and remove latch knob.
2. Loosen three hexagonal screws and remove hub.

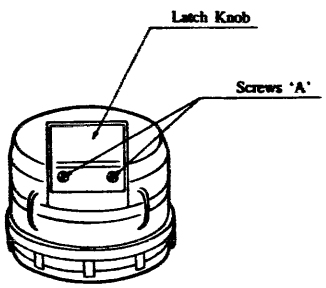
Mounting

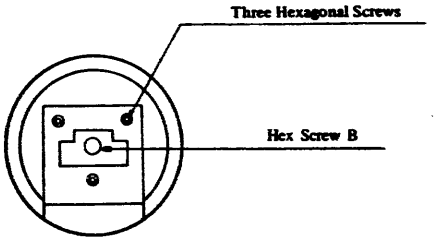
1. Attach new hub by the hexagonal screws.
2. Attach the knob by the screws A.

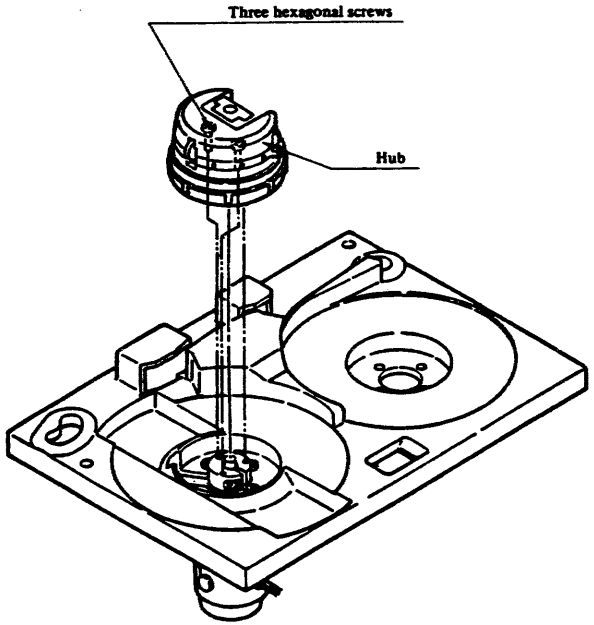
Adjustments

If a tape reel is loose on the hub or you cannot secure the hub latch, the locking spring can be adjusted.

1. Remove screws 'A' and remove knob
2. Turn hex screw 'B' to increase or decrease the locking pressure for the tape reel.
3. Replace latch knob and screws 'A'.







REP 1320	MACHINE REEL REPLACEMENT

Precaution of Replacement

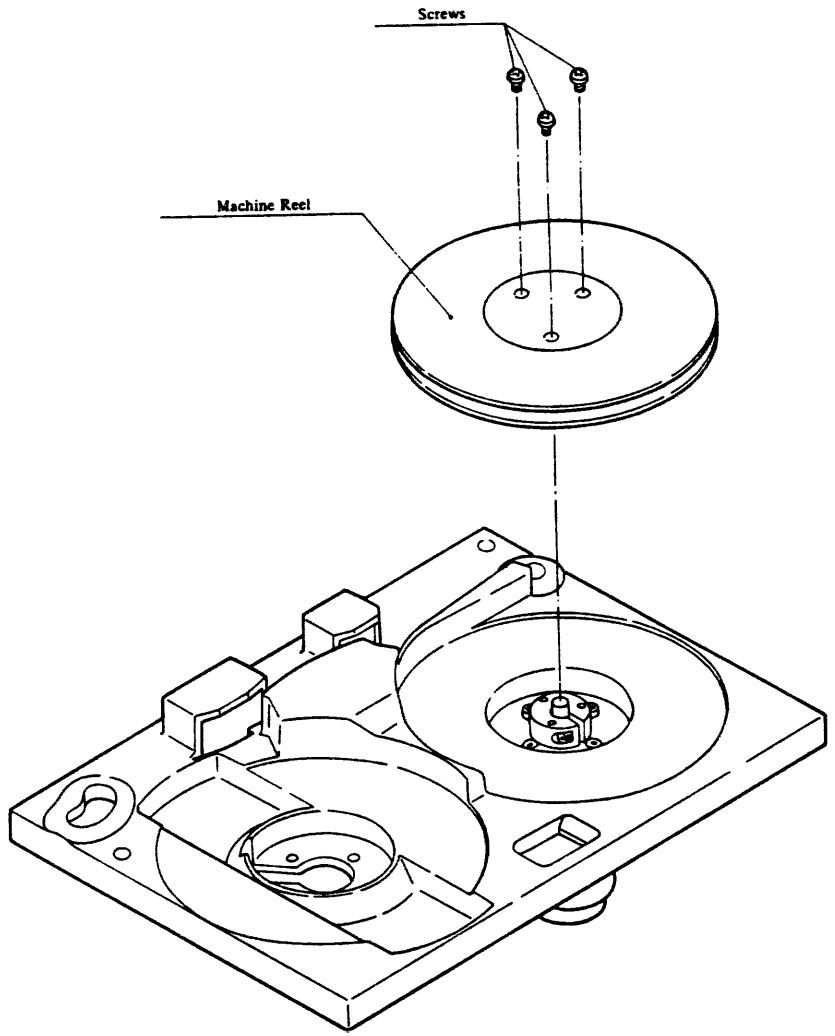
1. Wind the tape to the file reel completely.
2. Turn off the power supply.

Removal

1. Loosen three screws and remove the machine reel.

Mounting

1. Attach the machine reel with the three screws.



REP 1330	REEL TACHO REPLACEMENT

Precaution of Replacement

The replacement procedure for both file and machine reel tacho is the same.

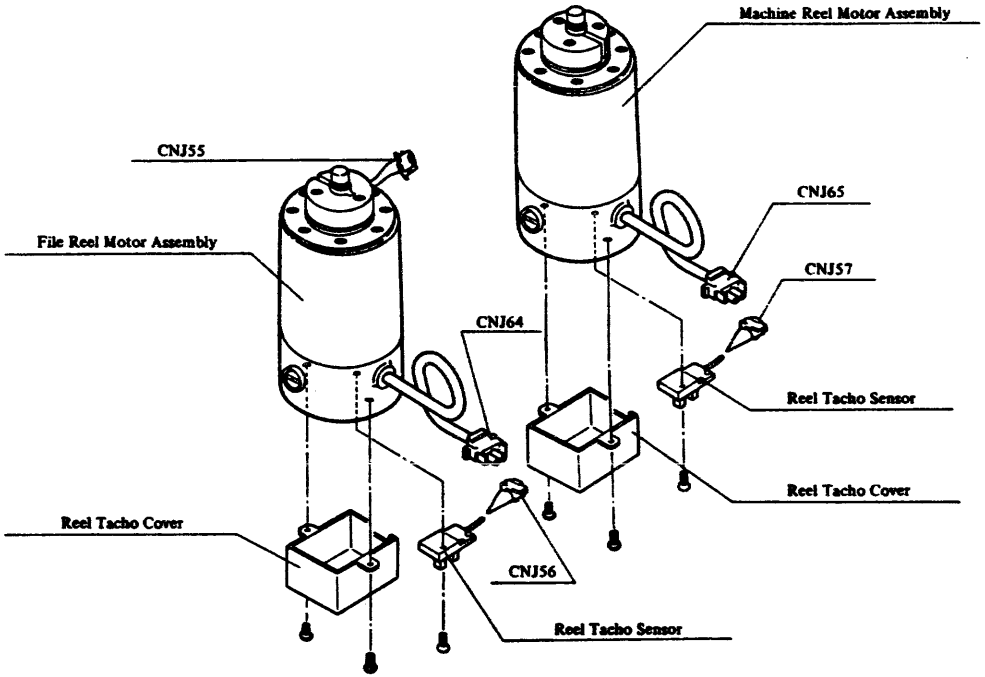
Turn off the power supply.

Removal

1. **Loosen two screws and remove the reel tacho cover.**
2. **Separate the cable, CNJ56 of file reel side or CNJ57 of machine reel side.**
3. **Remove the reel tacho composed of LED and photo transistor unit.**

Mounting

1. **Attach the tacho with the two screws.**
2. **Connect the cable, CNJ56 or CNJ57.**
3. **Attach the reel tacho cover with the screw.**



REP 1340	RIGHT/LEFT FAN REPLACEMENT

Precaution of Replacement

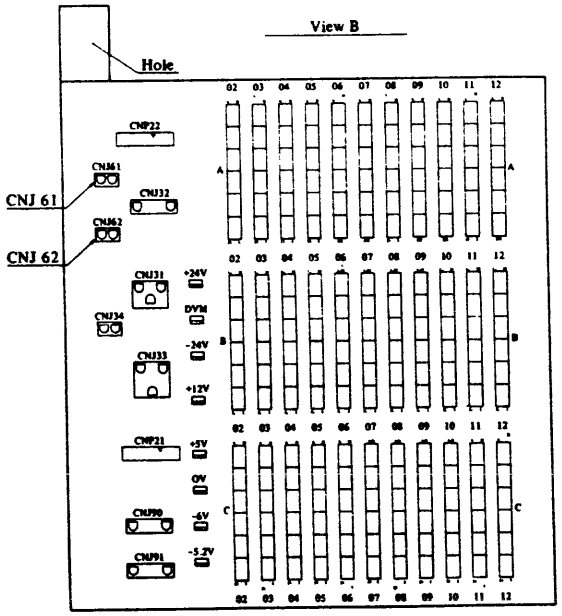
1. **Turn off the power supply.**

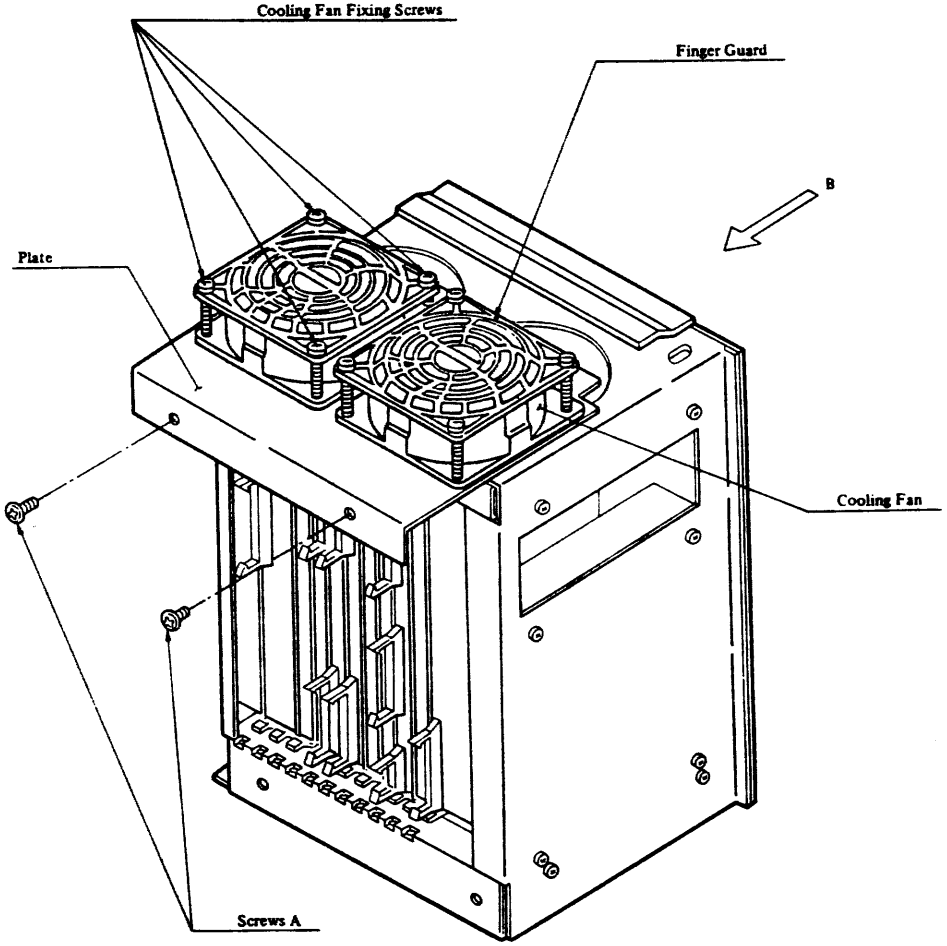
Removal

1. In case stand alone type: open a front and read cover. Refer to Chapter 2.
   In case rack mount type: open a front panel.
2. Disconnect the cooling fan connectors, CNJ61 and CNJ62.
3. Loosen and remove screws 'A'.
4. Remove the plate and put it on the floor.
   Caution should be taken when removing the fan cables.
5. Loosen the four screws of the cooling fan and remove them.
   Note: Finger guard is also removed at this time.

Replacement

1. **Attach the cooling fan with the finger guard by the four screws.**
2. **Return the plate, and thread the connectors into the hole.**
3. Secure screws A.
4. Attach the connectors. CNJ61 and CNJ62.





REP 1350	GUIDE REPLACEMENT

Precaution of Replacement

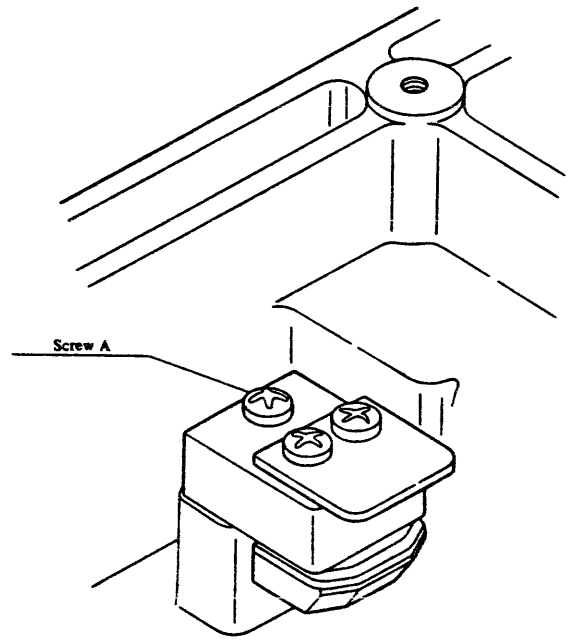
1. Wind the tape to the file reel completely.
2. Turn off the power supply.

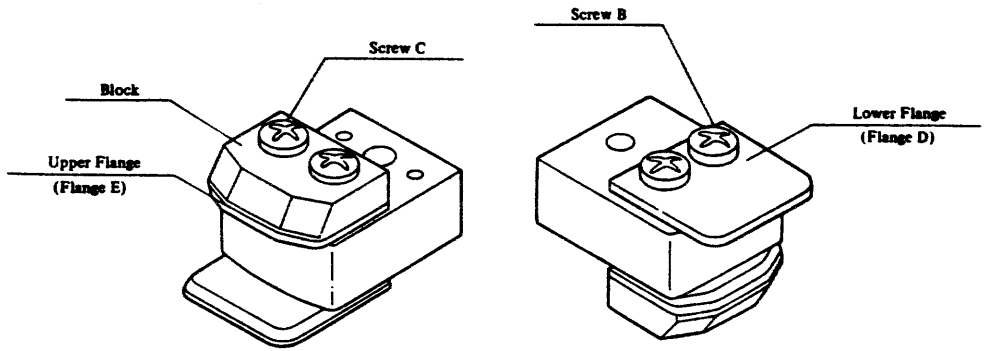
Removal

1. Open the magnetic tape panel. Refer to the REP 1050.
2. Remove the guide assembly with the screw A.
3. Remove a guide from the flange D with the screw B.
   Or remove the other guide from the flange E with two screws C.

Replacement

1. Attach the guide to the flange D with the screw B.
   Or attach the guide to the flange E with the screws C.
2. Attach the guide to the casting panel with the screw A.
3. Close the magnetic tape panel. Refer to the REP 1050.





REP 1370	SHIELD BLOCK REPLACEMENT

Precaution of Replacement

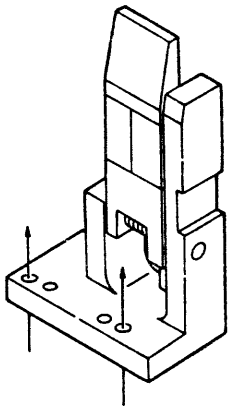
Be careful not to strike the read/write head surface with the shield block.

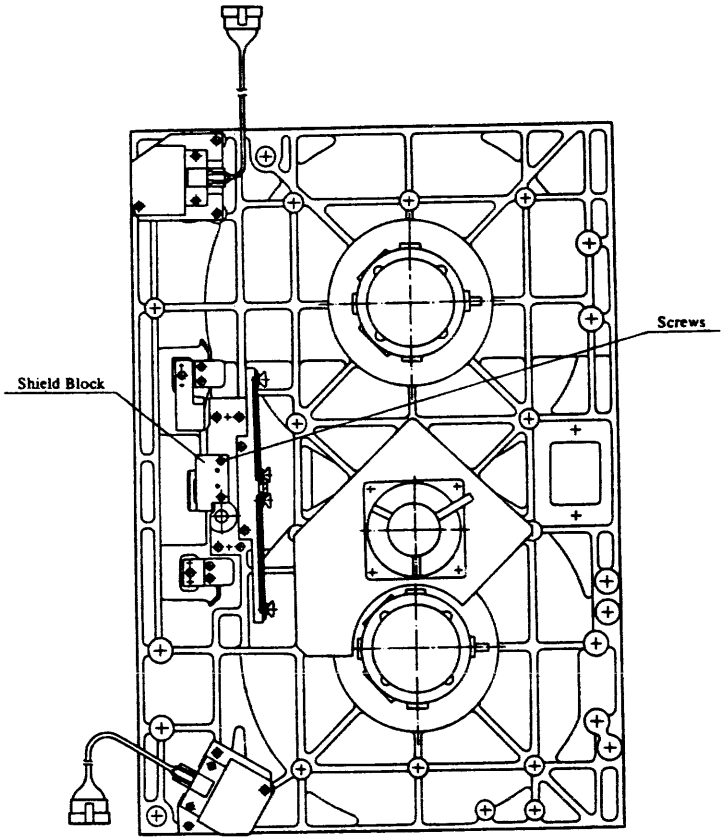
Removal

1. Open the magnetic tape panel. Refer to the REP 1050.
2. Loosen two screws and remove the shield block.

Mounting

1. Attach the shield block correctly by the positioning pins and fasten the screws.
2. Close the magnetic tape panel. Refer to the REP 1050.





REP 1380	LOADING FAN REPLACEMENT

Precaution of Replacement

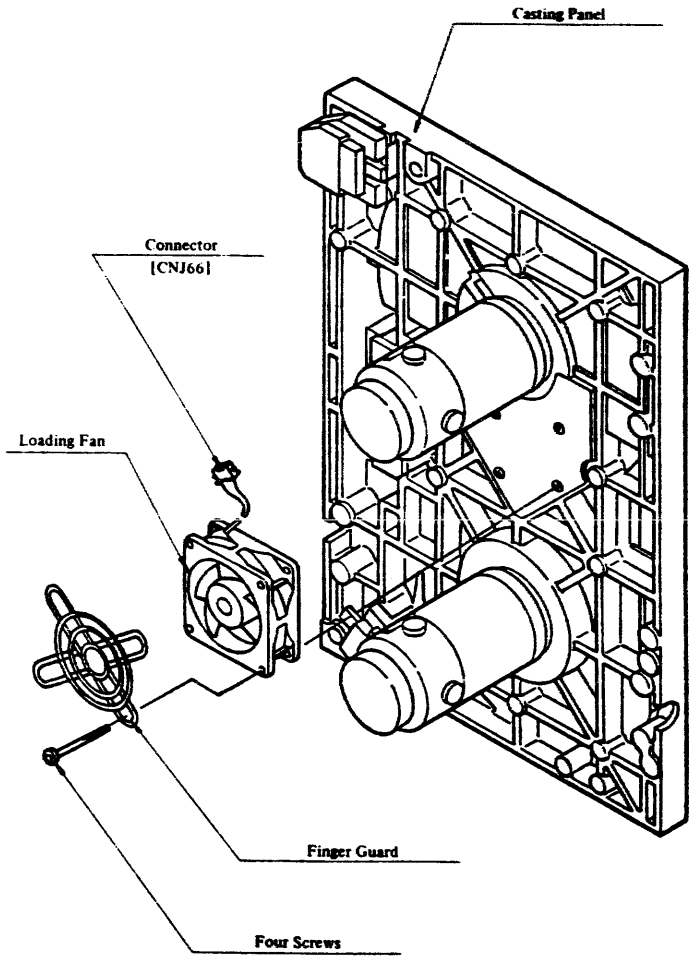
1. Wind the tape to the file reel completely.
2. Turn off the power supply.

Removal

1. Open the magnetic tape panel. Refer to the REP 1050.
2. Separate the connector CNJ66.
3. Loosen four screws of loading fan and remove them.
   Note: Finger guard is also removed at this time.

Replacement

1. Attach the loading fan with finger guard by the screws.
2. Attach the connector CNJ66.
3. Close the magnetic tape panel. Refer to the REP 1050.



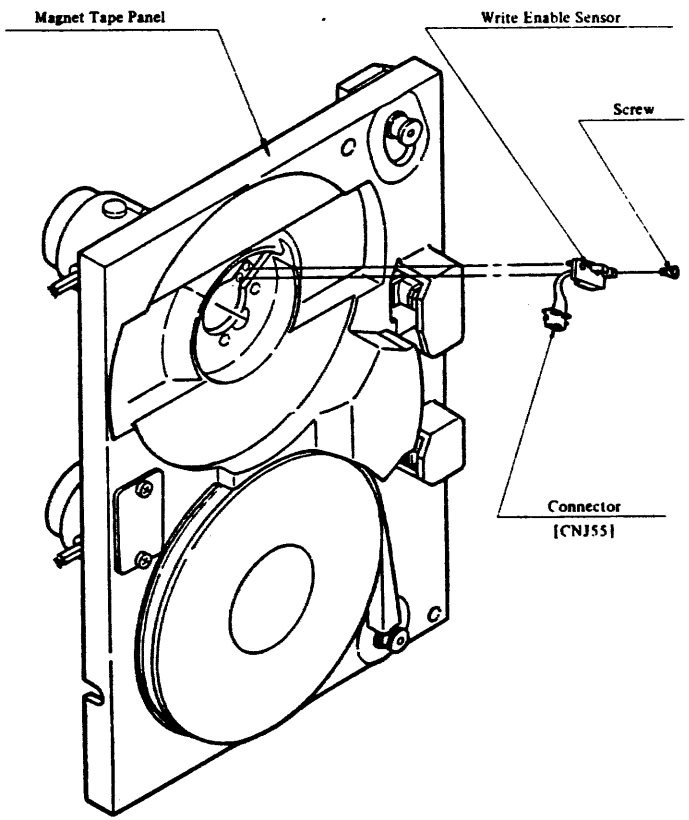
REP 1390	WRITE ENABLE SENSOR REPLACEMENT

Removal

1. Remove the reel hub. Refer to the REP 1310.
2. Open the casting panel. Refer to the REP 1050.
3. Separate the write enable sensor cable CNJ55.
4. Remove the write enable sensor with a screw.

Mounting

1. Attach the write enable sensor with the screw.
2. Connect the sensor cable CNJ55.
3. Close the casting panel. Refer to the REP 1050.
4. Mount the reel hub. Refer to the REP 1310.



REP 1400	BOT/EOT SENSOR ASSEMBLY REPLACEMENT

Precaution of Replacement

1. Wind the tape to the file reel completely.
2. Turn off the power supply.

Removal

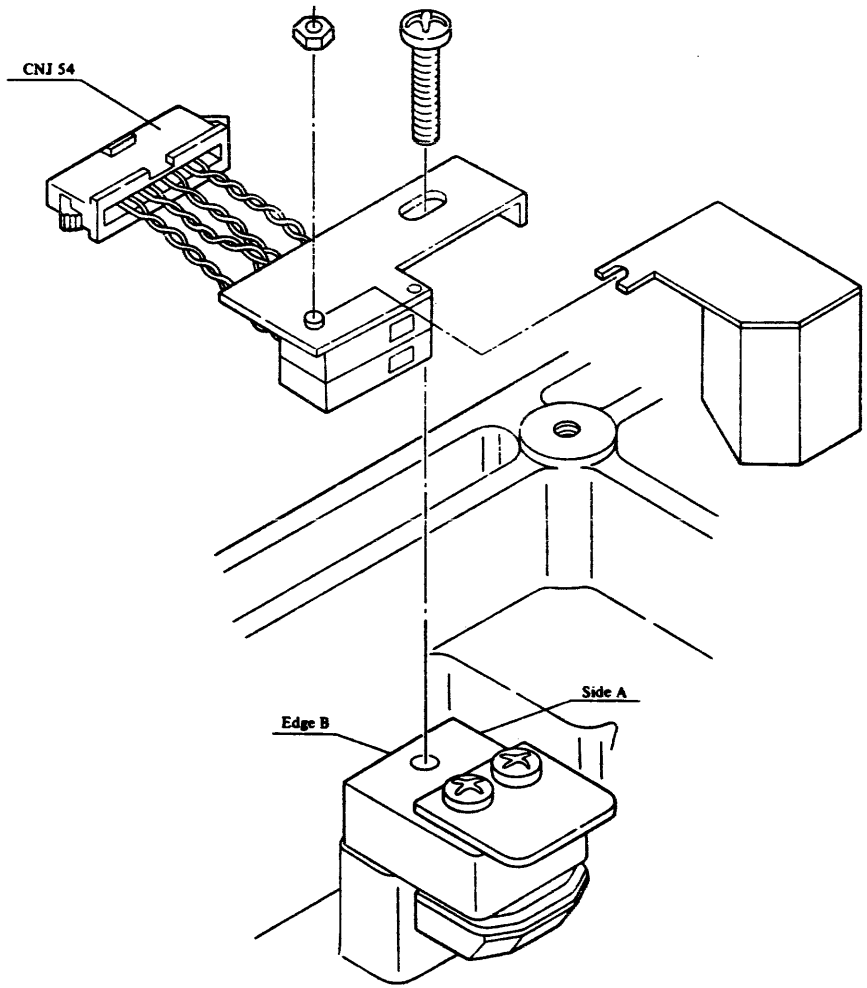
1. Disconnect BOT/EOT sensor assembly cable, CNJ54.
2. Remove the tape guide fixing screw then detach the BOT/EOT assembly.
   Note: Be carefull not to drop the screw because it attaches both the tape guide and the sensor.
3. Remove the sensor screw and detach the sensor.

Replacement

1. Attach the BOT/EOT sensor to the bracket by using the sensor screw.
2. Attach the BOT/EOT sensor assembly by the tape guide screw.
   Note: Push the sensor plate from side A and align the edge B to the tape guide when fixing the screw.
3. Connect the assembly cable.

Check and Adjustment

After this replacement, check and adjustment is required.
Refer to the REP 2310.



REP 1410	TENSION SENSOR ASSEMBLY REPLACEMENT

Precaution of replacement

1. **Wind the tape to the file reel completely.**
2. **Turn off the power supply.**
3. Caution should be taken not to damage the sensor.

Removal

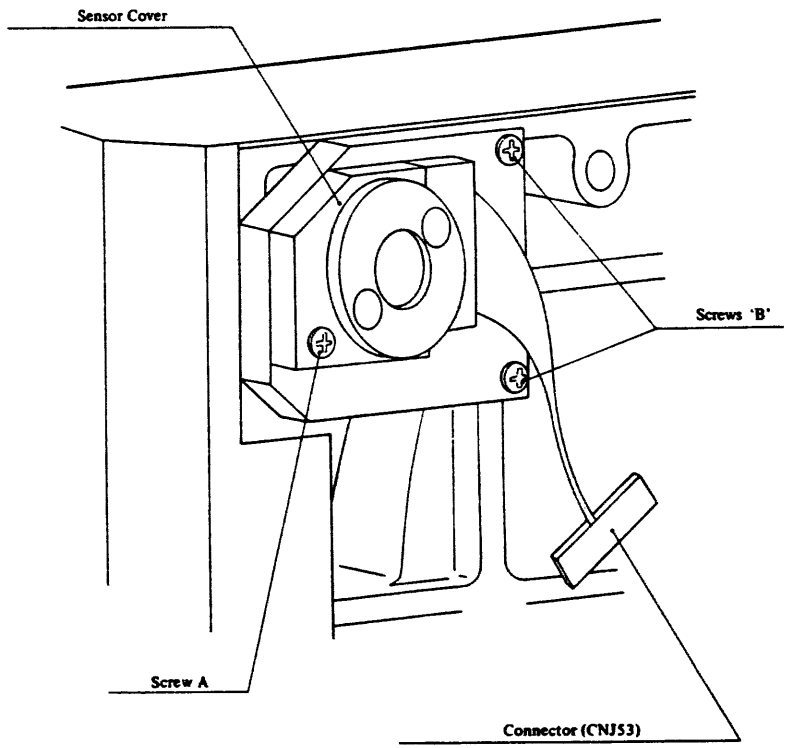
1. Separate connector CNJ53.
2. Loosen screw A, and remove the cover.
3. Loosen two screws 'B', and remove the sensor assembly.
   Note: Screw A is also used for the sensor cover.

Mounting

1. Attach the sensor assembly using the two screws 'B'.
2. Attach the cover using the screw A.
3. Attach the sensor assembly to the casting panel.
4. Attach the connector CNJ53.

Check and Adjustment

After this replacement, check and adjustment is required. Refer to the REP 2210.



REP 1420	IDLER TACHO ASSEMBLY REPLACEMENT

Precaution of Replacement

1. Wind the tape to the file reel completely.
2. Turn off the power supply.
3. Be careful not to strike the roller idler tacho assembly against others objects.

Removal

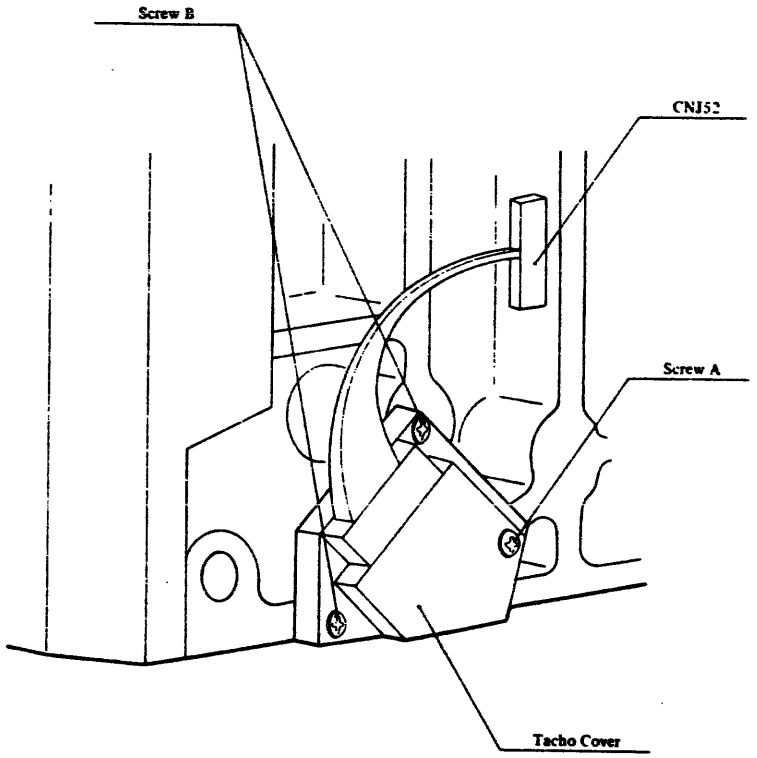
1. Separate connector CNJ52.
2. Loosen screw A, and remove the cover.
3. Loosen the two screws 'B', and remove the tacho assembly.
   Note: Screw A is also used for the tacho cover.

Mounting

1. Attach the sensor assembly using the two screws 'B'.
2. Attach the cover using the screw A.
3. Attach the tacho assembly to the casting panel.
4. Attach the connector CNJ52.

Check and Adjustment

After this replacement, check and adjustment is required.
Refer to the REP 2220.



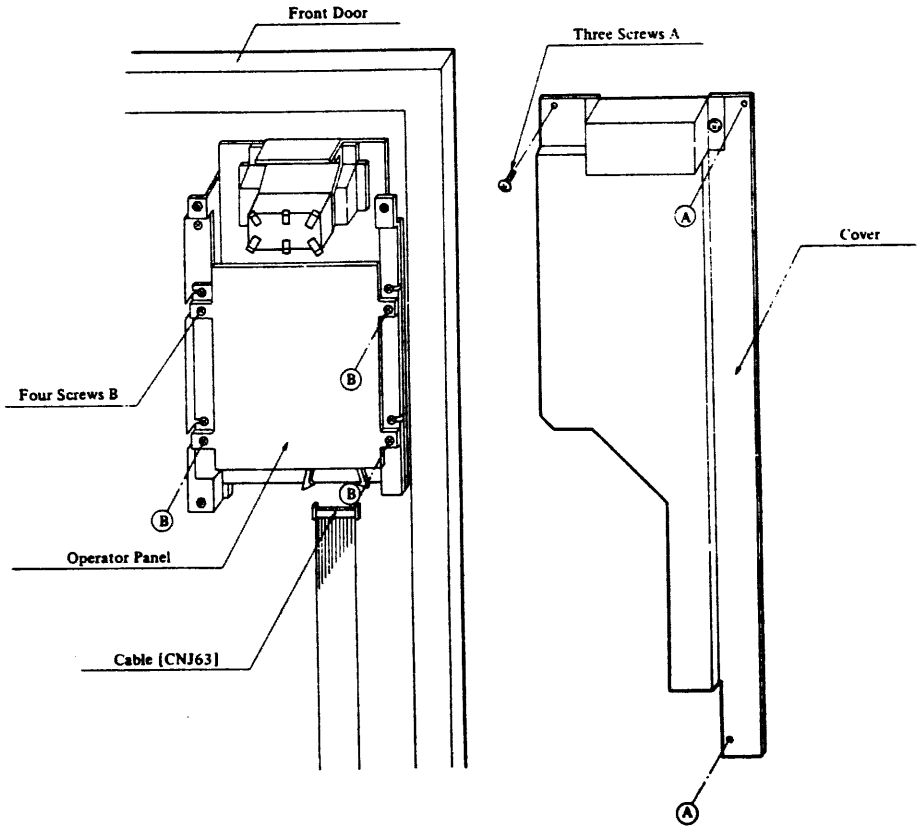
REP 1430	OPERATOR PANEL REPLACEMENT

Removal

1. Open the front door.
2. Loosen three screws A and remove the cover.
3. Disconnect the operator panel cable CNJ63.
4. Remove the operator panel bracket with four fixing screws B.
5. Remove the operator panel from the front door.

Mounting

1. Attach the operator panel to the front door by the screws B.
2. Connect the operator panel cable CNJ63.
3. Attach the cover to the front door by the screws A.



REP 1440	FILTER REPLACEMENT

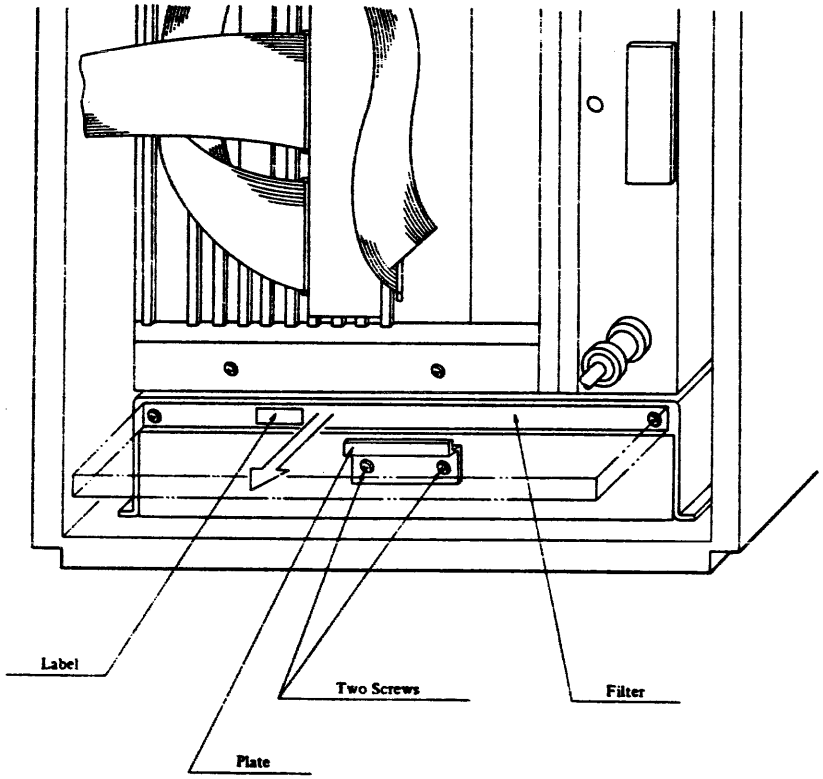
Note 1; There is a label on the side of the air filter. An arrow is printed on the label to indicate the direction of air flow. Check to see the label says arrow is up.
Note 2; In the case of the standalone, it is necessary to open the rear cover. The method is shown in the chapter 2.

Removal

1. Open the rear cover.
2. Loosen two screws and pull down the plate.
3. Remove the filter.

Replacement

1. Check the label of the arrow direction.
2. Insert the filter.
3. Slide the plate upward and fasten it with the screws.
4. Close the rear cover.



REP 1500	POWER SUPPLY REPLACEMENT

(1) Power Supply Unit

Be sure to turn the main line switch of the power supply to off. Power may be supplied even though the unit appears to be off. Remove AC line cord from wall supply.

Removing the unit

1. Remove the input cable and the connectors on the front panel (CNP-71, -72, -73, -74, and -75).
2. Remove the screws on the four corners of the unit, and remove the unit.

Installing the unit

1. Secure the unit with four screws.
2. Attach the connectors (CNP-71, -72, -73, -74, and -75).
3. Attach the input cable.

Reconnect the AC line cord to the wall supply.
Turn the power supply main line switch on.

(2) Replacing the Fuse

Removing the fuse

1. Open the back door of the unit.
2. Turn the main line switch to off.
3. Remove the fuse.

Putting in a fuse

1. Put in a fuse.
2. Turn the main line switch on.
3. Close the back door.

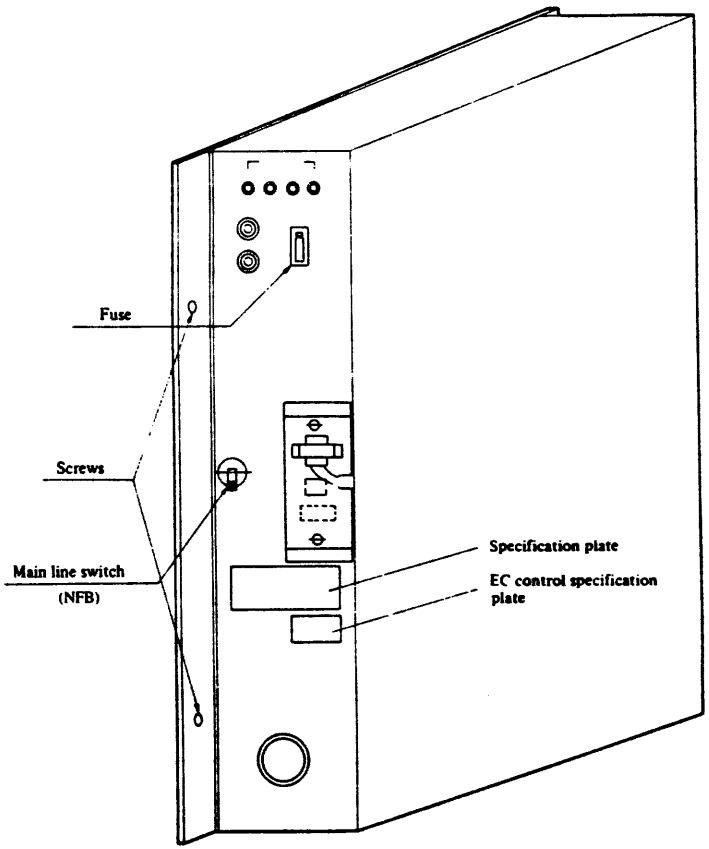


Figure: Power Supply External View (Rear)

REP 2010	OUTPUT VOLTAGE CHECK AND ADJUSTMENT

Procedure

1. Supply power, check and adjust the power supply in the servo off mode (i.e., unload state).
2. Connect a digital voltmeter to the +5V and 0V terminals on the back panel, and adjust the voltage to +5.00V. (See the following figure for the location of the variable resistor.)
   The power supply voltages on the back panel (-6V and +12V) must be in the following ranges:
   -6V --- -6.6 to -5.4V
   +12V --- +12.0 to 14.5V
3. Connect a digital voltmeter to the -5.2V and 0V terminals. (See the following figure for the location of the variable resistor.)
   The power supply voltages on the back panel (+24VM and -24VM) must be in the following ranges:
   +24VM --- +21.6 to +26.4V
   -24VM --- -21.6 to -26.4V
   If items (2) and (3) -- above -- are not satisfied, the power supply must be replaced.

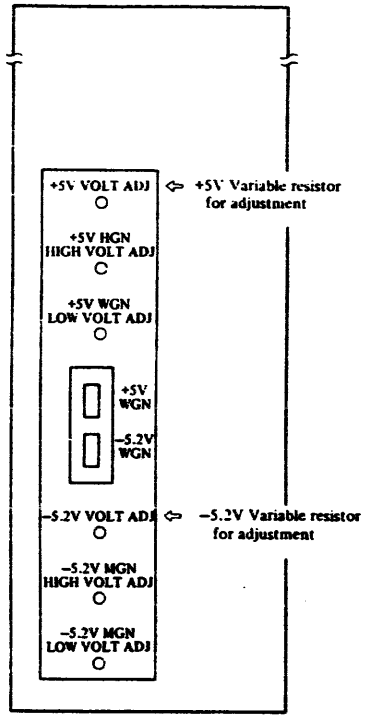


Figure: Power Supply Front View

REP 2110-1	AZIMUTH CHECK AND ADJUSTMENT

Note: In this section the following tools are used for azimuth check and adjustment.
a) head eraser
b) standard skew tape
c) small screwdriver

The azimuth check can be executed by the operator panel. The azimuth between two specified tracks is measured by the built-in circuit and displayed as blinking decimal points of the 2 digit indicators.
Operator panel switch performs the alternative of inner two tracks or outer two tracks.
If necessary, the adjustment is performed by rotating the screwdriver and watching the indicator.

Procedure

1. The skew tape mounting

Turn off the power supply.

Open the front door.

Erase the magnetism of the read/write head and erase head using the head eraser.

Attach standard skew tape to the reel hub.

2. Tape loading

While pressing the 'TEST' switch, press the 'START' switch. This will place the MTU in diagnostic mode and the 'TEST' mode indicator will be lit. The 'DENSITY SELECT' mode indicator will be in HOST select mode.

Set the 2 digit indicator to ''02'' code by pressing the 'START' or the 'UNLOAD' switch. The 'START' switch causes the indicator code to increase, the 'UNLOAD' to decrease.

Press the 'TEST' switch. The tape will load. After the tape is loaded the 2 digit indicator will be ''00'' and the start LED will be lit.

3. Azimuth check program execution

Set the 2 digit indicator to ''91'' by pressing the 'START' or the 'UNLOAD' switch. The 'START' switch caused the indicator code to increase, the 'UNLOAD' to decrease.

While pressing the 'TEST' switch, press the 'DENSITY SELECT' switch. The azimuth check program will start. The tape moves in the forward direction at low speed.

4. Switch functions and Azimuth display

In this routine, the switches of the operator panel function as mentioned below, after the azimuth check routine program is executed.

'START' switch:	**Forward tape movement.**
'UNLOAD' switch:	**Backward tape movement.**
'TEST' switch:	Tape start stop movement.
'DENSITY SELECT' switch:	Track select. At first ''I.I.'' is indicated on the indicator. The indication in changed alternatively by pressing this switch from ''0.0.'' to ''I.I.'' or ''I.I.'' to ''0.0.''. **The "I.I." means the azimuth display of Inner tracks. The "0.0." means the azimuth display of Outer tracks.**

The correct azimuth is displayed on the two decimal points. See the figure on REP 2110-2. One is skew lead indicator, the other is lag indicator.

The best adjustment is to realized the equal blinking of the two decimal point indicators.

REP 2110-2	AZIMUTH CHECK AND ADJUSTMENT

5. Check and adjustment in the forward direction

Check and adjust the azimuth in the forward direction in accordance with the following procedure.

If the tape stops, press the 'START' switch to move the tape forward. Adjust the azimuth of the inner two tracks, track 5 and track 6. Observe the blinking of the decimal points on the operator panel display to make adjustment shown in Table 1.
Set the screwdriver shown in the figure below.

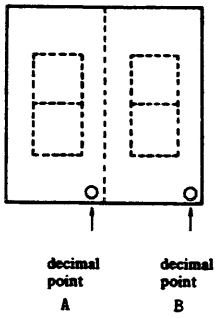
When inner work is completed, chenge the outer track azimuth display between track 1 and track 9 by pressing the 'DENSITY SELECT' switch.

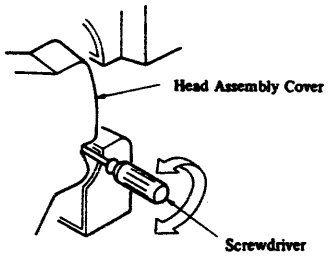
Perform the adjustment shown in the Table 1 by observing the blinking of the decimal point on the operator panel.

Then stop the tape by pressing the 'TEST' switch.

Table 1. Azimuth Adjustment

Item	Blinking of the decimal point on the operator panel's indicator	Skew adjustment screw direction
1	Decimal point 'A' and decimal 'B' on for the same amount of time	No adjustment required.
2	Decimal point 'A' on more then 'B'	Turn closkwise.
3	Decimal point 'A' on less then 'B'	Turn counter-clockwise.





6. Check adjustment in backward direction

Check and adjust the reverse direction azimuth in accordance with the following procedure.

Move the tape by pressing the 'TEST' switch. Then set backward direction by pressing the 'UNLOAD' switch.

Make sure that the azimuth value of the inner track is equal.

Change to the outer display by pressing the 'DENSITY SELECT' switch, and check the azimuth of the outer tracks; if the blinking of the decimal point differs much from that of the forward direction, perform the adjustment shown in the Table 1.

7. Recheck the forward azimuth

Perform item 5 above when backward azimuth adjustment is done, and make sure that the azimuth value does not differ much from the previous one.

8. Take up the tape

When the azimuth check and adjustment is completed, take off the skew tape by backward tape movement.
Do not use the unload switch to rewind the skew tape.

Note 1: During the forward movement, if EOT is detected, the direction of the tape is changed to backward.
Note 2: During the backward movement, if BOT is detected, the tape will unload.

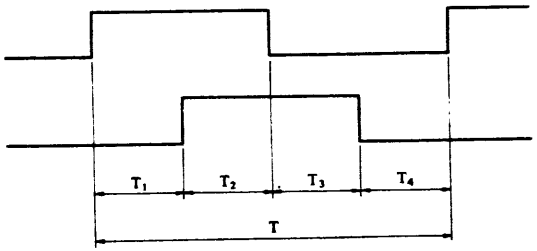
Read gain setting

After the azimuth is adjusted, set the PE read gain.
See REP 2330.

REP 2210	TENSION SENSOR CHECK AND ADJUSTMENT

When tension sensor assembly or PCA ''RPA'' is exchanged, check waveform of the sensor with a two channels oscilloscope and adjust variable resistors with a small screwdriver on the PCA ''RPA'' in following method.

1. Turn off the power of the unit.
2. Open door and open the casting panel with a big screwdriver.
3. Find the check pins on PCA ''RPA'' in Fig. 2210.2 and connect the probes of the oscilloscope to pin numbers 1 and 2 ground the oscilloscope.
4. Turn on the power.
5. Raise and lower the tension sensor roller by hand and observe waveform on check pins 1 & 2.
6. Check the waveform whether it satisfies the requirement shown in Fig. 2210.1.
7. If the waveform does not satisfy that Fig. 2210.1 turn variable resistor 3 and 4 on the PCA ''RPA'' shown in Fig. 2210.2 carefully to satisfy the condition.
8. If it is impossible to satisfy Fig. 2210.1, change tension sensor assembly or PCA ''RPA''.



$$\frac{T_1}{T} \geq 0.1,\ \frac{T_2}{T} \geq 0.1,\ \frac{T_3}{T} \geq 0.1 \text{ and } \frac{T_4}{T} \geq 0.1$$

$$0.7 \geq \frac{T_1 + T_2}{T} \geq 0.3,\ 0.7 \geq \frac{T_2 + T_3}{T} \geq 0.3$$

Fig. 2210.1

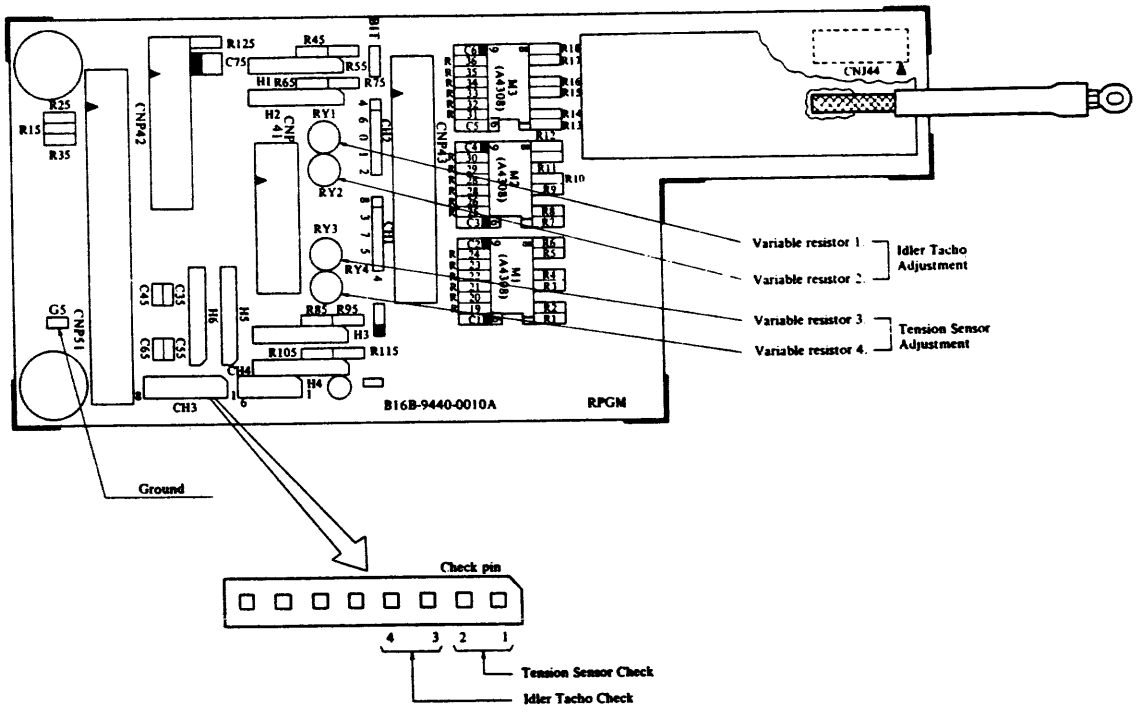


Fig. 2210.2

REP 2220	IDLER TACHO CHECK AND ADJUSTMENT

When idler tacho assembly or PCA ''RPA'' is exchanged, check waveform of the tacho with an oscilloscope and adjust variable resistors with a small screwdriver on the PCA ''RPA'' as following method.

1. Turn off the power of the unit.
2. Open door and open the casting panel with a big screwdriver.
3. Find the check pins on PCA ''RPA'' in Fig. 2210.2 and connect probes of the oscilloscope to pin numbers 3 and 4, ground oscilloscope.
4. Turn on the power of the unit.
5. Load a work tape by OPD* (Operator panel Diagnosis) code 02.
6. Run the tape forward by OPD code 41 (Data security erase).
7. Check the waveform whether it safisfies the requirement shown in Fig. 2210.1.
8. Run the tape backward by OPD code 02 (Rewind) and also check the waveform same as item 7.
9. If the waveform does not satisfy Fig. 2210.1, turn variable resistor 1 and 2 on the PCA ''RPA'' shown in Fig. 2210.2 carefully.
10. If it is impossible to satisfy the condition, change idler tach assembly or PCA ''RPA''.

* See Appendix B Offline Diagnosis by the operator panel.

REP 2310	BOT/EOT GAIN ADJUSTMENT

When BOT/EOT sensor or the PCA ''IFC'' is exchanged, the gain adjustment of the sensor is required. If an abnormal value is set, the tape will not load or an EOT marker can be missed.

The BOT/EOT gain can be adjusted by using the operator panel diagnostics as shown below.
For more detail information about operator panel diagnostics, see Appendix B.

(A) Prepare a work tape. Small size reel is better to reduce adjustment time.

(B) Mount and load the tape using code '02'.
The detailed method to use code '02' of the diagnostics is described below.
1. Push 'Start' key while keeping the 'Test' key depressed. 'Test' LED lights.
2. Set 2 digit indicator to code '02' by pressing 'Start' or 'Unload'. Start key causes 2 digit indicator code to increase, 'Unload' decrease.
3. Push 'Test' key.
4. Wait until 'Start' LED lights.

(C) Start the BOT/EOT adjustment, code '90' of the diagnostics.
1. Set 2 digit indicator to code '90' as same manner described (B) 2.
2. Push 'Density select' key while keeping the test key depressed. The BOT/EOT adjustment starts automatically.
3. Wait until tape unloads.
4. The 2 digit display must be 00. (Note)

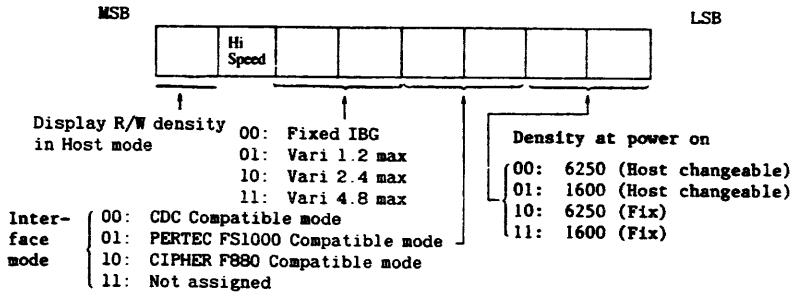
(D) Store new gain into nonvolatile memory using code '94' of the diagnostics.
1. Set 2 digit indicator to code '94' as same manner described B2.
2. Push 'Density select' key while keeping the test key depressed. This operation initiates a rewrite into the nonvolatile memory.

Note: If you failed to execute the automatic gain adjustment, rewrite the current BOT/EOT gain by self-diagnostic command described in REP 2320 (Parameter setting procedure). Recommended gain value is B0 to CF hexadecimal.

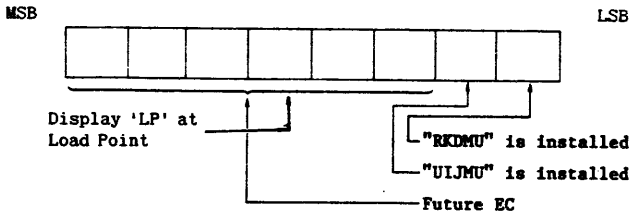
REP 2320-1	DEVICE TYPE/EC LEVEL/BOT GAIN/EOT GAIN

M244X stores a four byte parameter called ''Device Type'', ''EC Level'', ''BOT Gain'', and ''EOT Gain'', which are written into a nonvolatile memory. The meanings of these parameters are as follows.

(1) Device Type
Lower two bits of this byte mean the initial density at power on. The next two bits (bit 2, 3) mean interface mode. The next two bits (bit 4 & 5) is the variable IBG Length mode. Bit 6 means hi-speed. Bit 7 is reserved.



(2) This byte is used to know that the newest firmware. The lower two bits are already used as PCA 'RKDMU'' and ''UIJMU''. The other bits to be used for future engineering changes.



(3) BOT Gain
The value of this byte is the BOT gain. Usually the BOT gain is adjusted automatically to the optimized value by the diagnostic command. But in special cases the gain value can manually set to any value by using the special diagnostic command.

(4) EOT Gain
Same as the BOT Gain.

(5) Setting of the four byte parameters.
The four parameters can be modified by using the operator panel diagnostics as shown below.

(A) Push 'Start' key while keeping the 'Test' key depressed. The 'Test' LED lights and 2 digit indicator displays '00'.

(B) Set 2 digit indicator to '93' code by pressing 'Start' or 'Unload' key. 'Start' key causes 2 digit indicator to increase, and 'Unload' key decrease the 2 digit indicator.

(C) Push 'Density select' key while keeping the 'Test' key depressed. The 2 digit indicator displays 'dt' as shown Fig 2320.1 (a).

(D) Push 'Reset' key. In this state, the current device-type code is displayed on the 2 digit indicator.

(E) If you desire to modify the current device-type, push 'Start' or 'Unload' key and set 2 digit indicator code to the value (B).

(F) Push 'Test' key. The displayed device-type code is stored into RAM, the 2 digit indicator displays 'EL' as shown Fig. 2320.1 (b).

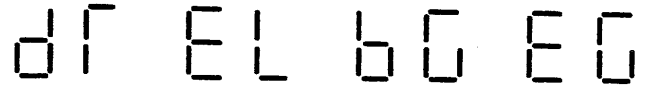
(G) Push 'Reset' key. In this state, the current EC-level code is displayed on the 2 digit indicator.
If you desire to modify this code, push 'Start' or 'Unload' key as same as step (B).

(H) Push 'Test' key to store the displayed EC-level code into RAM, the 2 digit indicator displays 'BG' as shown Fig. 2320.1 (c).

(I) Push 'Reset' key to display the current BOT-gain code.
This code can also edited to any value by 'Start' and 'Unload' key.

(J) Push 'Test' keyto store the displayed BOT-gain value into RAM, the 2 digit indicator displays 'EG' as shown Fig. 2320.I (d).

(K) Push 'Reset' key to display the current EOT-gain value, and change if you need.



(a) Device Type (b) EC Level (c) BOT Gain (d) EOT Gain

Fig. 2320.1

REP 2320-2	DEVICE TYPE/EC LEVEL/BOT GAIN/EOT GAIN

(L) Push 'Test' key to store the displayed EOT-gain value into RAM, the 2 digit indicator displays '00' code.
If you want to store the new parameters into nonvolatile memory, push 'Start' to set '94' command (Store parameter command) and push 'Density Select' key while holding down the 'Test' key.
This operation initiates rewrite parameters into the nonvolatile memory.

REP 2330	PE READ GAIN SETTING

There are no variable resistors for read PE gain adjustment. The amplifier gain is controlled by a digital gain control (DGC) amplifier. In the phase encoding memory the gain registor is controlled the microprocessor.

It is performed as follows, first writing continous flux change of 3200fci on a tape, second reading the burst followed by the setting automatic gain control (SAGC) of sixteen times executions third the averaging of the SAGC values. Then the value is evaluated whether it is reasonable or not by the microprocessor.

The gain value is stored into nonvolatile memory by command code 94 issued thru the operator panel.

For efficient maintenance, use a good quality work tape which is the same kind as the customers.

Note 1: Before executing this section, clean & check the r/w head and tape path.

Note 2: PE gain must be set when a part or PCA listed in Table 1 is replaced.

Table 1. If these items are replaced read gain adj. is required.

Item	Part name
1	read/write head
2	PCA 'RPA'
3	PCA' RDA'
4	PCA 'WTA'
5	PCA 'MPU'

PROCEDURE

1. Tape loading

   Load a work tape using diagnostic mode '02'

2. PE gain adjustment

   Set the 2 digit indicator to ''92'' code by pressing the 'UNLOAD' switch.

   While pressing the 'TEST' switch, press the 'DENSITY SELECT' switch. The PE read gain adjustment program starts.

   The tape runs forward at streaming speed, writing 3200fci flux reversal data. Tape rewinds to BOT, SAGC is performed in both high and low speed and the average value of the SAGC value is checked by the microprocessor. When the value is under the criterion, the operation is completed and the tape is unloaded, the 2 digit indicator displays ''00''.

3. PE gain adjustment error

   If the gain exceed the criterion, the display will be ''F.3'' and ''40.'' or another FSC will be indicated.

   In this case, first change the work tape to better one and perform the item 2 again. If the error occurs again, analyze the fault sympton code. The details are explained in chapter 5.

   Note: Unless the 'RESET' switch is not pressed, the MTU is in the diagnostic mode.

4. New gain storing

   Store the new gain into the nonvolatile memory using the diagnostic code "94" by pressing the 'START' switch.

   Note: Unless the 'RESET' switch is not pressed, the MTS is in the same diagnostic mode.

   While pressing the 'TEST' switch, press the 'DENSITY SELECT' switch. The store operation finishes instantaneously and 2 digit indicator displays ''00''.

CHAPTER 7 ILLUSTRATED PARTS CATALOG

7.1 M2441/M2443

The illustrated parts catalog (IPC) of the model M2441 and M2443 are shown in the visual index I, Figure 1, Figure 2, Figure 3.

7.2 M2442/M2444

The IPC of the model M2442 and M2444 are shown in the visual index II, Figure 11, Figure 12, Figure 13.

Note: The location and the nickname of printed circuit assembly (PCA) are shown in Appendix C. Refer to the Appendix if necessary.

VISUAL INDEX II STREAMING TAPE DRIVE

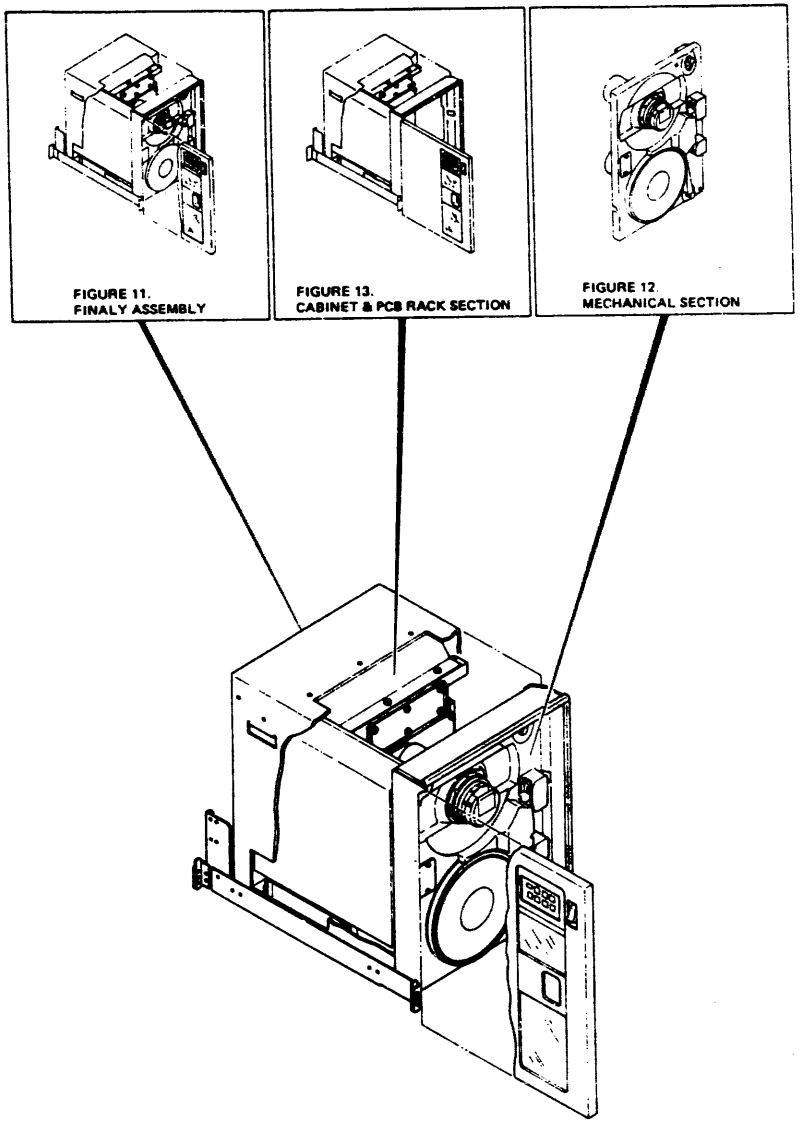


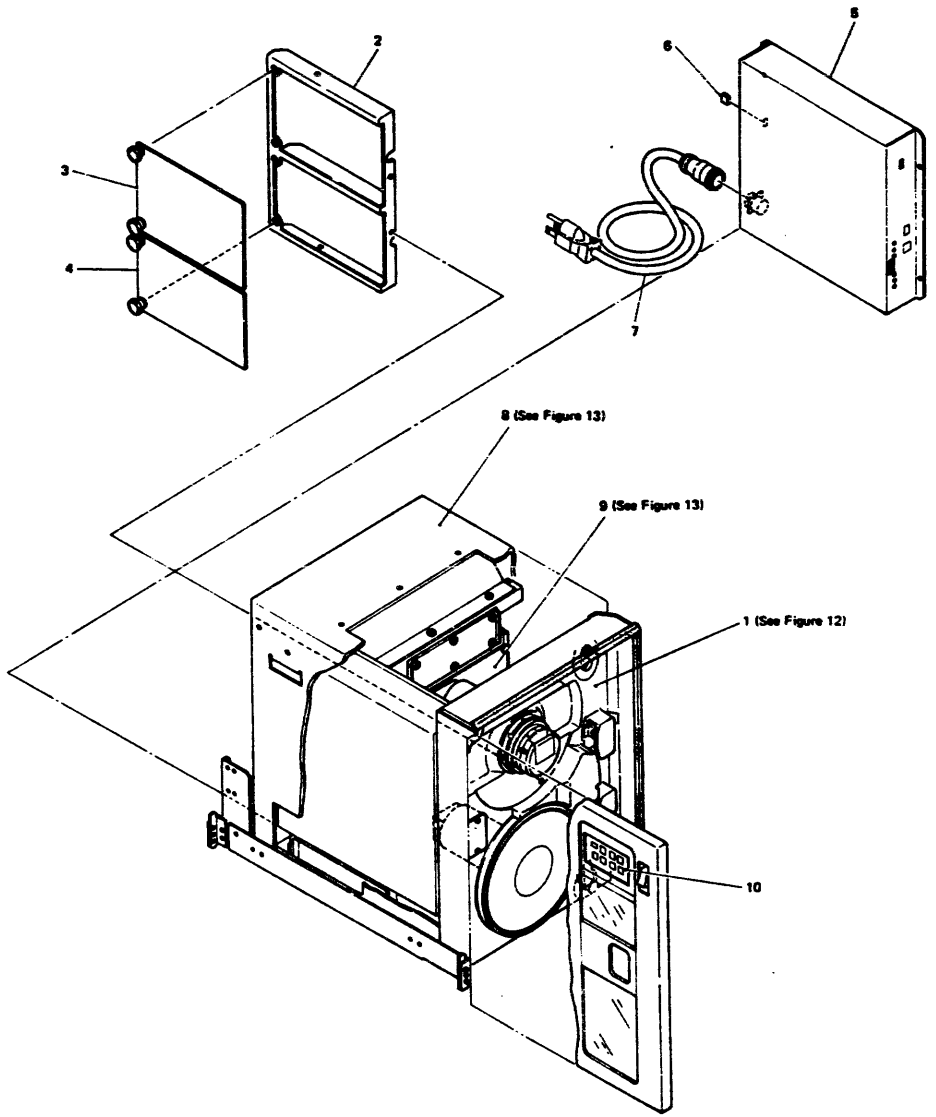
FIGURE 11.
FINALY ASSEMBLY

FIGURE 13.
CABINET & PCB RACK SECTION

FIGURE 12.
MECHANICAL SECTION

M2442A/M2444A'	1

FIGURE 11. FINAL ASSEMBLY

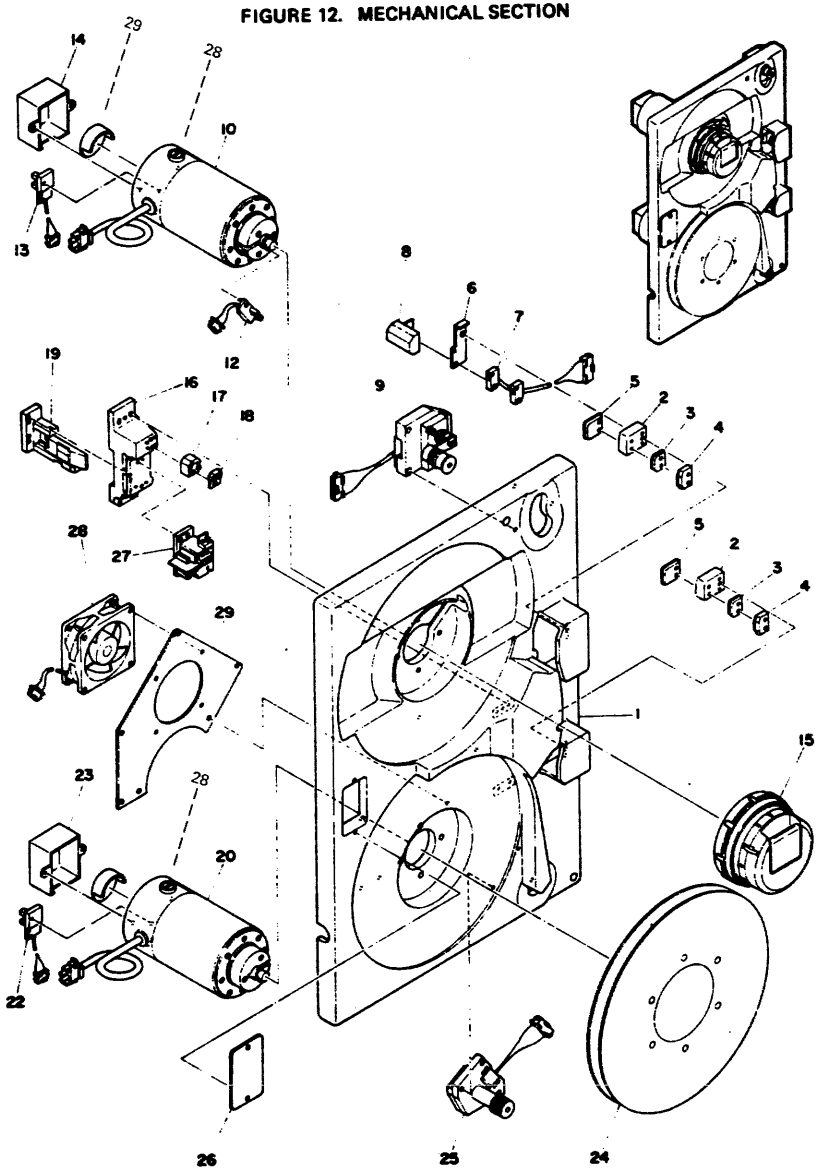


M2442A/M2444A	1

FIGURE 11. FINAL ASSEMBLY (M2442A/M2444A)

INDEX NO.	COMPOSITION & QUANTITY					SPECIFICATION	DESCRIPTION
	1					B03B-5325-B601A	M2442A Streaming Tape Drive
	1					B03B-5325-B701A	M2444A Streaming Tape Drive
		1				B03B-5320-D002A	M2442A Mechanical Unit
		1				B03B-5320-D003A	M2444A Mechanical Unit
1			1			B030-5320-T011A	Magnetic Tape Panel (Fig. 12)
2			1			B250-3570-X101A	Fitting Metal
-			2			F6-SW2MA-4x8S-M-ZN1A	Screw
* 3			1			B16B-9440-0010A#U	PCA 'RPA'
* 4			1			B16B-9470-0010A#U	PCA 'NTA' (M2442A only)
* 4			1			B16B-9470-0100A#U	PCA 'WTA' (M2444A only)
* 5		1				B14L-5105-0155A#A1	Power Supply
* 6			1			C60L-0020-0001#MP10	Fuse
-		4				F6-SW2MA-4x8S	Screw
7		1				B660-0280-T221A	AC Power Cable
8		1				B210-1860-T001A	Cabinet (Fig. 13)
9		1				B03B-5320-D021A	PCB Rack Unit (Fig. 13)
-		5				F6-SW2MA-4x8S	Screw
* 10		1				N860-3629-T001	Operator Panel
-		4				F6-SBD-4x6S-M-NI1A	Screw
		2				C960-0300-T001	PCA Extracting Tool
-		1				B660-1060-T117A#L180R1	Cable CNJ14-CNJ43
-		1				B660-0280-T091A#L200R1	Cable 1C07U-CNJ63
-		1				B660-0280-T143A#L600R0	Cable CNP71-CNP33
-		1				B660-0280-T146A#L700R0	Cable CNP72-CNP31
-		1				B660-0280-T147A#L600R0	Cable CNJ73-CNJ21
-		1				B660-0280-T153A#L100R1	Cable CNP32-CNJ64/65
-		1				B660-0280-T154A$L190R1	Cable CNJ11-CNJ42/48
-		1				B660-0280-T155A#L180R1	Cable 1C06-CNJ41/47
-		1				B660-0280-T195A#L200R1	Cable CNP74-Contact
-		1				B660-0280-T217A#L300R0	Cable CNP75-CNP34
-		1				B660-0280-T170A	Cable CNJ51-CNP52/57
-		2				B660-0720-T201A#L390R0	FG Cable 390 mm
-		1				B660-0720-T201A#L270R0	FG Cable 270 mm

FIGURE 12. MECHANICAL SECTION

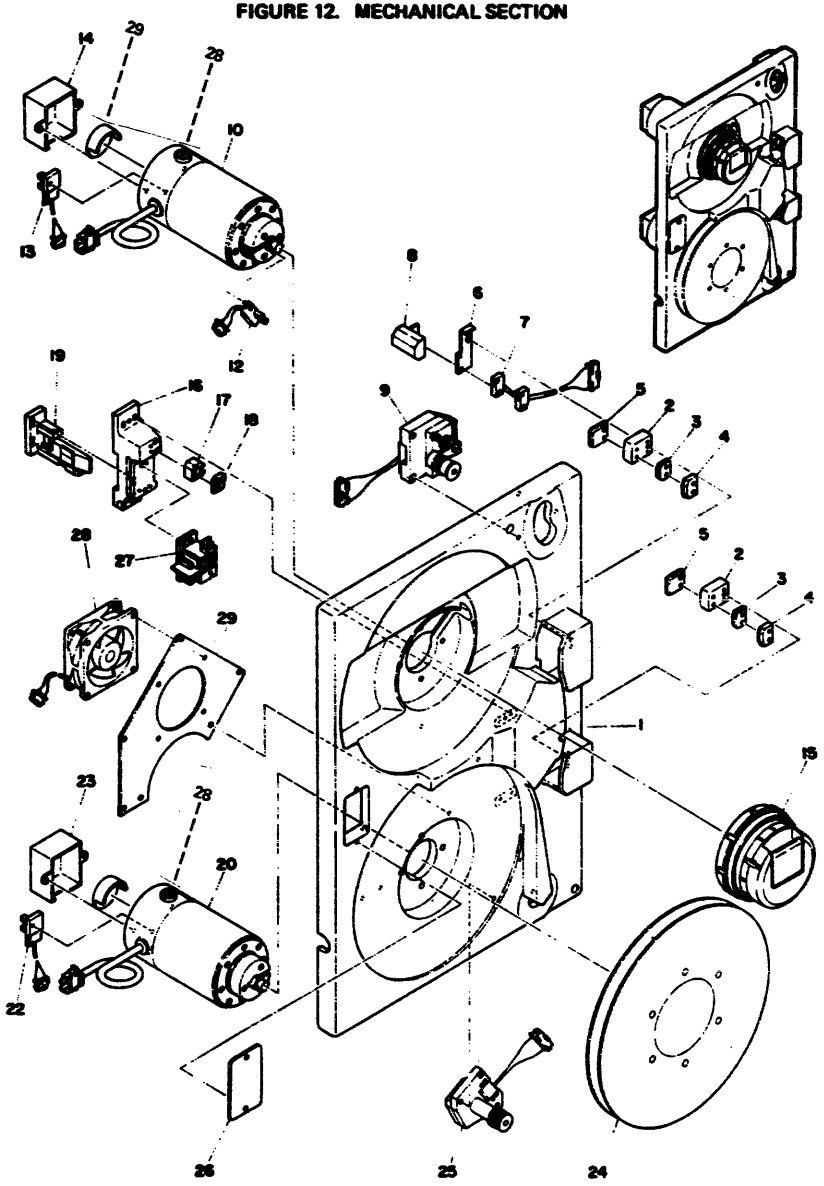


M2442A/M2444A	1

FIGURE 12. MECHANICAL SECTION – (1/2) (M2442A/M2444A)

INDEX NO.	COMPOSITION & QUANTITY					SPECIFICATION	DESCRIPTION
	1					B030-5320-T011A	Magnetic Tape Panel
1		1				B030-5320-X006A	Casting Panel
*		2				B030-5320-V102A	Guide Assembly
2			2			B030-5320-X106A	Guide
* 3			2			B030-5320-X107A	Upper Flange
-			4			F6-SBD-4x6S-M-NI1A	Screw
4			2			B030-5320-X109A	Block
* 5			2			B030-5320-X108A	Lower Flange
-			2			F6-SBD-4x6S-M-NI1A	Screw
-			2			F6-SBD-4x12S-M-NI1A	Screw
*		1				B030-5320-V127A	BOT/EOT Sensor Assembly
6			1			B030-5320-Y105A	Plate
7			1			B030-5320-V123A	BOT/EOT Sensor
8			1			B030-5320-V128A	Mirror Block
-			1			F6-SBD-3x20S-M-NI1A	Screw
-			1			F6-NI-3S	Nut
-		1				F6-SW2NA-4x25S-M-ZN1A	Screw
* 9		1				B030-5320-V109A	Tension Sensor Assembly
-		2				F6-SW2NA-4x20S-M-ZN1A	Screw
-		1				F6-SW2NA-4x30S-M-ZN1A	Screw
		1				B030-5320-T302A	File Reel Motor Unit
* 10			1			B030-5320-V302A	File Reel Motor Assembly
* 12			1			B030-5320-V205A	Write Enable Sensor
-			1			F6-SSA-3x8S	Screw
* 13			1			B030-5320-V203A	File Tacho sensor
-			1			F6-SSA-3x8S	Screw
14			1			B030-5320-X204A	Cover
-			2			F6-SW2NA-3x6S-M-ZN1A	Screw
-		4				F6-BA-6x12-M-ZN1A	Bolt
* 15		1				B030-5320-V450A	Reel Hub Assembly
16		1				B030-5320-V100A	Head Block
			1			B030-5320-X101A	Base Plate
			1			B030-5180-X103A	Spring
			1			B030-5180-X102A	Nut
			1			B300-0410-X007A	Screw
			3			F6-SBD-4x8S	Screw
*			1			B030-5320-V122A	Tape Cleaner
17				1		B030-5180-V109A	Cleaner
18				1		B030-5320-X156A	Plate
			2			F6-SSA-3x20S	Screw

FIGURE 12. MECHANICAL SECTION



M2442A/M2444A	1

FIGURE 12. MECHANICAL SECTION – (2/2) (M2442A/M2444A)

INDEX NO.	COMPOSITION & QUANTITY						SPECIFICATION	DESCRIPTION
* 19		1					B030-5320-V120A	Shield Block
-		2					F6-SW2NA-3x8S	Screw
		1					B030-5320-T303A	Machine Reel Motor Unit
* 20			1				B030-5320-V303A	Machine Reel Motor Assembly
* 22			1				B030-5320-V204A	Machine Tacho sensor
-			1				F6-SSA-3x8S	Screw
23			1				B030-5320-X204A	Cover
-			2				F6-SW2NA-3x6S-M-ZN1A	Screw
-		4					F6-BA-6x12-M-ZN1A	Bolt
* 24		1					B030-5320-V501A	Machine Reel Assembly
-		3					F6-SW2NA-4x16S-M-ZN1A	Screw
* 25		1					B030-5320-V103A	Idler Tacho Assembly
-		2					F6-SBD-4x16S-M-ZN1A	Screw
-		1					F6-SBD-4x25S-M-ZN1A	Screw
26		1					B030-5320-X002A	Plate
-		2					F6-SBD-4x6S	Screw
* 28		1					B030-5320-T350A	Loading Fan
29		1					B030-5320-X007A	Plate
-		4					F6-SW2NA-3x40S	Screw
* 27	1						B860-1780-T001A	Magnetic Head
-	2						F6-SBD-4x10S-M-NI1A	Screw
-	1						F6-SNA-3x6BS	Screw
-	1						F6-WH-3PB	Washer
							B960-0110-T016A	Cleaning Kit

FIGURE 13. CABINET & PCB RACK SECTION

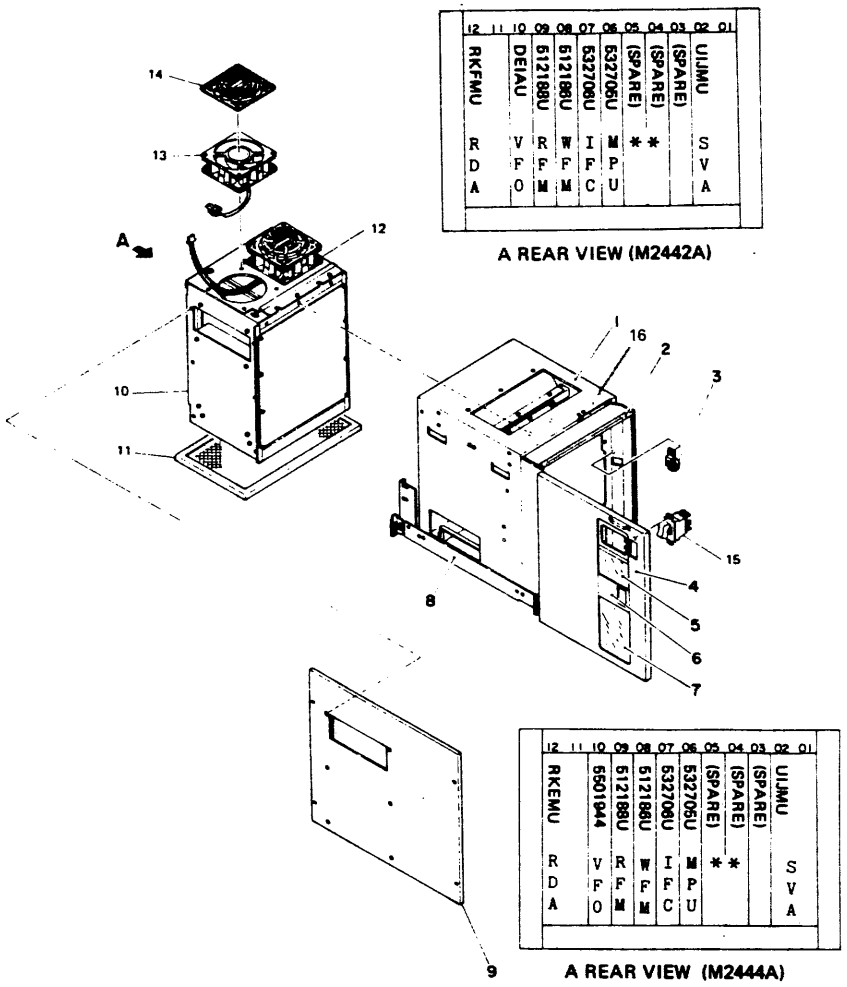


FIGURE 13. CABINET & PCB RACK SECTION (M2442A/M2444A)

INDEX NO.	COMPOSITION & QUANTITY	SPECIFICATION	DESCRIPTION
10	1	B03B-5320-D021A	PCB Rack Unit
-	5	F6-SW2NA-4x8S	Screw
	1	B03B-5320-E021A	M2442A PCA Package
*	1	C16B-5121-0860#U	PCA 'WFM'
*	1	C16B-5121-0880#U	PCA 'RFM'
*	1	C16B-5327-0050#U	PCA 'MPU'
*	1	C16B-5327-0060#U	PCA 'IFC'
*	1	B16B-9890-0020A#U	PCA 'RDA' (M2442A only)
*	1	B16B-9460-0100A#U	PCA 'SVA'
*	1	C16B-5501-0840#U	PCA 'VFO' (M2442A only)
	1	B03B-5320-E022A	M2444A PCA Package
*	1	C16B-5121-0860#U	PCA 'WFM'
*	1	C16B-5121-0880#U	PCA 'RFM'
*	1	C16B-5327-0050#U	PCA 'MPU'
*	1	C16B-5327-0060#U	PCA 'IFC'
*	1	B16B-9920-0010A#U	PCA 'RDA' (M2444A only)
*	1	B16B-9460-0100A#U	PCA 'SVA'
*	1	C16B-5501-0940#U	PCA 'VFO' (M2444A only)
**		B03B-5325-0010A	PCA 'BUF' Option
* 11	1	B90L-1155-0019A	Filter Assembly
* 12	1	B03B-5320-D022A	Right Fan Unit
* 13	1	B03B-5320-D023A	Left Fan Unit
14	2	B90L-1540-0001A	Finger Guard
	8	F6-SBD-3x45S-M-NI1A	Screw
* 15	1	C56L-0460-0003	Power Switch
-	2	F6-SW2NA-3x8S	Screw
16	1	B210-1860-X026A	Locking Metal Upper
	1	B210-1860-X020A	Locking Metal Lower
	2	F6-SKMH-6X25S-M-NI1A	Locking Screw

FIGURE 13. CABINET & PCB RACK SECTION

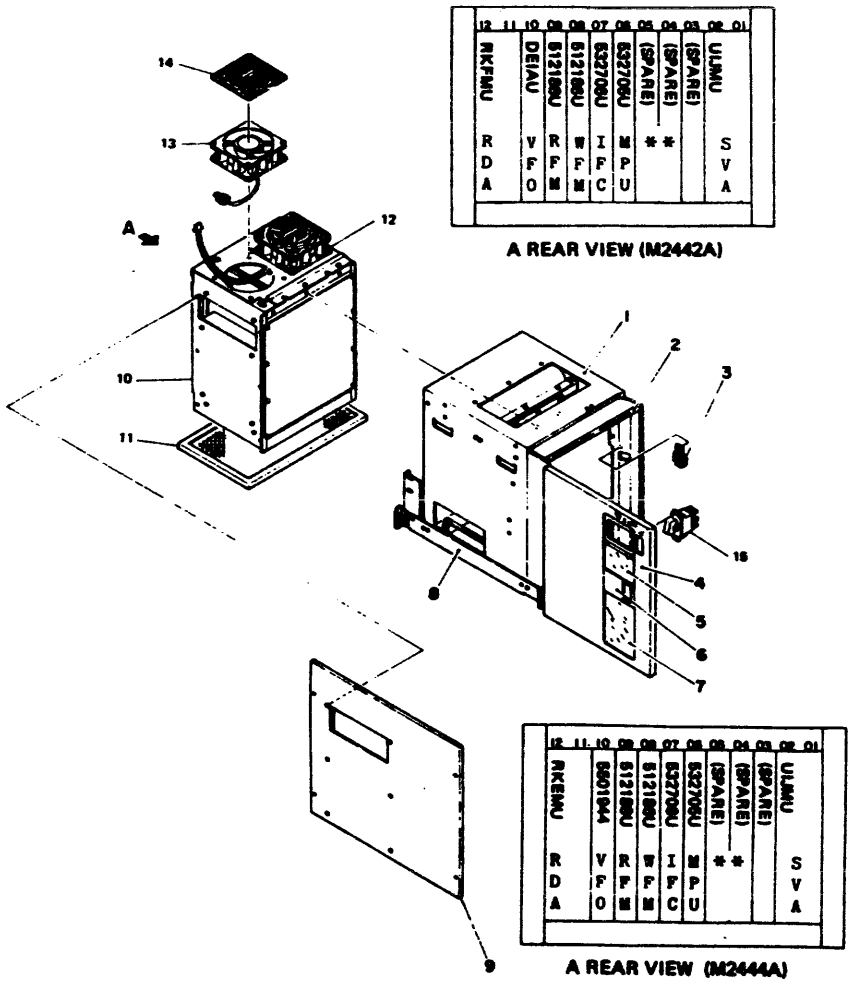


FIGURE 13. CABINET & PCB RACK SECTION (M2442A/M2444A)

INDEX NO.	COMPOSITION & QUANTITY					SPECIFICATION	DESCRIPTION
	1					B210-1860-T001A	Cabinet
1		1				B210-1860-V001A	Frame Assembly
2			2			B210-1860-X012A	Sponge
			1			B210-1860-X011A	Sponge
* 3		3				B30L-0970-0102A	Roller Catch
-		12				F6-SW2NA-2.6x12S-M-N11A	Screw
4		1				B210-1860-V120A	Front Door Assembly
5			1			B210-1860-X108A	Plate
-			4			F6-N1-4S	Nut
-			4			F6-WM-4S	Washer
-			4			F6-WB-4S	Washer
6			1			B210-1860-X126A	Fitting Metal
-			4			F6-N1-4S	Nut
-			4			F6-WM-4S	Washer
-			4			F6-WB-4S	Washer
7			1			B210-1860-X109A	Plate
-			4			F6-N1-4S	Nut
-			4			F6-WM-4S	Washer
-			4			F6-WB-4S	Washer
		1				B210-1860-V201A	Right Rail Assembly
8		1				B210-1860-V202A	Left Rail Assembly
9		1				B210-1670-W551A	Plate
-		6				F6-SW2NA-3x8S	Screw
*	1					B55L-0400-0001A	Door Switch
	1					B210-1860-V006A	TUV Switch Interlock
	1					B210-1860-X039A	TUV Door Interlock

VISUAL INDEX

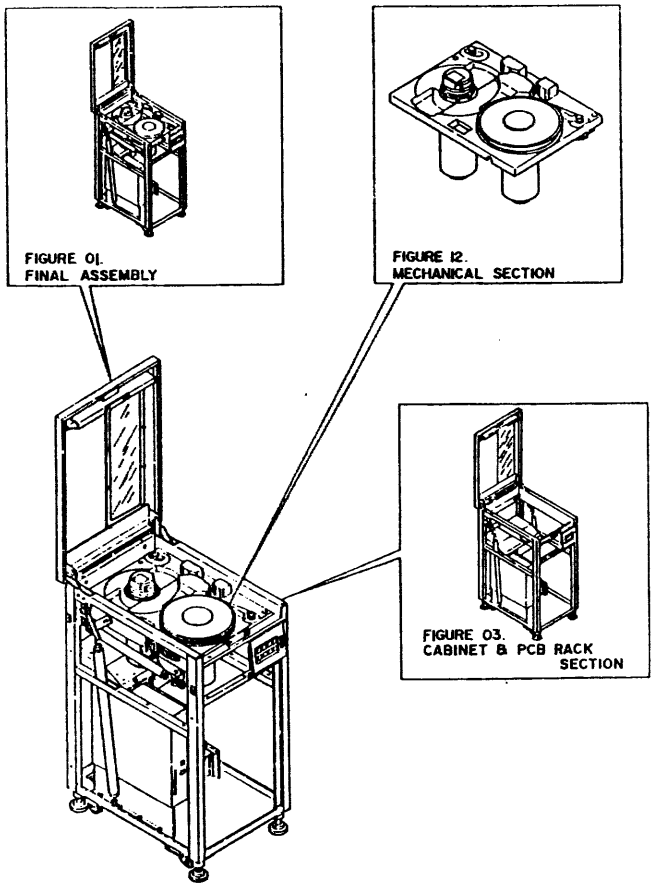


FIGURE 01. FINAL ASSEMBLY

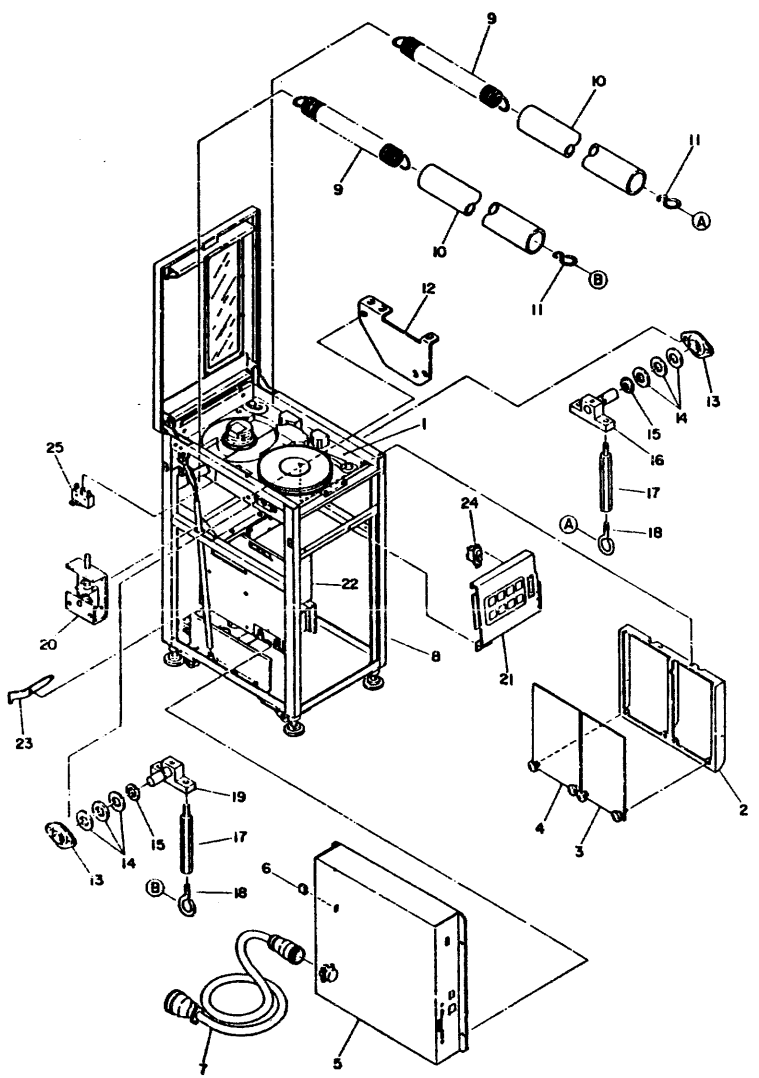


FIGURE 01. FINAL ASSEMBLY (M2441A/M2443A)

INDEX NO.	COMPOSITION & QUANTITY					SPECIFICATION	DESCRIPTION
	1					B03B-5325-B101A	M2441A STREAMING TAPE DRIVE
	1					B03B-5325-B201A	M2443A STREAMING TAPE DRIVE
		1				B03B-5320-D002A	M2441A MECHANICAL UNIT
		1				B03B-5320-0003A	M2443A MECHANICAL UNIT
1			1			B03B-5320-T011A	MAGNETIC TAPE PANEL, (FIG. 12
2			1			B250-3570-X101A	FITTING METAL
			2			F6-SW2NA-4X8S-M-NI1A	SCREW
* 3			1			B16B-9440-0010A#U	PCA 'RPA'
* 4			1			B16B-9470-0010A#U	PCA 'NTA' (M2441A)
* 4			1			B16B-9470-0100A#U	PCA 'WTA' (M2443A)
* 5	1					B14L-5105-0155A#A1	POWER SUPPLY UNIT
* 6			1			C60L-0020-0001#MP10	FUSE
* 5	1					B14L-5105-0155A#A2	POWER SUPPLY UNIT
							MODEL REVISION
							M2441A ON AND AFTER C2
							M2443A ON AND AFTER B1
							M2441AC ON AND AFTER A0
							M2443AC ON AND AFTER A4
		4				F6-SW2NA-4X8S-M-NI1A	SCREW
7		1				B660-0280-T221A	AC POWER CABLE
8		1				B210-1670-T003A	CABINET (FIG. 03)
9		2				B210-1670-X327A	SPRING
10		2				CT-GPJ-030-#7H7	SPRING COVER
11		2				B210-1670-X332A	FORK
12		1				B210-1670-X914A	DETENT. PLATE
		3				F6-BA-6X10-M-ZN1A	BOLT
13		2				CT-BA-F1518	BEARING
		4				F6-BA-6X16-M-ZN1A	BOLT
14		6				B210-1670-X901A	SPRING PLATE
15		2				JB-WM-14S	WASHER
		2				JB-C-15	C-RING
16		1				B210-1670-V907A	BLOCK ASSY
		2				F6-BA-6X16-M-ZN1A	BOLT
17		2				B210-1670-X904A	ROD
18		2				B210-1670-X905A	J-BOLT
		2				F6-N1-6S	NUT
19		1				B210-1670-V901A	BLOCK ASSY
20		1				B210-1670-V902A	DETENT. ASSY
		4				F6-SBD-4X8S-M-NI1A	SCREW
* 21		1				N860-3629-T001	OPERATOR PANEL
		4				F6-SBD-4X6S-M-NI1A	SCREW
* 22		1				B03B-5320-D021A	PCB RACK UNIT (FIG 03)
		5				F6-SW2NA-4X8S	SCREW
* 23		2				C960-0300-T001	PCA EXTRACTING TOOL
* 24		1				C56L-0460-0003	POWER SWITCH
		2				F6-SW2NA-3X85	SCREW
* 25		1				B03B-5320-D028A	SWITCH
		2				F6-SW2NA-2.3X10S-M-NI1A	SCREW
		1				B660-1060-T117A#L180R1	CABLE CNJ14-CNJ43
		1				B660-0280-T091A#L200R1	CABLE 1C07U-CNJ63
		1				B660-0280-T143#L600R0	CABLE CNP71-CNP33
		1				B660-0280-T146A#L700R0	CABLE CNP72-CNP31
		1				B660-0280-T147A#L600R0	CABLE CNJ73-CNJ21
		1				B660-0280-T153A#L100R1	CABLE CNP32-CNJ64/65
		1				B660-0280-T154A#L190R1	CABLE CNJ11-CNJ42/48
		1				B660-0280-T155A#L180R1	CABLE 1C06-CNJ41/47
		1				B660-0280-T195A#L200R1	CABLE CNP74-CONTACT
		1				B660-0280-T1217A#L300R0	CABLE CNP75-CNP34
		1				B660-0280-T170A	CABLE CNJ51-CNP52/57
		3				B660-0720-T201A#L390R0	FG CABLE 390 MM
		4				B660-0720-T201A#L270R0	FG CABLE 270 MM

FIGURE 03. CABINET & PCB RACK SECTION

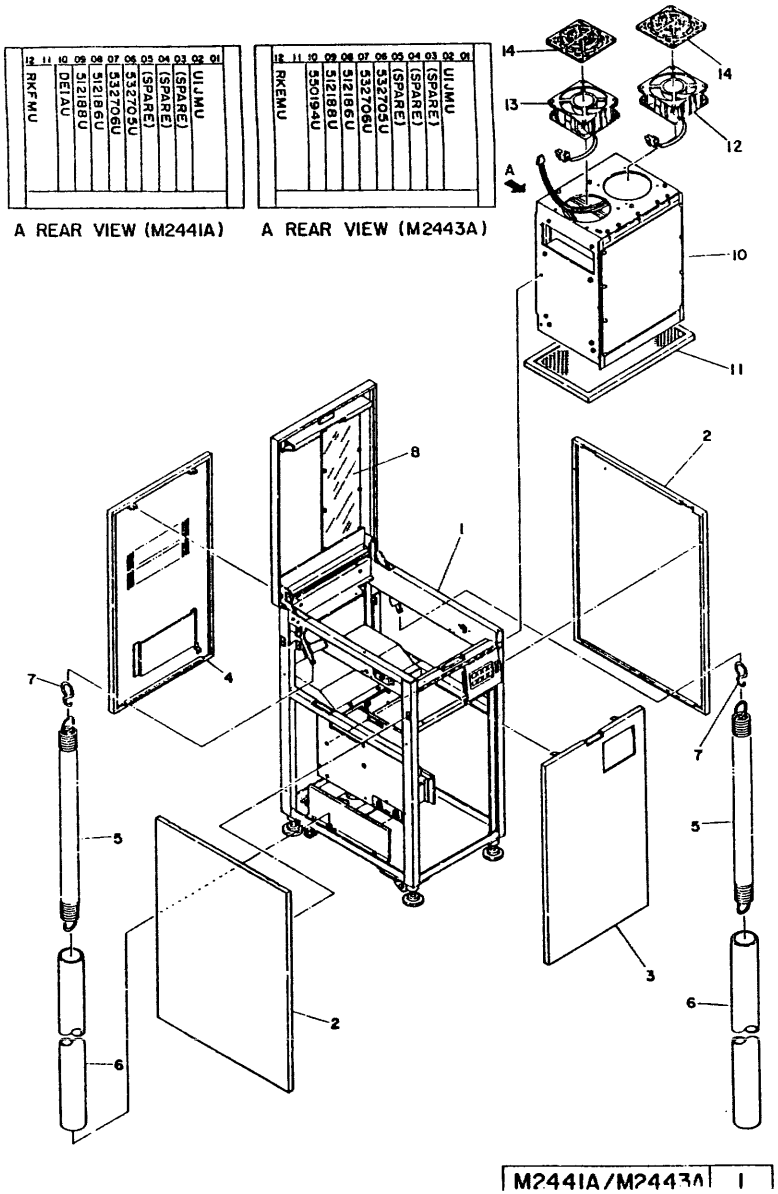


FIGURE 03. CABINET & PCB RACK SECTION (M2441A/M2443A)

INDEX NO.	COMPOSITION & QUANTITY	SPECIFICATION	DESCRIPTION
1	1	B210-1670-T003A	CABINET
2	2	B210-1670-V670A	SIDE COVER ASSY
	4	F6-SBD-4X105-M-NI1A	SCREW
3	1	BZ10-1670-V655A	FRONT COVER ASSY
4	1	B210-1670-V660A	REAR COVER ASSY
5	2	B210-1670-X913A	SPRING
6	2	CT-GPJ-030-1767	SPRING COVER
7	2	B210-1670-X328A-NI1A	FORK
8	1	B210-1670-X610A	WINDOW
	8	F6-A1-45-M-NI1A	NUT
	8	F6-WB-45-M-NI1A	WASHER
	8	F6-WM-45-M-NI1A#A1	WASHER
10	1	B0B-5320-D021A#MP10	PCA RACK UNIT
	5	F6-SW2NA-4X6S-M-NI1A	SCREW
	1	B03B-5320-E021A	M2441A PCA PACKAGE
*	1	C16B-5121-0860#U	PCA 'WFM'
*	1	C1B6-5121-0880#U	PCA 'RFM'
*	1	C16B-5327-0050#U	PCA 'MPU'
*	1	C16B-5327-0060#U	PCA 'IFC'
*	1	B16B-9890-0020A#U	PCA 'RDA' (M2441)
*	1	B16B-9460-0100A#U	PCA 'SVA'
*	1	C16B-5501-0840#U	PCA 'VFO' (M2441)
	1	B03B-5320-E022A	M2443A PCA PACKAGE
*	1	C16B-5121-0860#U	PCA 'WFM'
*	1	C16B-5121-0880#U	PCA 'RFM'
*	1	C16B-5327-0050#U	PCA 'MPU'
*	1	C16B-5327-0060#U	PCA 'IFC'
*	1	B16B-9920-00010A#U	PCA 'RDA' (M2443A)
*	1	B16B-9460-0100A#U	PCA 'SVA'
*	1	C16B-5501-0940#U	PCA 'VFO' (M2443A)
* 11	1	B90L-1155-0019A	FILTER ASSY
* 12	1	B03B-5320-D022A	RIGHT FAN UNIT
* 13	1	B03B-5320-D023A	LEFT FAN UNIT
14	2	B90L-1540-0001A	FINGER GUARD
	8	F6-SBD-3X455-M-NI1A	SCREW

APPENDIX A FIELD TESTER FUNCTION

A.1 Introduction

The field tester for M244X has two functions. One is to display the content of registers to which the microprogram may access, another function is the capability of the execution of many commands in an offline state. These functions are useful for the installation and maintenance.

A.2 Top View of The Field Tester

Figure A.1 is the top view of field tester.

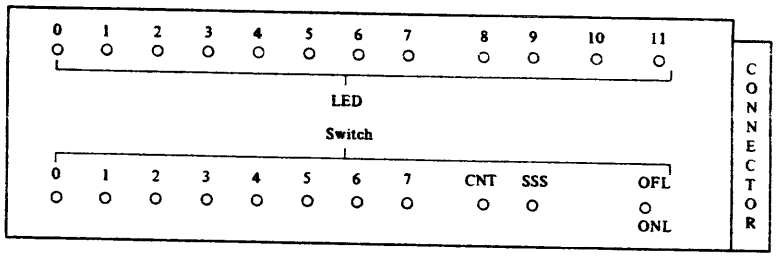


Figure A.1 Top view of field tester

A.3 Function of LEDs and Switches

A.3.1 OFL/ONL switch (two position toggle switch)

This switch is used to change the M244X between the online and offline state. When the switch is turned to the OFL position, the M244X is in the offline mode and negates all interface signals. Only when the tape tension is off, can the the MTU be placed in the offline state.

A.3.2 Switch 0-7 (two position toggle switch)

These switches are used to set the addresses of microprogram registers or command codes.

A.3.3 CNT switch (two position momentary toggle switch)

This switch is used to display the contents of microprogram registers addressed by switches 0-7.

A.3.4 SSS switch (two position momentary toggle switch)

This switch is used to start or stop the offline command which is specified by switches 0-7.

A.3.5 LED 0-7 (lamps)

These lamps are used to display the content of microprogram resisters. The content of register is fetched during a branch operation of the micro instruction and is displayed by LEDs.

A.3.6 LED 8 (lamp)

This lamp is lit when an error condition is detected in the execution of a offline command.

A.3.7 LED 9 (lamp)

This lamp is lit when the offline command is terminated correctly.

A.3.8 LED 10 (lamp)

This lamp is lit while the offline command is executing.

A.3.9 LED 11 (lamp)

This lamp is lit while the MTU is in offline mode.

A.4 Display of The Register

The contents of a register can be displayed by LED in either online or offline mode. To check the contents of registers following actions are needed.

(1) Set the register's address in switch 0-7 in hexdecimal.

(2) Hit CNT switch.

(3) LED 0-7 shows the content of register. If the address is more than ''80'' (hex), more information can be retreived.

* Register of interface control, set switch 0 up.
* Register of device control, set switch 0, 1 down.
* Register of servo control, set switch 1 up.

A.5 Offline (test) Mode

Turn ONL/OFL switch to OFL position to go into offline mode. If a tape has been loaded in the online state, this has no affect.

A.6 Execution of Offline Commands.

A.6.1 Loading of a tape

Check the tape tension is released. If the tension is on, unload a tape and then set offline state.

Mount a tape and push the hub lock nob. Thread a tape and wrap it around the machine reel hub.

Two ways are provided for a tape loading. One is to press the START switch of the operator panel, another is showed below.

(1) Set "80" (hex) to switch 0-7.

(2) Turn SSS switch on. START LED of operator panel is lit just after SSS switch is pressed.

Wait till the completion of the loading and then the offline command can be operative.

A.6.2 Offline command by field tester

Following commands are available by pushing SSS switch. Table A.1 through A.3 show the commands of field tester.

Table A.1 Field tester command

Code	Command	Code	Command
00	Ignore door switch		
20	Space	30	F-read (c) with retry
21	Read	31	B-read (c) with retry
22	Space file	32	F-read (c) error stop
23	Space file with data	33	B-read (c) error stop
24	Space (c)	34	F-read (c) stop at TM
25	Read (c)	35	B-read (c) stop at TM
26	Space file (c)	36	Backspace-read (c)
27	Space file with data (c)	37	Space-back read (c)
28	Backspace	38	FRD to EOT, BRD to BOT (c)
29	Back read	39	FRD to EOT & rewind
2A	Backspace file	3B	1 block read & rewind (c)
2B	Backspace file with data	3C	Write to EOT & rewind
2C	Backspace (c)	3D	Write to EOT & rewind (c)
2D	Back read (c)	3E	WRT to EOT, BRD to BOT, FRD to BOT & rewind (c)
2E	Backspace file (c)	3F	Write-backspace-read to EOT & rewind
2F	Backspace file with data (c)		

Notes:
1: (c) means continuous executing of command till stop condition detected.
2: F- means forward, B- means backward.
3: FRD, BRD mean forward and backward read respectively.
4: WRT means write and TM means tape mark.

Table A.2 Field tester command

Code	Command	Code	Command
40	Erase fix length	50	9042/3200 fci unformat WRT
41	Erase fix length (c)	51	3014/1600 fci unformat WRT
42	Erase variable length	52	9042/3200 WRT feed through
43	Erase variable length (c)	53	9042/3200 WRT cross talk
44	Write	54	3014/1600 WRT cross talk
45	Write (c)	55	Run FWD with read status
46	Write tape mark	56	Run BWD with read status
47	Write tape mark (c)	57	Continous SAGC with write
48	Write (c) with retry	58	Continuous SAGC with read
49	Write (c) error stop	59	Continous SAGC with BRD
4A	Write TM (c) with retry	5A	Head output check FWD vs BWD
4B	Backspace-write (c)		
4C	Loop write to read	5C	Azimuth adjust forward
4D	Loop write to read (c)	5D	Azimuth adjust backward
4E	Backspace-erase-write		
4F	1 block write & rewind (c)		

Table A.3 Field tester command

Code	Command	Code	Command
70	Write with mask bit 0	80	Load
71	Write with mask bit 1	88	Enable go-down time
72	Write with mask bit 2	89	Disable go-down time
73	Write with mask bit 3	8C	Set 1K block mode
74	Write with mask bit 4	8D	Reset 1K block mode
75	Write with mask bit 5	8E	Enable key to RDAC
76	Write with mask bit 6	8F	Disable key to RDAC
77	Write with mask bit 7	Ax	Set DGC count to "x"
78	Write with mask parity bit	Bx	Set slice level to "xy"
79	Write with mask bit 1, 8	Cy	
7A	Write with mask bit 2, 3		
7B	Write with mask preamble		
7C	Write with mask postamble		
E0	Reset	F4	Disable ROM operating CMD
E1	Data security erase	F5	Enable ROM operating CMD
E2	Set low speed	F6	Disable ROM operating CMD
E3	Set high speed	F9	Store ROM
E4	Rewind	FA	Write device type/EC level
E5	Unload	FB	BOT/EOT gain adjust
E6	Retension	FC	reserved
E8	Set long gap mode		
E9	Set normal gap mode	FD	reserved
EA	Set high density		
EB	Set low density		
EE	Start/stop forward		
EF	Start/stop backward		

A.6.3. Statistical record

The statistical records are stored in work register of interface control phase while execution of command ''2x'', ''3x'' and ''4x'' except ''38'', ''3D'', ''3E''. The statical records are showed in Table A.4. The statistical records are cleared when new command is issued.

Table A.4 Statical records stored in work register

Register			Contents
Upper		Lower	
B0	B1	B2	Command count
B3	B4		Data check count
B5	B6		1 or 2 track correction count
B7			Retry out count
B8	B9		Tape marks
BA	BB		VRC errors
BC	BD		CRC errors
BE	BF		Miscellanious errors
C0	C1		Multitrack errors
C2	C3		Envelope check count
C4			Start read check count
C5			End data check count
C6			Early begin read back check count
C7			Slow begin or slow end read back check count
C8			IBG detected during write
C9			Skew errors or write tape mark errors
CA			Crease detected
CB			No track pointer errors
CC			Velocity change errors
CD			SAGC errors
CE			Write bus parity errors, write trigger VRC errors or write formatter bus parity errors
D0	D1		Error track 1 (bit 5)
D2	D3		Error track 2 (bit 7)
D4	D5		Error track 3 (bit 3)
D6	D7		Error track 4 (bit P)
D8	D9		Error track 5 (bit 2)
DA	DB		Error track 6 (bit 1)
DC	DD		Error track 7 (bit 0)
DE	DF		Error track 8 (bit 6)
E0	E1		Error track 9 (bit 4)

A.6.4 Stop condition of continuous executing command

The conditions showed below cause the termination of continuous execution of command.

(1) Pressing SSS switch during execution of command.

(2) Detection of equipment check.

(3) Detection of overflow of the statical record.

(4) 1024 times of command execution in 1K block mode.

(5) In the forward direction, the detection of EOT.

(6) Double tape mark at read or space operation. Because there may be no data block after the end of file.

(7) In the backward direction, the detection of BOT marker.

(8) Detection of data check in error stop mode.

(9) Detection of tape mark in tape mark stop mode.

A.6.5 Sense byte at the offline mode

Sense bytes are stored in the registers from "40" to "4F". They can be seen by the field tester. But Device type (sense byte 0, bit 2), sense byte 1 and sense byte 2 are not set in the offline mode.

A.7 Command Operation

A.7.1 Load (code 80)

Loading operation is executed like the start switch of the operator panel.

A.7.2 Enable/Disable go-down time (code 88/89)

When code 88 or 89 is issued, GODOWN bit in register 57(hex) is set or reset respectively.
GODOWN bit is applied to code 2x, 3x or 4x to specify the interval between commands and also to 53, 54 to specity the length of erased area.
The interval between commands is twice of switch 0-7(hex) by 96 microseconds while 800 microseconds without GODOWN bit. the length of erased area of write for cross talk check command is the length for about 2.65 seconds while 96 QTP without GODOWN bit.

A.7.3 Set/Reset 1K block mode (code 8C/8D)

1K block mode is applied for command 2x, 3x, 4x except 38, 3D, 3E to specigy the number of command which have to be executed.

A.7.4 Enable/Disable key to RDAC (code 8E/8F)

This mode is applied to some 5x command to set the slice level of read amplifier to the value directed by switch 0-7. If switch 0-7 is 80(hex), the slice level is 0% and switch 0-7 is 00(hex), it level is 246%. If the value of switch is over 80(hex), it is inverted by "FF"(hex). The value of 1 count of switch is 2%.

A.7.5 Command 2x (read group)

(1) Space (code 20), Backspace (code 28)

These commands cause the tape to be moved in the forward or backward direction respectively and next block is skipped without data transfer operation.

(2) Read (code 21), Back read (code 29)

These commands cause the tape to be moved in the forward or backward direction respectively and next block is read.

(3) Space file (code 22), Backspace file (code 2A)

These commands cause the tape to be moved in the forward or backward direction respectively till next first tape mark is detected.
In forward direction, the movement of tape will be stopped when the first IBG is detected after EOT so that the tape must not be winded into the machine reel.

(4) Space file with data (code 23), Backspace file with data (code 2B)

These commands cause the tape to be removed in the forward or backward direction respectively and data blocks are read till next tape mark is detected.

(5) Space continuously (code 24), Read continuously (code 25)
Space file continuously (code 26)
Space file with data continuously (code 27)
Backspace continuously (code 2C)
Back read continuously (code 2D)
Backspace file continuously (code 2E)
Backspace file continuously (code 2F)

These commands specify the repetition of execution of same command until the one of the stop condition is encountered.

A.7.6 Command 3x (combination)

(1) Forward read (c) with retry (code 30)
Backward read (c) with retry (code 31)

The operation of these commands is almost the same as code 25 or code 2D respectively, but in these commands dretry will be executed when data check is detected. If the retry count is over 15, next block will be read.

(2) Forward read (c) error stop (code 32)
Backward read (c) error stop (code 33)

The operation of these commands is almost same as code 25 or code 2D respectively, but the operation stops when data check is encountered.

(3) Forward read (c) stop at tape mark (code 34)
Backward read (c) stop at tape mark (code 35)

The continous read operation stop when a tape mark is encountered.

(4) Backspace-read (c) (code 36)

This command causes the alternate operation of back space and forward read until the stop condition is detected. this command may be issued after code 32 for the analysis of the error data block.

(5) Space-back read (c) (code 37)

This command causes the alternate operation of space and back read until the stop condition is detected. The purpose of this command is same as code 36 and this is used for the back read operation.

(6) FRD to EOT, BRD to BOT (c) (code 38)

This command causes the continuous operation of forward or backward read with retry till the stop condition is detected, and the direction is changed when the stop condition is encountered. No statical record is stored.

(7) Forward read to EOT & rewing (code 39)

The operation is almost same as code 30 but the rewind operation is executed when the one of the stop condition is detected.

(8) 1 block read & rewind (c) (code 3B)

The operation of this command is the alternation of read and rewind. This command may be used to analyze the motion of read command at BOT area.

(9) Write to EOT & rewind (code 3C)

This command causes the tape to be moved in the forward direction and continuous formatted write operations are executed toward EOT. When data check is encountered, retry is executed by backspace and erase operation. The tape will be rewound when EOT marker is detected.

(10) Write to EOT & rewind (code 3D)

The operation is same as code 3C, but continous write operation are executed again after rewind operation. No statical record is stored.

(11) Write to EOT, back read to BOT, read to EOT & rewind (c) (code 3E)

The operation of this command is separated in to four parts. The first part is a write operation to EOT, the second is a back read operation to BOT, the third is a read operation to EOT and the last is a rewind operation. These four operations are executed cyclically. No statical records is stored.

(12) Write-backspace-read to EOT & rewind (code 3F)

The operation of this command is the cyclic operation of write, backspace and read toward EOT.

A.7.7 Command 4x (write group)

(1) Erase fix length (code 40)
Erase fix length (c) (code 41)

These commands cause the tape to be moved in the forward direction. The erase operation about 3.5 inches is executed. At code 41, the operation is repeated till the stop condition is encountered.

(2) Erase variable length (code 42)
Erase variable length (c) (code 43)

The operation of these commands is almost same except the length of erased area. Its length which is controlled by the microprogram is about 4K bytes length.

(3) Write (code 44), write (c) (code 45)

These commands cause the tape to be moved in the forward direction. A formatted write operation is done. The block length is about 4K bytes. When specified code 45, the operation is repeated until the stop condition is found.

(4) Write tape mark (code 46), write tape mark (c) (code 47)

These commands cause a tape mark to be written after a fixed length erasure. When code 47 is issued, the operation is repeated till the stop condition is detected.

(5) Write (c) with retry (code 48)

The operation is the same as code 45 except the retry sequence when a data check is detected. The operation is repeated till the stop condition is detected.

(6) **Write (c) error stop (code 49)**

The operation is almost same as code 45 but it will stop when data check is detected.

(7) **Write tape mark (c) with retry (code 4A)**

The operation is the same as code 47 but when a write tape mark is detected, back space operation of fixed length and the fixed length erase operation is executed and the retry of write tape mark is executed.

(8) **Backspace-write (c) (code 4B)**

This command causes the alternate operation of backspace and write operation till the stop condition is detected. The purpose of this command is the analyze the write operation at the time the write error occured.

(9) **Loop write to read (code 4C)**
Loop write to read (c) (code 4D)

These commands cause the write operation without tape movement. Write current of head is cut off. If code 4D is issued, the operation is repeated till the stop condition is found.

(10) **Backspace-erase-write (code 4E)**

The purpose of this command is the simulation of the retry sequence in write. More than one block must have been written before this command is issued. When this command is issued, backspace operation and erase fixed length operation and write operation are executed.

(11) **1 block write & rewind (code 4F)**

The purpose of this command is for the analyze the write operation around the BOT marker. The operation is repeated until the stop condition is found.

A.7.8 Command 5x (diagnostic aid)

(1) **9042/3200 fci unformat write (code 50)**

This command causes a special burst to be written to EOT. The density of the burst is 3042 fci in GCR mode and 3200 fci in PE mode.
The purpose of this command is for SAGC (code 58, 59), or for the check of head resolution ratio by 9042/3014 fci at GCR or 3200/1600 fci at PE.

(2) **3014/1600 fci unformat write (code 51)**

This command causes a special burst to be written to EOT. The density of the burst is 4014 fci in GCR mode and 1600 fci in PE mode.
The purpose of this command is same as code 50.

(3) **9042/3200 fci write for feed through check (code 52)**

This command causes an intermittent burst to be written EOT. The density of the burst is 9042 fci in GCR mode and 3200 fci in PE mode. The length of the written burst is 24 QTP (about 1.4 mm) and the erased length is 96 QTP (about 5.6 mm). The purpose of this command is to check the feed through noise during write operation.
Figure A.2 shows the intermittent burst pattern.

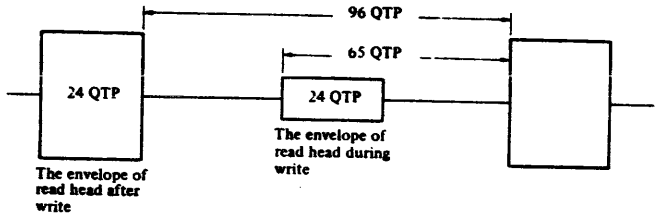


Figure A.2 Intermittent burst of code 52

(4) 9042/3200 write for cross talk checking (code 53)
3014/1600 write for cross talk checking (code 54)

This command causes a special pattern showed in Figure A.3 to be written the EOT marker. The density of the burst is 9042 (code 53) / 3014 (code 54) fci in GCR mode and 3200 (code 53) / 1600 (code 54) fci in PE mode.
The erased length of each track is 96 QTP normally. But when GODOWN bit is set by issuing code 88 command, it is expanded to 2.65 seconds.
This command has to be issued before issuing code 56 or 57 to observe the cross talk noise.

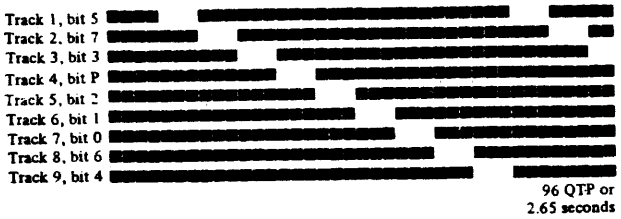


Figure A.3 Pattern of cross talk checking

(5) Run forward with read status (code 55)
Run backward with read status (code 56)

At code 55 command the tape is moved in the forward direction EOT marker and at code 56 command the tape is moved to BOT.
These command is used for the checking the cross talk noise by oscilloscope.

(6) Continous SAGC with write (code 57)

This command causes the same operation as code 50 and continous SAGC operation like the manner during write operation of ARA burst.

(7) Continous SAGC with read (code 58)
Continous SAGC with back read (code 59)

At code 58 the tape is moved toward EOT with continuous SAGC operation as same manner as read operation during ARA burst. At code 59 the tape is moved toward BOT, and the operation is same as code 58.
These commands have to be used for setting the read amplifier gain for PE, if the exchange of R/W head is needed.
16 times SAGC action is performed by every 2 seconds. Average counts of 16 times SAGC are stored in register 90-99 of device control phase.

(8) Head output check FWD/BWD (code 5A)

This command causes the density mode to be 6250 rpi, and tape high speed. The tape is moved in the forward direction and SAGC operation is executed with 90% slice level. The gain count of read amplifier after SAGC is checked and if it is over 13 (hex), the tape will be stoppped and LED 8, 9 are lit. Then the tape runs about 5.8 meters and the direction is changed to backward. The ouput of read head is checked with 44% slice level during running about 1.9 meters. If the output of any track is not detected, LED 8 is lit. Otherwise LED 9 is lit.

(9) Azimuth adjust forward (code 5C)
Azimuth adjust backward (code 5D)

The purpose of this command is to check and adjust the head by using the master skew tape.
With code 5C, the tape is moved in the forward direction and code 5D the direction is backward. During execution, if the switch 0 of the field tester is off, the skew is checked by track 4 and 5. If the switch 0 is on, checking tracks are 1 and 9. Track 1 and 9 are used for the fine adjustment.
If the left decimal point of the operator panel is lit, the screw for azimuth adjustment must turn to clockwise direction. If the right decimal point of the operator panel is lit, the direction is counter-clockwise.

A.7.9 Command 7x (diagnostic aid)

(1) Write with mask bit (code 70-7A)

Thses commands cause the same operation as normal write operation except a specified bit is not written.
The error track must be the same as the specified track is set in the sense byte showed in register 44 and 45.

(2) Write with mask preamble (code 7B)

This command causes the same operation as a normal write operation except the preamble is masked. The fault symptom code of this command is E240 and start read check bit in sense byte 14 (register 4E) is set.

(3) Write with mask postamble (code 7C)

This command causes the same operation as normal write operation except the postamble is masked. The fault symptom code of this command is E21A and IBG detected bit sense byte 14 (register 4E) is set.

A.7.10 Command Ax, Command Bx, Cx (diagnostic aid)

(1) Set DGC count to "x" (code Ax)

The gain of read amplifier is set to "x". The count is relative value and "0" is minimum, "F" is maximum value. "x" is specified by lower 4 bits of switch of the field tester.

(2) Set slice level to "xy" (code Bx, Cy)

The slice level is set to "xy" after command Bx and Cy are executed.
"x" and "y" are lower digit of each command.
The value of "xy" is the ralative value of the slice level. The actual value of 1 count is about 20 mV. When "xy" is specified as "80", the actual slice level is 0 V (0%) and when "xy" is specified as "00", the actual value is about 4.9 V (246%).
When "xy" is over "80", the microprogram inverts its value.

The slice level of read amplifier can be set only at the ready status. The practical value of the slice level which is set by these commands is ("ADAC"-"xy") at the new M2442A or M2444A. "ADAC" value can be seen in register 84.

A.7.11 Command Ex (control command)

(1) Reset (code E0)

This command is used to reset the sense data or command operation which is executing.

(2) Data security erase (code E1)

This command causes the tape to be moved in the forward direction and continuous erase operation about 1 meter beyond EOT marker is executed.

(3) Set low speed (code E2)

The speed mode is set to low speed mode by this command.

(4) Set high speed (code E3)

The speed mode is set to high speed mode.

(5) Rewind (code E4)

The tape will be rewound to BOT marker.

(6) Unload (code E5)

The tape will rewind to BOT and the unload.

(7) Retension (code E6)

The tape will be wound to EOT at 200 ips, then rewound to BOT at low speed.
This command may be used for the the maintenance of the media.

(8) Set long gap (code E8)

The length of IBG will be twice of normal write operation after this command is issued.

(9) Set high density (code EA)
Set low density (code EB)

These commands are used to specify the density of a write operation.
Code EA is for 6250 BPI and code EB is for 1600 BPI.
If the density select switch of the operator panel is not host select mode, these commands have no effect but the control bit (CMPE) is set or reset by these commands.

(10) Start/stop forward (code EE)
Start/stop backward (code EF)

These commands cause the tape to start or stop in the forward or backward direction respectively. If BOT or EOT marker is detected, the direction is changed.
The time of running forward or backward is specified by the switch 0-3.
The interval time from the start point of the deceleration to the start point of the acceleration is specified by switch 4-7 of the field tester.
(switch 0-3) x 7.87 msec is go-up time.
(switch 4-7) x 3.84 msec is go-down time.

A.7.12 Command Fx (adjustment)

(1) Enable ROM operationg command (code F5)

This command is used to enable the execution of codes F9, FA, FC and FD.
FACTORY bit of register 56 is set when this command is issued.

(2) Disable ROM operating command (code F4, F6)

These commands are used to reset FACTORY bit.

(3) Store ROM (code F9)

This command causes the data in RAM such as Device type, EC level, gain count of BOT or EOT sensor and gain count of read amplifier to be written into ROM.

(4) Write device type/EC level (code FA)

The purpose of this command is to set the device type, EC level or to change the gain count of BOT or EOT sensor.

(5) BOT/EOT gain adjust (code FB)

The purpose of this command is to adjust the gain of BOT/EOT sensor. When this command is issued, the tape is moved to search BOT and the correct value for the sensor is stored in RAM (register B0 of device control phase) and then the tape is moved to search EOT marker and stopped at EOT and correct value is stored in RAM (register B1).

A.7.13 Ignore door switch (code 00)

The state of the door switch is not checked after this command is issued. This command is useful for the azimuth adjustment or tension sensor/idler sensor adjustment operation.

APPENDIX B OFFLINE DIAGNOSIS BY THE OPERATOR PANEL

B.1 Set to Diagnostic Mode

Press the TEST switch and while pressing it, press the START switch. The MTU goes into the diagnostic mode and the TEST mode indicator will be lit. The DENSITY SELECT mode indicator will be in HOST select mode.

If the MTU has already been loaded the TEST switch is ignored. Make sure that the MTU is in a tension off state before going into TEST mode.

B.2 To Set the Routine Number

The testing routine number can be set by the START or UNLOAD switch. START is for (+1), UNLOAD switch is for (-1). If one of them is pressed for more than 1 second, the routine number is automatically increased or decreased. The routine number is indicated by the 2 digit 7 segment LEDs.

B.3 Start the Diagnostic Operation

To start the diagnostics the TEST switch should be pressed. While executing the operation, the routine number is indicated. If the specified routine number is from 90 to 22, the operation is initiated by pressing DENSITY SELECT and TEST switches.

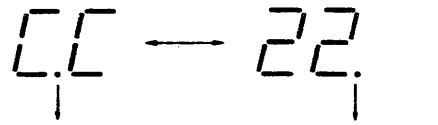
B.4 Termination of the Diagnostic Operation

When the specified operation terminates normally, the 7 segment LEDs is changed to ''00''.
The last routine number is stored in the RAM, after the LED 7 segment goes to ''00'' if the START switch is pressed, the LED indicates the next higher routine number.

B.5 Error Indication

If some error was detected, the Fault Symptom Code (FSC) is indicated alternately on the LED.
At this time, if the START switch is pressed, the LED indicates upper 2 bytes of the Fault Location Code (FLC), the UNLOAD switch is for the lower 2 bytes of the FLC. If TEST switch is pressed, 2 bytes of the microprogram state are indicated, DENSITY SELECT switch is for the routine number.

Example: Indication of the Fault Symptom Code



If the detected error was caused by an operation mistake such as the door opened, the 7 segment LED indicates the code L1 to L5.

B.6 Interruption of the Diagnostic Operation

If the TEST switch is pressed during the diagnostics, the operation is stopped and the LED indicates ''00''.
If TEST switch is pressed again, the routine that was interrupted will be executed again.
Note: If the routine number is 91 or 93, the meaning of the switches is changed.

RESET switch resets the diagnostic mode.

B.7 Error Reset

In the case that the error is detected by the formatter of the interface control program, the error is reset by pressing DENSITY SELECT and TEST switches.
If the error is detected by the device control or servo control program, the error is reset by pressing RESET only, and in this case the diagnostic mode is also reset.

B.8 Operation Time

In the case that the specified routine is "01" and the full reel (2400 feet) is used, the operation time is about 7 minutes. If a quater tape is used, it takes about 5 minutes.

B.9 Diagnostic Routine

Table B.1 shows the diagnostic routines.
When routine ''01'' is specified, teh tape will be loaded and routine 10 to 42 will be executed. If the routine ''06'' is specified, routine 10 to 19 will be executed.
If the routine is not 01 or 06, only the specified routine will be executed.

B.9.1 Code 00, 07-08, 43-89, 95, 96, and 98: No operation

B.9.2 Code 01: Load & run default routines

The tape will be loaded and routines 10 to 42 will be executed

B.9.3 Code 02: Load

The tape will be loaded. This routine should be done if the MTU is not all ready loaded. The following routines require a tape to be loaded 03 to 05, 20 to 42 or 90 to 92.

B.9.4 Code 03: Rewind

The tape will be rewound to the BOT marker.

B.9.5 Code 04: Unload

The tape will be rewound onto the supply reel.

B.9.6 Code 05: Retension

The tape will be wound on to the machine reel at 200 IPS to the EOT marker and rewound and unloaded at low speed. This routine is for media maintenance.

B.9.7 Code 06: Run routine 10 to 19

Routine 10 to 19 will be executed continuously. These routines can be executed even if a tape is not loaded.

Note: To loop diagnostics routines hold down the test switch and press density select (This has no effect in routines 90 - 99)

Table B.1 Operator panel diagnostic routines

Code	Contents
00	No operation
01	Load & run default test routine. (from code 10 to 42)
02	Load
03	Rewind
04	Unload
05	Retension
06	Run routine 10 - 19
09	Ignore door switch
10	Check reset test
11	LSI scan test
12	Time sensor test
13	Block format test
14	LWR test GCR high/low
15	LWR test PE high/low
16	Mask/Error track test by LWR GCR, high speed
17	Mask/Error track test by LWR GCR, low speed
18	Mask/Error track test by LWR PE, high speed
19	Mask/Error track test by LWR PE, low speed
20	Tacho counter test (QCTRH, QCTRL)
21	Read level test by GCR, high speed
22	Feed through test by PE, low speed
23	GCR identification burst test
24	PE identification burst test (low speed)
25	PE identification burst test (high speed)
26	GCR/low/normal/combination command test
27	GCR/low/long/combination command test
28	GCR/high/normal/combination command test
29	GCR/high/long/combination command test
30	PE/low/normal/combination command test
31	PE/low/long/combination command test
32	PE/high/normal/combination command test
33	PE/high/long/combination command test
34	GCR error detection/correction test
35	PE error detection/correction test
36	Tape mark detection test
37	BOT test (back into load point) by GCR
38	BOT test (back into load point) by PE
39	Command sequence test by GCR
40	Command sequence test by PE
41	Data security erase test
42	Unload & offline
90	BOT/EOT sensor gain adjust
91	Azimuth adjust
92	PE read amplifier gain adjust
93	EC level/Device type set
94	Device parameter set
97	Buffer parameter setting
99	Run initial diagnosis & reset diagnostic mode

B.9.8 Code 09: Ignore door switch

After this routine is done, the state of the door switch is not checked and the other routine can be executd with the door open.

B.9.9 Code 10: Check reset test

The interruption from the interface control program to the device control program is checked.

B.9.10 Code 11: LSI scan test

The 9 CMOS master slice LSIs are tested by scan mode.

B.9.11 Code 12: Time sensor test

The time sensor logic in the formatter and its function is to detect the read signal on the tape. The all ''1''s data is transferred to the time sensor logics and checked by Loop Write to Read mode.

B.9.12 Code 13: Block format test

The decode logics of the time sensor output is tested.

B.9.13 Code 14, 15: Loop write to read test

Loop write to read command is tested in GCR/PE mode and high/low speed mode.

B.9.14 Code 16 - 19: Error track test by loop write to read

Loop write to read with track mask is tested like code 14 or 15 and the error track pointers are checked.

B.9.15 Code 20: Tacho counter test

The tape is moved in the forward direction in high and low speed and the tacho pulse counter is tested.

B.9.16 Code 21: Read level test

In PE, low speed mode, the head output ratio of forward vs. backward is checked.

B.9.17 Code 22: Feed through test

In PE, low speed mode, the feed through of the head is checked.

B.9.18 Code 23 - 25: Identification burst test

In PE, GCR mode and high or low speed mode, the identification burst is written and checked. Also in GCR mode the SAGC operation is checked.

B.9.19 Code 26 - 33: Combination command test

In 8 modes (GCR/PE, high/low spped, normal/long gap), the basic read/write command listed below are tested.

1. write
2. write tape mark
3. write
4. erase fixed length
5. write
6. write tape mark
7. write tape mark
8. backspace file
9. backspace file
10. back read
11. backspace
12. backspace file
13. space file
14. read
15. space
16. space file

B.9.20 Code 34, 35: Error detection/correction test

Write blocks with 1 or 2 tracks dead and back read and read command are issued. The error track pointer is tested and error detection or correction and data check are checked.

B.9.21 Code 36: Tape mark detection test

Pseudo tape marks are written and checked by the spacefile command.

B.9.22 Code 37, 38: BOT test

Erase command is issued from BOT then backspace is issued. The tape reaches BOT and an error is checked.

B.9.23 Code 39, 40: Command sequence test

The read/write commands are tested with status changing as listed below.

write → backward → forward → write
in low and high speed

B.9.24 Code 41: Data security erase test

Data security erase is tested.

B.9.25 Code 42: Unload

The tape will be rewound onto the supply reel.

B.9.26 Code 90: BOT/EOT gain adjustment

Before executing this routine, the tape should be loaded. The gain of BOT/EOT sensor is automatically adjusted and stored in RAM. The gain stored in RAM is written in the NOV-RAM by executing routine 94.
See Chapter 6 REP 2310/2320.

B.9.27 Code 91: Azimuth adjustment

Use the master skew tape and load it by routine 02 before issuing this routine. See Chapter 6 REP 2110.

In this routine, the meaning of the switches on the operator panel are changed.

"START" : Forward movement
"UNLOAD" : Backward movement
"TEST" : Start or stop movement
"DENSITY SELECT" : Compared track change
At first "11" is indicated at LED.
The indication is changed alternately by pressing this switch from "11" to "00" or "00" to "11".
"11" means that the skew is compared by inner 2 tracks (track 5, 6).
"00" means by outer 2 tracks (track 1, 9).
"2 decimal points": Indication of the skew.
Adjust the screw until 2 indicators are lit equally.

During the operation, if EOT is detected, the direction of tape drive is changed to backward. If BOT is detected, the tape is unloaded.

B.9.28 Code 92: PE read amplifier gain adjustment

Use a work tape of good quality.
Load it by code 02.
All "1"s data with 3200 fci is written for about 20 meters, then the tape is rewound. 16 times of SAGC operation are done and mean value of the gain count is stored in RAM at high and low speed.
See Chapter 6, REP 2330.

B.9.29 Code 93: EC level/device type setting

This routine is for the changing of Device type or EC level or BOT/EOT gain.
See Chapter 6, REP 2320.
The meaning of the device type is as below.

most significant ← → least significant

bit 0	bit 1	bit 2, 3	bit 4, 5 interface	bit 6, 7 Density on power up
RESERVED	HI SPEED	GCR/PE 00: .3/.6 01: 1.2/1.2 10: 2.4/2.4 11: 4.8/4.8	0 0: CDC compatible 0 1: PERTEC compati 1 0: CIPHER compati 1 1: reserved	0 0: HOST & 6250 0 1: HOST & 1600 1 0: 6250 1 1: 1600

The data stored in RAM such as BOT/EOT gain, PE read amplifier gain, EC level and Device type data are stored in NOV-RAM.

B.9.31 Code 99: Run initial diagnostics and reset diagnostic mode

The power up diagnosis is executed and reset test mode and return to the initial state. Cable connection and others are checked.

APPENDIX C PCA REFERENCE TABLE

PCA name	PCA Location (Slot No.)	M2441A (Old Type) M2442A (Old Type) (Note 1)	M2441A (New Type) M2442A (New Type)	M2443A M2444A
WFM (Write Formatter)	1A 08	C16B-5121-0860#U (512186U)		
RFM (Read Formatter)	1A 09	C16B-5121-0880#U (512188U)		
MPU (Microprocessor Unit)	1A 06	C16B-5324-0800#U (532480U)	C16B-5327-0050#U (532705U)	
IFC (Interface Controller)	1A 07	C16B-5324-0810#U (532481U)	C16B-5327-0060#U (532706U)	
SVA (Servo Amplifier)	1A 02	B16B-9460-0010A#U (UIDMU)	B16B-9460-0100A#U (UIJMU)	
VFO (Variable Frequency Oscillator)	1A 10	C16B-5501-0840#U (DEIAU)		C16B-5501-0940#U (550194U)
RDA (Read Amplifier)	1A 12	B16B-9890-0010A#U (RKDMU)	B16B-9890-0020A#U (RKFMU)	B16B-9920-0010A#U (RKEMU)
WTA (Write Amplifier)	near head	B16B-9470-0010A#U (WAOMU)		B16B-9470-0100A#U (WAPMU)
RPA (Read Pre-Amplifier)	near head	B16B-9440-0010A#U (RPGMU)		
BUF (Buffer option)	1A 05	Not acceptable	B17B-0160-0010A#U	

Note 1 Old type has serial No #1∿2/M2441A, #1∿26/M2442A.

*** PRODUCT TEST RECORD ***

TESTED AT ; MAGNETIC TAPE UNIT TESTING DEPT.
NAGANO PLANT, FUJITSU LIMITED

MODEL	: M2444A MTU	SERIAL NO.	: 188
SPECIFICATION	: B03B-5325-B701A	MANUFACTURED DATE	: 1985-9
POWER FREQUENCY	: 50/60 HZ	TEPERATURE	: 23 ℃
TESTED DATE	: September. 20' 1985	HUMIDITY	: 51 %

1) SPECIFIED REQUIREMENTES

ITEM	DESCRIPTION		TEST RESULT
TAPE SPEED	25 IPS	FORWARD 2.662 ~ 2.770 KHZ BACKWARD 2.662 ~ 2.770 KHZ	2.712 KHZ 2.722 KHZ
	75 IPS	FORWARD 7.986 ~ 8.312 KHZ BACKWARD 7.986 ~ 8.312 KHZ	8.152 KHZ 8.165 KHZ
REWIND TIME	150 SEC OR LESS		140 SEC
ACCESS TIME	25 IPS	44.0 ~ 60.0 MS	50.7 MS
	75 IPS	116.0 ~ 147.0 MS	131.9 MS
REPOSITION TIME	25 IPS	160.0 ~ 210.0 MS	180.4 MS
	75 IPS	488.0 ~ 634.0 MS	607.2 MS
OUTPUT VOLTAGE	ADJUSTABLE VOLTAGE ; +5V , -5.2V		REFER TO (2)
FUNCTION TEST & RELIABILITY TEST GROUNDING CONTINUITY TEST DIELECTRIC VOLTAGE WITHSTAND TEST			GOOD

2) OUTPUT VOLTAGE (CHECK POINT ; BACK PANEL)

VOLTAGE	+5V	-5.2V	+12V	-6V	+24V	-24V
VALUE	+5.0 V	-5.2 V	+12.3 V	-5.7 V	+24.3 V	-24.3 V

3) REVISION

RKEMU : 04D	550194U : 05D	512188U : 17I	512186U : 18M	532705U : 25J 19H
532706U : 15H	UIJMU : 25C	RPGMU : 05C	WAPMU : 03A	POWER UNITE : 01A 04B

MACHINE REEL MOTOR : 01A	SPEED SENSER ASM : 01A	REEL HUB ASM : 02A
FILE REEL MOTOR : 01A	TENSION SENSER ASM : 02B	BACK PANEL : 02B
SHIELD BLOCK ASM : 02B	MACHINE REEL ASM : 02B	

4) MODEL REVISION; B3

TESTED BY ; FUYUKI MAKI F. Maki

APPROVED BY ; NORIO ONODERA for Y. Ueno

FAI 02

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