EK-0TU80-TM-001

TU80 Tape Subsystem

Technical Manual

digital

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Technical Manual

Prepared by Educational Services
of
Digital Equipment Corporation

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PREFACE

This manual contains information pertinent to the installation, operation, and maintenance of the TU80 Tape Subsystem. The subsystem is defined as the TU80 Tape Transport, I/O Interface, and the M7454 UNIBUS Adapter Module, and the 874 Power Controller.

Related documents are listed in Appendix C of this manual.

RECORD OF REVISIONS

REVISION	COMMENTS
A (2-16-83)	Manual Released. This manual is current with series code 10.

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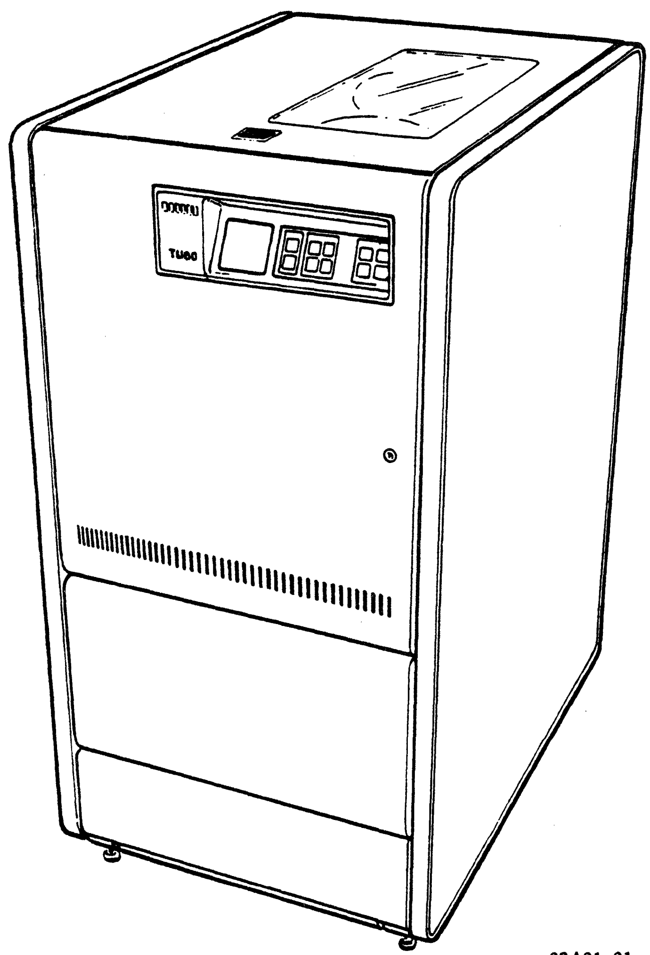
Section 1 - GENERAL DESCRIPTION

1.1 GENERAL

The TU80 Streaming Tape Unit is a microprocessor-based, electronic and mechanical assembly that includes all hardware and firmware necessary for the transfer of Phase Encoded (PE) data to and from half-inch wide magnetic tape.

The horizontally mounted TU80 is a fully integrated tape storage system packaged with its formatter and power controller in a standard H9643 cabinet.



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TU80 TAPE TRANSPORT

Solid-state electronics replace many devices that were traditionally mechanical. Tape moves from reel to reel, maintaining its tension with an electronically controlled servo. This non-buffered approach allows performance equivalent to that of a conventional capstan-controlled drive in the start/stop operating mode. The TU80 contains no capstan motor drive, tension arms, vacuum columns, or associated components. Read/Write functions are accomplished in an ANSI-compatible format at 1600 CPI Phase Encoding.

The TU80 Subsystem consists of the stand-alone Streaming Tape Unit, the 874 Power Controller, and a UNIBUS Adapter Module (Figure 1-1). This module is designed for the UNIBUS-oriented PDP-11 and VAX Processors. It plugs into a host computer's UNIBUS Small Peripheral Controller (SPC) slot and provides communication with the corresponding Streaming Tape Unit. Refer to Figure 1-2 for a block diagram of the TU80 Subsystem.

NOTE

The TU80 cabinet may hold an optional disk drive mounted under the tape transport at the bottom of the cabinet. Consult the User Guide of the appropriate disk drive for user information.

The TU80 tape transport includes a tape deck with a read/write head, reel hubs, servo motors, power supply and air bearings. Printed circuit modules contain the following electronic features: servo power amplifier, read/write, reel servo control, data encoding and decoding, and two microprocessors with their support devices (for transport control in both the operational and diagnostic modes). The device features a quick-release reel latch which, like its simplified tape threading path, is designed for ease of operation.

The unit has three operating modes: 25 ips Start/Stop, 25 ips streaming, and 100 ips streaming (refer to paragraph 4.10.1 for start/stop and streaming modes of operation). Dual data transfer rate capability is achieved by allowing selection of the 25 ips modes and 100 ips mode through the automatic speed control within the TU80 transport. The 25 ips modes operate at an instantaneous data rate of 40,000 bytes per second and the 100 ips mode operates at 160,000 bytes per second.

Selection of a normal Inter-block Gap (IBG) length of 0.6 inch or a long IBG length of 1.2 inches is available through the formatter. Optionally, in 100 ips streaming mode, long and short gaps can be selected to be variable lengths.

All transport address and feature selections are required to be verified (and/or set) before TU80 initialization. These selections are performed through the jumpers on the Formatter/ Control Module as shown in Appendix B of this manual.

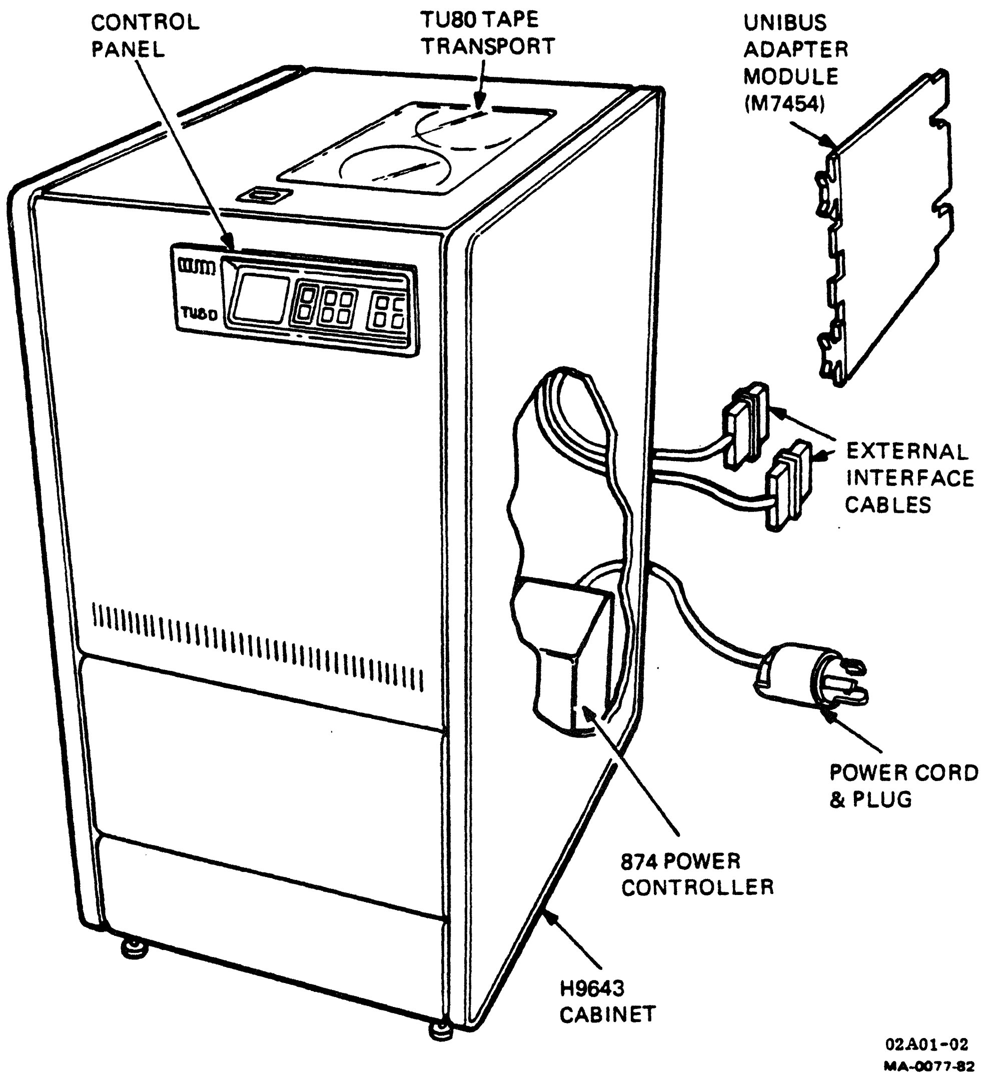

Figure 1-1. TU80 TAPE SUBSYSTEM

Off-line diagnostic routines are designed into the transport and are capable of isolating faults throughout its electronics. These diagnostic routines which are initiated via the operator's control panel, and consist of operator and field service diagnostics, are explained in detail in the TU80 Subsystem Diagnostic Test Documentation/Pathfinder (EK-OTU80-SV).

The host I/O controller is capable of monitoring the transport's status through the Status Transfer command. In addition to the off-line routines initiated by the control panel, Power-On Health Check is also an integral part of the TU80. The TU80 automatically performs a "power-on health check" sequence of host routines to check AC/DC power lines and the control panel each time power is applied.

Table 1-1 provides a list of mechanical and electrical characteristics for the TU80.

On-line diagnostics are performed under the host CPU control and are listed in the applicable system's diagnostic listings.

NOTE

Appendix C provides the listing of the TU80 documents available to the user.

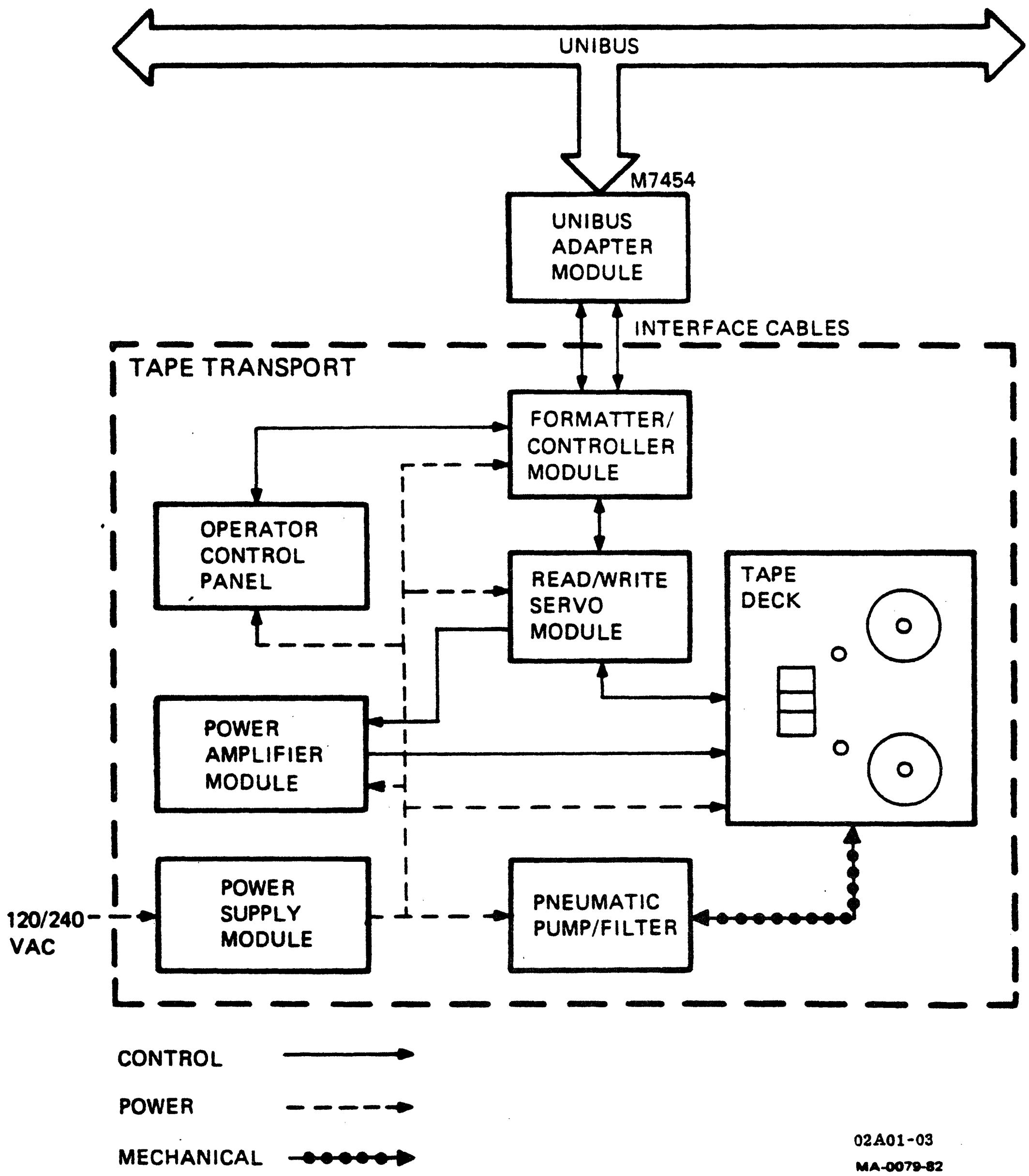

Figure 1-2. TU80 TAPE SUBSYSTEM BLOCK DIAGRAM

Table 1-1. MECHANICAL & ELECTRICAL CHARACTERISTICS

FUNCTIONAL CHARACTERISTICS:	
Tape Speed (Nominal)	
Low Speed Start/Stop Mode	25 in/sec
Low Speed Streaming Mode	25 in/sec
High Speed Streaming Mode	100 in/sec
Tape Capacity (Maximum)	40 Mbytes
Data Transfer Rate (Burst)	
Low Speed Mode	40 Kbyte/sec
High Speed Streaming Mode	160 Kbyte/sec
Data Format/Recording	9 track, phase encoding, 1600 bit/inch
Rewind Time (Nominal)	2.5 minutes
Load Time (Maximum)	15 seconds
PHYSICAL CHARACTERISTICS:	
Electronics	Solid-state
Tape Width	12.65 mm (0.5 in)
Tape Thickness	38.1 micron (1.5 mil)
Tape Tension	2.23 N (8.0 oz)
Reel Diameter	26.7 cm (10.5 in) *
Reel Capacity	732 m (2400 ft) *
Transport Dimensions	105.7 cm (H) x 54.6 cm (W) x 76.2 cm (D) 41.6 in (H) x 21.5 in (W) x 30.0 in (D)
Transport Weight (In Cabinet)	280 lbs (127 kg)
UNIBUS Adapter	Standard quad-size module
OPERATIONAL CHARACTERISTICS:	
Power Requirements	
Voltage	93 to 128 VAC, 120 VAC nominal, 60 Hz, single phase 187 to 256 VAC, 220 or 240 VAC nominal, 50 Hz, single phase

* Smaller tape reels are also allowed.

Table 1-1. MECHANICAL & ELECTRICAL CHARACTERISTICS (Cont'd)

Power Requirements (Cont'd)	
Current	Average Input Current 2.0A rms at 100 ips
Power Consumption	300 VA - Standby and Loaded 550 VA maximum - Start/Stop
Power Controller	Model 874B, 50 Hz, 240V, 12A Model 874D, 60 Hz, 120V, 24A
Power Cord	3-wire, #12 AWG, 16 foot long plug - NEMA 6-15P (50 Hz) - NEMA 5-30 (60 Hz)
Model Variations	Model TU80-AA, 120V, 60 Hz Model TU80-AB, 240V, 50 Hz
Operating Temperature **	10°C (50°F) to 40°C (104°F)
Storage Temperature	-10°C (14°F) to 50°C (122°F)
Relative Humidity	20% to 80% (10% to 90% in storage
Altitude	Up to 3048 m (10,000 ft) or 688 millibars (9.98 psi)
Heat Dissipation (Average)	580 BTU/hour
Acoustical Noise	51 dba for open office environment
Data Reliability	
Recoverable Write Error	1 in 10^8 bits
Recoverable Read Forward Error	1 in 10^9 bits
Recoverable Read Reverse Error	1 in 10^8 bits
Unrecoverable Read Error	1 in 10^{10} bits
Unrecoverable Write Error	Not Allowed

** Restricted by the operating temperature of the media.

1.2 FUNCTIONAL DESCRIPTION

The TU80 is interfaced to the host Central Processing Unit (CPU) via the UNIBUS Adapter Module (M7454). This module is plugged into a UNIBUS SPC slot in the CPU. The module processes data using the packet processing protocol. The Adapter Module-TU80 communication link is accomplished via a parallel interface cable set which connects the M7454 Module to the transport's control system.

The TU80 Control System (Figure 1-2) comprises two logic modules and a power amplifier module. The two logic modules are functionally partitioned and each module contains a microprocessor for control of all module functions.

One module is the Formatter/Control PC board. The Formatter/Control Module provides high speed data interchange between the transport and host system, including such functions as data fetching and formatting and read/write operation. It also handles a single track, "on-the-fly" data error error correction, and initiates and monitors the built-in diagnostic routines.

The other control module is the Read/Write/Servo PC board which controls the tape drive mechanism operation.

The power amplifier module receives low voltage analog signals from the logic modules and outputs a higher voltage, higher current signals to the reel motors.

A power supply module mounted behind the tape deck provides all required AC/DC voltages to the transport modules and mechanisms.

The TU80 logic is compactly mounted in a metal cage underneath the tape deck.

1.2.1 TU80 UNIBUS Adapter Module (M7454)

The UNIBUS Adapter Module provides a functional interface between the TU80 and PDP-11/VAX Computers. This interface module handles streaming and start/stop mass storage back-up with large volume data transfers and information interchange through ANSI- compatible tape media. The M7454 controls command decoding, data fetching and storing, and data transmission to/from the TU80.

The quad-size M7454 module plugs directly into any Small Peripheral Controller (SPC) slot of the DIGITAL host CPU. A set of internal (ribbon) and external (shielded) cables connect the adapter module to the tape transport. External interface cable length is 3.66 m (12 feet). Effective external cabling length is 2.7 m (9 feet).

NOTE

Refer to Appendix A for detailed information on the M7454 UNIBUS Adapter.

1.3 PHYSICAL DESCRIPTION

The TU80 is a cabinet-enclosed, horizontally mounted unit designed to provide front access for both operator and maintenance functions. Operator access for tape mounting is via the hinged top cover. Maintenance access to the underside of the tape deck is achieved by opening the top cover and front door and releasing the deck latch located at the left underside of the tape deck. Releasing this latch allows the tape deck to pivot such that the underside of the deck is positioned to the front of the cabinet in a vertical position.

The input power cord and interface cables enter the cabinet at the rear bottom of the unit. Access to this area is via a hinged rear door.

1.3.1 Tape Deck - Top

Refer to Figure 1-3 for component locations. The following components are located on the front of the transport. A brief description of the components and their function is provided as follows.

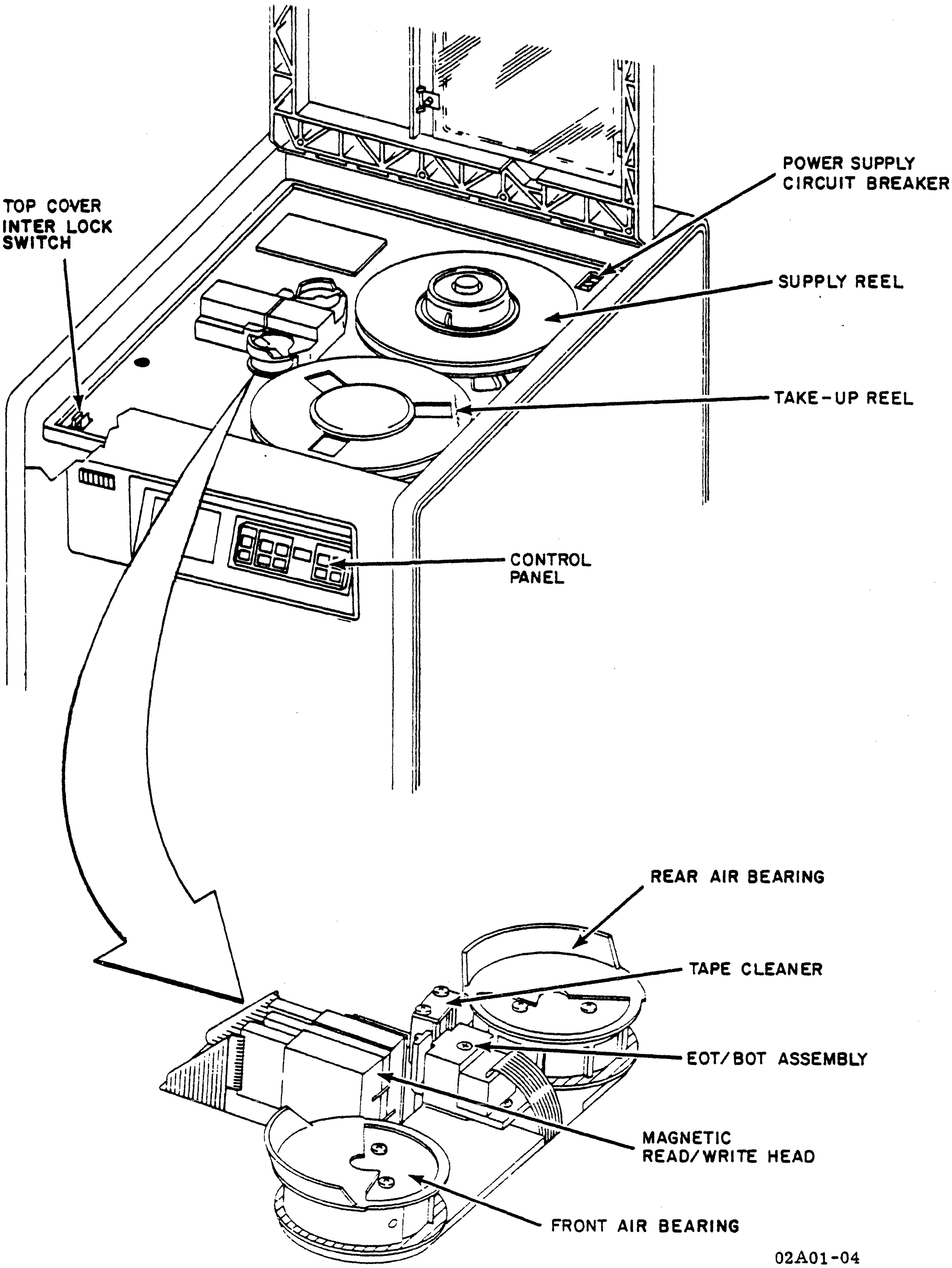

Figure 1-3. TAPE DECK COMPONENT LOCATIONS, TOP VIEW

1.3.1.1 Supply Reel - The supply (rear) reel is mounted on a manual mechanical-latching hub. The supply hub is latched by pressing the periphery of the hub face while the supply reel is positioned against the bottom flange of the hub. The reel is released by pressing the center button on the hub face.

1.3.1.2 Take-Up Reel - The take-up (front) reel is a permanently mounted reel secured to the take-up motor shaft.

1.3.1.3 Air Bearings - The air bearing/tension sensor assembly is used to sense and control air pressure across the air bearings, thus reducing tape friction and providing constant (8 ounce) tape tension by the corresponding action of the supply reel motor. The air bearings also guide tape across the magnetic heads.

1.3.1.4 Magnetic Head Assembly - The magnetic head is a dual-gap read/write unit designed to perform the read/write functions in a 9-track PE mode. The dual-gap head allows a write-to-tape operation, read-only operation or read-after-write operation. A full-width erase head is also provided to erase the tape by DC saturation in the forward direction before passing over the write head.

1.3.1.5 Tape Cleaner - The tape cleaner assembly consists of two blades and a vacuum port to attract tape to the cleaner surfaces. The cleaners are designed so that one cleaner cleans tape in the forward direction and the second cleans tape in reverse direction. The vacuum system directs the stripped particles through a screen and into a filter.

1.3.1.6 BOT/EOT/AOT Assembly - Load Point/End of Tape is detected optically. Photo-transistors detect light reflected from BOT and EOT markers on tape. A no-tape-present condition is detected when both BOT and EOT photo-transistors detect a reflective marker normally blocked by the presence of tape.

1.3.1.7 File Protect - The file protect assembly consists of a 360° reflecting ring around the supply hub and a photo-transistor mounted adjacent to the reflecting ring. If a write enable ring is installed in the supply reel, the reflecting ring is in direct line with the photo-transistor. If a write enable ring is not present, then the reflecting ring is out of the path of the photo-transistor.

1.3.1.8 Power Switch - The main power switch (circuit breaker) is located at the top rear corner of the tape deck. In the OFF position (0 side depressed), input power is removed from the power supply. This circuit breaker must be ON (1 side depressed) in order to perform the Subsystem Power-On operation from the control panel.

1.3.1.9 Top Cover Interlock - The transport is equipped with an interlock switch/top cover latch located at the lower left corner of the tape deck. This interlock is basically a safety device to prevent reel motion, unless the front cover is closed and secured.

1.3.2 Tape Deck - Bottom

Refer to Figure 1-4 for component locations. The following components are located on the bottom of the tape deck. A brief description of the components and their function is provided as follows.

1.3.2.1 Tape Deck Latch - This latch enables the tape deck to be placed in the maintenance position for access to the bottom tape deck assemblies.

1.3.2.2 Power Supply - The power supply accepts the input AC voltage and converts it to six (+5, -6, +15, -15, +25, +38) DC output voltages. The supply contains a line filter, unit circuit protectors, on/off circuit breaker, logic master clear circuit, pneumatic pump motor control, cooling blower control, and voltage and current monitors.

1.3.2.3 Pneumatic Pump and Filter/Regulator System - The pneumatic pump is a 120V (60 HZ) or 220/240V (50 HZ) AC inductor motor with a 4-blade, carbon vane pump. The compressor output air is routed to a filter where any carbon particles are removed before distribution to tape deck components. Mounted directly onto the filter is a piston-type pressure regulator which maintains a constant 2.0 PSI output to the upper and lower air bearings. The vacuum portion of the pump draws air from the tape cleaner.

1.3.2.4 Power Amplifier Module - The power amplifier module receives the low voltage analog signals from the control logic and outputs a higher voltage, high current to the reel motors. Outputs are dependent on the requirements of the velocity and tension servo systems.

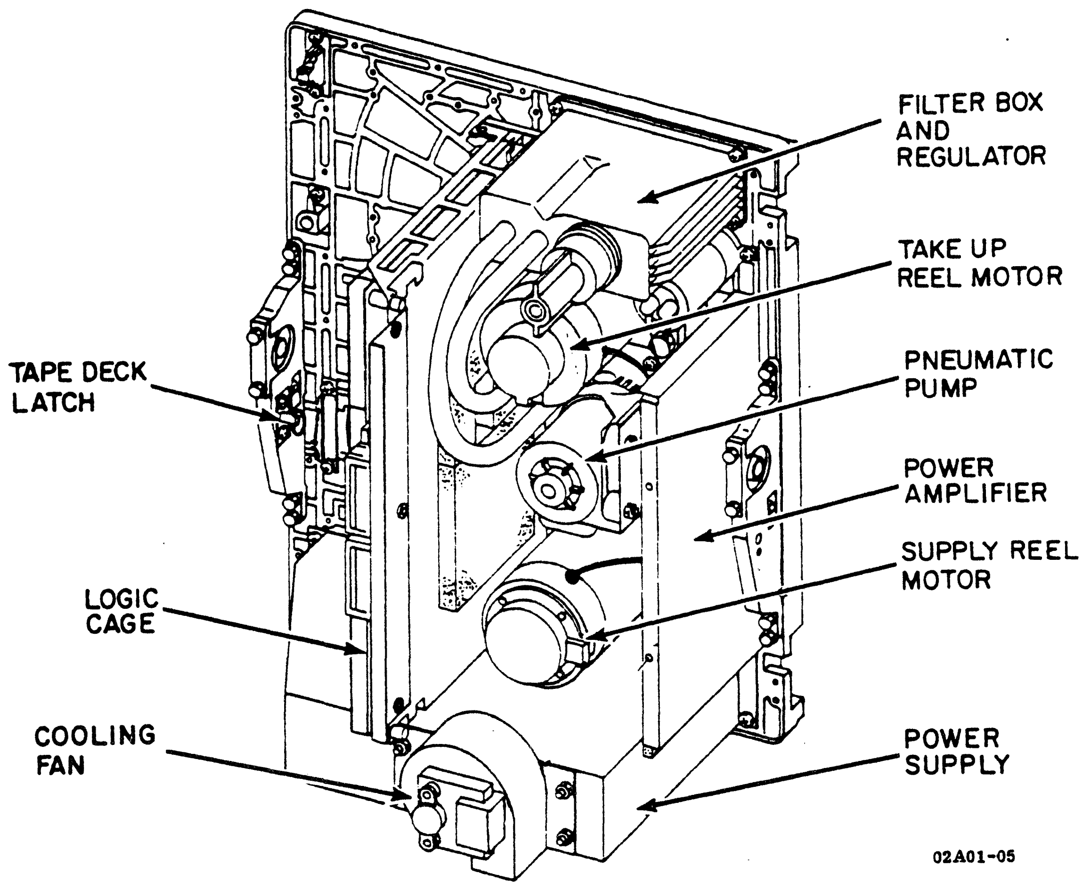

Figure 1-4. TAPE DECK COMPONENT LOCATIONS, REAR VIEW (ACOUSTIC COVER REMOVED)

1.3.2.5 Cooling Fan Assembly - The cooling fan is a squirrel-cage type assembly located at the rear of the power supply. Cooling air is drawn across the rear deck assemblies and through the power supply. The fan motor is compatible with either 120 or 240 volt operation.

1.3.2.6 Logic Cage - The logic cage consists of a logic bracket assembly and the Read/Write/Servo and Formatter/Control Modules. The modules are inserted into top and bottom hinges at the rear of the bracket assembly and are secured with thumb screws in the normally closed position. Releasing the thumb screws allows the hinged modules to be positioned for access to components.

1.3.2.7 Reel Motors - The reel motors are conventional, permanent-magnet DC motors. The supply reel motor works in conjunction with the upper and lower air bearings to control tape tension across the recording surface of the magnetic head. The air bearings sense the proximity of tape via air pressure and, in effect, activate the pressure sensors. The sensors cause the servo to maintain a constant tension by action of the supply reel motor. The take-up reel motor has a 1000-segment tachometer attached which provides velocity control.

1.3.3 Control Panel (Front Door)

The control panel includes a set of operational control switches, indicators, and a display located at the top right of the front door. These controls enable the operator to initiate and monitor TU80 operations and the off-line diagnostic routines.

1.4 EQUIPMENT CONFIGURATION

The equipment configuration of the transport is determined by the equipment identification plate plus the FCO log that must be present with every transport. A description of the ID plate and the FCO log is given in the following paragraphs.

1.4.1 Equipment ID Plate/Serial Tag

The ID plate/serial tag is located on the inside of the hinged front door. Refer to Figure 1-5 for the following items contained on the plate.

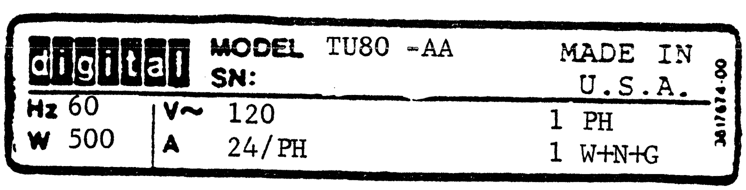

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Figure 1-5. EQUIPMENT IDENTIFICATION PLATE

MODEL - Indicates the model designation and model variation for the unit.

SN - Indicates the serial number which is unique for each transport and is assigned sequentially by the manufacturer.

HZ - Indicates the frequency parameters (cycles per second) of the input voltage.

W - Indicates the total operating power consumption of the transport.

V - Indicates the input voltage requirement of the transport.

A/Ph - Indicates the maximum ampere requirement per phase.

Ph - Indicates the phase requirement of the transport.

W+N+G - Indicates the configuration of the input power line cord (active wire + neutral + ground).

1.4.2 Field Change Order Log

A Field Change Order is a change to the transport after it has been shipped from the manufacturing facility. It is important that the FCO log is kept current by the person installing the FCO, so that the exact configuration of the transport can be referenced.

2.1 SITE REQUIREMENTS

2.1.1 Space Requirements

Space requirements for operator and maintenance access via the top, front, and rear hinged doors are shown in Figure 2-1.

2.1.2 Power Requirements

Power requirements for the TU80 are listed in Table 1-1. The appropriate power plugs, receptacles, and circuit breakers are an integral part of the TU80.

The UNIBUS Adapter Module (M7454) typically draws 4.0A at +5 VDC. The power for the module is derived from the host CPU through the dedicated pins of the CPU backplane.

2.1.3 Environmental Requirements

The TU80 transport should be located in an area free of excessive dust, dirt, and corrosive fumes and vapors. The bottom of the cabinet and air vents on the doors must not be obstructed. The operating environment requirements are:

o Temperature:	10°C (50°F) to 40°C (104°F)
o Relative Humidity:	20% to 80%
o Altitude:	Up to 3048M (10,000 feet) [barometric pressure of 688 millibars (9.98 PSI)]

2.2 ACCEPTANCE OF DELIVERY

Carefully inspect the shipping container on all sides, including top and bottom, for severe gouges, cuts, abrasive tears, or badly smashed corners or edges. Damage of this type indicates mishandling in shipment, and the unit may have been damaged. Record all details of damage, and have the carrier's representative sign it before accepting delivery.

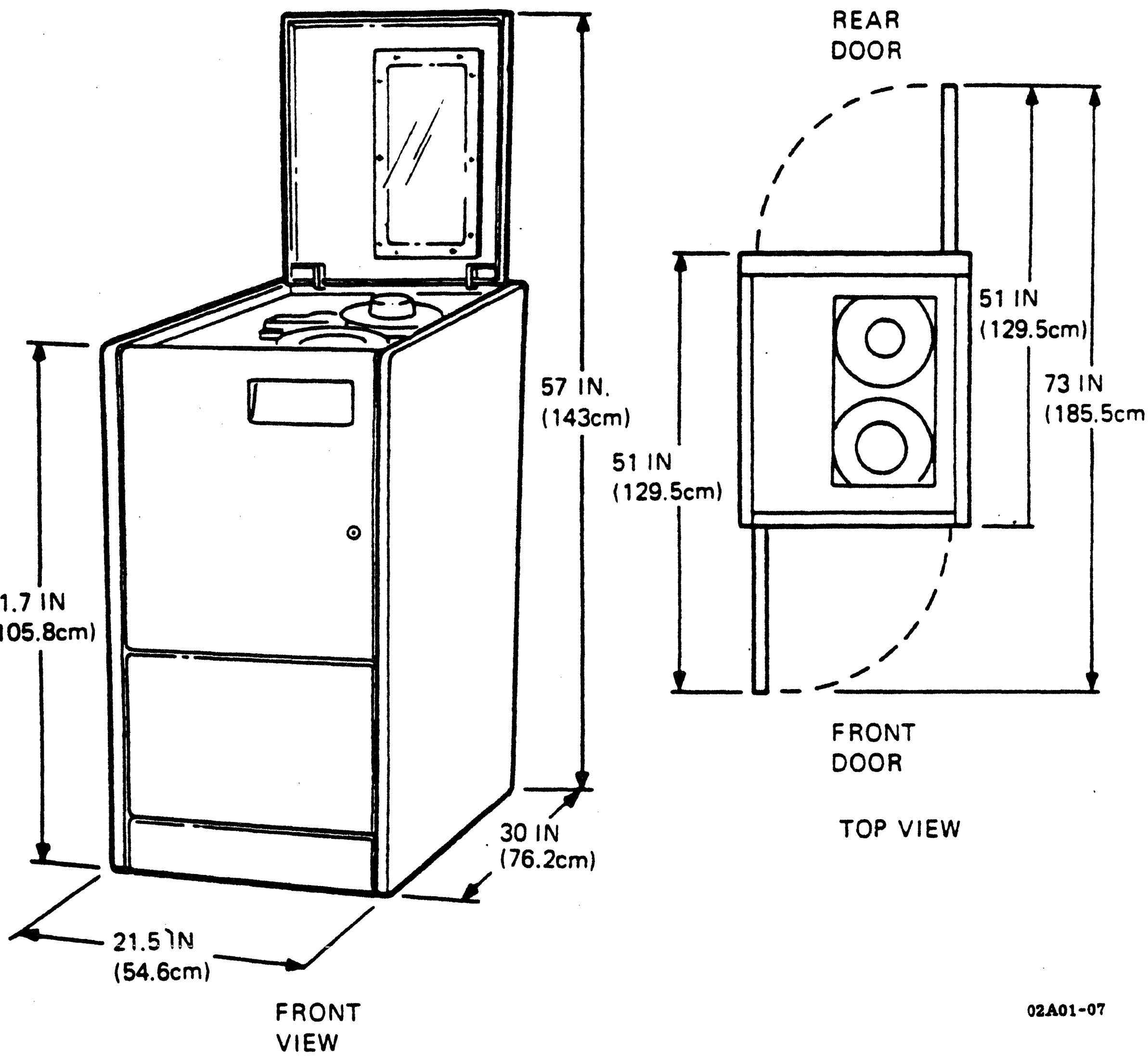


Figure 2-1. TU80 SPACE REQUIREMENTS

2.3 UNPACKAGING AND INSPECTION

2.3.1 Floor Loading and Routing

The TU80 transport is shipped in a cardboard container mounted on a wooden pallet. The shipping weight is 330 pounds (149 kg). The container dimensions are 51 inches high, 29 inches wide, and 41.5 inches deep. Check the route that the unit will travel to the installation site to ensure problem-free delivery. Net weight (unpackaged) of the transport is 280 pounds (127 kg).

2.3.2 Unpackaging and Removal From Pallet

The unpacking and removal procedures are illustrated in Figure 2-2. Numbers on the illustrations correspond to the numbers referenced in the following procedures.

1. Cut and remove straps holding stabilizer to cardboard container and remove stabilizer.
2. Cut and remove the shipping straps around cardboard container (1).
3. Lift and remove top container cover (2).
4. Carefully lift and remove the two ramps from top of cabinet. Set them aside for future use.
5. Lift and remove protective carton (3).
6. Remove top pad and polybag (4).
7. Referring to Figure 2-3, attach the two ramps to the pallet, noting the LEFT and RIGHT markings on the ramps.
8. Unbolt and remove the four black shipping brackets.

WARNING

> This is a two-person procedure. Take extreme care to prevent the TU80 from rolling uncontrolled down the ramps or off either side of the pallet when releasing the leveling bolts.

9. While holding the TU80 on the pallet, turn each leveling bolt so that each wheel makes contact with the pallet to allow the cabinet to roll free.

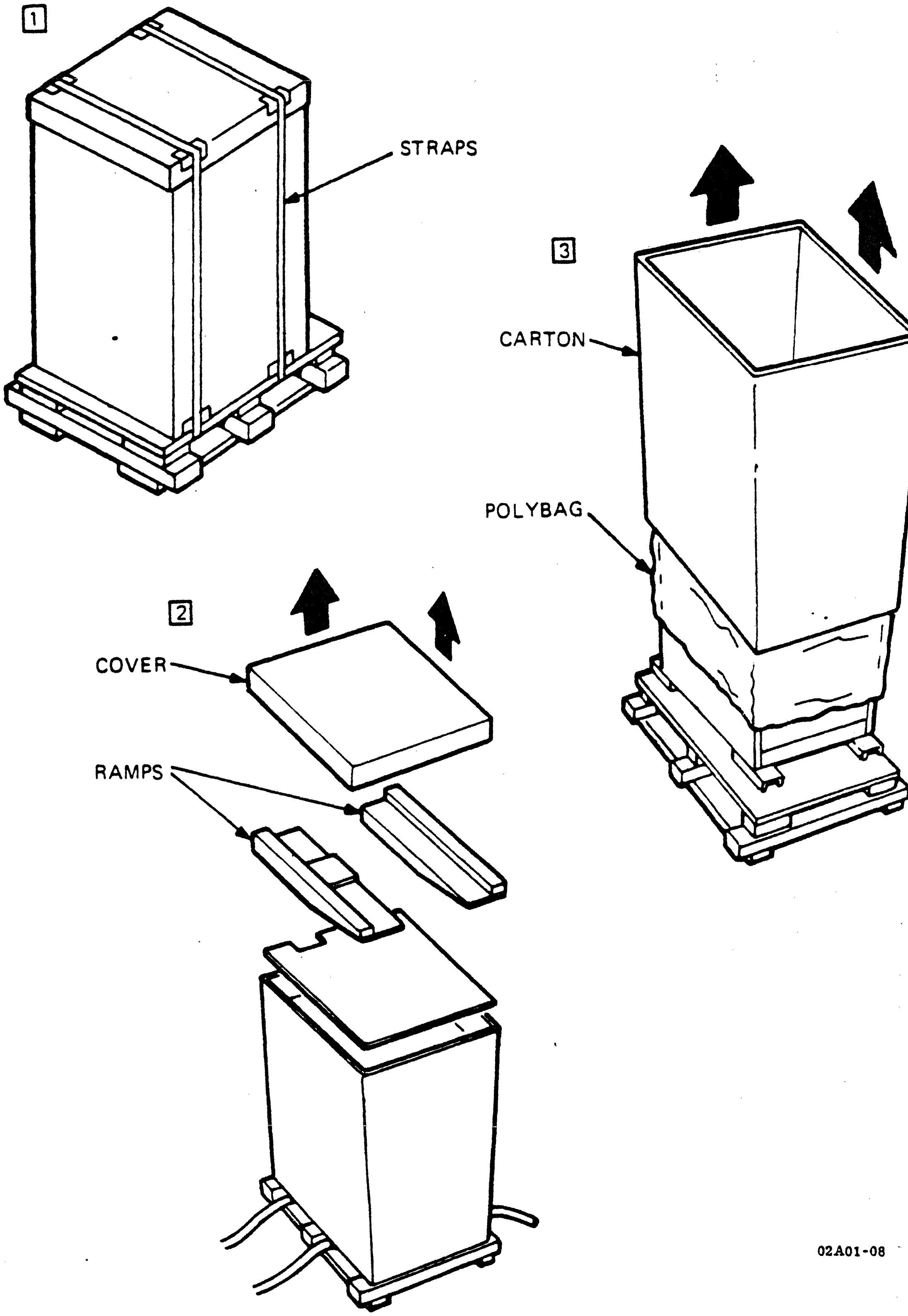


Figure 2-2. UNPACKING THE TU80

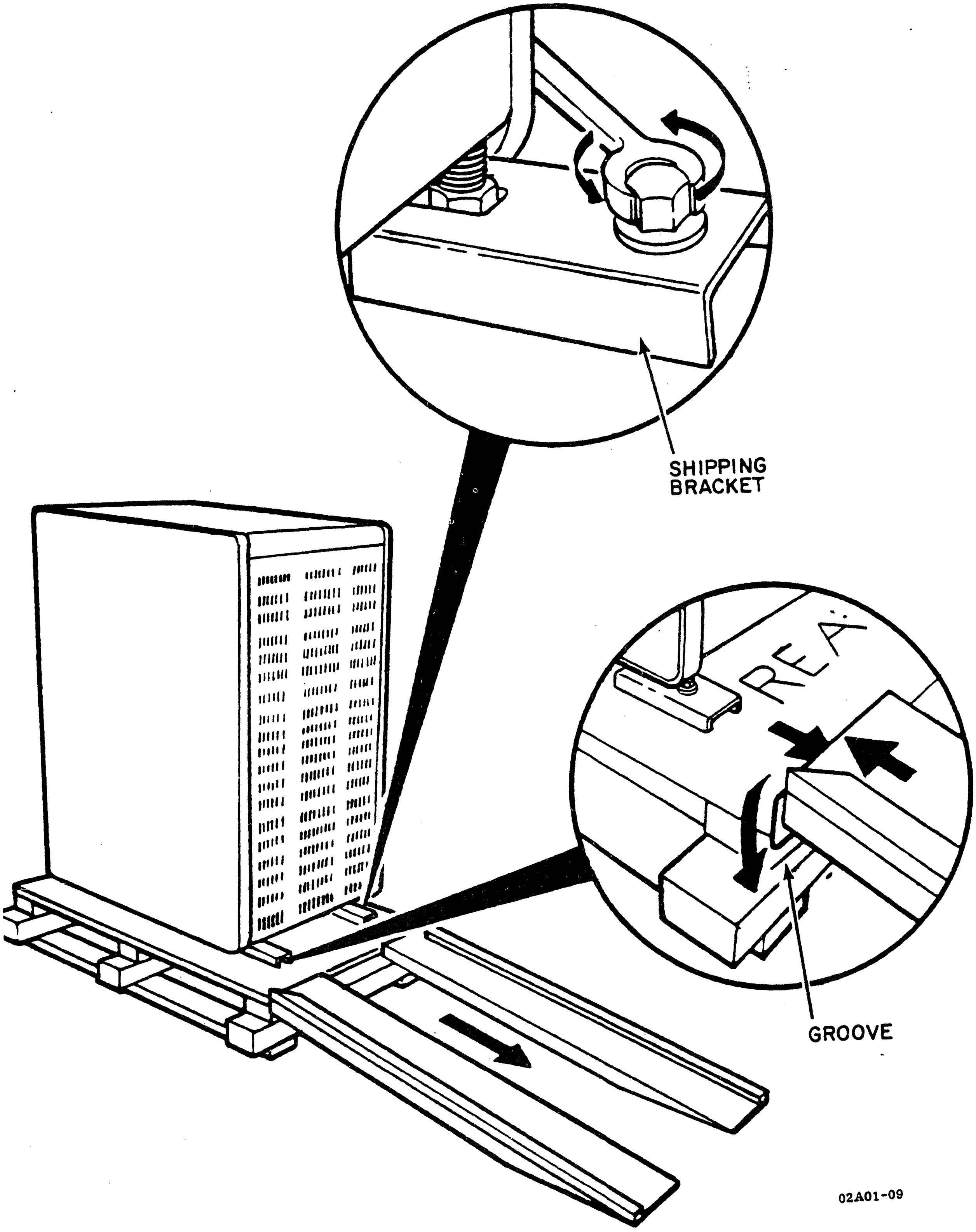


Figure 2-3. REMOVING THE TU80 FROM SHIPPING PALLET

10. With one person on each side of the cabinet, carefully roll it down the ramps onto the floor.

11. Remove the ramps. Store the pallet, ramps, and carton for future use.

2.3.3 Inspection

After removing the TU80 from its container and shipping pallet, perform a visual inspection as described in the following steps. Report any damage to the responsible shipper and the local DIGITAL Sales Office.

1. Inspect all panels, doors, door latches, and control panel for any obvious damage.

2. Using a 5/32 inch Allen wrench, open front and rear doors and inspect cabinet interior for any foreign material and loose or damaged components or cables.

3. Pull top cover latch and lift top cover. Inspect tape deck for broken glass, damaged magnetic head components, and damaged reels.

4. Check for any foreign materials that may have lodged in tape reels. Rotate supply and take-up reels.

5. Check tape path for any sharp edges. Close top cover and the front and rear doors.

2.4 OPERATION PREPARATIONS

The TU80 transport should be placed in a location not further than 2.7M (9 feet) from the host CPU and with adequate space clearances for air circulation and servicing.

TU80 preparations for operation are performed as follows.

2.4.1 Mechanical Installation

1. Roll transport to its correct location.

2. Open rear door and remove cardboard box with the TU80 Accessory Kit (TU80K-AC).

<u>If there is a disk drive in the TU80 cabinet, proceed as follows:</u>

1. Install the extension stabilizer P/N H9544-HC (Figure 2-4).

- Unwrap the stabilizer and mounting hardware.
- Slide the stabilizer in place from the rear of cabinet.
- Fasten the tether cable to the stabilizer using the supplied hex head screw.
- Thread on the stabilizer's leveling foot.

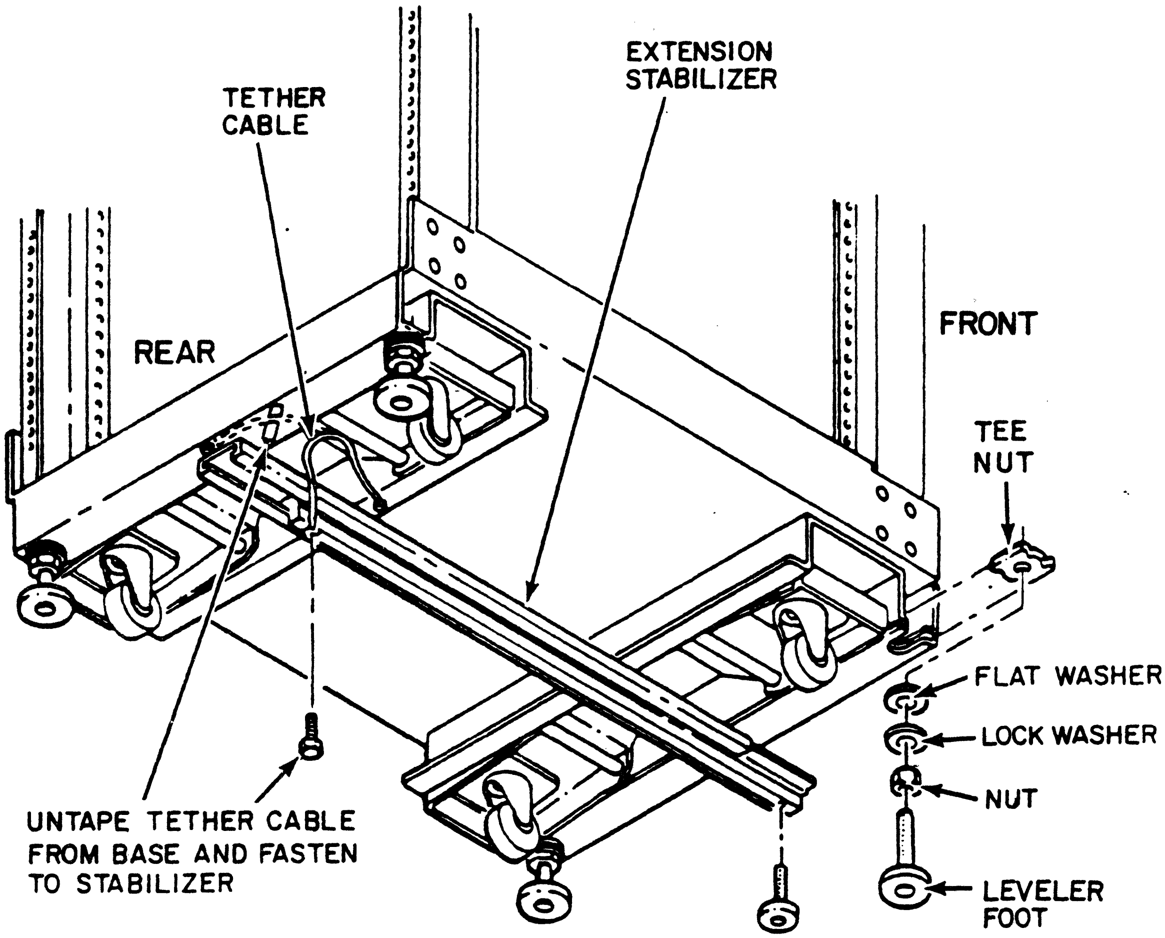


Figure 2-4. CABINET LEVELER FEET ASSEMBLY AND EXTENSION STABILIZER

2. Lower four leveler feet as shown in Figure 2-5.

   - Lower the leveler foot to contact the floor.
   - Using a 3/4 inch open-end wrench, turn the top nut up to the top and tighten.
   - Repeat for the remaining feet to stabilize the unit.

3. Proceed to paragraph 2.4.2 Electrical Connection.

<u>If there is no disk drive in the TU80 cabinet, proceed as follows:</u>

1. Remove two end (side) panels and the rear door as shown on Figure 2-6.

   - Pull up the spring pins and remove the rear door (Figure 2-6A). Remove the ground strap using a 5/16 inch flat-blade screwdriver.
   - Remove the door hinge brackets located in the rear bottom left and right corners of the cabinet using a 7/16 inch open-end wrench (Figure 2-6B).
   - Remove the end panels by lifting them up and away from the unit.
   - Remove the ground straps from the side (end) panels using a 5/16 inch flat-blade screwdriver.

2. Remove two rear leveler feet (Figures 2-4 and 2-5).

   - Using a 3/4 inch open-end wrench, loosen and lower the top nut on a foot.
   - Place a 9/16 inch open-end wrench on the bottom nut on a foot and turn the nut upward.
   - Back the foot off the floor, then pull it outward to remove.

3. Install the rear stabilizer P/N H9455-MJ (Figure 2-7).

   - Install two couplers in the stabilizer base.

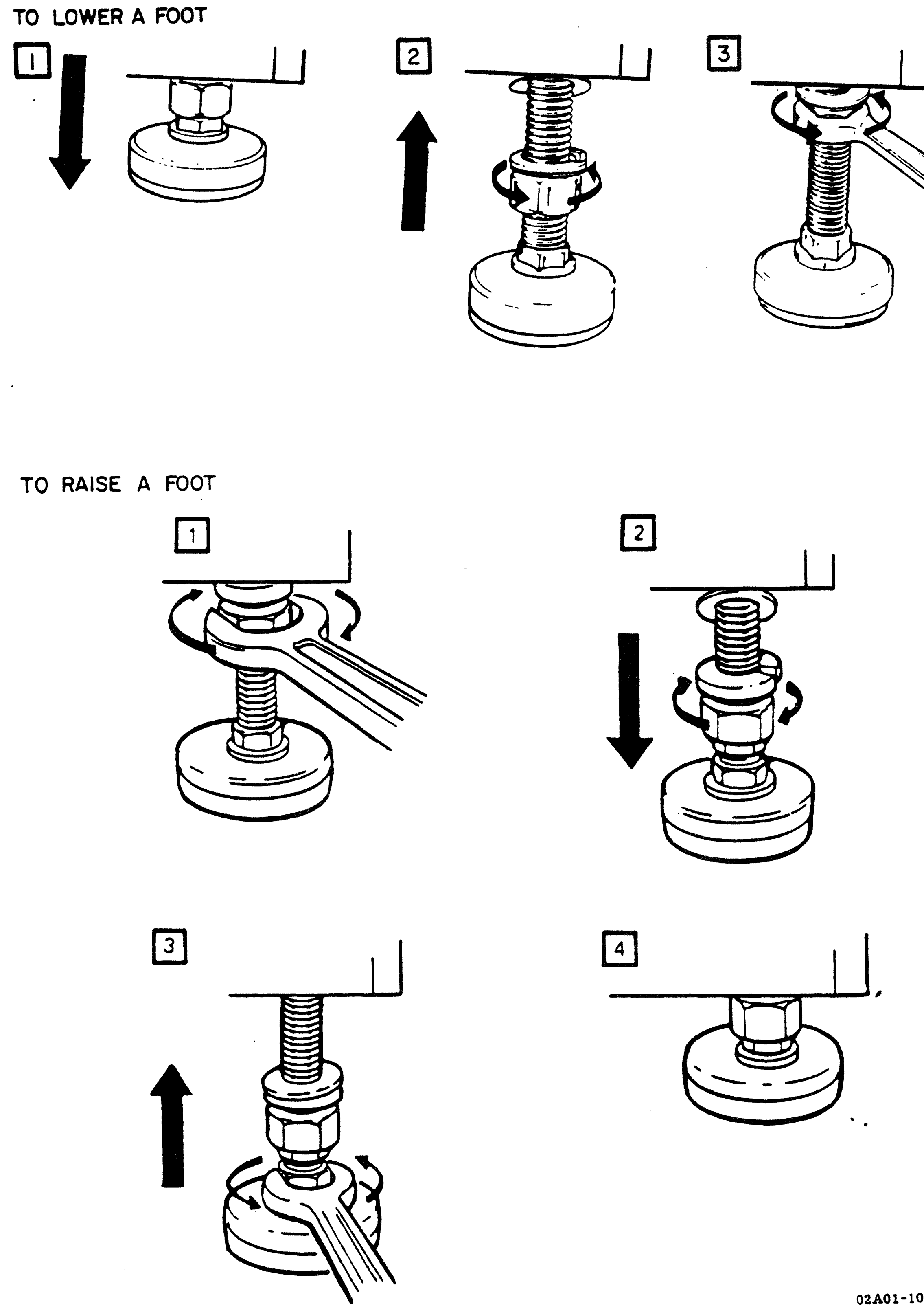


Figure 2-5. LEVELER FEET ADJUSTMENTS

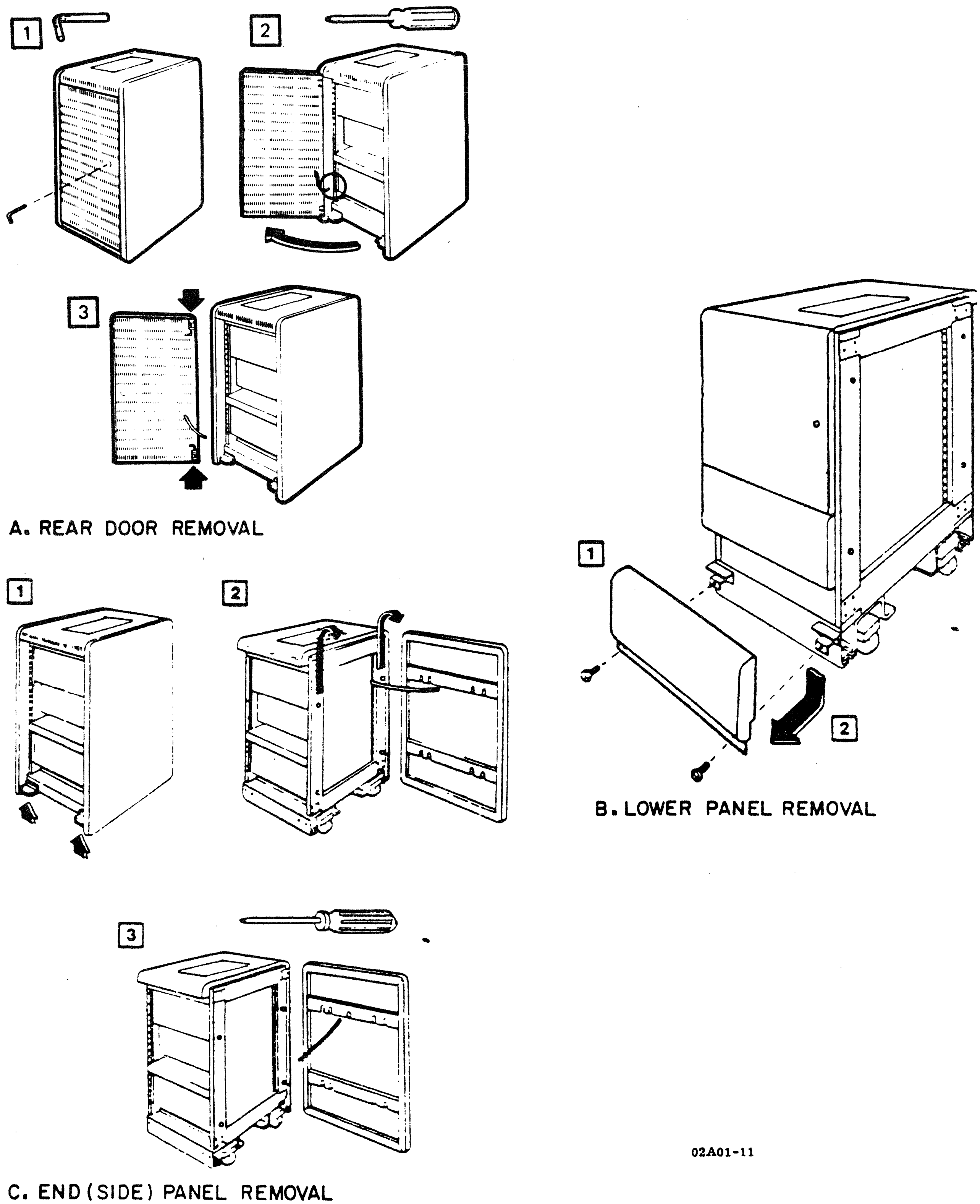


Figure 2-6. CABINET ASSEMBLY

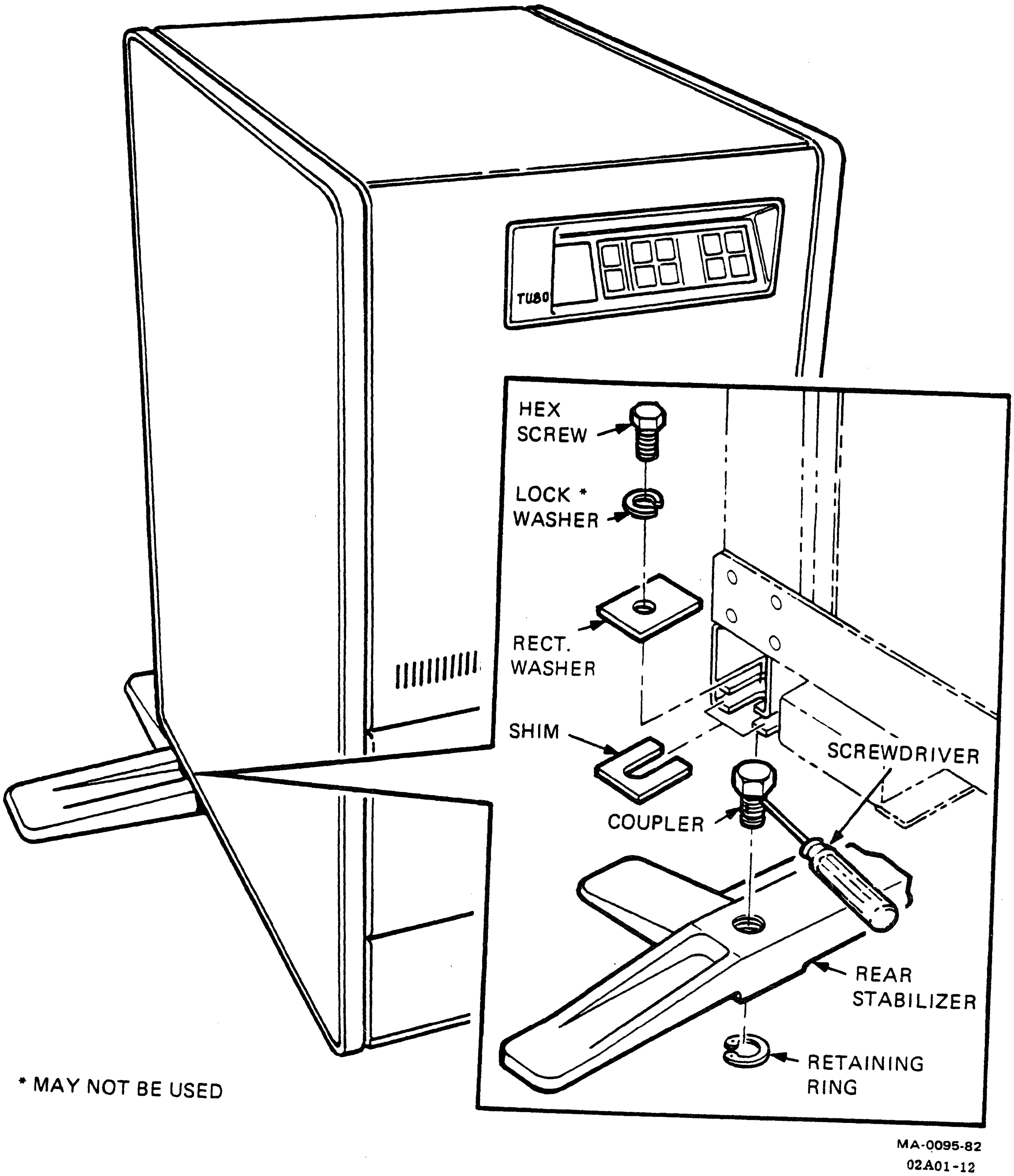


Figure 2-7. REAR STABILIZER INSTALLATION

- Slide the stabilizer under the rear bottom of the cabinet so that the couplers are directly under the mounting slots.

- Install the rectangular washers, retaining washers, and hex screws. Do not tighten the screw yet.

- Level the cabinet by adjusting the couplers. Use a screwdriver inserted into a hole in the coupler to jack it.

NOTE

To raise the cabinet, turn the coupler counterclockwise; to lower cabinet, turn the coupler clockwise.

- Slide the shims in place in the mounting slots.

- Tighten the hex screws using a 3/4 inch box wrench and #2 Phillips screwdriver.

4. Adjust the leveler feet to completely stabilize the cabinet (Figure 2-5) using the 3/4 inch and 9/16 inch open-end wrenches.

5. Replace the end panels and rear door on the cabinet and reattach the ground straps.

NOTE

If you need to move the transport to another location within the room, raise the leveler feet. Release the nuts on the feet using the 3/4 inch and 9/16 inch open-end wrenches (Figure 2-5), then pull each foot up to the top.

2.4.2 Grounding

Grounding can be done mechanically when the TU80 cabinet is bolted to another system unit cabinet, or electrically by the central grounding line from the last CPU connected to the existing ground stud on the cabinet rack.

2.4.3 Electrical Connection

NOTE

Check TU80 Equipment Identification (ID) plate for power specifications. Make sure that local line voltage and frequency are compatible with the transport power specifications.

1. Check that the power ON/OFF circuit breaker on the 874 Power Controller is in ON position and the REMOTE/LOCAL switch is set to REMOTE position (Figure 2-8).

2. Connect the remote power switching wire from the TU80 Power Controller (any of the four connectors) to the CPU Power Controller.

3. Check that the power cable from the transport power supply is plugged into the AC connector in the rear of the power controller.

4. Plug power cable into a local power outlet.

5. Open the TU80 top cover and set the power switch to the ON (1 depressed) position. Turn CPU power on. The LOGIC OFF indicator on the TU80 control panel should illuminate.

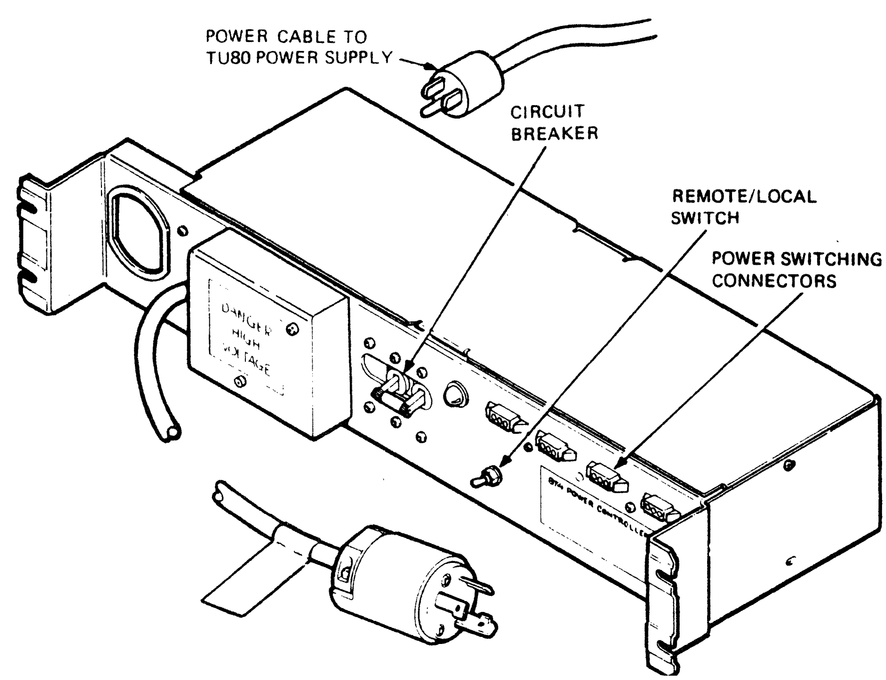


Figure 2-8. 874 POWER CONTROLLER MA-0096-82 02A01-13

NOTE

When installed, the TU80 should be in remote power-on mode controlled by the CPU.

5. Turn the CPU power off. Now proceed with the M7454 UNIBUS Adapter installation and interfacing the TU80 with the CPU.

2.5 UNIBUS ADAPTER MODULE INSTALLATION/REPLACEMENT AND INTERFACE CABLING

The M7454 UNIBUS Adapter Module is a standard quad-height module and is positioned in a Small Peripheral Controller (SPC) slot of the host computer backplane. The M7454 is connected to the TU80 transport by a set of internal and external interface cables (Figures 2-9 and 2-10).

When the M7454 has to be installed in the CPU (at the time of subsystem installation or module replacement), the installation procedure includes M7454 preparation (adress switch checking or setting), M7454 installation in the SPC slot, and interface cabling. Refer to the following paragraphs and figures for required information.

If the M7454 is already installed in the CPU (the turn-key system configuration), proceed directly to the TU80 External Cabling (paragraph 2.5.3).

2.5.1 M7454 Preparation and Installation

NOTE

Use the CPU Kit (TU80K-CP).

1. Remove M7454 module, cables, bulkhead connectors, and mounting brackets from CPU kit shipping container. Unwrap them and examine for any physical damage.

2. On M7454 adapter module, check (and if necessary, select) the proper UNIBUS address, interrupt vector, and word burst on a single, 10-position DIP switch in location 20C (Figures 2-11 and 2-12).

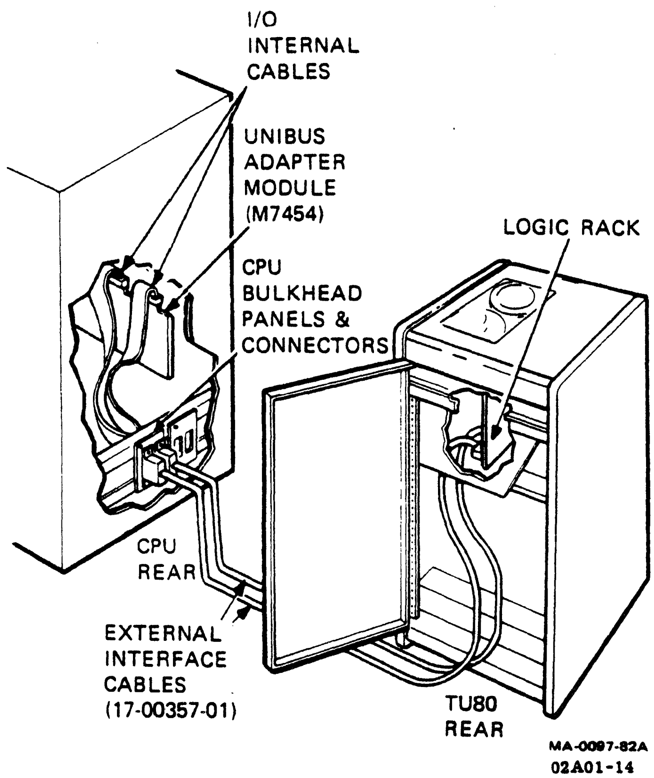


Figure 2-9. INTERFACE CABLING

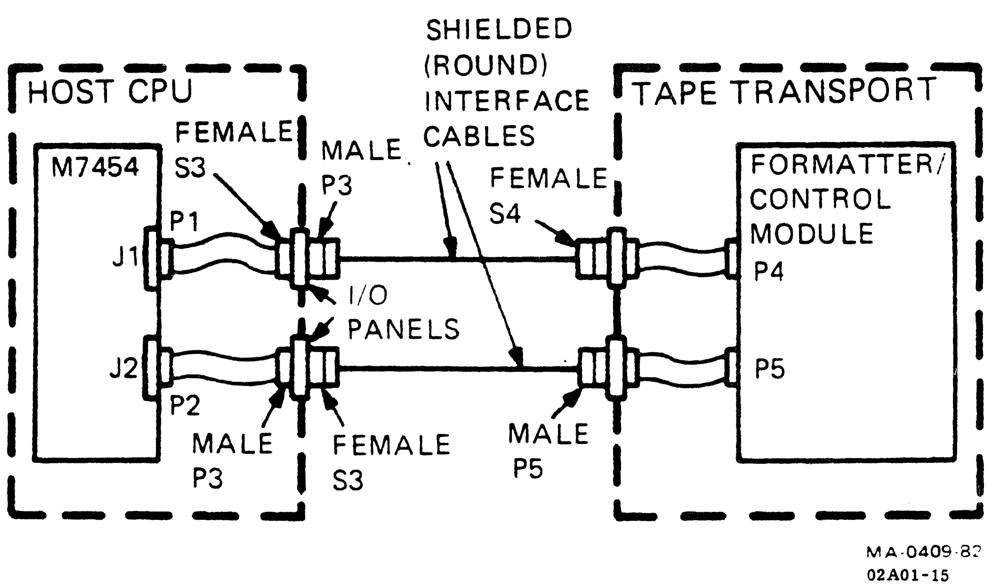


Figure 2-10. PLUG-TO-PLUG INTERFACE CABLE CONNECTIONS

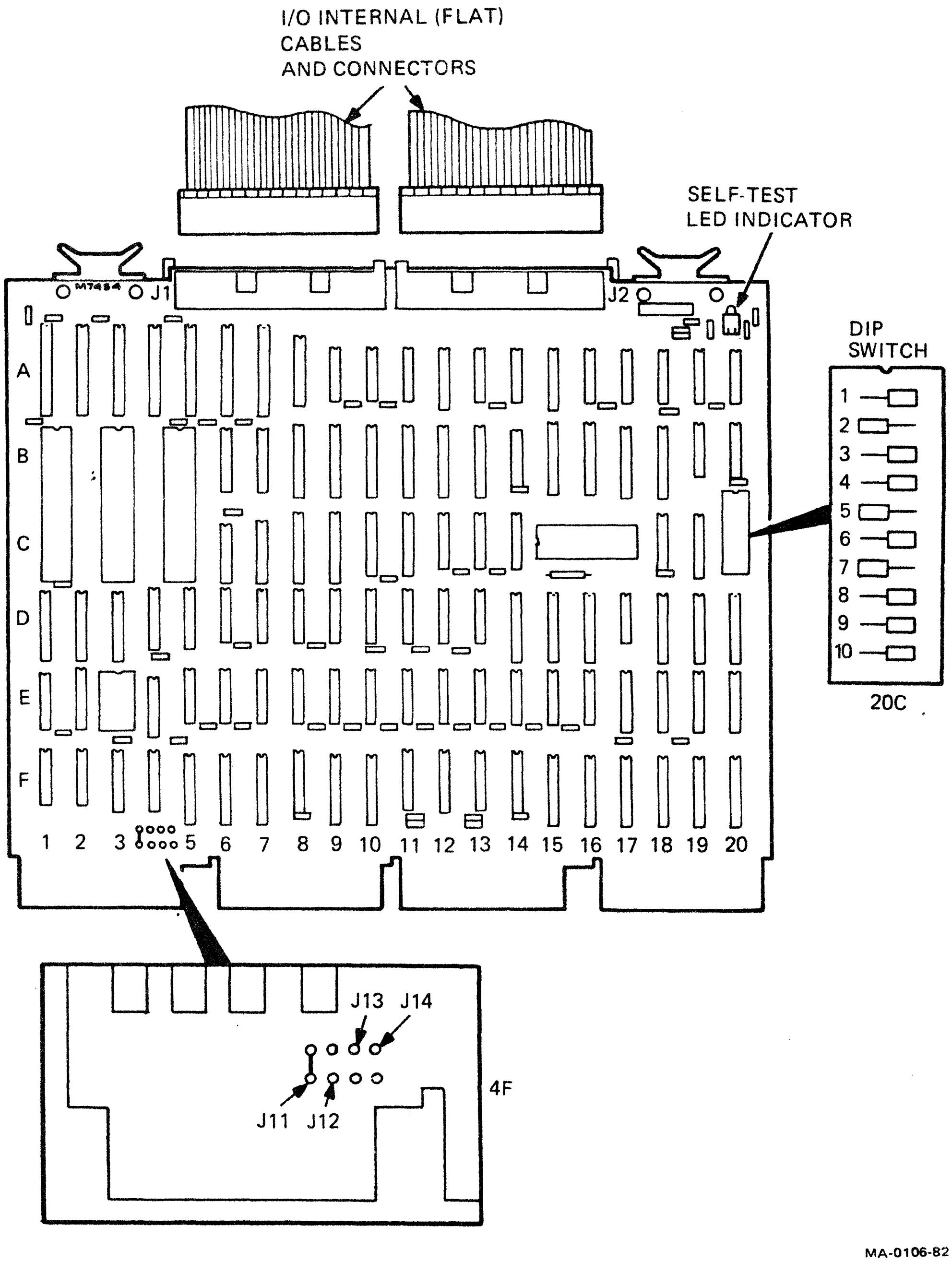


Figure 2-11. DIP SWITCH ON M7454 MODULE

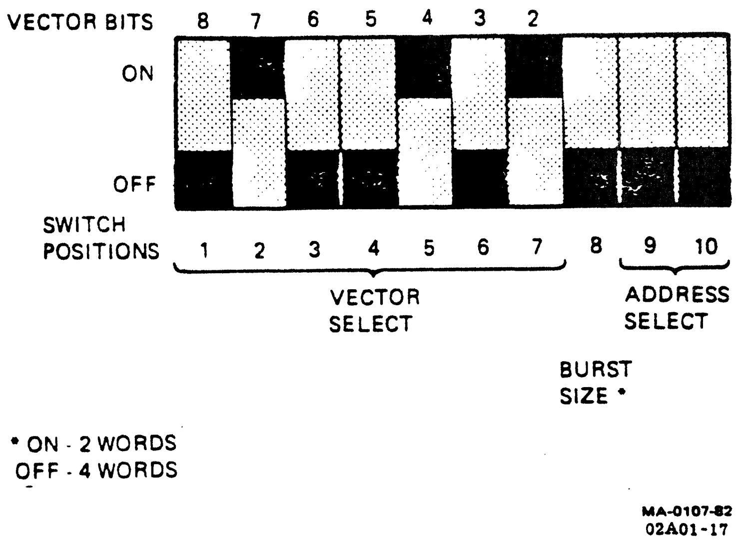


Figure 2-12. DIP SWITCH SETTING IN A SINGLE TU80 CONFIGURATION

NOTES

1. The typical UNIBUS Address and Vector for a single TU80 Subsystem configuration are specified in Table 2-1.

   When more than one (up to four) of the TU80 Subsystems are installed with the host system, the UNIBUS Addresses and Vectors are selected according to Table 2-2.

2. Switch positions 1 thru 7 are used to select vector bits 8 thru 2. Switch position 8 is used to select 2-word or 4-word burst size. Two-word burst size is used for UNIBUS operation. Switch positions 9 and 10 are used to determine a transport number and corresponding UNIBUS Address.

CAUTION

Check the jumpers in location 4F on the module. Jumpers J11 thru J14 are used to select the UNIBUS Address Range. The standard position (J11 is in) is shown in Figure 2-11. The standard starting address is 772522_8.

JUMPERS ARE FACTORY-SET. DO NOT MOVE THEM WHEN IN VAC OR PDP CONFIGURATION. These jumpers must be moved if the address range has to be moved.

3. Plug two internal ribbon cables (NOT KEYED CONNECTORS) into J1 and J2 edge connectors on M7454 module (Figure 2-10). Plug cable with male external connector into J2 and cable with female external connector into J1 on board.

4. Remove G727 bus grant card from desired SPC slot. Remove Non-Processor Grant (NPG) jumper (cut CA1 to CB1) in SPC slot.

5. Carefully insert M7454 module into SPC slot.

Table 2-1. SINGLE-TU80 ADDRESS SELECTION

UNIT NO.	ADDRESS	VECTOR	SW.9	SW.10
0	1725228_8 $F5221_{16}$	224_8 94_{16}	ON	ON

Table 2-2. ADDRESS SELECTION IN MULTI-TU80 CONFIGURATION

TRANSPORT	UNIT NO.	ADDRESS	VECTOR	SW.9	SW.10	CONFIGURATION
1	0	172522_8 $F552_{16}$	224_8 94_{16}	ON	ON	(Unit 0)
2	1	172526_8 $F556_{16}$	float*	ON	OFF	1 (Units 0,1)
3	2	172532_8 $F55A_{16}$	float*	OFF	ON	3 (Units 0, 1,2)
4	3	172536_8 $F55E_{16}$	float*	OFF	OFF	4 (Units 0, 1,2,3)

* Floating Vector: 300 to 700_8

2.5.2 CPU Internal Cabling

Examine the CPU for compliance with the FCC installation specifications. According to the FCC requirements, the CPU should have the I/O bulkhead connector frame at the rear bottom of its cabinet. Then follow the flowchart (Figure 2-13) and use the applicable procedures.

2.5.2.1 Procedure A

1. Install the I/O panel (P/N 74-26907-12) on the CPU's I/O bulkhead frame at the bottom of the CPU cabinet (Figure 2-14A). Secure the I/O panel with two screws.

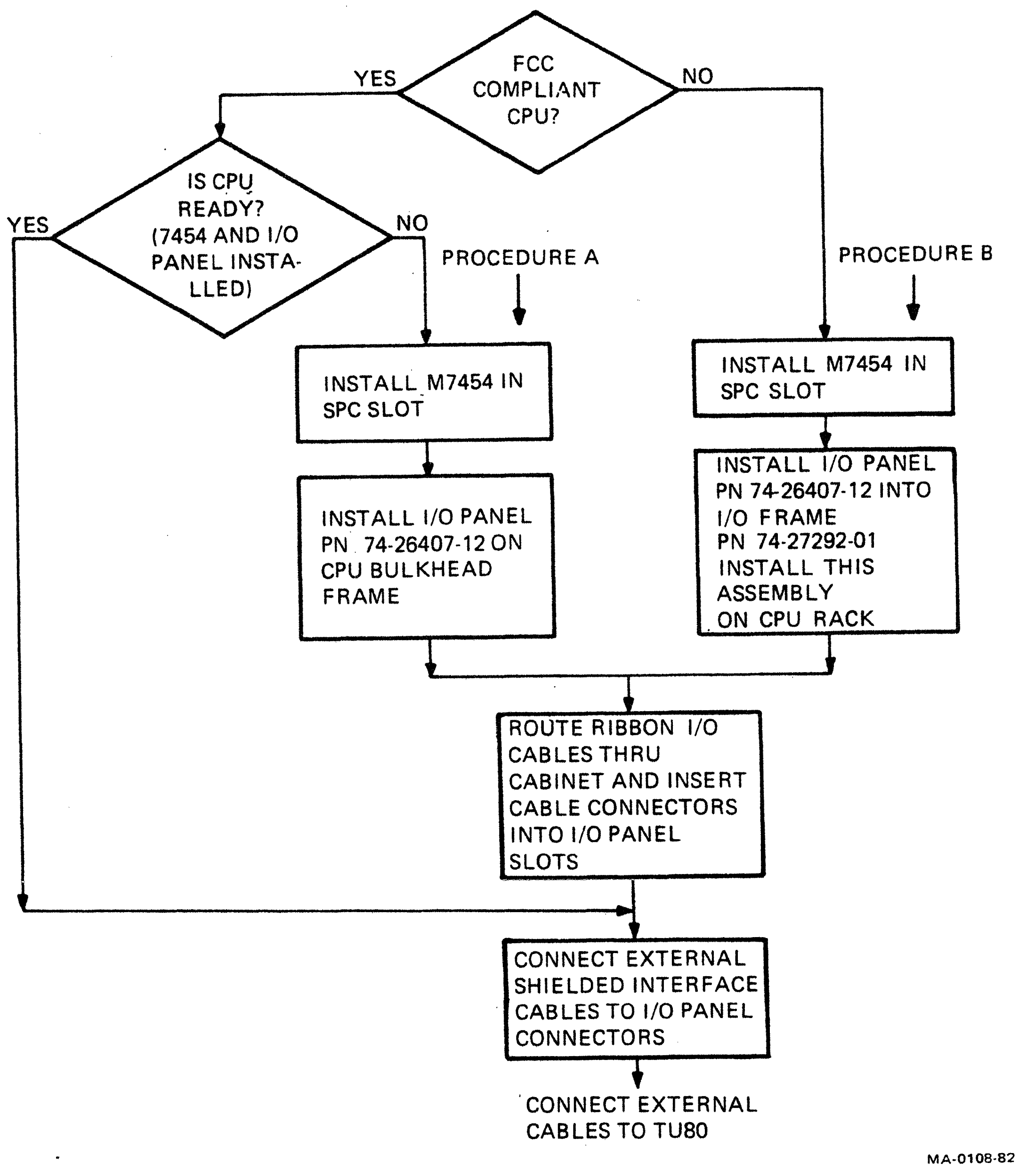


Figure 2-13. I/O CABLING FLOWCHART

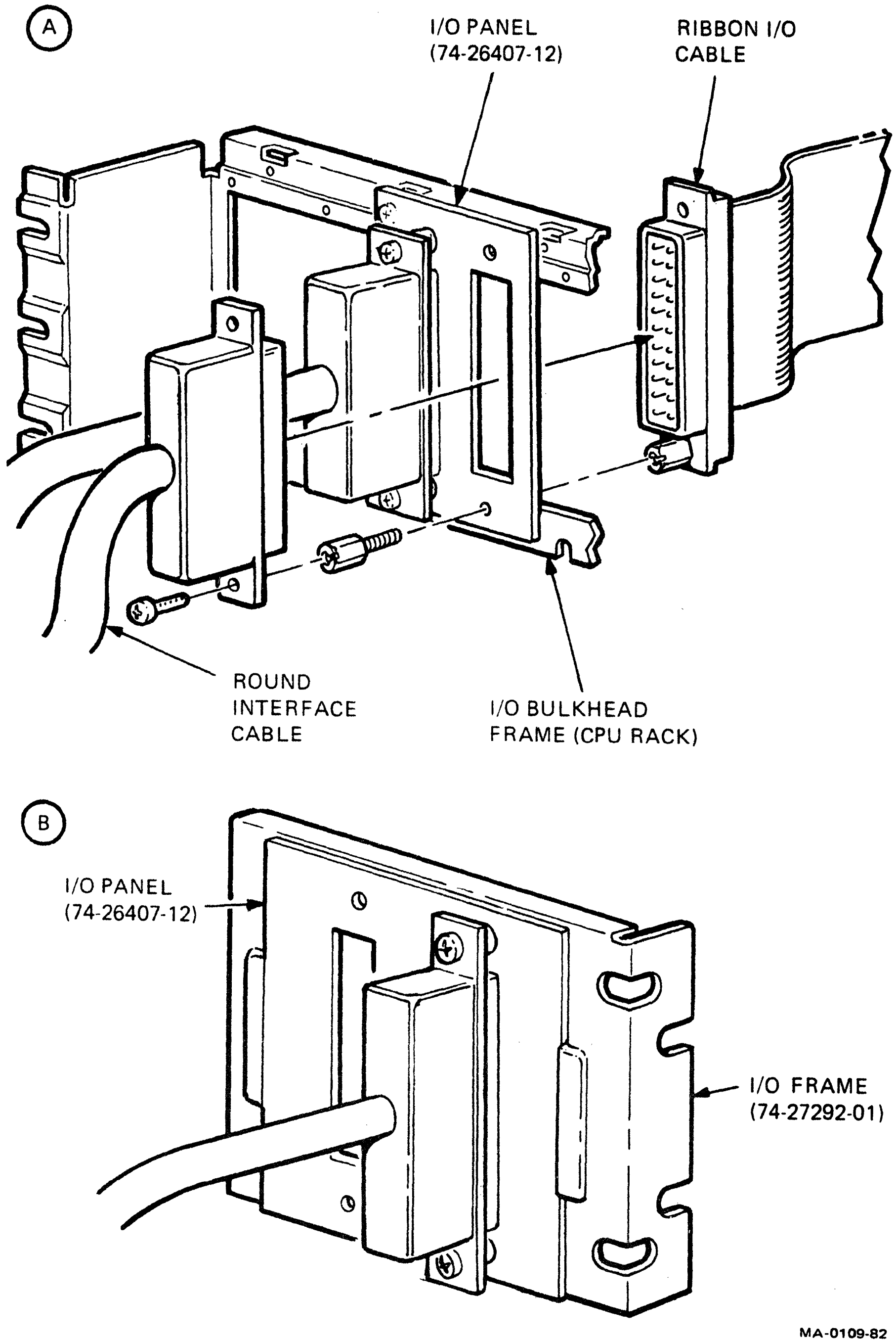


Figure 2-14. I/O CABLE INSTALLATION

2. Route the internal I/O ribbon cables from the M7454 module through the CPU cabinet to the CPU frame and insert the cable connectors into the slots on the I/O panel.

3. Proceed with external interface cabling.

NOTE

Use care not to chafe the internal cables against other modules and chassis parts.

2.5.2.2 Procedure B

1. Mount the I/O panel (P/N 74-26407-12) on I/O frame (P/N 74-27292-01) and secure with two screws (Figure 2-14).

2. Install the I/O frame (with I/O panel) on the CPU rack. Find the best location in the CPU rack to accommodate internal and external interface cabling.

NOTE

Most recommended location for the I/O frame is at the rear bottom of the CPU cabinet.

3. Repeat steps 2 and 3 above.

2.5.3 TU80 External Cabling

NOTE

Use the Accessory Kit TU80K-AC.

1. On the TU80 transport, open top cover. Use a screwdriver to loosen pawl fastener on left side of tape deck near magnetic head assembly.

2. Open front door using an allen wrench.

3. Locate service lock (deck latch) (Figure 2-15) under tape deck on left side of cabinet. Pull on service lock handle to release it. Keep it in this position.

4. Tilt tape deck upward until it is in vertical (service) position.

NOTE

Listen for a click indicating that tape deck is locked in this position.

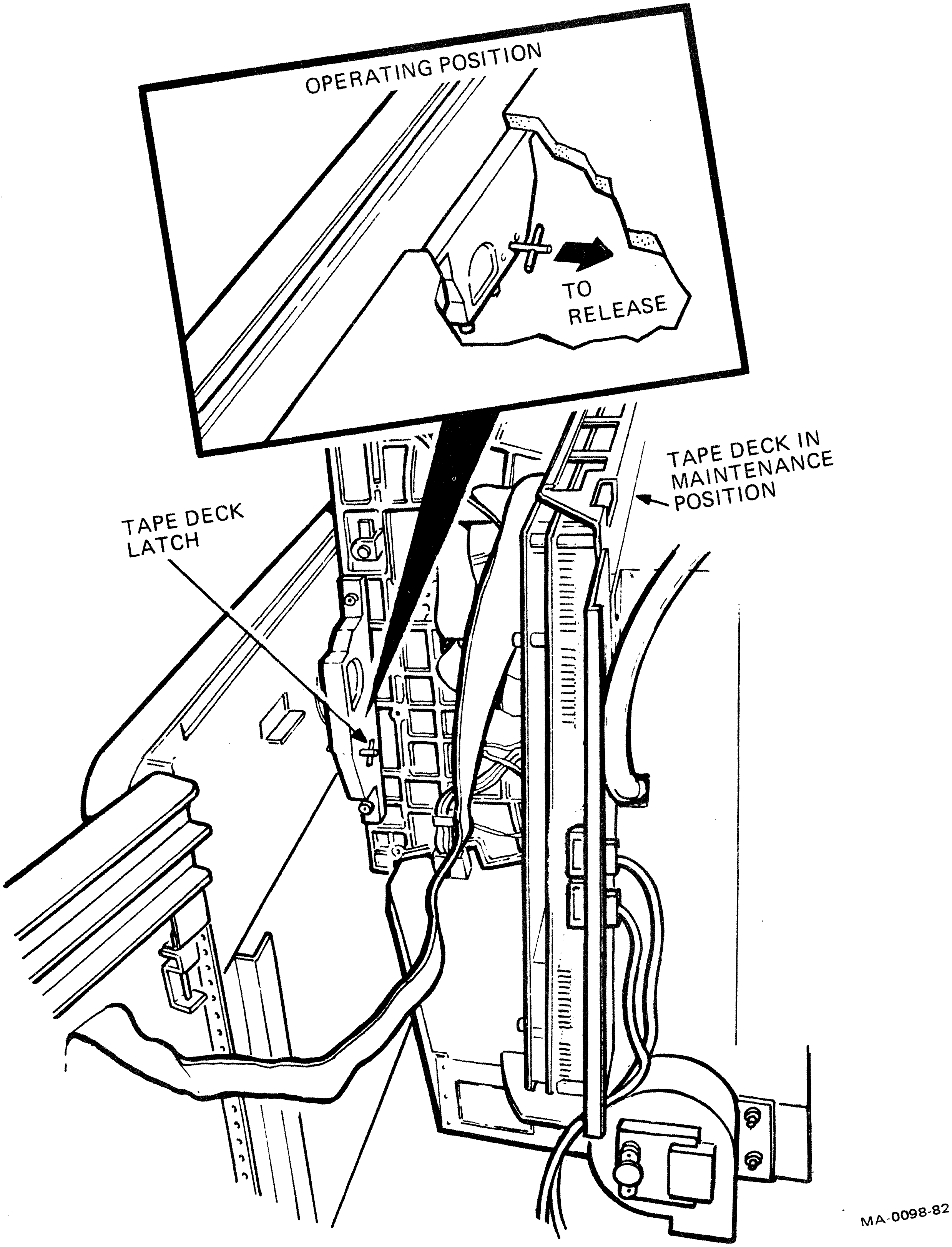


Figure 2-15. TAPE DECK IN MAINTENANCE POSITION (EXTERNAL I/O CABLING)

CAUTION

Be sure not to snag control panel cable on any other cables within TU80 cabinet.

5. Open TU80 rear door. Route external shielded interface cables (P/N 17-00357-01) from CPU back-to-front of cabinet (Figure 2-9).

6. Insert cables into respectively keyed bracket connectors on logic rack mounting plate (refer to Figure 2-10 for plug-to-plug cable connections). Secure each plug with two flat-head screws.

7. On the CPU side, insert interface cables into respectively keyed bulkhead connectors on CPU I/O frame (or bracket). Secure each plug with two screws (Figure 2-14).

8. Release tape deck latch and tilt tape deck downward to horizontal position.

9. Close front and rear doors.

2.6 TU80 ACCEPTANCE DIAGNOSTIC TESTS

This chapter lists all tests necessary to perform to properly check and accept the TU80 Tape Subsystem after its installation.

2.6.1 TU80 Acceptance Test Listing

2.6.1.1 Resident Diagnostics

1. Power-Up Health Check
2. Basic Operator Diagnostic Test (Test 01)
3. UNIBUS Adapter Module Internal Diagnostic

2.6.1.2 Host Diagnostics

1. PDP-11 Front End Diagnostic
2. PDP-11 Data Reliability Diagnostic
3. VAX Front End Diagnostic
4. VAX Data Reliability Diagnostic

NOTE

> Refer to the Diagnostic Documentation of the installed DEC computer for the applicable information on how to run and interpret the Host Diagnostics.

Chapter 5.4 in the Maintenance Section of this manual provides detailed information of the TU80 Diagnostics. Follow the instructions in this chapter on how to initiate and run the TU80 Diagnostic Tests.

2.6.2 TU80 Acceptance Test Procedure
TU80 acceptance testing starts with the off-line resident diagnostic to check the tape transport performance and continues with the on-line diagnostic to test the TU80 Tape Subsystem. The acceptance Testing must be performed in the following steps:

2.6.2.1 Power-On Health Check - This self-test diagnostic checks ac power and functionality of the control panel and major logic modules of the TU80 Tape Transport. To start the health check, press the LOGIC-ON pushbutton (assume that the power switch is on).

2.6.2.2 Basic Operator Test 01 - This test checks basic transport functions and tape motions including BOT/EOT tape motion, read data, and write data. A write enabled, known good quality tape should be used for this test. This test runs to completion in approximately 10 minutes (with a 2400 foot long tape).

2.6.2.3 M7454 UNIBUS Motion Self-Test - The M7454 module performs the built-in self-test at the host system power-up. To run this diagnostic test, the host CPU must be turned off/ turned on. The M7454 self-diagnostic checks the M7454's microprocessor, sequencer data paths, and buffer area. Successful test completion is indicated by the illuminated LED indicator on the module.

2.6.2.4 Host Diagnostics - Depending on the host system's model, either PDP11 or VAX Diagnostics should be performed to chekc the TU80 on-line performance.

3.1 GENERAL

This section contains an explanation of the TU80 Control Panel and instructions on the tape loading and unloading procedures. Instructions are also provided for operator corrective actions for specific malfunctions indicated by the fault code display panel.

3.2 CONTROL PANEL

Figure 3-1 shows the TU80 control panel switches and status indicators. The left side of the control panel contains operator switches/indicators. The 2-digit display is used to indicate a fault code related to an abnormal operating condition or a test code when in the diagnostic mode. The right side of the panel contains the switches for running the internal diagnostic tests.

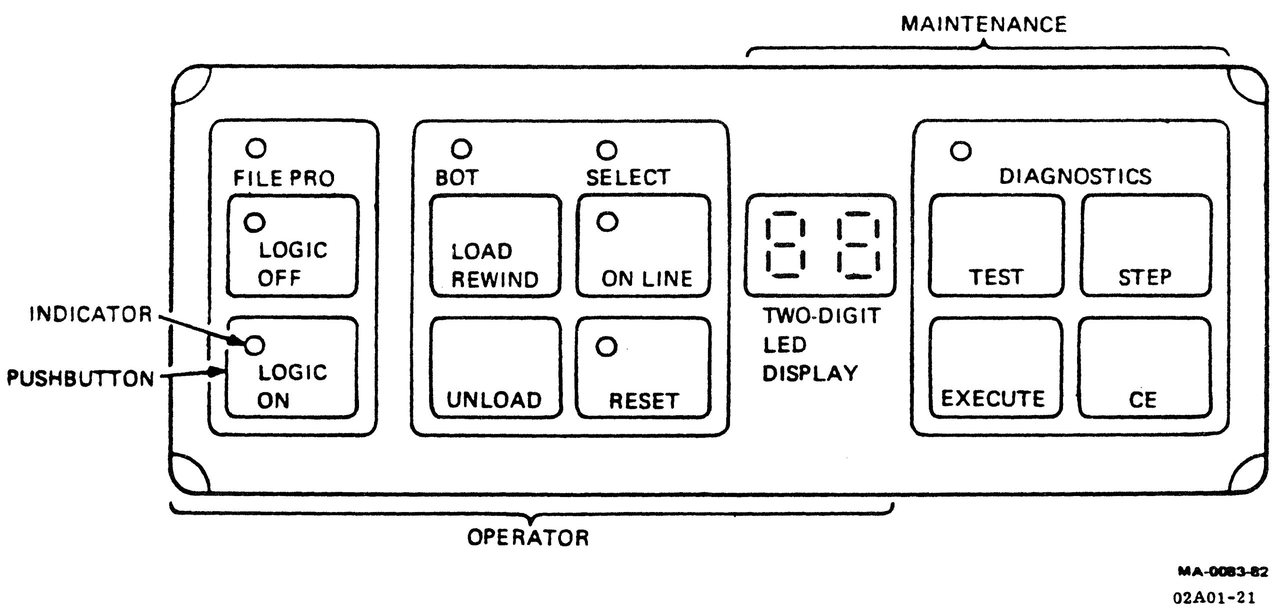


Figure 3-1. CONTROL PANEL

Table 3-1. OPERATOR CONTROLS

SWITCH/INDICATOR	FUNCTION
LOGIC OFF	Switch - When depressed, power will be removed from transport logic circuitry and LOGIC OFF indicator turns on. Indicator - When illuminated, indicates a standby power condition exists (power supply is on, cooling fan starts turning, and transport logic is off). If indicator is off with no other indicators on, then POWER switch (circuit breaker) is off (0) or there is a power supply problem. If this indicator is off and LOGIC ON indicator is on, all transport circuitry is in power-on condition and ready for use.
LOGIC ON	Switch - If depressed when POWER switch (circuit breaker) is on (1), the transport logic and control system is powered up. Indicator - When on, indicates transport circuitry is powered up.
BOT	Indicator - When on, indicates tape is positioned at beginning-of-tape (BOT) marker.
LOAD/REWIND	Switch - If transport is powered on and tape is threaded, depressing this switch causes a load operation to be performed. If tape is loaded, depressing the switch causes a rewind operation to BOT.
UNLOAD	Switch - If tape is loaded at BOT, depressing this switch causes tape to unload from take-up reel and tape path onto supply reel. If is tape is loaded beyond BOT, it rewinds to BOT. If tape is threaded, but no loaded, depressing the switch will cause transport to slowly unload tape onto supply reel.

Table 3-1. OPERATOR CONTROLS (Cont'd)

SWITCH/INDICATOR	FUNCTION
ON-LINE	Switch - If tape is loaded, depressing this switch causes TU80 to go on-line and become accessible by the host system. Depress RESET switch to take TU80 off-line. Indicator - When on, it indicates that TU80 is in on-line mode. All switches except RESET and LOGIC OFF are inhibited.
FILE PRO	Indicator - When on, indicates absence of a write enable ring in supply reel and a write operation is inhibited. Otherwise, a write operation is allowed.
SELECT	Indicator - When on, indicates that TU80 is selected by host system for read/write operation.
RESET	Switch - When depressed, this switch places transport off-line, stops tape motion, and clears error status. The switch can stop a load or rewind operation. It also turns off RESET indicator and clears diagnostic test conditions. Indicator - When on, indicates that TU80 is in a fault or diagnostic status. A 2-digit display may contain a fault or diagnostic code.
Diagnostic Controls	
DIAGNOSTIC	Indicator - When on, indicates that TU80 is in diagnostic/test mode. The indicator remains on until RESET switch is depressed.
TEST	Switch - If tape is threaded, but not loaded, depressing this switch places unit in diagnostic/test mode.
STEP	Switch - In the diagnostic/test mode, depressing this switch causes diagnostic/test sequence numbers in 2-digit display to be incrmented to digit required.

Table 3-1. OPERATOR CONTROLS (Cont'd)

SWITCH/INDICATOR	FUNCTION
EXECUTE	Switch - In the diagnostic/test mode (and test number displayed), depressing this switch initiates the diagnostic test.
CE	Switch - If TU80 is in diagnostic/test mode, simultaneously depressing the CE (Customer Engineer) switch and TEST switch recalls an internal diagnostic routine (Field Service Tests) to aid a Field Service Representative.

Operator Hints

1. When LOGIC ON indicator is on, all control panel switches and indicators are functional except LOGIC OFF indicator.
2. The ON-LINE switch can be depressed while tape is loading. The TU80 goes on-line immediately when loaded.
3. When RESET indicator is on, the control panel is not operable except for LOGIC OFF and RESET switches. To turn indicator off, press RESET switch.
4. Tape unloading is performed at low speed. If there is a lot of tape on take-up reel, and you wish to do it more quickly, you can do it faster by depressing LOAD/REWIND first and then UNLOAD.

3.3 OPERATING PROCEDURE

The operating procedure includes preparing and loading the tape reel, powering on the transport, placing it on-line to the host computer, and checking its operational status. If a fault code appears on the 2-digit display during loading or routine operation, refer to section 3.4, Operator Corrective Actions.

3.3.1 Inserting Write Enable Ring

Before mounting the reel of tape onto the supply hub, determine whether or not the tape is to be recorded (write operation performed). If write operations are to be performed, place a write enable ring into the bottom recessed portion of the reel (Figure 3-2).

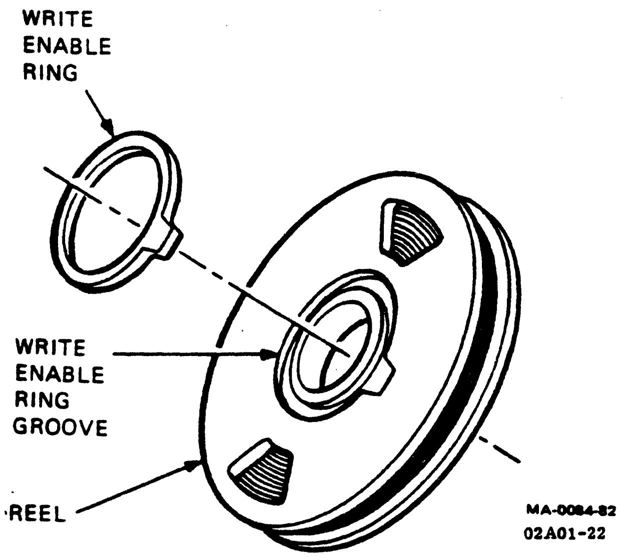


Figure 3-2. WRITE ENABLE RING

3.3.2 Tape Threading and Loading

Perform this procedure to thread and load tape.

1. Pull cover latch towards the front and lift top access cover. Check that power switch is in ON position (1 depressed). The LOGIC OFF indicator should be on.

NOTE

The power switch can be in the ON position all the time to enable the TU80 transport to be powered on under CPU control.

2. Depress the LOGIC ON switch. The power-up health check is initiated. The LOGIC OFF indicator goes off and all other indicator momentarily go on. The LOGIC ON and FILE PRO indicators should remain on.

NOTE

Depressing the LOGIC ON switch enables the transport power amplifier module, control logic, and support circuits. If a fault code is displayed at this time, depress the RESET and LOGIC OFF switches and then LOGIC ON switch again to repeat the check. If the fault code persists, call Field Service.

3. Depress inner button on the face of supply reel hub.

4. Mount supply reel onto hub so that reel is seated on bottom flange. Secure reel by depressing the periphery of the hub face to latch the reel.

5. Thread magnetic tape through tape path as shown in Figure 3-3.

6. Wrap tape leader (a length of tape before BOT marker) onto take-up reel for several turns.

CAUTION

Make sure that tape is positioned correctly over all tape path components, otherwise, tape damage may occur.

7. Close and latch top cover.

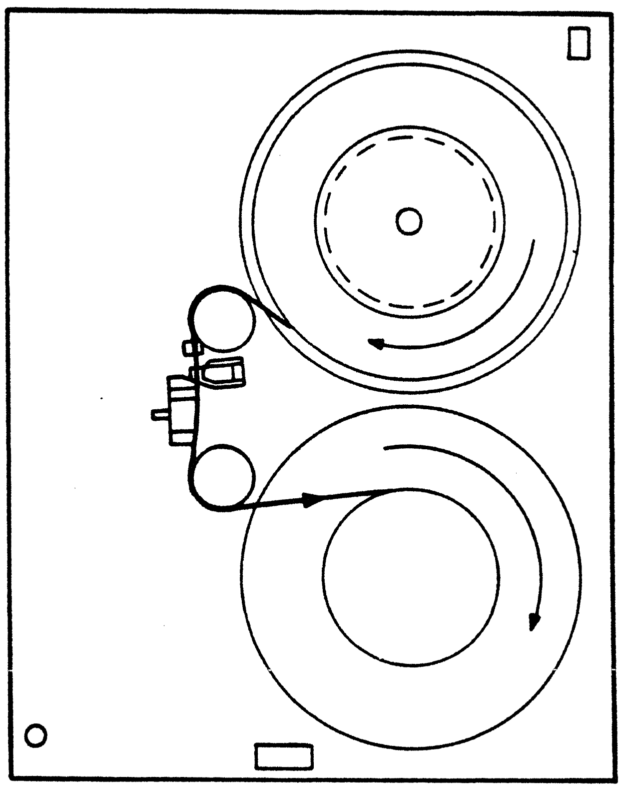


Figure 3-3. TAPE PATH

8. Depress LOAD/REWIND switch. In 1 second, air pressure builds at air bearings and tape starts moving in forward direction. This motion stops when BOT marker on tape is detected. If tape was over-threaded and BOT marker was positioned after sensor, forward tape motion continues for approximately 40 feet. Then the transport initiates reverse tape motion until BOT marker is detected. At this moment, tape motion stops and BOT indicator is on.

NOTE

If LOAD fails and tape does not move to BOT, check for BOT marker on tape.

9. Depress ON-LINE switch to place unit on-line to the host system. The switch may be depressed while load operation is in progress. On completion of a load operation, the transport indicates ON-LINE status by turning ON-LINE indicator on. (If the transport is ready for a write operation, the FILE PRO indicator goes off.) Now the transport is ready for use.

3.3.3 Tape Unloading

The following are procedures for unloading tape manually or in on-line mode.

3.3.3.1 Manual Mode - Perform this procedure to unload tape manually.

1. Depress RESET switch to place transport off-line.
2. Depress UNLOAD switch. Tape moves in reverse direction (rewind) sently winding onto supply reel reel until it clears take-up reel and tape path.

NOTE

If loaded beyond the BOT marker, tape rewinds to BOT.

3. Open top cover and depress center button of supply reel hub. The hub unlatches and supply reel can be removed.
4. Close top cover to prevent dust accumulation on tape deck components.

3.3.3.2 On-Line Mode - When on-line to the host CPU, the unload operation can be performed under CPU control.

3.4 OPERATOR CORRECTIVE ACTIONS

If a fault condition is indicated on the control panel (RESET indicator is on and a fault code is indicated on the digital display), refer to the Fault Recovery Table on the inside of the top cover (also Table 3-2 below) and to the Fault Code Matrix, Table 5-2, in section 5.4 of this manual.

Table 3-2. OPERATOR CORRECTIVE ACTIONS

FAULT CODE	CORRECTIVE ACTION
01 - 09	Clean magnetic head and tape path.
10	Ensure cover door is securely closed.
11	Thread tape.
12	Latch supply reel hub.
13	Thread tape correctly as shown on tape threading diagram.
14	Check for BOT marker on tape. Attach BOT/EOT marker.
15	Indicates RESET switch depressed inadvertently by operator. Reinitiate test.
16	Check for presence of write enable ring in supply tape reel. Install the ring if not present.
17	Check for presence of EOT marker. Attach EOT marker.
18	Initiates that tape was loaded when test was initiated. Thread tape, but DO NOT depress LOAD switch.
20 - 29	Mount a tape of known good quality.
All Others	Attempt to run Diagnostic Test 01 (refer to section 5.4).

4.1 GENERAL DESCRIPTION

This section of the manual discusses the principles of operation of the TU80 Tape Unit. Descriptions are provided for all functions of the TU80 on a major component basis. Major areas of discussion are as follows:

- o Power Generation and Distribution
- o Pneumatic System
- o Read/Write/Servo Board Functions
- o Formatter/Control Functions
- o Power Amplifier Operation
- o Head Operation/Recording
- o Interface and Timing Considerations

Text is supported by diagrams, flowcharts and timing charts, where required, to simplify understanding of the description. Diagrams contained herein are condensed and simplified and, in no way, should they be used for TU80 troubleshooting. Logic diagrams and schematics contained in the Field Service Print Set take preference over any diagrams contained in the theory of operation. Refer to Figure 4-1 for a block diagram of the TU80.

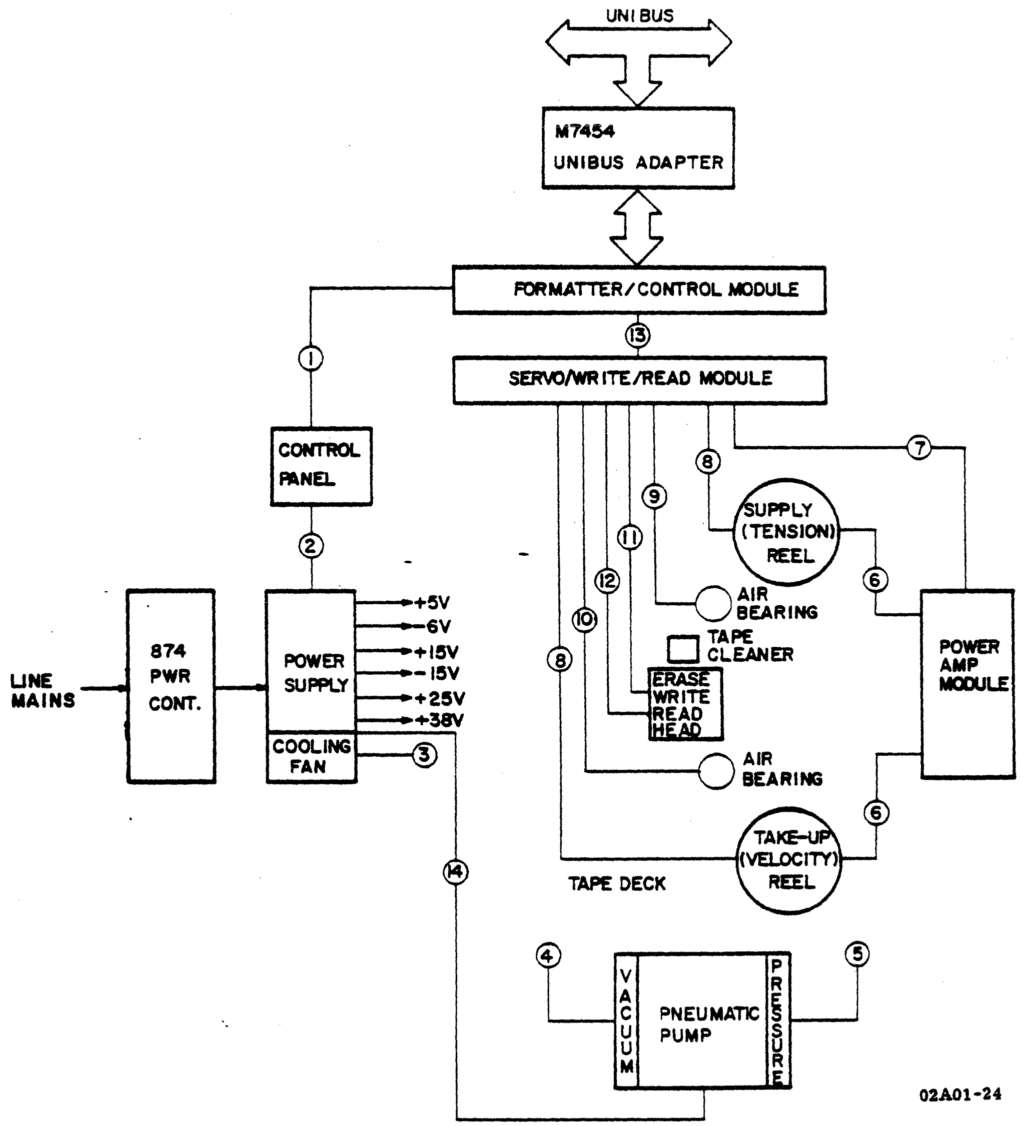
A brief functional description of major areas of the TU80 Tape Unit is given in succeeding paragraphs. A more detailed circuit description is then discussed with accompanying block diagrams and flowcharts.

NOTE

> The TU80 Subsystem description and operation is presented in Appendix A of this manual along with the description of the M7454 UNIBUS Adapter Module.

4.2 PHYSICAL DESCRIPTION

The TU80 is a manual load, reel-to-reel tape drive unit requiring no capstan drive, tension arms or vacuum columns. Tape is transported directly under electronic control, with no tape buffers required. Tension is sensed electronically by tension sensors built directly into the tape path. The five major equipment components or subsystems are Formatter/Control logic, Servo circuits, Read/Write Head assembly and circuits,



1. OPERATOR/DIAGNOSTIC COMMANDS
2. ON/OFF SWITCHES AND PANEL INDICATOR VOLTAGES
3. COOLING AIR TO ALL ASSEMBLIES
4. VACUUM SUPPLY TO TAPE CLEANER
5. PRESSURE TO AIR BEARINGS
6. DRIVE CURRENT TO REEL MOTORS
7. SPEED/TENSION CONTROL
8. TACH INFO TO SERVO CIRCUITS
9. BEARING SENSOR TENSION INFO
10. BEARING SENSOR TENSION INFO
11. WRITE DATA TO TAPE
12. READ DATA FROM TAPE
13. LOGIC CONTROL AND FORMATTING INFO
14. POWER TO PUMP MOTOR

Figure 4-1. TU80 FUNCTIONAL BLOCK DIAGRAM

Pneumatics/Cooling systems, and the Power Supply and Distribution circuitry. The following paragraphs give a brief description of the overall TU80 functions.

4.2.1 Power Supply

The power supply is activated when the ON/OFF power switch (main circuit breaker) is in the ON position. This allows the LOGIC OFF indicator on the control panel to illuminate, and also supplies the AC power to operate the cooling fan motor.

Pressing the LOGIC ON switch generates all the necessary DC voltages used throughout the TU80 logic circuits, as well as initiating a MASTER CLEAR pulse. This pulse is used to steer the control logic functions to a starting or known state prior to starting a Load operation.

4.2.2 Tension/Speed Control

The Load function is initiated by the LOAD switch on the control panel. The pneumatic pump is activated at this time, causing air pressure to be gated to the air bearings. Air pressure gated through holes in the bearings actually senses the tension of the tape through sensors physically located on the air bearings. The sensor output signals are applied to a tension servo circuit, whereby, the supply (file) reel is directed to drive so that a constant tension of approximately 8 ounces is maintained across the tape path at all times.

Tape speed is maintained through the use of a 1000 line tach and a one-line tach located on the rear of the reel motors. Tach information is applied to an electronically controlled servo, whereby, a calculation is made of the linear velocity (inches per second) and the radius of the take-up reel. Because the radius of tape on the reel is always a known factor, then the linear velocity can be compensated for without the use of a capstan drive circuit.

4.2.3 Magnetic Head

The magnetic head fulfills the objective of the TU80; ie., read from or write to the magnetic tape. This assembly consists of a sectionalized read/write head and an erase head. Selection of the read or write modes of operation is made by the host through the control logic circuits. Data is transferred from or to the host via data lines that are gated to the individual read heads by the read/write circuits. Read recovery circuits convert the readback data to a digital format compatible with the control and formatter logic. Write driver circuits convert the logic-compatible write data to current levels required to drive the write head coils.

4.2.4 Format Control

The TU80 performs all data formatting functions internal in the formatter logic circuits. Functions controlled by the transport include PE ID Burst, Preamble, Postamble, File Mark, and Skew Compensation.

4.2.5 Interface

The TU80 transport interface is based upon the Industry Standard Interface requirements for 1/2 inch tape products. Modifications to this standard interface have been made to accommodate the TU80. Specific interface features are as follows:

4.2.5.1 Streaming Mode Operations - Speed Select Command and Status Lines are required for setting start/stop or streaming modes and identifying motion states.

4.2.5.2 Gap Length - The TU80 Formatter will automatically extend the interblock gap (while writing data) from the minimum of 0.6 inch to a maximum of 1.2 inches. This feature allows the tape to "stream" more effectively by reducing the number of repositioning cycles.

4.2.5.3 Sense Transfer - Allows for the transfer of sense information.

4.2.5.4 Interface Loopback - Allows for the looping of write-to-read lines on the transport interface.

4.3 POWER SUPPLY

4.3.1 General Description

AC power from a single AC power outlet is supplied through a standard, 3-wire power cord (60 Hz only) to the 874 Power Controller located at the bottom rear of the TU80 cabinet. The 874 Controller features a 12A (50 Hz) or 24A (60 Hz) circuit breaker, and provides regulated 120 VAC (60 Hz) or 240 VAC (50 Hz) to the TU80 power supply located at the top rear of the TU80 cabinet. The 874 Power Controller is connected to the host CPU by a power switching cable. This gives the CPU control over the TU80 power supply in the on-line mode of operation.

The power supply accepts regulated inputs of 120 VAC (60 Hz) or 220/240 VAC (50 Hz) power, with the only change in configuration being the positioning of the Voltage Select PC board. A functional description of this change is discussed in succeeding paragraphs. The major function of the power supply is to provide AC power to the cooling fan and pneumatic pump, generate DC voltages used throughout the transport, and provide shut-down capabilities in the event of abnormal voltage conditions.

4.3.2 Physical Description

Power supply components consist of the AC input receptacle, line filter, circuit breaker (mounted on the top front of tape deck), Voltage Select PC board, main Power Supply PC board and Power Supply Control PC board. A simplified block diagram of major power components is shown in Figure 4-2. A brief functional description of the three power supply PC boards is as follows:

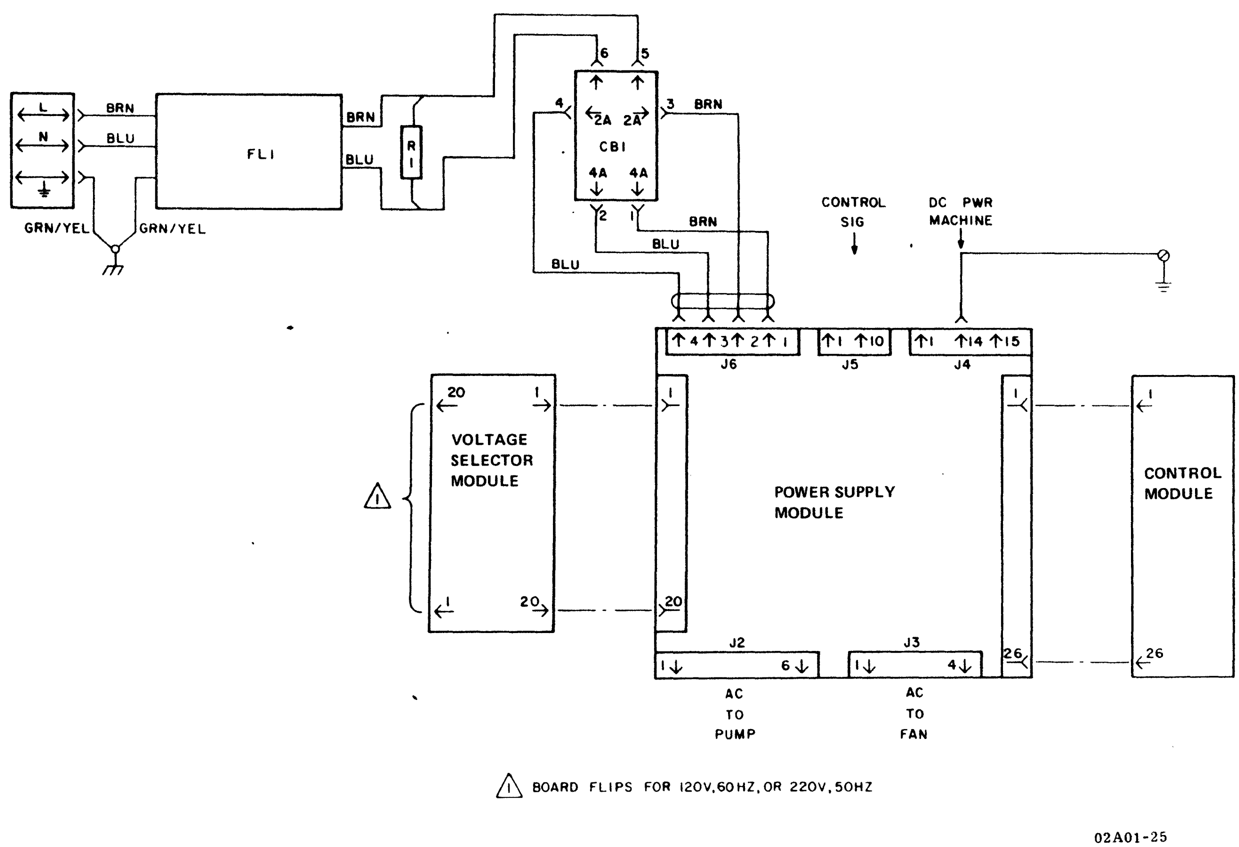


Figure 4-2. MAJOR POWER SUPPLY COMPONENTS

4.3.2.1 Voltage Select PC Board - This board consists of two connectors labeled J1A and J1B and two fuses. One fuse is used in the input AC lines to a standby voltage supply, and the remaining fuse is used for protection of components in the internal high voltage circuit. The land layout of the board is such that the input lines from the line filter are matched to the input transformer in a configuration compatible with either 120 VAC (60 Hz) or 220/240 VAC (50 Hz). Connector J1A is inserted into the main PC board if 120 VAC is provided; connector J1B is used for the 220/240 VAC requirement. Connector keys are provided on the board edge connectors to eliminate the possibility of incorrect insertion. The Voltage Select PC board is mounted vertically into the power supply main PC board at connector J6.

4.3.2.2 Power Supply Control PC Board - The Control board consists of the low voltage and over-voltage detect circuits, LOGIC ON switch and LOGIC OFF switch receiver circuits, LOGIC ON/OFF control panel indicator circuits, master clear circuit and power-on latching circuit. Like the Voltage Select PC board, the Control board is mounted vertically into the main PC board at connector J8.

4.3.2.3 Power Supply Main PC Board - The main PC board is responsible for the function of the power supply; i.e., generating DC voltages for all functions in the TU80. A brief description of the circuits, comprising the main PC board, is as follows:

- Standby Voltage Circuit - Standby voltages of +20, +15 and +5 volts are developed to provide a separate supply voltage for all other control circuits associated with the power supply. The standby voltages are used only within the power supply.

- Pulse Width Modulator - This circuit monitors the +5 volt logic level and developes a pulse train to drive the half bridge switching converter. The pulse width modulator also provides the means by which abnormal conditions cause the shut-down of the output voltages.

- Half-Bridge Switching Converter - This circuit contains the pulse width modulator, totem-pole driver circuits, high voltage rectifier, and transformers coupling the converted energy to the regulated DC voltage output circuits.

- Regulated DC Voltages - The regulated DC voltages generated on the main PC board include +5V, -6V, $\pm$ 15V, +25V and +38V. The circuits consist of output transformers, full wave rectifiers, filtering networks and regulators.

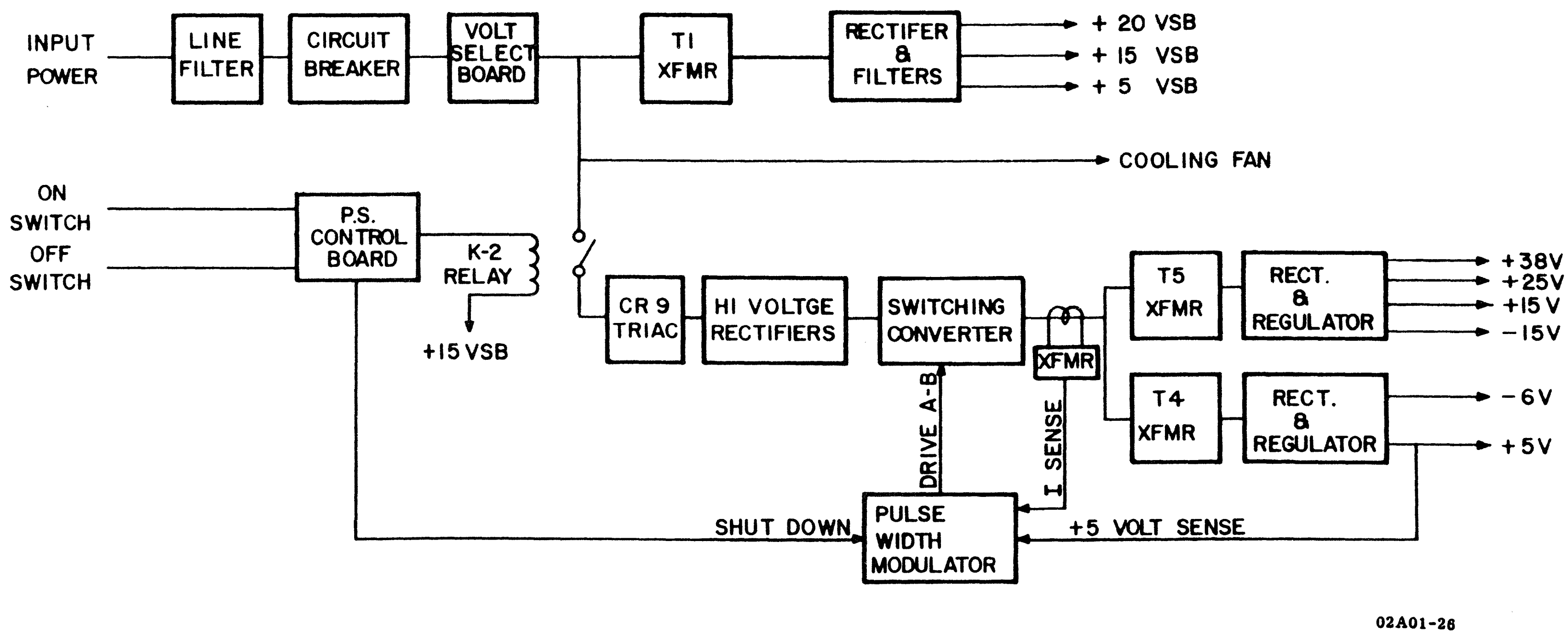


Figure 4-3. POWER SUPPLY BLOCK DIAGRAM

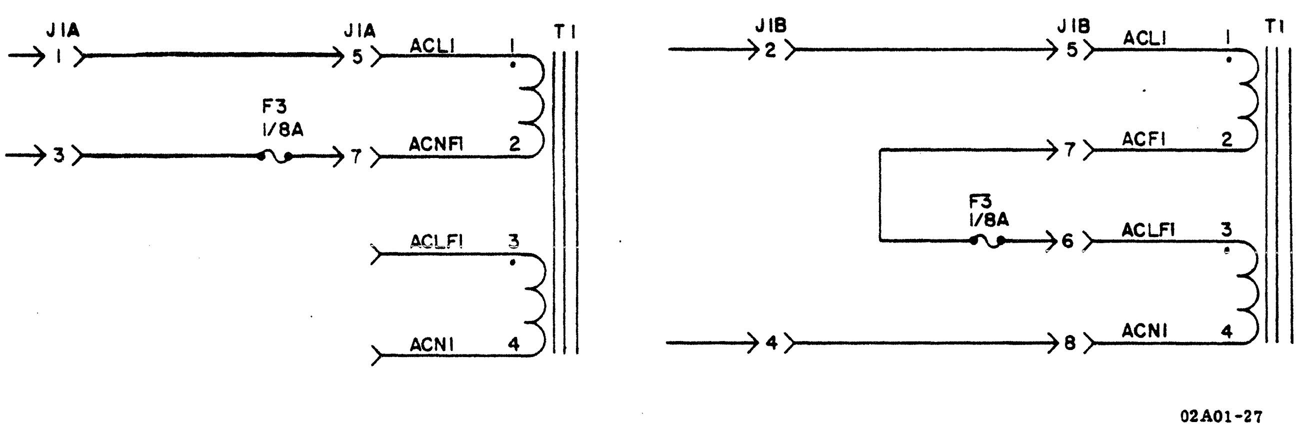
4.3.3 Power Supply Functional Description

The following discussion of circuit operation is presented in the sequence in which the power supply is activated. Reference should be made to the accompanying block diagrams or to the Power Supply Schematics contained in the Field Service Print Package.

4.3.3.1 Input Power Selection - Input power (120V 60 Hz or 220/240V 50 Hz) is applied from the power line cord connected to the power supply receptacle and into a line filter for noise suppression. Power is then supplied to the transport power switch (circuit breaker) located on the tape deck. The switch portion of the circuit breaker is labeled 1 (ON) and 0 (OFF). With the circuit breaker placed in the 1 position, input power is routed through connectors and into the Voltage Select PC board. It is, at this point, that circuit selection is made for either 120 or 220/240 volts AC. Refer to Figure 4-4 for circuit differences.

If 120V 60 Hz input power is being applied, the Voltage Select PC board is positioned such that connector J1A is plugged into the main PC board. If an overload conditions is present at transformer T1, the F3, 1/8A fuse would blow. The fuse is situated so that any external taps of the primary (i.e., pneumatic pump operation) do not affect the fuse, which is used only for detection of an overload condition at transformer T1.

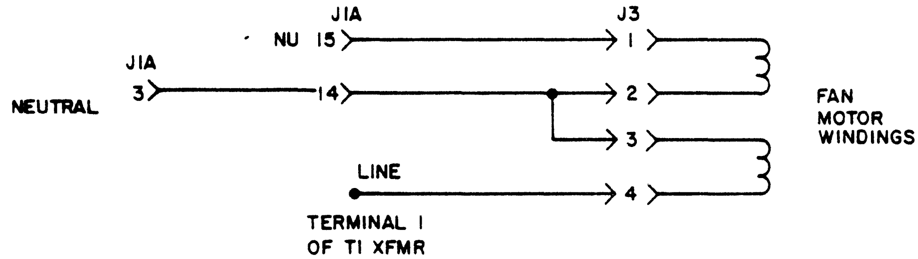
If 220/240V 50 Hz input power is being applied, then the Voltage Select PC board is positioned such that connector J1B is plugged into the main PC board. With this configuration, the two primaries of transformer T1 are wired in series, with only the F3 fuse applicable to the circuit.



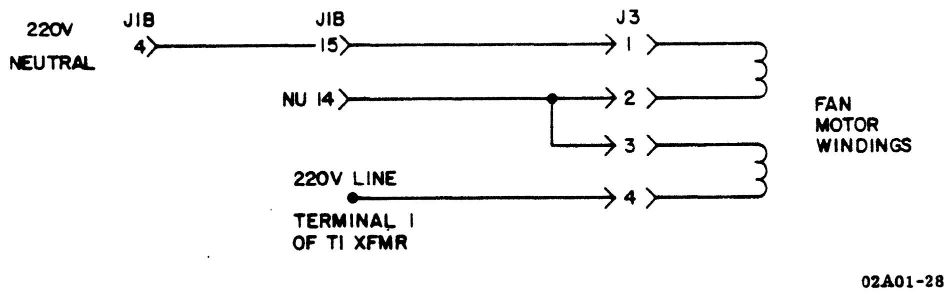
A. 120 VAC 60 Hz Power Input B. 220/240 VAC 50 Hz Power Input

Figure 4-4. VOLTAGE SELECT PC BOARD

Also, note that, at this point (power applied, circuit breaker ON), the AC line is applied to the cooling fan motor. The cooling blower has a three-line input and is configured as shown for either 120 or 220/240 volt application. Wiring to the neutral line is determined in the Voltage Select PC board.



A. 120 VAC 60 Hz Power Input



B. 220 VAC 50 Hz Power Input

Figure 4-5. COOLING FAN WIRING

4.3.3.2 Standby Voltage Generation - Standby voltages of +20, +15 and +5 volts are developed to provide a separate supply voltage for all control circuits associated with the power supply. These voltages are present when input power is applied and the circuit breaker is placed in the ON position. Development of the standby voltage is as follows:

Input power is applied to the T1 standby transformer and converted to a +20 standby voltage via a full wave rectifier and filter network. The +20 VSB is used as a control voltage for the half-bridge switching converter and control panel OFF indicator, and is also used to develop the +15 standby voltage.

The +15 standby voltage is developed by a LM317 voltage regulator. The resistor divider network R3/R4 determines the required output of this regulator. Plus 15 volts is used as a supply voltage for the K-1 pump enable relay, K-2 current-on relay, pulse width modulator, over and under voltage detect circuits and master clear circuits, and is used as the source voltage to develop +5 standby voltage.

The +5 standby voltage is developed by a LM317 voltage regulator circuit similar to that used on the +15 VSB line. Plus 5 VSB is used as the supply voltage to operate all of the TTL chips used throughout the power supply. The Q3 transistor located between the +5 and +15 volt circuits is used in the event of the +15V supply being shorted to the +5 volt supply. If the +5V supply increases above 6.2 volts, diode CR36 would forward bias transistor Q3, causing a +5V potential at the resistor divider network of the +15 VSB voltage regulator. The +15 VSB regulator would then be regulated to approximately 6.2 volts, eliminating any damage that would otherwise occur to the TTL circuits fed by the +5V supply.

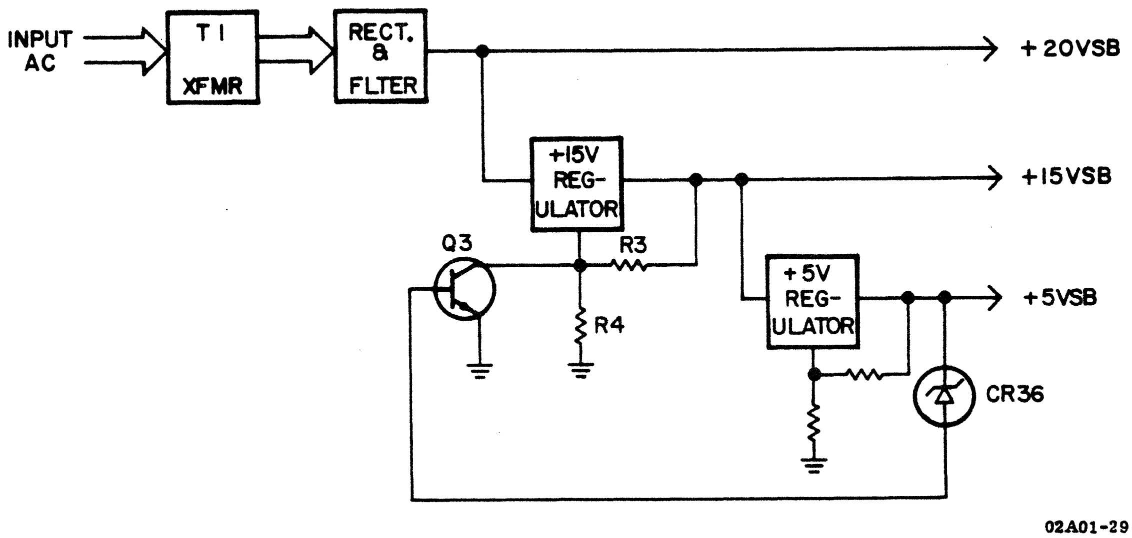


Figure 4-6. STAND-BY VOLTAGE GENERATION

The only effect of the standby voltage outside the power supply is the OFF indicator on the control panel. The Power-On flip-flop (reset at this time) turns on the OFF LED transistor and supplies currented limited (20 ma) +20 VSB to the OFF indicator.

While in the standby mode, the ION signal is a logic 1 (High), keeping the pulse width modulator in a shut-down condition.

4.3.3.3 Power-On Sequence (Refer to Figure 4-7, Power-On Flowchart) - The purpose of the power-on function is to provide the required regulated DC voltages to the transport's control, formatter and servo circuits. The power-on sequence also enables the abnormal (low/over) voltage detect circuits within the power supply.

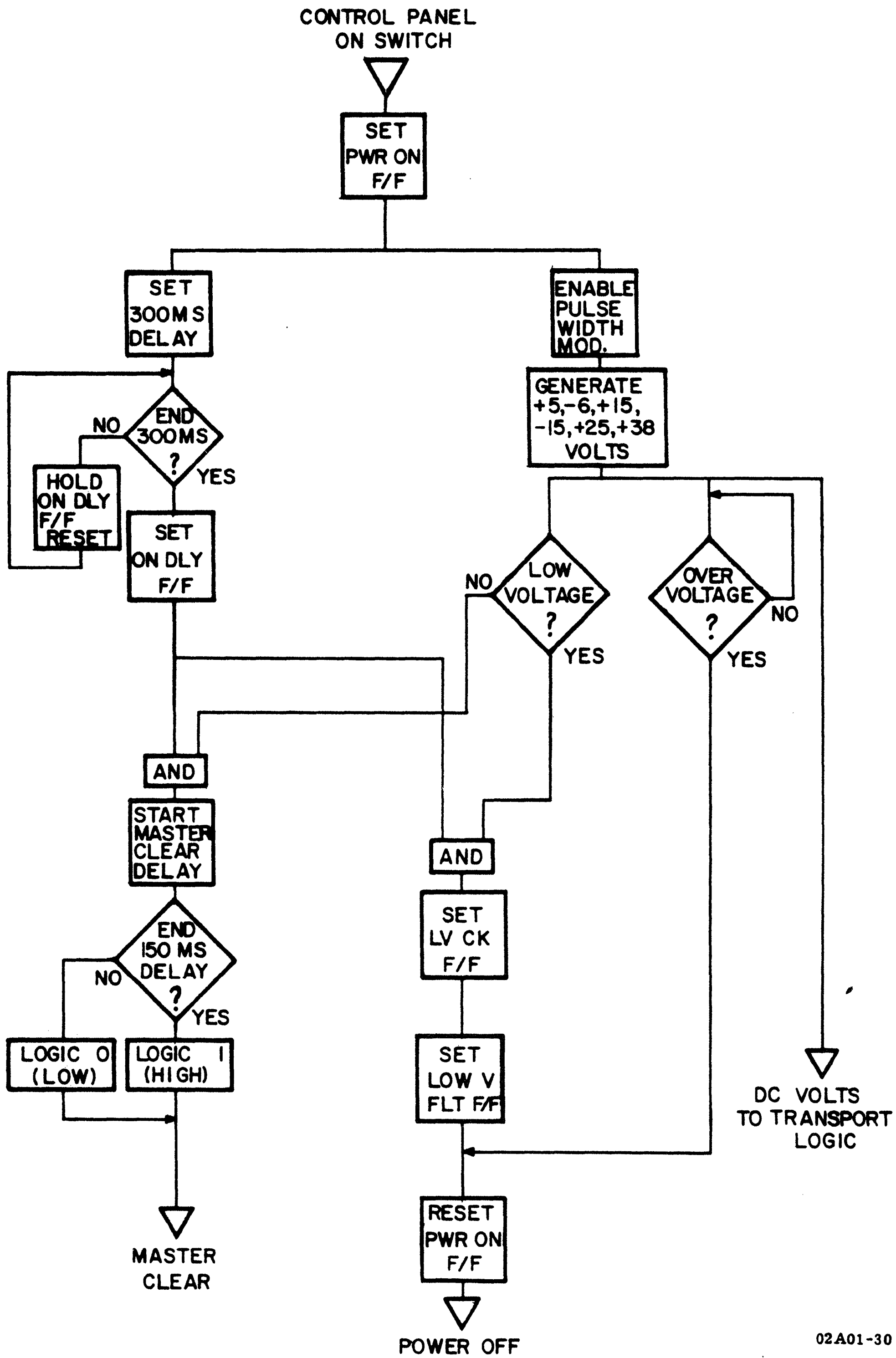


Figure 4-7. POWER-ON SEQUENCE FLOWCHART

Power-On is initiated by pressing the LOGIC-ON switch on the control panel (assuming that the circuit breaker is in the 1 position). This action causes a momentary turn on of the power-on transistor which triggers the POWER-ON flip-flop to the set state. The reset output of the flip-flop removes the ION (low) signal from the pulse width modulator, enabling a 25 KHz pulse train output (DRIVE A/DRIVE B). These outputs are the control signals to develop the +5, -6, ± 15, +25 and +38 volt logic levels used throughout the transport. An explanation of the pulse width modulator and DC circuits are discussed in succeeding paragraphs.

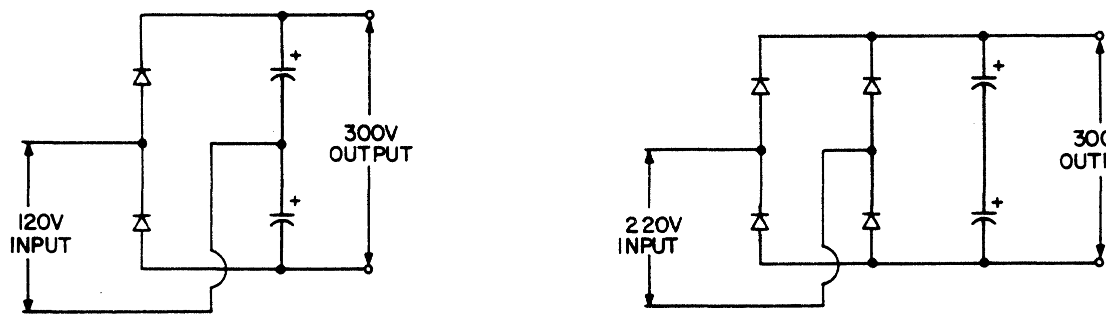
Concurrent with the development of the DC voltages, the POWER-ON flip-flop also initiates a power-on delay, which is used to inhibit detection of low voltage until the DC voltages are expected to attain their nominal voltage level. The reset output of the POWER-ON flip-flop initiates a RC time delay of approximately 300 ms. This delay prevents the ON DLY flip-flop from setting which, in turn, forces the LVCHECK flip-flop to remain reset. At the conclusion of the 300 ms delay, a comparator triggers the ON DLY flip-flop. The LVCHECK flip-flop is now primed to receive a Low Voltage signal, if that condition is detected. Low voltage detection is discussed in succeeding paragraphs.

The ON DLY flip-flop also removes one of three inhibits from the Master Clear circuit.

The Master Clear (MCLR) circuit is provided to the transport logic to "steer" the control functions to a starting or known state during ON/OFF and other detected abnormal conditions. The MCLR circuit contains a time delay circuit of approximately 150 ms, which is used to assure output voltage stability prior to inactivating Master Clear. Three inputs are used to control MCLR: PON (Power On flip-flop), LOWV (Low Voltage), and ONDLY (On Delay flip-flop). The output of the MCLR is held low active during transitional periods, and is allowed to de-activate to a high level after all three controlling inputs are logic high.

At the conclusion of Master Clear, the ON LED transistor is turned on which applies +5V to the LOGIC ON indicator on the control panel.

4.3.3.4 Switching Converter (Refer to Figures 4-8 and 4-9) - The high voltage supply for the switching converter consists of two electrolytic capacitors charged through a diode bridge network. The output capacitors are configured such that during 120V operation, the circuit functions as a voltage doubler, with the output capacitors connected in series. During 220V operation, the output capacitors are connected in series, and the input line is full-wave rectified. The resulting effect is that an output voltage of approximately 300V is supplied to the switching converter, regardless of whether 120V or 220 VAC is supplied. A simplified diagram of output capacitors and bridge configuration is shown in the figures below.



A. 120 VAC Input B. 220/240 VAC Input

Figure 4-8. HIGH VOLTAGE GENERATION 02A01-31

DRIVE A and DRIVE B (from the pulse width modulator) appear at the input of two peripheral drivers. These drivers, in the on state, positive input, provide a ground output. In the off state, the output is an open collector circuit. An example of circuit operation is as follows: As the signal level of DRIVE B goes negative, driver pin 5 becomes an open collector. This provides a circuit from R12, +20 VSB, through the primary of transformer T2, to ground of the peripheral driver pin 3. With terminal 2 of T2 at a positive potential, an induced positive voltage is also present at terminal 10 of the secondary of T2, causing transistor Q1 to turn on. With Q1 turned on, a current path is now provided via Q1, T2 windings 5 and 6, and through the primaries of transformers T4 and T5. The induced voltage in the secondary of T4 and T5 is rectified, as described in the DC Voltage paragraph.

During conduction of Q1, the current flow through T2 terminals 5 and 6 applies a "load proportional" drive current to base of Q1.

DRIVE B peripheral driver is turned on (ground output) when the DRIVE B signal returns to the high level. With both DRIVE A and DRIVE B in the on state, the primary of T2 is essentially shorted, causing Q1 to turn off. The charge stored in capacitor C10, during conduction of Q1, is applied as a back bias to Q1 when T2 is shorted. This ensures an immediate turn off of Q1 to produce the resultant waveform shown in Figure 4-9.

When DRIVE A signal goes negative, the peripheral driver pin 3 outputs an open collector, and a current path is provided in the opposite direction through transformer T2 primary winding. Terminal 7 of T2 secondary now has a positive reference and Q2 is turned on. Current flow through T4 and T5 is now in the opposite direction via Q2 and T2 windings 5 and 6.

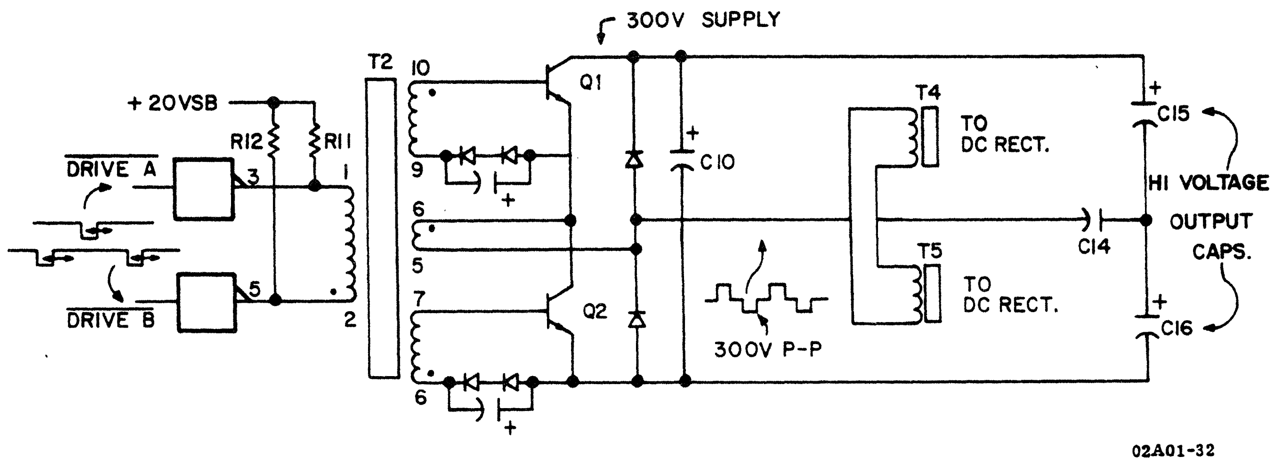


Figure 4-9. SWITCHING CONVERTER CIRCUIT

4.3.3.5 DC Voltages - The DC voltages generated by the power supply, for use throughout the TU80 transport, are as follows:

VOLTAGE	USED ON
+5V	All modules as a supply voltage for TTL circuits
-6V	Read Amplifier Circuits
+15V	Servos, Power Amplifier and Read Recovery VFO
-15V	Servos and Power Amplifier
+25V	Write Driver Circuits
+38V	Power Amplifier

All DC voltages are generated and regulated in a similar manner. The output of the secondary windings of the Switching Converter transformers T4 and T5 are inputted to a full wave rectifier and filtered by a choke/capacitor filter network. Negative 6 volts and ± 15 volts are regulated by LM317 and LM337 voltage regulators, with resistor divider networks providing the required regulator programming. Plus 5 volts circuit does not require a voltage regulator due to the compensation circuit supplied by the pulse width generator discussed previously.

4.3.3.6 Low Voltage/Over-Voltage Detection - The detector circuits are comprised of the various DC input voltages, voltage divider resistor networks, +2.5 reference voltage and LM339 voltage comparators. If any of the input DC voltages exceed the circuit threshold set up by the resistor networks and reference voltage, the comparator outputs a ground potential. This output then initiates a shut-down of the transport power supply. If the voltages are within the parameters listed below, the comparators will have open outputs.

NOMINAL VOLTAGE	LOW VOLTAGE THRESHOLD	OVER-VOLTAGE DETECTION
+5V	+4.53	+6.0
-6V	-5.0	-6.96
+15V	+12.58	+17.25
-15V	-12.58	-17.25
+25V	+21.25	+28.13
+38V	+25.25	+50.3

4.3.3.7 Power Supply Shut-Down - There are three circuits which cause the TU80 to power-down. They are an over-voltage condition, low voltage condition, and control panel LOGIC OFF switch being pressed.

- Over-Voltage - When an over-voltage condition occurs, the voltage comparators of the detection circuit output a ground potential. This ground signal (labeled OFF) resets the POWER-ON flip-flop. Signal ION becomes a logic 1 (high), causing the pulse width modulator to shut down. With no output from the modulator, all DC voltages to the transport are dropped. Concurrent with the shut-down of the pulse width modulator, the Master Clear signal goes to a logic 0 (low), thereby resetting affected circuits in the transport logic. The LOGIC OFF indicator on the control panel is illuminated by the shut-down condition.

- Low Voltage - When a low voltage condition occurs, the voltage comparators of the detection circuit output a ground potential. This ground signal (labeled LOWV) sets the Low Voltage Check flip-flop, if the ON DLY FF is set, causing LV FAULT FF to set which results in the POWER-ON flip-flop going reset. With POWER-ON flip-flop in the reset state, the power supply is shut down in the same manner as described in the Over-Voltage discussion above.

- Control Panel LOGIC OFF Switch - Pressing the LOGIC OFF switch causes a logic 0 (low) to exist at the reset input of the POWER-ON flip-flop. When the POWER-ON flip-flop is in the reset state, the shut-down of the power supply occurs in the same manner as described in Over-Voltage and Low Voltage discussed in previous paragraphs.

4.4 PNEUMATIC SYSTEM

4.4.1 Functional Description

The pneumatic system generates and distributes the air pressure and vacuum requirements of the transport. The pneumatic system consists of a carbon-vane centrifugal pump, tape cleaner intake port, filter/regulator assembly, and pressure ports of the air bearings.

The pneumatic pump is enabled by the microprocessor during the load sequence. A PUMPEN signal from the logic energizes K-1 relay located in the power supply. The contacts of K-1 relay triggers a triac which gates the single phase input power to the pump motor. Motor wiring is configured for 120 or 220/240 volt input via the Voltage Select PC board in the power supply.

With the pump motor operating, the air intake (vacuum) side of the pump is from the tape cleaner assembly. Refer to Figure 4-10 for a block diagram of vacuum and pressure distribution. In addition to the tape cleaner intake, a small bleeder hole exists on the elbow fitting between the pump and plastic hose from the tape cleaner. The vacuum affect at the tape cleaner is approximately 8.0 inches H_2O.

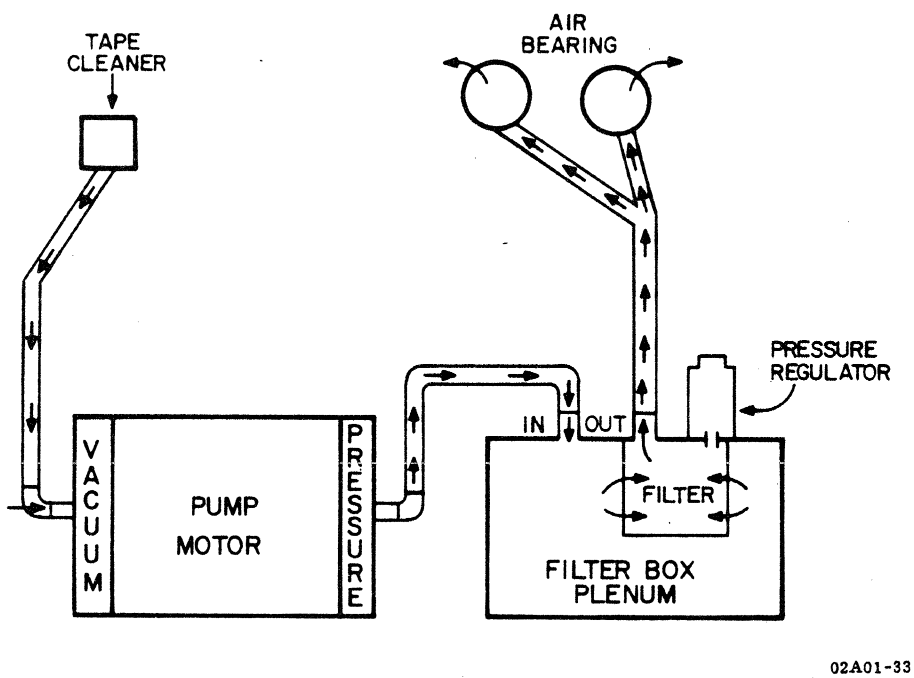


Figure 4-10. VACUUM AND PRESSURE DISTRIBUTION

The regulator portion of this assembly is a spring-controlled valve that causes any pressure above 2.0 PSI to be bled out of the system. The air pressure is filtered by a hepa filter, acting as a high efficiency particle accumulator to clean the air prior to application to the air bearings. Air is forced through the filter and a hollow shaft. One end of the shaft is open and contacts the bleeder valve so that pressure in excess of 2.0 PSI is removed. The inside area of the filter (now regulated to 2.0 PSI) is applied to the deck plenum which directs the air pressure to the air bearings.

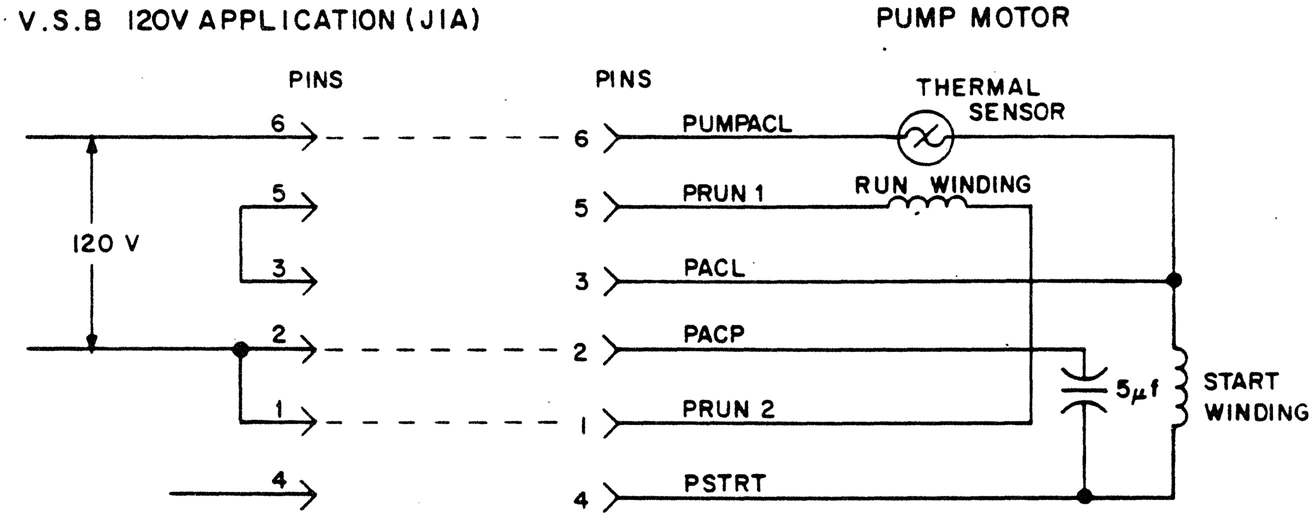
4.4.2 Pneumatic System Operational Description

Operation of the pneumatic system is obtained via the power supply by the presence of 15 VSB and low active -PUMP signals. Together, these signals energize K-1 relay and trigger triac CR8. The output of triac CR8 provides the pump with the single phase operating voltage.

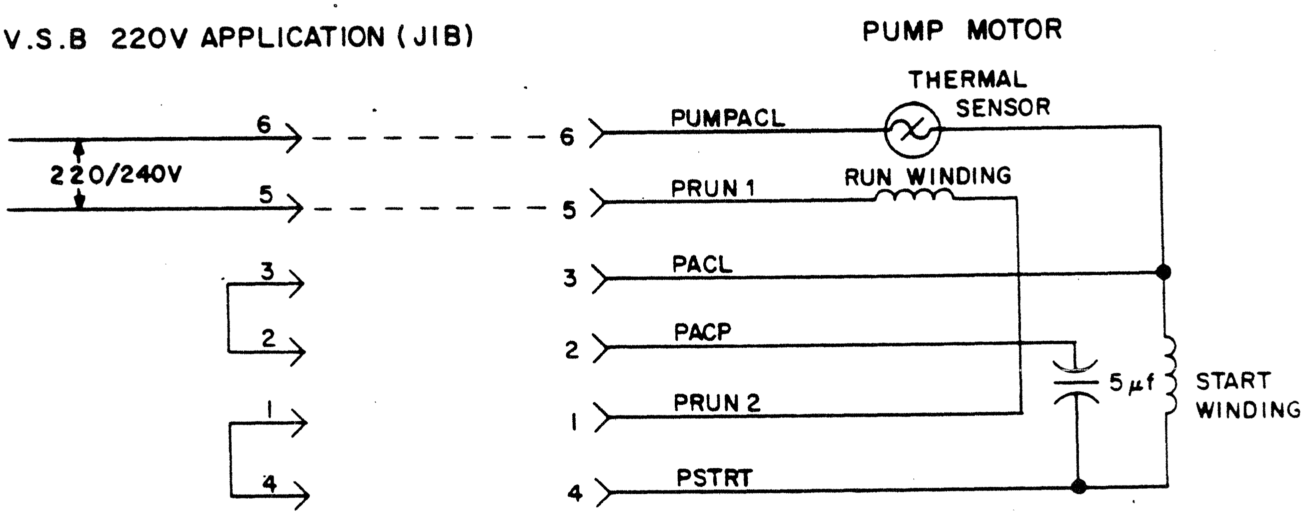
The following figures illustrate motor wiring configurations for 120 or 220/240 volt inputs via the Voltage Select PC board in the power supply.

In the 120V mode of opeation, single phase input power is applied to the motor via pins 2 and 6 of connector P2. During initial motor start-up, an external 5 uF capacitor is utilized to create a phase difference. In this configuration, the capacitor is connected in series with the start motor winding.

In the 220/240V mode of operation, single phase input power is applied to the motor via pins 5 and 6 of connector P2. During initial motor start-up, an external 5 uF capacitor is utilized to create a phase difference. In this configuration, the capacitor is connected in parallel with the start motor winding. For both configurations, the pump motor contains a self-recovering thermal sensor.



A. 120 VAC CONFIGURATION



B. 220/240 VAC CONFIGURATION

Figure 4-11. PNEUMATIC PUMP WIRING

4.5 READ/WRITE/SERVO MODULE FUNCTIONAL DESCRIPTION

4.5.1 Introduction

The Read/Write/Servo Module used in the TU80 Tape Unit has a multiple of distinct functions resident on one module. In order to simplify the functional description, each section will be described separately. The basic functions are as follows:

- Microprocessor and Associated Hardware
- Servo For Both Take-up (Velocity) and Supply (Tension) Reels
- Head Write Drivers and Write Current Programmable Regulator
- Head Read Amplifiers with Envelope Detection and Clip Voltage Generation Circuits

4.5.2 Microprocessor

The microprocessor (uP) for the board is constructed with the 6802 uP chip being the basis. The 6802 uP has two 8-bit accumulators, an 8-bit Condition Code Register and a 16-bit Stack Pointer, Program Counter and Index Register. In addition, the device contains 128 bytes of internal RAM and an internal clock which is operated off of a 4 MHz crystal. All inputs and outputs of the 6802, and all other devices on the processor bus, are TTL compatible. Output devices connected to the processor data bus have tri-state drivers, with some being bi-directional.

The input, output and control lines radiate out to the various peripheral and memory devices on the board from the uP. The desired peripheral or memory device is selected by decoding a portion of the processor address bus, and gating it with the Valid Memory Address (VMA).

A Peripheral Interface Adapter Chip (PIA, 6821) is used to communicate between the Read/Write/Servo Module uP and Formatter Module uP. The PIA's sixteen bi-directional peripheral data lines (Ports A and B), two interrupt inputs (CA1 and CB1), and two peripheral controls (CA2 and CB2) are used to establish a hand-shake communication between the two TU80 logic modules.

In essence, the communication between the two processors is established with Ports A and B (of the PIA) interfacing the processors data and CA1, CB1, CA2 and CB2 acting as the attention and acknowledgement lines to the processors (through the Interrupt Request (IRQ) line to the processor).

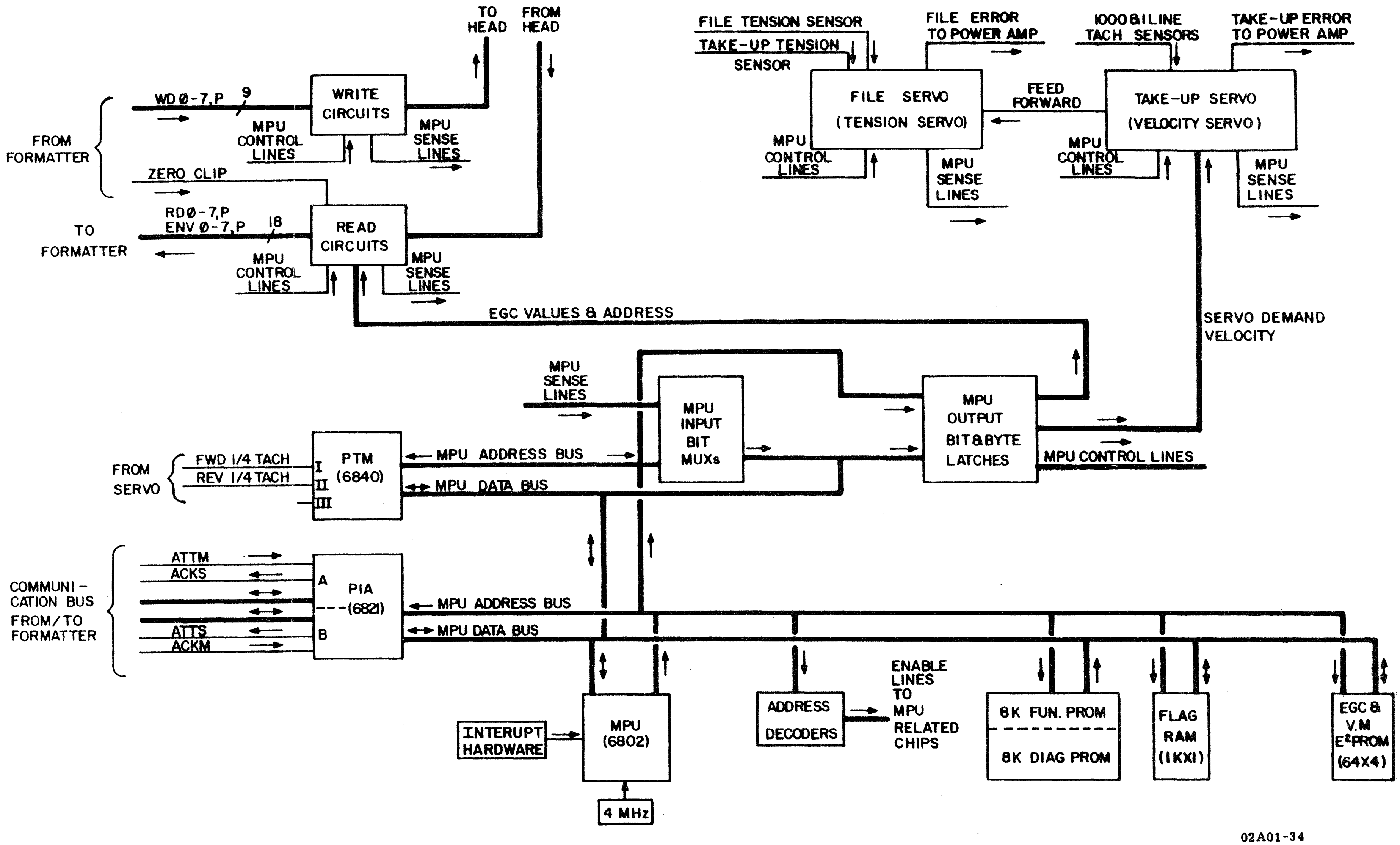


Figure 4-12. READ/WRITE/SERVO MODULE BLOCK DIAGRAM

In order for the processor to count servo tachs (forward and reverse), and provide a real time clock for the processor, a Programmable Timer Module (PTM, 6840) is attached to the processor data bus and related control lines. The PTM contains three 16-bit counters, each independently programmed by the processor through the PTM's control registers. The counters decrement on each subsequent clock period which may be an external clock or processor clock. The source of the clock and desired mode of operation is defined by the contents of the PTM's three control registers. Separate enable lines are provided to gate on or off the clock to each counter. The PTM IRQ to the processor is activated as a result of an interrupt condition from one of the three counters if enabled.

The functional and diagnostic program for the processor reside in two Read-Only Memory (ROM) chips. Each contains 8K x 8 bits and connects directly to the processor address and data bus. When the ROM is enabled by the processor (through the address decoder), the data relative to the current processor address is conveyed to the data bus by the ROM within one processor cycle time. Sockets are provided for both ROM's providing for easy processor code updates.

Various Medium Scale Integration (MSI) devices are attached to the processor data and address bus to allow the processor to interface with the servo, read and write hardware. MSI devices consist of bit input multiplexers, bit output latches, byte output latches, and related address decoding devices.

Single input data bits are passed through the bit input multiplexers, to the processor on data bit 7 (the most significant bit - MSB), upon selection of one of the various bit input multiplexers. The selection of a given data bit and multiplexer (to the processor) is dependent on the address conveyed by the processor to the multiplexer and address decoding devices.

Bit output latches are used to convey individual bits from the processor to the hardware. No connection to the processor data bus is made. Bit output latches are set by the processor writing to the related odd address, and reset by the processor writing to the related even address. The selection of a given bit and bit output latch is dependent on the address conveyed by the processor to the latch and address decoding devices. All latches will be reset by the master reset line.

Byte output latches are used to pass bytes of data from the processor to the hardware. Output data is derived from the processor data bus upon a write operation (by the processor) to the byte output latch address. The selection of a given byte output latch is dependent on the address conveyed by the processor to the address decoding devices. All byte latches will be reset by the master reset line.

A 1K x 1 bit Random Access Memory (RAM, 2102) device provides the processor with storage for flag bits representing the transport status. The flag RAM is written at both the output bit latch address and flag RAM address; therefore, it contains the flag status bits defined by the processor code, and also reflects the state of all the bit output latches. Flag RAM bits are set by the processor writing to the related odd address, and reset by the processor writing to the related even address. The selection of a given flag bit (in a processor read or write operation) is dependent on the address conveyed by the processor to the flag RAM and address decoding devices. Data can only be read from the flag RAM at the flag RAM address, and not the bit latch address.

A nonvolatile 64 x 4 bit static RAM (2210) is also attached to the processor to provide a means of storing the read amplifiers gain values and velocity servo offset multipliers. The 64 x 4 bit static RAM front end is overlaid bit-for-bit with a nonvolatile 64 x 4 bit electrically erasable PROM (E^2 PROM). Data is transferred back and forth between the RAM and E^2 PROM by an array store and array recall signals. The selection of the RAM/E^2 PROM and of a given (4-bit) RAM/E^2 PROM byte (in a processor read or write operation) is dependent on the address conveyed by the processor to the RAM/E^2 PROM and address decoding devices. Data is transferred between the processor and RAM/E^2 PROM over the processor data bus upon device selection. A two-position jumper is provided to prevent unintentional changes to the data contained in the E^2 PROM. Data can only be transferred to the E^2 PROM with the jumper in the W4-STORE position.

4.5.3 Tension Servo

The tension servo system is comprised of two tension servo transducers, input operational amplifiers, reference voltage inputs, take-up motor error input, summing circuit, analog switch circuit for mode selection, and above/below tension level comparators for servo shut-down in the event of component failure.

The two tension sensors are located on either side of the magnetic head. One sensor is located between the velocity servo motor (take-up reel) and the magnetic head, and the second is located between the tension servo motor (supply reel) and magnetic head.

During a load sequence, prior to starting the pump motor, the microprocessor sweeps TTENOFF and FTENOFF levels from their maximum voltage to the minimum voltage. At the point at which the TTENOFF and FTENOFF zero their respective operational amps, the TTENZERO and FTENZERO signals toggle causing the microprocessor to stop the changing sweep levels. The effect of this action is to determine the point at which both tension transducers have a zero offset. The microprocessor maintains the TTENOFF and FTENOFF levels at the determined offset until the next load sequence.

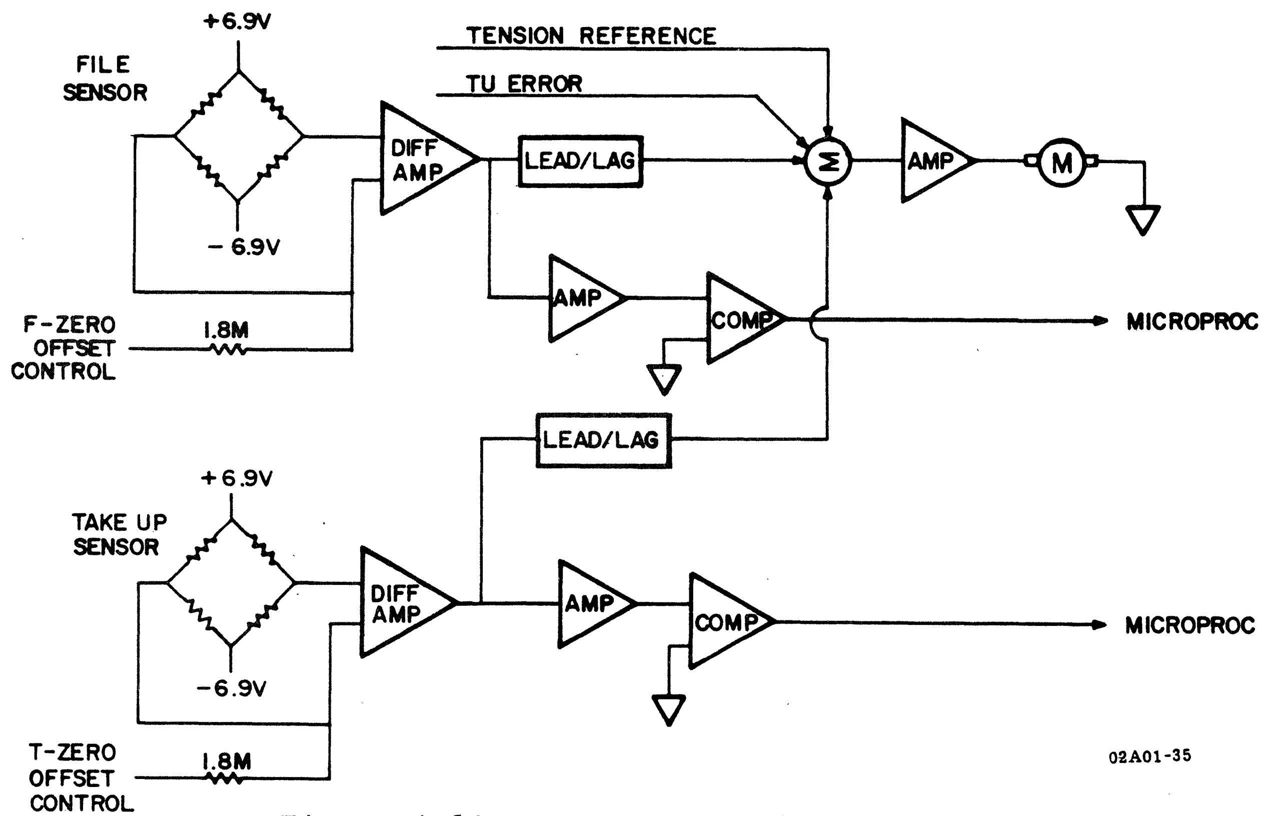


Figure 4-13. TENSION SERVO - SIMPLIFIED

The inputs to the tension servo circuit are TTENTRANS, FTENTRANS, + REF and TUER. The TTENTRANS and FTENTRANS signals come directly from the tension sensors with a signal input proportional to the variance of tension felt by the sensor. The tension reference is derived from a 6.9 volt supply and a 1.78M ohm resistor. This reference voltage is equivalent to 16 ounces of tape tension, and is used to bias the circuit so that 8 ounces of tension is developed. The fourth input is the TUER signal and is proportional to the current in the take-up motor at any given time.

At an optimum condition, where both sensors are sensing 8 ounces of tension, the 16 ounce (+ REF) reference is effectively neutralized. The only dynamic effect on the circuit, at this time, would be the action of the take-up reel motor. With the TUER being summed with the neutralized tension/reference voltage inputs, the tension motor (supply) reacts proportionally to the current in the take-up motor, as indicated by TUER.

Any variance in tape tension would cause a change in the sensor op amps' outputs. This voltage output is subtracted from the tension reference, with the result summed with TUER. The difference of all these signals is multiplied by a high gain amplifier when tape is in motion.

The PRKD input term to the tension servo is active during a Parked or No Tape Motion condition. With PRKD active, the operational amplifier used as a high gain multiplier, after the summing network, is switched to a low gain amplifier.

The above/below tension limit protection circuits consist of a series of comparators, with inputs referenced to predetermined voltage levels corresponding to high or low tension levels. If above or below tension levels are sensed on either of the tension sensors, the microprocessor is notified via signals TAUTL, TBLTL, FAUTL or FBLTL and a shut-down of the servo is initiated. Refer to Figure 4-12 for a simplified presentation of this circuit.

4.5.4 Velocity Servo

The velocity servo consists of a digital-to-analog converter (DAC), decode flip-flops connected to a digital tachometer, operational amplifiers, and three presettable counters. The DAC converts 8 bits of information labeled "Demand Velocity" (DMDVEL) into a signal proportional to the desired velocity. The demand velocity can vary from 0 to 255 with complete control at any speed. The DAC output at 25 ips is 1/2 volt per radian per second. A radian per second is derived from the linear tape velocity (ips) divided by the radius of the take-up reel.

At the beginning of tape (BOT), the radius is 2.56 inches. At the end of tape (EOT), the radius is approximately 4.9 inches when using a 2400 foot reel of tape. The voltage at the output of the DAC is approximately 9.76 volts at 25 ips (speed divided by 2.56 inches) at BOT and 5.0 volts at EOT. The voltage at the DAC output will not change when 100 ips is selected, however, the rotational speed will change accordingly. The signal FWD determines the polarity of the analog demand velocity signal for rotation of the take-up motor in each direction.

Rotational velocity is generated and referred to as "analog tachometer" (ANALOG TACH). The analog tach (TP9) is also proportional to 1/2 volt in the 25 ips mode. In the 100 ips or rewind mode, the analog tach is less (i.e., 8 or 15 times) than the rotational speed. The analog tach is derived from the 2-phase, 1000-line tachometer physically mounted on the rear of the velocity motor. The output signals, phase A and phase B, are decoded into direction and divided down (depending on the speed selected). The divided tach triggers a 128 microsecond one-shot. The decoded direction is logically Anded with the 128 microsecond one-shot and then filtered to become the analog tach.

The analog tach is subtracted from the demand velocity at operational amplifier C8A pin 6 and compensated with a lag-lead filter. This signal is then multiplied by 1 or 8, depending on speed and becomes the take-up error (TUER). The take-up error is proportional to the desired current in the velocity motor and is equivalent to 1.0 volt per amp.

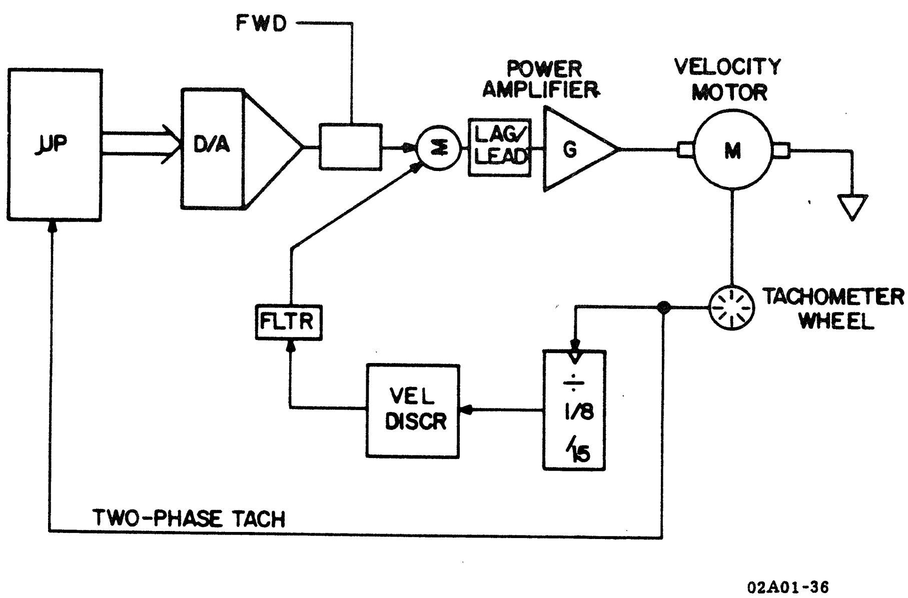


Figure 4-14. VELOCITY SERVO - SIMPLIFIED

4.5.5 Write Circuits

4.5.5.1 Write Drivers - The write drivers and control circuits consist of 18 write drivers (2 per track), write and erase head voltage control, degauss, and erase sense circuits. Write data is gated via the TWDO-7,P input data lines through the write drivers by the presence of WRITE ENABLE and the absence of FILE PROTECT signals (the write enable ring is installed in the supply reel).

The write drivers are arranged so that two opposite drivers are servicing one input line. A true signal (logic 1) on the input line causes one driver to assume an open output while the complimentary driver assumes a ground output. Thus, current flows through the head coil in one direction only. If the input line is false (logic 0), then the write drivers' outputs are reversed and the head current flow is in the opposite direction.

Write head voltage to the head coils is developed as follows: Q2 transistor is switched on by the absence of FILE PROTECT and REWIND signals. As Q2 is turned on, +24 volts is applied to pin 3 of the voltage regulator. Pin 1 input of the regulator is determined by the output of OP AMP C16 and the status of Speed Select. Selection of either H SELECT 0 or L SELECT 0 introduce a Select-By-Test resistor which is matched to the impedance of the head. This signal is applied to the voltage regulator circuit as WRITE CUR along with resistor R126, and determines the voltage to the individual head coils.

4.5.5.2 Degauss - During the course of a write operation, a condition of residual magnetism is built up around the write coils. If the residual magnetism is not neutralized, the possibility of partial tape erasure is possible during succeeding tape operations.

In order to prevent this unwanted magnetism, the transport performs a degauss operation at the conclusion of a write function. The degauss capacitor C71 is charged and remains charged as long as a write operation is in progress. At the conclusion of a WRITE command, the DEGAUSS signal effectively cancels out the positive voltage charging capacitor C71 and the capacitor begins to discharge through resistor R124. Thus, pin 5 input to OP AMP C16 sees a decreasing positive voltage, the affect of which results in an exponential decay of write current. Concurrent with the discharge of the degauss capacitor and decaying write current, the write data input lines are switched at a 10 KHz rate. As the write current is switched at 10 KHz, the exponential decay of the current waveforms causes any residual magnetism to be neutralized.

4.5.5.3 Erase - The erase circuit is enabled by the presence of ERASE ENABLE and the absence of REWIND signals, and uses an open collector driver circuit to provide ground return for erase current. Erase voltage is supplied by the same +24 volts used to develop the write voltage. An integral part of the erase circuit is an OP AMP configured to detect the level of erase current, and provide an ERASE SENSE signal to the sense multiplexers.

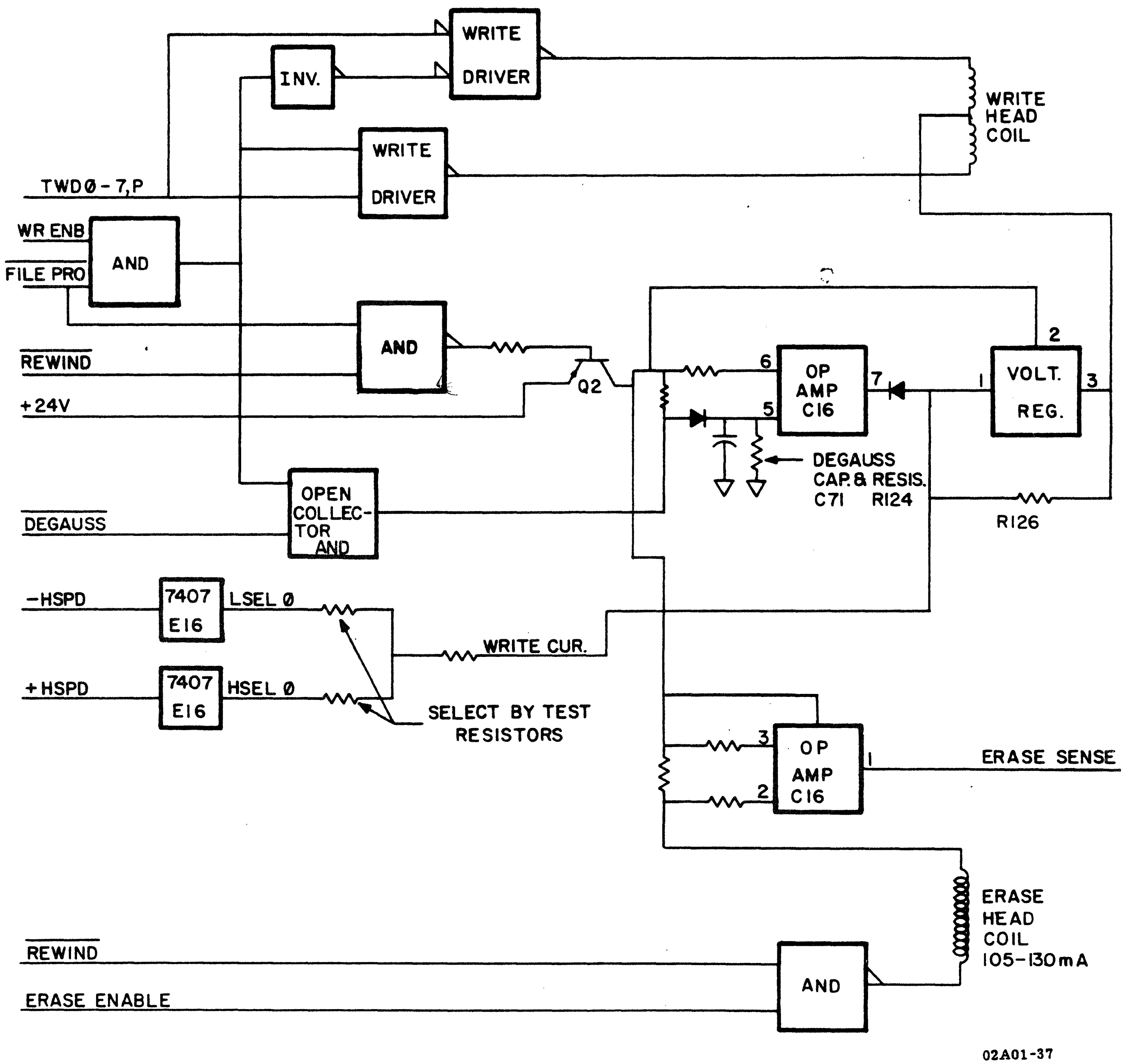


Figure 4-15. WRITE/ERASE BLOCK DIAGRAM

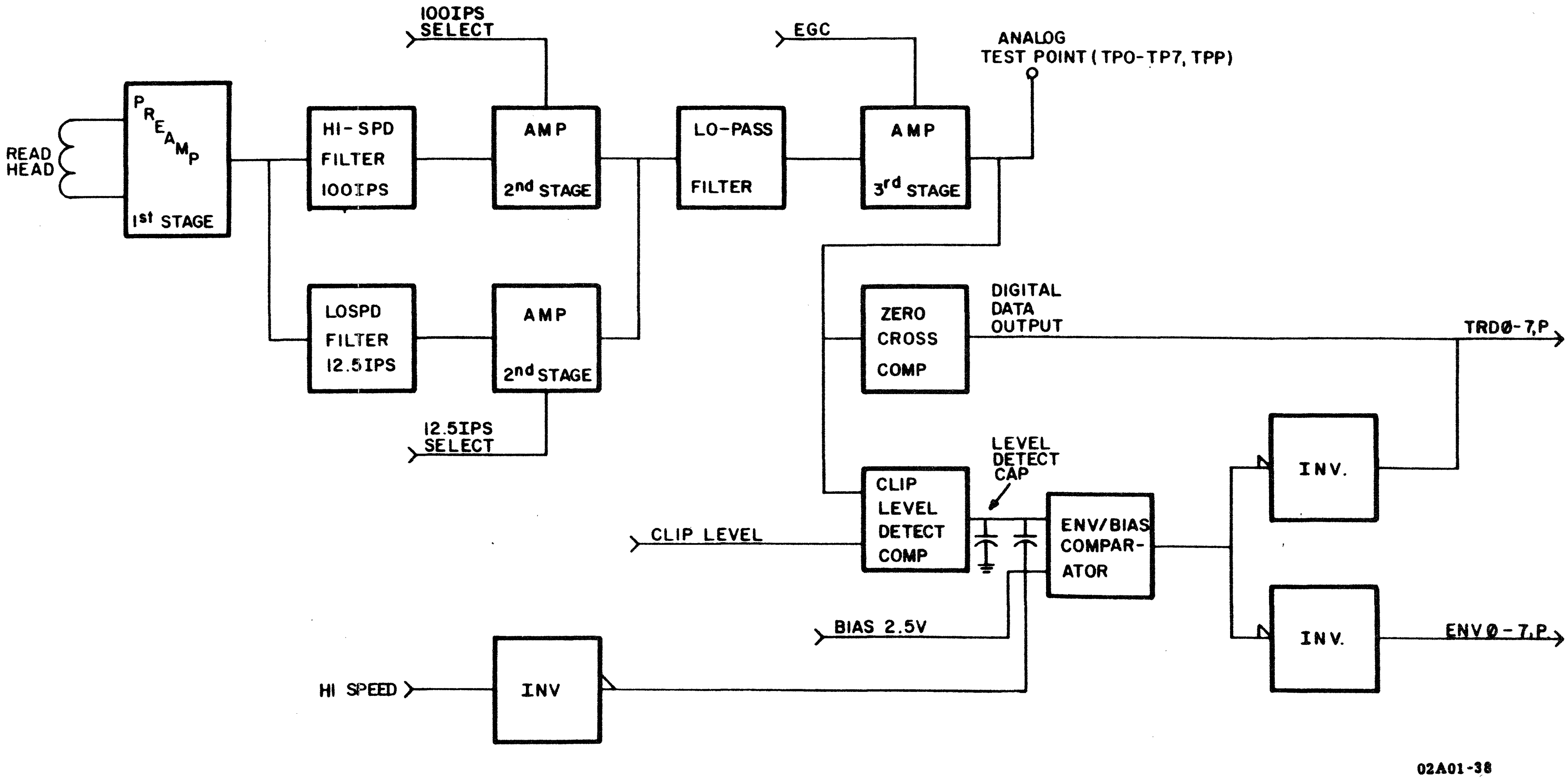


Figure 4-16. Read Circuits Block Diagram

4.5.6 Read Circuits

A read operation is initiated from the M7454 controller during any read or write operation. As tape motion is initiated and tape passes across the read head coils, recorded data on the tape induces a voltage in the head coils. This voltage has to be amplified and circuit selection made depending on tape speed. The entire read chain is responsible for detection of data, amplification of weak readback signals, and conversion of the analog signal to a digital TTL logic level for use in the control and formatter portion of the TU80 tape transport.

As data is detected when tape passes the read head, the induced voltage in the range of 4.0 to 8.4 MVp-p (25 ips), or 10.0 to 22.0 MVp-p (100 ips) is differentially coupled to a preamplifier. This preamplifier provides a gain of 100 to the relatively low signal from the head coils. After amplification, the READ signal is routed to two separate filter and differentiator circuits, which also tend to normalize different voltage amplitudes prior to the second stage of amplification.

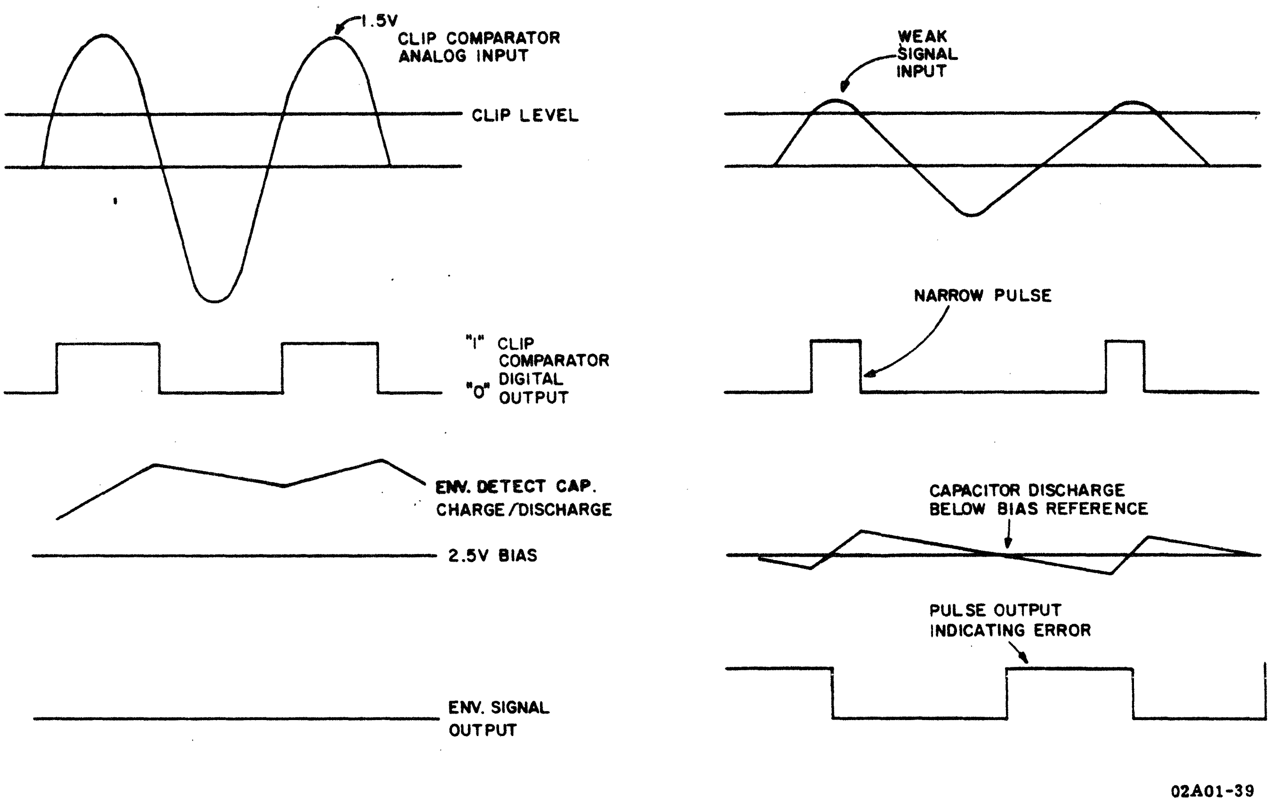
The second amplifier stage is selected by the presence of either the low or high speed input signal. If low speed is active, then that amplifier provides further amplification of the READ signal from the low speed filter and differentiator circuit. The 100 ips amplifier will have no output at this time due to the absence of the 100 ips input signal. The amplified READ signal is then routed through isolation resistors and a low-pass filter and attenuator. The low-pass filter eliminates any high frequencies above the data frequency. Because of the isolation resistors and attenuation of the low-pass filter, the signal is subjected to a third stage of amplification. This stage utilizes an Electronic Gain Control (EGC) circuit to determine the gain. Refer to the EGC discussion in succeeding paragraphs. The EGC level to the amplifier ensures that the output of the third stage is approximately 1.5 volts peak-to-peak as seen at the analog test points (TP1 thru TP9).

The third stage amplifier output is connected to a comparator used as a zero cross detector. If the differential input signal is positive, the zero cross detector output switches to a positive voltage. If the differential input signal is negative, the zero cross detector output switches to a ground potential.

A second comparator is also connected to the third stage output. This circuit compares the single-ended output voltage of the third stage with a clip level voltage. The clip levels, as follows, are a percentage of the nominal input voltage and are predetermined by the microprocessor, depending on the type of operation being performed. Because a maximum readback amplitude is expected during a read-after-write operation, the clip level is relatively high (25%) to ensure that a strong signal has been written.

During a normal read operation, the microprocessor sets the clip level to 0.3% after recognizing the beginning of the preamble. This 0.3% clip is maintained throughout the data record until the postamble is detected. The clip level is then set to 16% while the read head is traversing the inter-record gap. This insures that any noise in the gap will not be detected as data.

Referring to the waveform figure, it can be seen that the greater the amplitude of the analog signal, the wider the output pulse of the clip level detector. The pulse width should always be greater than 30% of the analog waveform.



A. Correct Data Condition

B. Weak Signal Error Condition

Figure 4-17. READ CHAIN WAVEFORMS

The output of the level detector is coupled directly to a bias comparator which establishes the validity of the detected data. As the analog input to the level detector exceeds the clip level, the level detector assumes an open collector output. This allows +5 volts to charge capacitor C110. As C110 charges above the bias voltage, the bias comparator output goes to ground potential. As long as valid data is being received, the pulse width of the level detector should be of sufficient duration (30%) so that capacitor C110 does not discharge below the 2.5 bias voltage. If the analog signal is of such small amplitude that the level detector outputs a pulse of less than 30% of the waveform, then capacitor C110 is allowed to discharge below 2.5 volts and the bias detector outputs a positive pulse. This condition is recognized by the formatter as an error, and the data is inhibited from appearing on the output lines.

4.5.6.1 Electronic Gain Control (EGC) - EGC is designed to replace the potentiometer that would normally be used to determine the readback amplitude of recorded data. The circuit is activated through the use of field service diagnostics when the Read/Write/Servo PC board or magnetic head is replaced, or if reported errors are such that the field service determines the need to activate EGC.

The EGC lines during normal operation are constant, and provide the appropriate input to the third stage amplifiers to set a nominal output of 1.5 volts at the analog test point. This output voltage may vary slightly due to magnetic head wear or the type of magnetic tape being used.

Operation of the EGC circuit during the off-line field service diagnostics is as follows: A write function is initiated and the readback signals are sampled through the ENV outputs of the read chain, with an EGC clip level set at 96%. The test is initiated with a binary bit count of 128 (80 Hex) applied to the Digital-to-Analog Converter (DAC). The output voltage of the DAC is then applied to an analog multiplexer. The microprocessor provides the input gating to the multiplexer so that the voltage conversion of the 128 count is applied to each of the nine read circuits on an individual basis.

Using one read channel for discussion purposes, EGC voltages are set up as follows: The voltage equivalent of the binary 128 count is gated through the analog multiplexer and charges a 0.1 uF capacitor to the value whereby, the read amplifiers have a mid-point gain. As data is read from tape, the output of the read amplifier is sampled by the envelope comparator. If the ENV signal is low, the microprocessor uses a successive approximation method of the binary count to the DAC so that an optimum EGC voltage is applied to the read amplifiers. If the

ENV signal is low or inactive, the microprocessor lowers the binary count by half (64) to the DAC. The DAC then outputs a voltage equivalent to the 64 count to the EGC capacitors.

The read amplifier gain is increased and the ENV signal is again sampled by the microprocessor. The microprocessor adjusts the binary count either up or down by half of the previous count, depending on whether the ENV signal is active or inactive. This method of successive approximation is continued until the microprocessor determines, via the ENV signal, that the read gain is optimum. In this manner, the count "zeros in" on the point at which the ENV signal is active except for extraneous pulses going inactive. At this point, it can be assumed that, if the ENV signal is mostly active at the 96% EGC clip level, then when the normal clip of 25% (WRITE) is used, then ENV signal will be a solid active level.

The binary count for each read channel is stored in memory. During normal on-line operations, the microprocessor will access memory every 11 milliseconds and the EGC voltage charges the 0.1 uF refresher capacitor to maintain a constant gain of the third stage read amplifier.

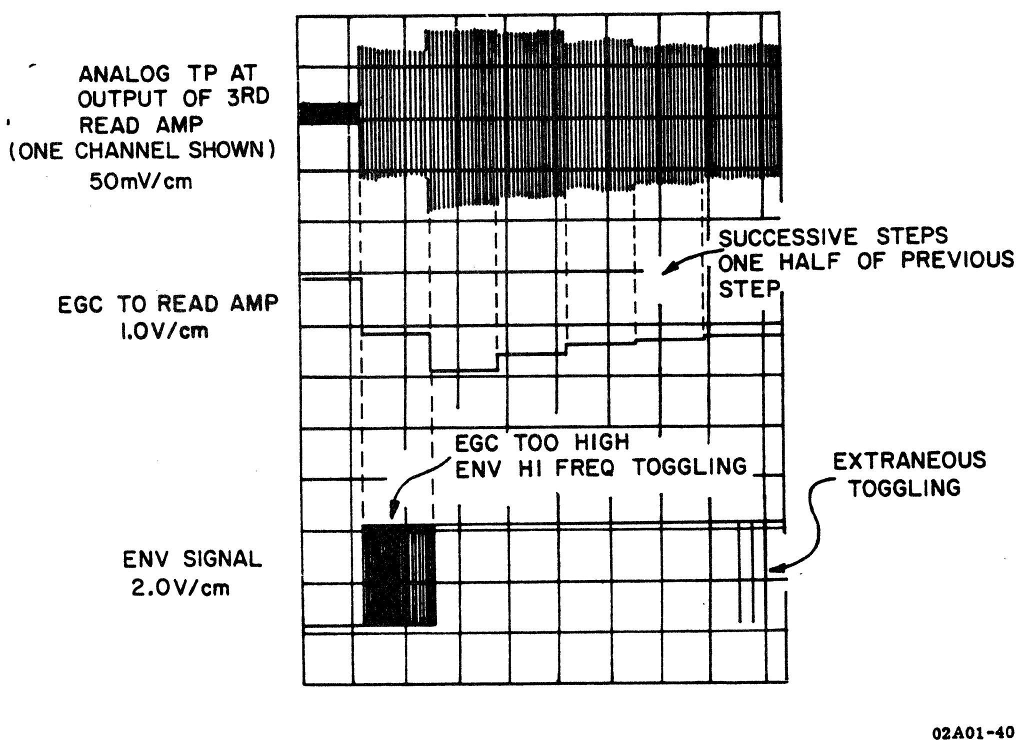


Figure 4-18. ELECTRONIC GAIN CONTROL WAVEFORMS

4.6 FORMATTER/CONTROL MODULE FUNCTIONAL DESCRIPTION

4.6.1 Microprocessor

The formatter microprocessor (uP) for the Formatter/Control Module is constructed around the 6802 uP chip being the basis. The 6802 uP has two 8-bit accumulators, an 8-bit Condition Code Register and a 16-bit Stack Pointer, Program Counter and Index Register. In addition, the device contains 128 bytes of internal RAM, and an internal clock which is operated off of a 3.84 MHz crystal. All inputs and outputs of the 6802 and all other devices on the processor bus are TTL compatible. Output devices connected to the processor data bus must have tri-state drivers. The timing diagrams for the processor read and write operations are located in Figures 4-21 and 4-22 respectively, with actual operating timing constraints listed in Table 4-1. The processor is operated at 0.96 MHz rate.

The input, output and control lines radiate out to the various peripheral and memory devices on the board from the top. All of the attached peripheral and memory devices are able to function at the processor rates as listed and illustrated in Table 3-1 and Figures 4-21 and 4-22. The desired peripheral or memory device is selected by decoding a portion of the processor address bus and gating it with the Valid Memory Address (VMA).

The MC6821 Peripheral Interface Adapter (PIA) is a programmable device and interfaces the 6802 uP to the read/write control logic. It has sixteen bi-directional peripheral data lines (Parts A and B), two interrupt inputs (CA1 and CB1), and two peripheral control lines (CA2 and CB2). Four control registers (within the PIA) are used to define the data direction of each bit in Parts A and B, the active transition for CA1 and CB1, and the active or response transition of CA2 and CB2.

Table 4-1. PROCESSOR READ/WRITE TIMING CONSTRAINTS

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Address Delay	t_{AD}	--	--	270	ns
Peripheral Read Access Time $t_{acc} = t_{ut} - (t_{AD} + t_{DSR})$ $(t_{ut} = t_{cyc} - t_o)$	t_{acc}	--	--	530	ns
Data Set-Up Time (Read)	t_{DSR}	100	--	--	ns

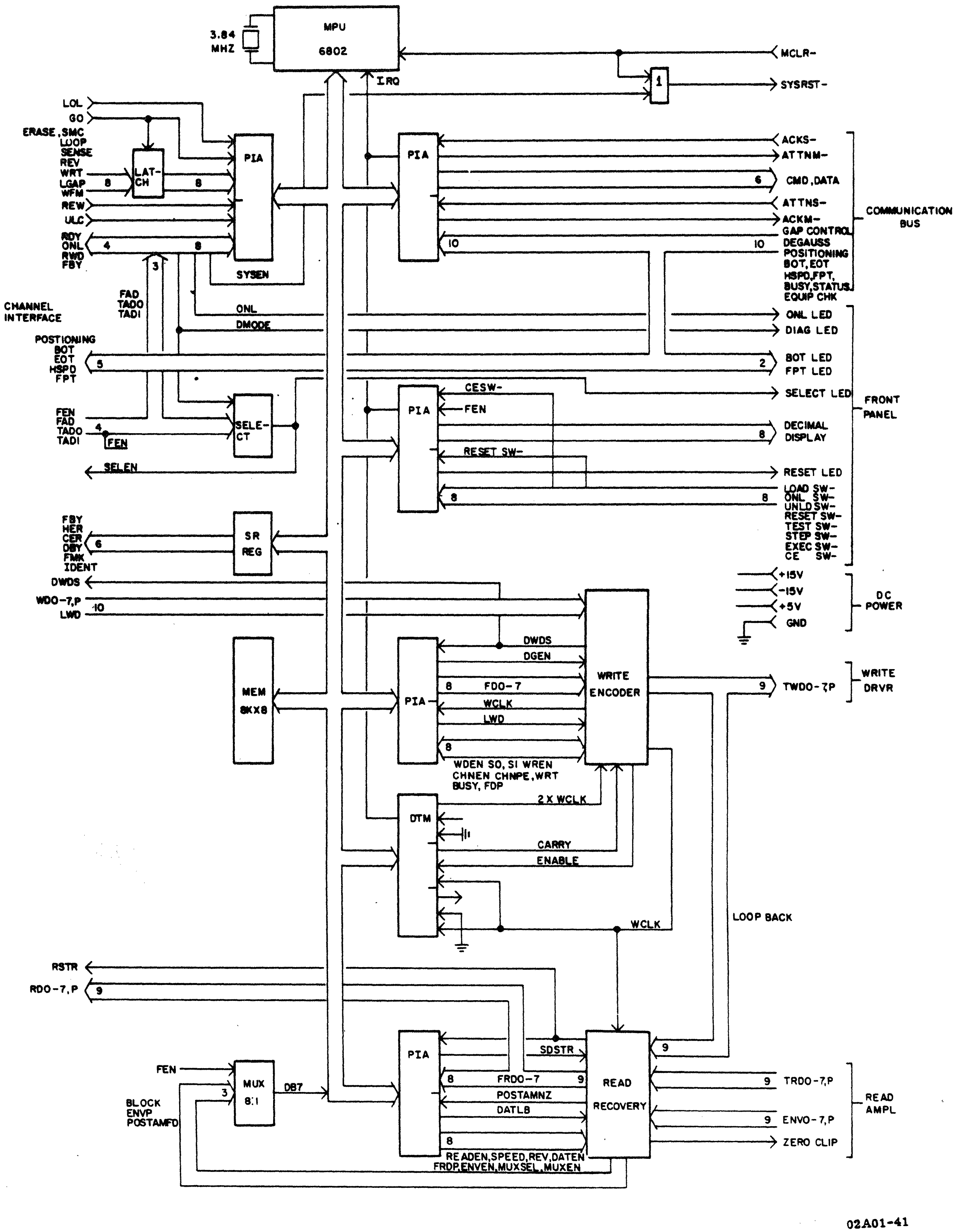


Figure 4-19. FORMATTER/CONTROL BLOCK DIAGRAM

Table 4-1. PROCESSOR READ/WRITE TIMING CONSTRAINTS (Cont'd)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Input Data Hold Time	t_H	10	--	--	ns
Output Data Hold Time	t_H	30	--	--	ns
Address Hold Time (Address, R/W, VMA)	t_{AH}	20	--	--	ns
Data Delay Time (Write)	t_{DDW}	--	165	225	ns

Five PIA's are used on the board. PIA 0 is used to communicate between the Read/Write/Servo uP and Formatter/Control Board uP. The communication between the two processors is established with Ports A and B (of the PIA) interfacing the processor's data and CA1, CB1, CA2 and CB2 acting as attention and acknowledgement lines to the processors (through the Interrupt Request (IRQ) line to the processor). Figure 4-20 indicates the basic interface protocol across the PIA between the processors.

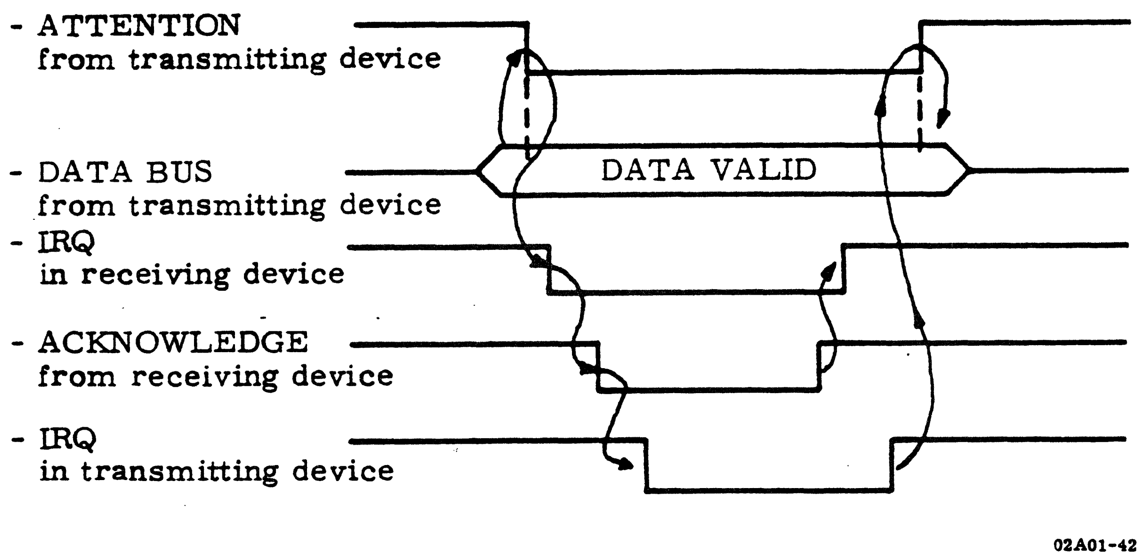


Figure 4-20. PIA COMMUNICATION PROTOCOL

PIA 1 is used to interface the uP to the control panel. Part A is connected to the eight switches on the control panel and Part B is connected to the display drivers. The PIA could be programmed to cause an interrupt on pressing of the Reset or CE switch, or on transition of the FEN line. PIA 2, along with other logic, is used to interface the uP to the M7454 UNIBUS Controller/Adapter. PIA 3 is used to control the read logic and PIA 4 is used to control the write logic on the board.

A Programmable Timer Module (PTM 6840) is attached to the processor data bus and related control lines. It generates proper write clocks, a control line (Carry) at preamble and postamble time in the write operations, and it helps the up generate a various amount of delays during the read/write operations. The PTM contains three 16-bit counters, each individually programmed by the processor through the PTM's control registers. The counters are highly versatile in that each can be programmed by the processor to operate for squarewave generation, the gated delaying of signals, generation of single pulses with controlled duration, the pulse width modulation. The counters decrement on subsequent clock periods which may be an external clock or processor clock. The source of the clock and desired mode of operation is defined by the contents of the PTM's three control registers. Separate enable lines are provided to gate on or off the clock to each counter. The PTM IRQ to the processor is activated as a result of an interrupt condition from one of the three counters if enabled.

The source of the IRQ (from the PTM) is located by reading the single PTM status register, and is then cleared by reading the respective interrupting counter's 16-bit contents. A Reset bit in Control Register 1 of the PTM can be used to hold all counters inactive.

The functional and diagnostic programs for the processor reside in a Read-Only Memory (ROM) chip. It contains 8K x 8 bits and connects directly to the processor address and data bus. When the ROM is enabled by the processor (through address decoder), the data relative to the current processor address is conveyed to the data bus by the ROM within one processor cycle time.

An 8-bit addressable latch and an 8-bit input multiplexer are used to increase I/O capability of the processor. Single input data bits are passed through the bit input multiplexer to the processor on data bit 7 (the most significant bit [MSB]), upon selection of the bit input multiplexer. The selection of a given data bit and the bit input multiplexer (to the processor) is dependent on the address conveyed by the processor to the multiplexer and address decoding device. The bit output latch is used to convey individual bits from the processor to the hardware. No connection to the processor data bus is made. The bit output latch is set by the processor writing to the related "Cx" address, and reset by the processor by writing to the related "8x" address. The selection of a given bit and bit output latch is dependent on the address conveyed by the processor to the latch and address decoding devices.

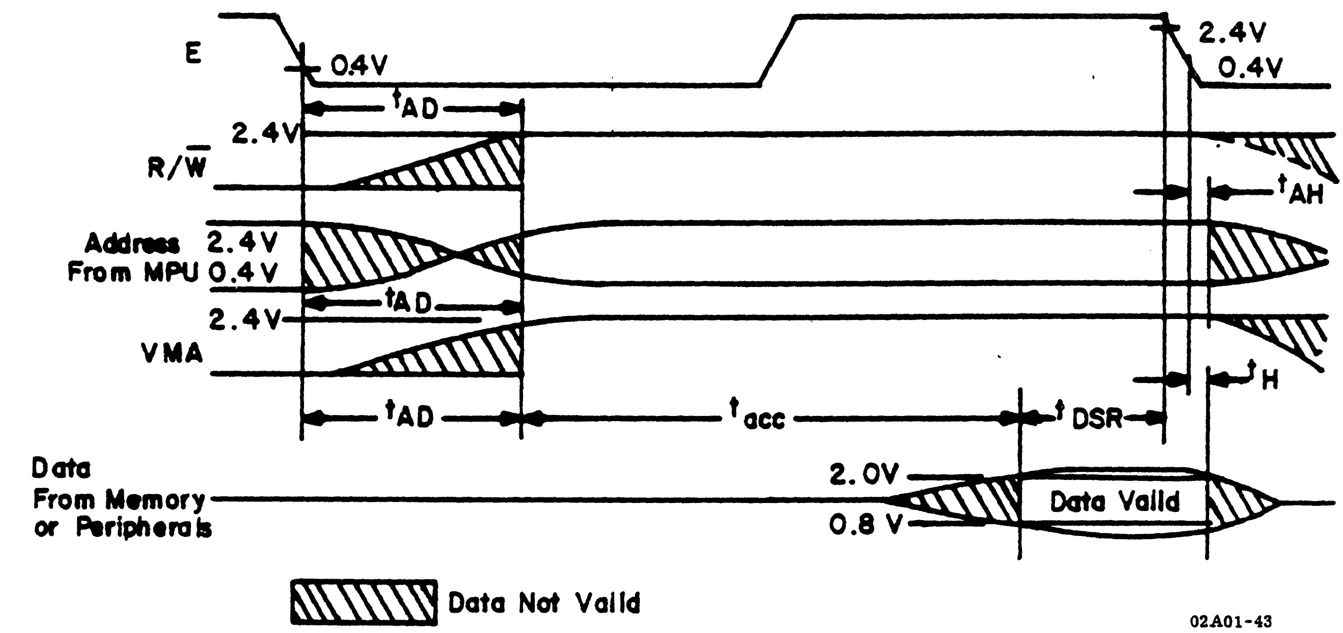


Figure 4-21. PROCESSOR READ OPERATION

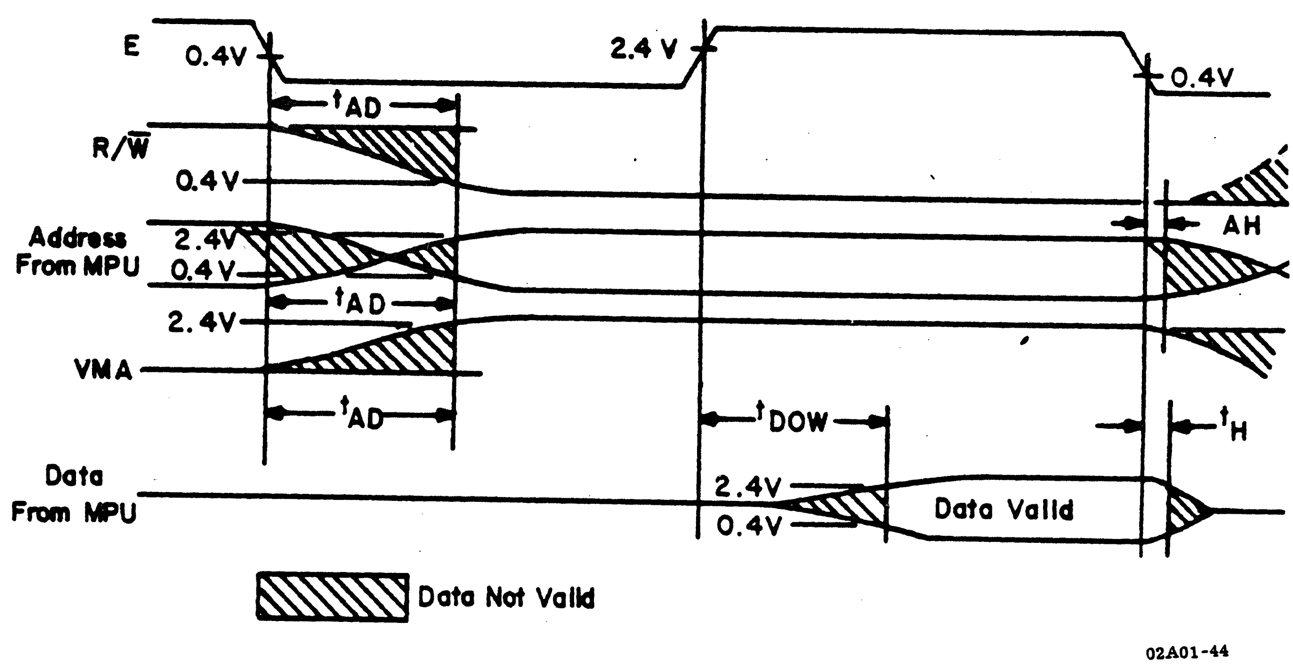


Figure 4-22. PROCESSOR WRITE OPERATION

4.6.2 Write Circuits

The write operation is controlled by PIA 4, PTM and write circuits. The PTM is programmed by the microprocessor to generate write clock, depending upon speed and function to be performed. The PTM is also programmed to generate the control signal "CARRY" at preamble and postamble time during the write operation. The Timer 3 on the PTM is used as a variable timer to control a various amount of time delays during the read/write operation. A brief description of the signals controlling the write operation follows:

Signal	Description
WCLK	Write Data Frequency programmable by microprocessor.
CARRY	Controls Preamble and Postamble in Write.
WRT BUSY	Write operation is in progress.
CHNPE	Channel is in Parity Error.
CHNEN	Enables Channel side for interface data.
WDEN	Enables Write Data to device.
WREN	Enables Write operation.
S1,S0	Selects ID, File Mark, Channel Data or Processor-generated Data.
FDO-FDP	Processor-generated Data.
LWD	Processor-generated Last Word signal.
DGEN	Enables Degauss operation.

A PROM (82S123) is used in the write circuits. It controls writing of preamble, data and postamble and it also controls the ID, file mark, data and format write operations, and generates the Demand Write Data Strobe (FDWDS). The write operation is explained with the timing diagram in Figure 4-23.

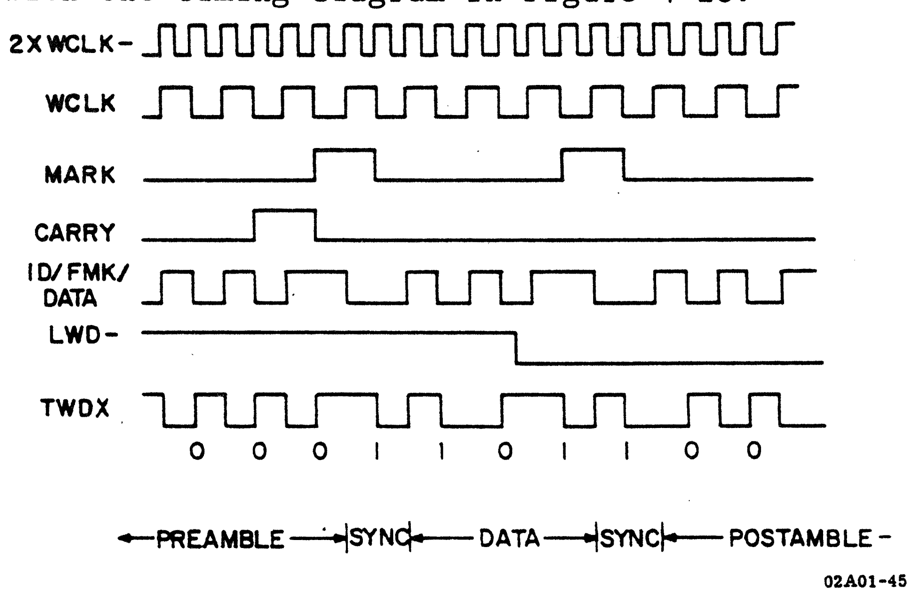


Figure 4-23. FORMATTER WRITE OPERATION

4.6.3 Read Circuits

The read circuits consist of a Variable Frequency Oscillator (VFO), deskew buffer circuits for each track and error correction circuits. PE read signals from the tape transport are applied to read circuits, one for each channel.

On the tape, bits on the various recording tracks belonging to the same byte cannot be expected to lie on a straight line across the tracks or, upon reading, to be received by the formatter at the same time. This is due to head and tape path imperfections. The data is said to have skew and, for PE data, the formatter must deskew the data such that the bits belonging to the same byte, upon being transferred to the M7454 Module, are all transmitted at the same time. This is accomplished in the formatter by storing and delaying the first arrived bits until all the bits belonging to the same byte have arrived, and then transferring them collectively to the CPU.

The read data from the read head is received on lines TRDO-TRDP. In the formatter, it goes through deskew process. The deskew circuits consist of a PROM and a FIFO along with some other logic. The PROM generates a Data Strobe (DSTR-) when a new data bit comes in; it generates Data Ready (DRDY) when the bit is deskewed and ready for loading into FIFO; it recognizes the first one transition as a SYNC and generates a SYNC pulse; and it also generates a Drop-Out (DROP) upon indication of Drop-Out or Drop-In. The FIFO allows for deskew in the read data. Once the SYNC is recognized, it starts saving further data until all other tracks are ready with the data. It generates Bit Ready (BRDY) when the bit is ready for error detection, and then outputs to the host system. A counter is used to create a window for data and phase transitions. The data strobe initiates the window, and the counter counts the clocks and generates a pulse (CARRY) to reset the window (DGATE). The timings in the deskew buffer operation is shown in Figures 4-24 and 4-25.

Single track "on-the-fly" error correction is performed on the data. The error correction circuit uses a PROM and other logic circuits. The PROM, called "DROP PROM", generates signals NO DROP, MLT DROP and SGL DROP/CER when there is no Drop-Out in the block, more than two tracks dropped out in the block, and only one track dropped out in the block respectively. A parity checker checks the parity of the read data and generates PE (Parity Error) on even parity data. Single track error is corrected by using the PE and DROP signals for each track. If there is a PE without any track Drop-Out, a NO TRK PTR (No Track Pointer) is generated which then generates UNCORRDATA (Uncorrected Data). When there is a multi-track Drop-Out, no correction is performed.

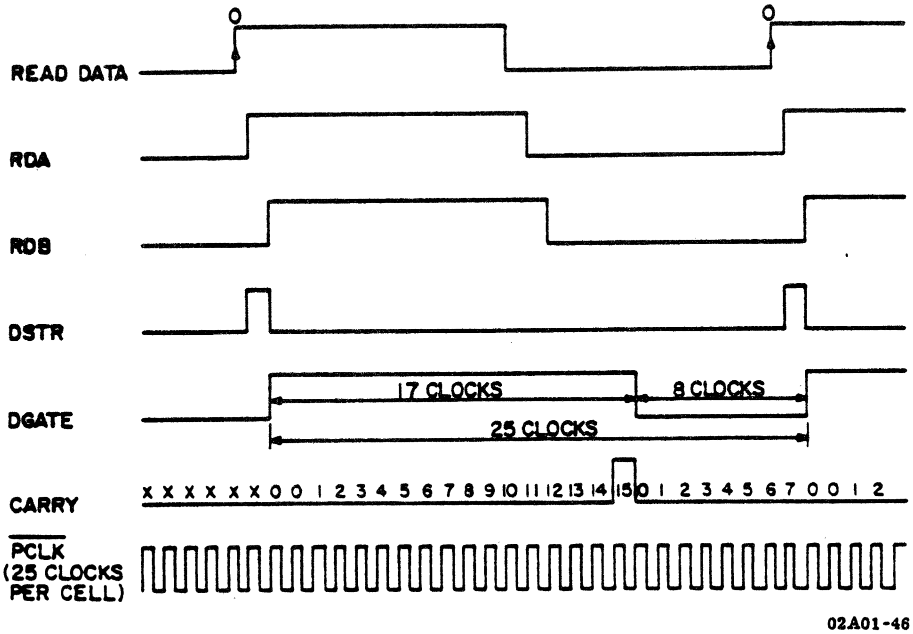


Figure 4-24. PE RECOVERY - DATA CELL TIMING

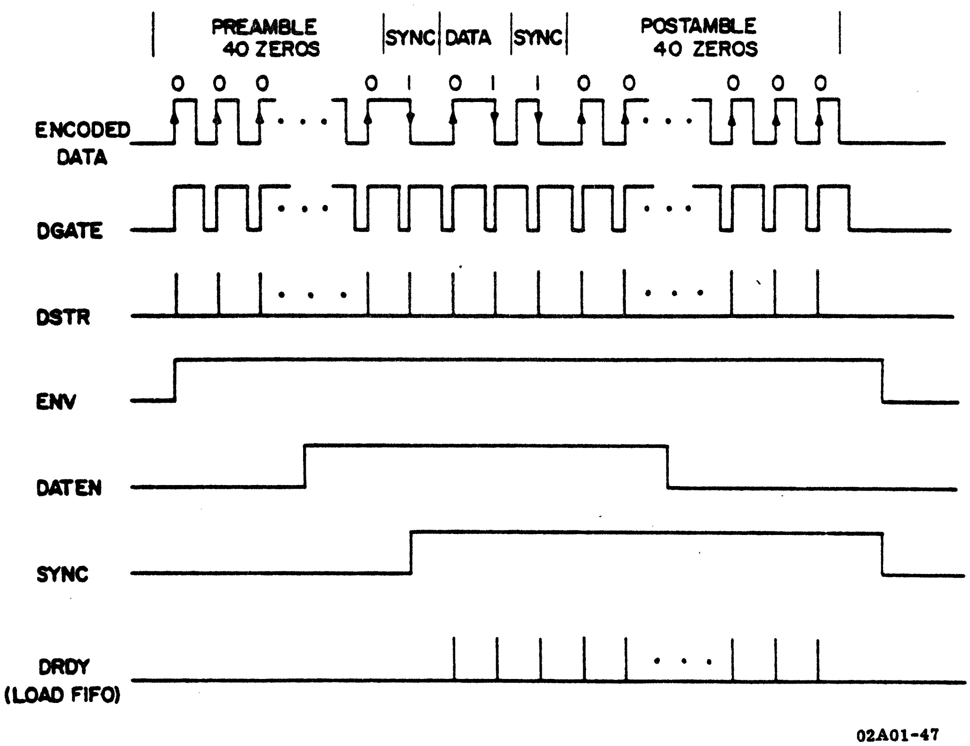


Figure 4-25. PE READ RECOVERY TIMING

4.7 POWER AMPLIFIER MODULE FUNCTIONAL DESCRIPTION

The Power Amplifier is an electronic assembly consisting of two identical amplifiers capable of converting voltage error signals from the Read/Write/Servo Module to proportional currents passing through two motors (TAKE-UP and FILE). The torques created provide the acceleration and tension to the connecting tape between the two motors. The operation of one amplifier is as follows:

The amplifier has an H-bridge voltage switcher driven by a Pulse Width Modulation (PWM) converter contained within a current feed-back loop. The resulting current is uninterrupted, but varying with an average value proportional to the input voltage, with a gain factor of 1 amp per volt. A soft dead-band of ± 300 MV exists where the gain factor quickly approaches zero within this region of input.

An overall block diagram is shown in Figure 4-26. The signal flow proceeds from the differential error input through U1 with Unity Gain Summing, with the current feed-back voltage from U2. The resulting difference is multiplied by five through U3 and compared to two triangle voltages by comparators U4 and U5. These waveforms are shown in Figure 4-27. Two quadrants of input are shown to point out that only one of the negative-active outputs from U4 and U5 exists at any given time. The peripheral drivers U6 and U7 connect the PWM outputs from the comparators to the appropriate transistors Q1 through Q4. At this point, it can be seen how the enabling to the H-bridge is performed. The gating of -SVPEN and -SVEN allow diagnostic control. The SW5 signal (Switched +5 Volts) is applied as the source of drive to the lower bridge. It can be quickly removed during Power On and Off sequencing or during a high over-current condition. The circuitry for providing SW5 is shown in Figure 4-26. Motor current is sensed through the appropriate resistor R1 or R2 and connected to U2 through a low-pass filter. The filter removes switch-over spikes caused by shorting currents through commutating diodes CR1 through CR4 and non- aligned switching times of the two transistors in any one diagonal. The filter plays no part in compensation for loop stability or rejecting the 20 KHz current ripple.

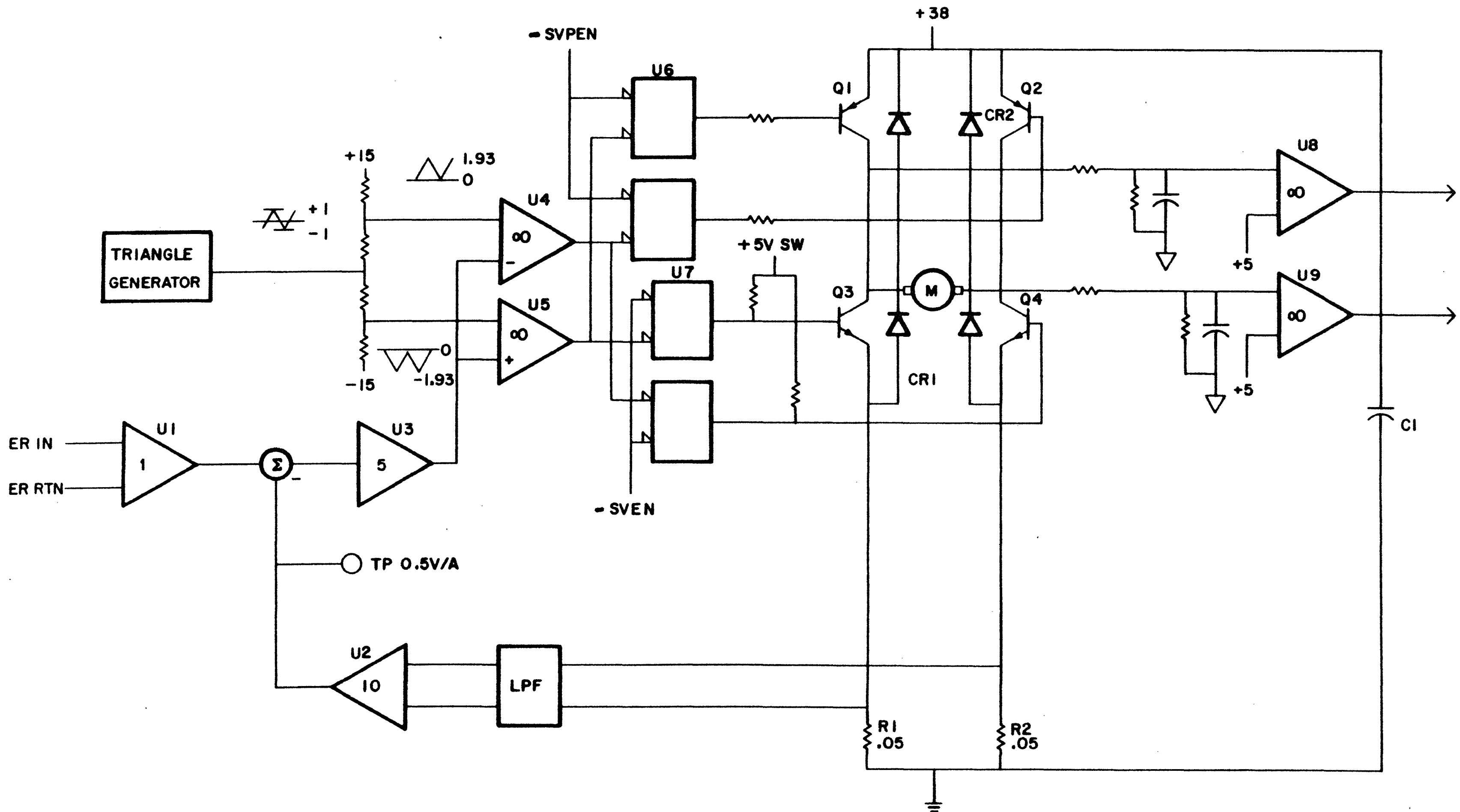


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Figure 4-26. POWER AMPLIFIER BLOCK DIAGRAM

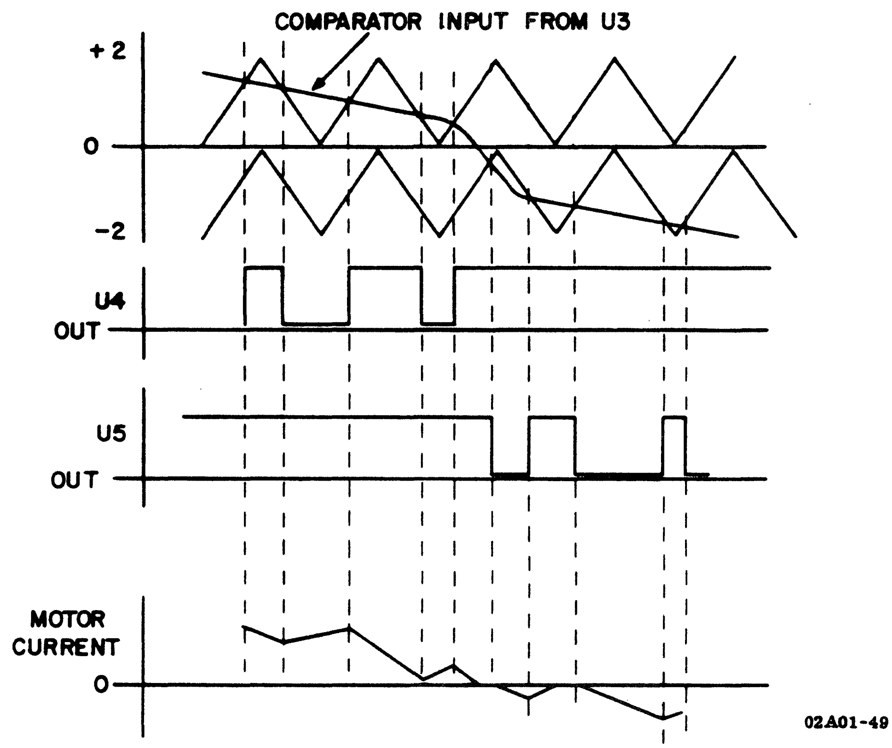


Figure 4-27. POWER AMPLIFIER WAVEFORMS

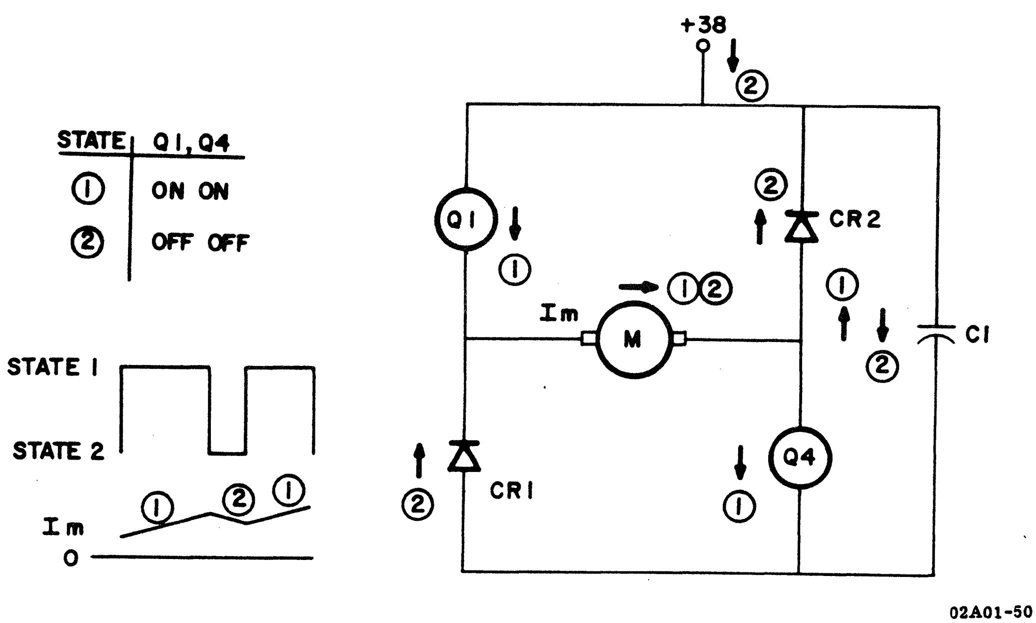


Figure 4-28. H-BRIDGE SWITCHING

Figure 4-28 shows a quadrant of the H-bridge and the states of current flow for a given DC input. In State 1, current is flowing in Q1 and Q4, 'charging' the motor. In State 2, the motor is 'discharging' through CR1 and CR2 and through CR3, thus charging C1. It should be noticed that the capacitor C1 is discharging during State 1. The capacitor is also charged by the power supply during State 2.

A block diagram of the Switched 5-Volt line for biasing the lower stages of the H-bridge, and also the peripheral drivers for biasing the upper stage, is shown in Figure 4-29. The 5-volt shut-down is needed because the peripheral drivers become uncontrolled below 4 volts, thereby turning on both sides of the bridge in the presence of 38 volts. The Master Clear signal from the power supply and the over-current one-shot also make use of comparator U4 for shut-down. If more than 20 amps flow in any sense resistor for longer than 5 usecs, one-shot, U3 is triggered which extends for 0.5 second and prevents the comparator from turning off U5 for that time.

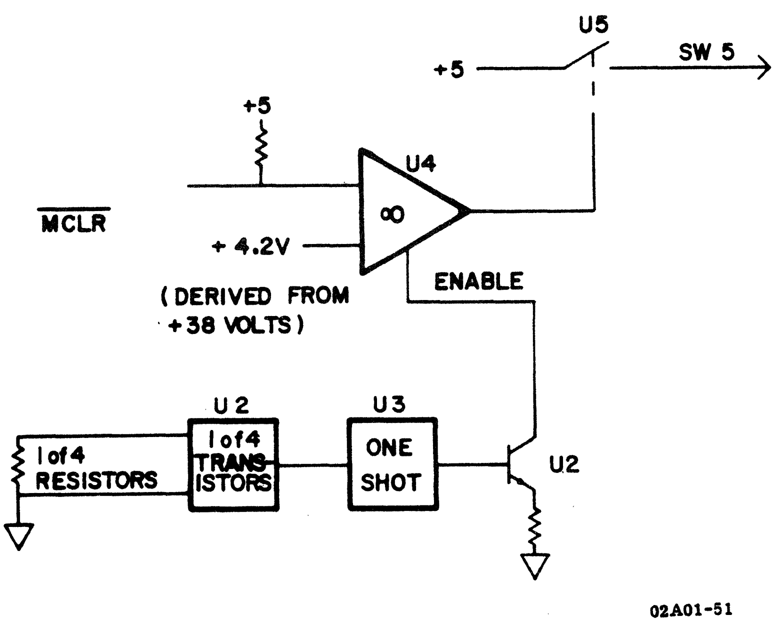


Figure 4-29. SWITCHED +5 VOLTS

4.8 HEAD ASSEMBLY OPERATION

Figure 1-2 shows the location of the head assembly with respect to other tape components. The read/write subsections of the head consist of nine individual write heads and nine individual read heads. The two sections are mounted in tandem in such a way that, when in forward motion, tape passes first under the write heads and then under the read heads. The width of a write is slightly wider than its corresponding read head, thus asserting that a read head will always scan within the track of its write head.

Individual read and write heads are configured of a wire-wound core placed to influence the magnetic field of an associated read or write gap cut into the assembly. During a write operation, the direction of current flow through a winding is established by the nature of the data pattern to be transcribed onto the tape. As current flows through the windings in a write head, a magnetic field is induced across the write gap. As tape passes into the influence of this field, the magnetic particles on the tape are aligned by the lines of flux across the write gap. When current flow through the coil windings is reversed due to data change, the magnetic particles on the tape are realigned in the opposite direction. As the tape passes under the read, the direction, in which the magnetic particles on the tape are aligned, is detected by the read head core. This electrical signal is amplified by the preamplifiers and is then transmitted to the formatter for processing.

An erase head is also included in the head mechanism. The erase head is energized by a current (DC) during a write operation. This action aligns all tape particles in the same direction prior to passing under the write head. Thus, all information is erased from a tape before new information is written. During a read operation, the erase head is turned off in order to preserve pre-recorded data.

A tape cleaner contacts the tape and removes all foreign particles from the tape prior to reaching the head assembly. Cleaner blades dislodge any foreign material on the tape, which is then removed from the tape path area by vacuum.

4.8.1 Recording Techniques and Formats

Streaming tape transports read or transcribe data in the PE (phase) recording schemes. The following paragraphs provide a brief review of techniques and associated tape formats.

4.8.1.1 Tape Composition - Magnetic tape is constructed of a plastic base material that is coated on the recording side with a substance containing minute iron oxide particles mixed with a binding agent. The recording surface thus is sensitive to the influence of electrically generated magnetic fields.

The magnetic recording technique employs a data-dependent current switching scheme to set he polarization pattern of individual write heads. Discrete segments of the magnetically sensitized tape, when passed through the magnetic field of an associated write head, are forced to assume a corresponding polarization pattern. During a read operation, the data-descriptive polarization patterns carried by the previously recorded tape influence the polarity of the electrical signals induced into the read head coils.

4.8.1.2 Phase Modulation - Technique and Format - The phase modulation method records "1" and "0" bits on tape by changing the direction of current through the write head. A change in current direction results in a corresponding change in direction of the magnetic flux in the write head. As tape passes under the write head, magnetic particles in the tape align with the direction of magnetic flux. Particles aligned in one direction represent a "1" bit, while particles aligned in the opposite direction represent a "0" bit.

When the erase head flux is positive, a change in write head flux from negative to positive records a "1" bit on tape (Figure 4-30). A flux change from positive to negative represents a "0" bit. When two "1's" are written in succession, the magnetic flux must return to the negative before the second "1" can be written. The flux must return to the positive state between two "0" bits. This flux transition (phase bit) between two identical data bits contains no information. The phase bit establishes the proper polarity if two identical bits ("1's" or "0's") are written in succession.

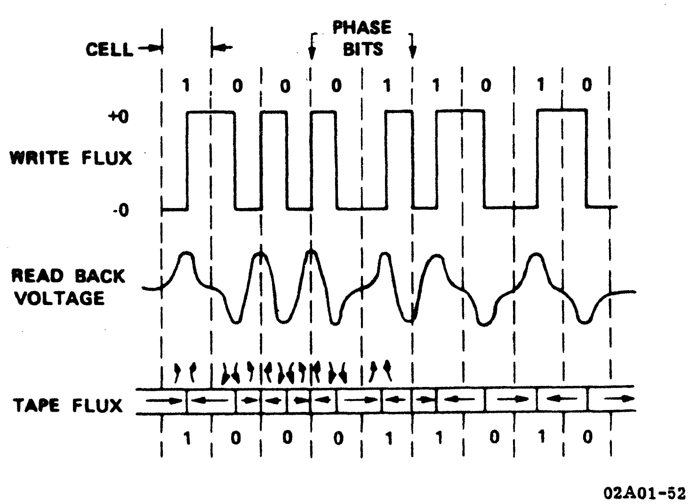


Figure 4-30. PE MODULATION RECORDING

A cell is the time needed to transfer one data bit of information. Each data bit and phase bit requires one magnetic flux change. One inch of phase recorded tape contains 1600 data bits per track. The total number of flux changes per inch varies between 1600 and 3200, and depends on the pattern written.

The following characteristics describe the readback signal during phase modulation recording:

1. A positive pulse in the middle of a cell indicates a "1"; a negative pulse indicates a "0".
2. A positive pulse at the junction of two cells indicates that both cells contain "0". Conversely, a negative pulse at the junction indicates that both cells contain "1's".
3. The absence of a pulse at the junction of two cells indicates that the cell contains opposite binary bit values.

The identification burst shown in Figure 4-31 identifies the phase modulation method of recording information. The burst contains of alternate "1's" and "0's" (1600 flux changes per inch) written on track 4 only. During the burst, all other tracks are erased. A minimum gap of 0.5 inch must exist between the burst the first block of data.

4.8.1.3 Phase Modulation Character Configuration - Data is recorded on the 9 tracks in Figure 4-31. Track 1 is the track closest to the operator; the remaining 8 tracks are numbered consecutively from 2 to 9. Track 4 is used to check character parity on information in the other 8 tracks. If an even number of "1's" is written in the 8 information tracks, a "1" will be written in track 4 to give an odd parity check. If an odd number of "1's" is written in the 8 information tracks, a "0" will be written in track 4.

A data block consists of a preamble, data and a postamble as shown in Figure 4-31. The preamble identifies the beginning of a block and consists of 41 characters. The first 40 characters are "0's" in all tracks and the last character is a "1" in all tracks. The postamble idenfifies the end of a data block. It consists of 41 characters which are a mirror image of the preamble; that is, the first character is a "1" in all tracks and the last 40 characters are "0's" in all tracks. The postamble also identifies the data block when performing a Reverse Read operation.

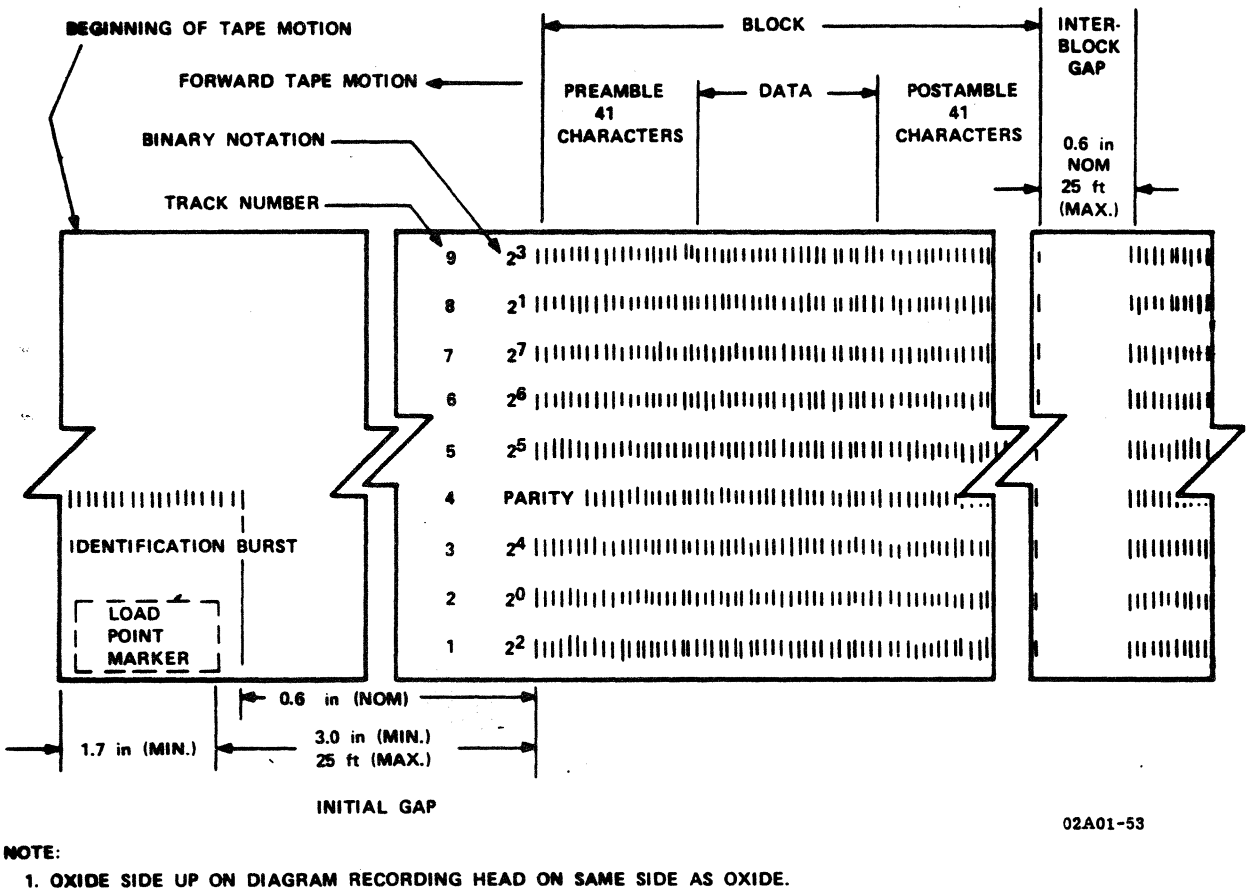


Figure 4-31. PHASE ENCODED TAPE FORMAT

4.9 TU80/TRANSPORT INTERFACE

4.9.1 Electrical Interface

All lines are low true and driven by 2-state devices, type SN7438. These lines are received by the circuit shown in Figure 4-32. The following voltage levels apply:

	Transmitted	Received
True = 0	0.0V - 0.4V	0.0V - 0.8V
False = 1	2.4V - 5.0V	2.0V - 5.0V

4.9.2 Mechanical Interface

4.9.2.1 Connector Requirements - The Formatter/Control module connectors for this interface are two 50-pin printed circuit edge connector.

4.9.2.2 I/O Cabling Requirements - Cable requirements are as follows:

1. Formatter/Control module to logic cage bracket
   Ribbon Cables P/N 77017711 and 77018821

2. Logic cage bracket to CPU bulkhead connectors
   Shielded Round Cables P/N 17-00357-01 (Pair)

3. CPU bulkhead connectors to M7454 Module
   Ribbon Cables P/N 70-19922 (Male), 70-19923 (Female)

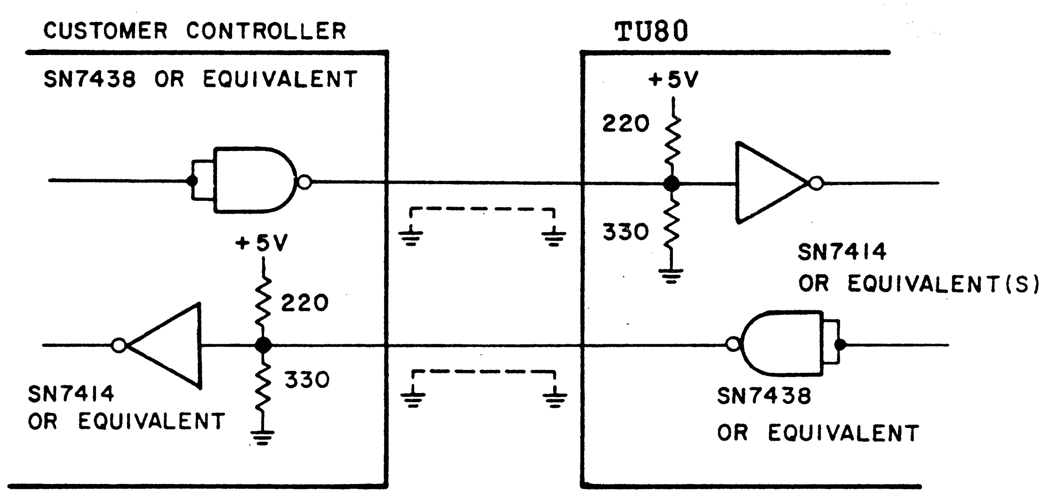


Figure 4-32. INTERFACE CONFIGURATION 02A01-54

4.9.2.3 Formatter/Control Module Connector Pin Configuration

CONNECTOR	SIGNAL PIN	RETURN PIN	SIGNAL
J4	2	1	-FFBY
|	4	3	-FLWD
|	6	5	-FWD4
|	8	7	-FGO
|	10	9	-FWD0
|	12	11	-FWD1
|	14	13	Spare
|	16	15	-FLOL
|	18	17	-FREV
|	20	19	-FREW
|	22	21	-FWDP
|	24	23	-FWD7
|	26	25	-FWD3
|	28	27	-FWD6
|	30	29	-FWD2
|	32	31	-FWD5
|	34	33	-FWRT
|	36	35	-FLGAP
|	38	37	-FEDIT
|	40	39	-FERASE
|	42	41	-FWFM
|	44	43	Spare
|	46	45	-FTAD0
|	48	47	-FRD2
J4	50	49	-FRD3

The prefix "F" denotes Formatter Interface Signals.

4.9.2.3 Formatter/Control Module Connector Pin Configuration (Cont'd)

CONNECTOR	SIGNAL PIN	RETURN PIN	SIGNAL
J5	1	5	-FRDP
|	2	5	-FRD0
|	3	5	-FRD1
|	4	5	-FLDP
|	6	5	-FRD4
|	8	7	-FRD7
|	10	9	-FRD6
|	12	11	-FHER
|	14	13	-FFMK
|	16	15	-FID
|	18	17	-FFEN
|	20	19	-FRD5
|	22	21	-FEOT
|	24	23	-FOFL
|	26	25	Spare
|	28	27	-FRDY
|	30	29	-FRWD
|	32	31	-FFPT
|	34	33	-FRSTR
|	36	35	-FDWDS
|	38	37	-FDBY
|	40	39	-FHSPD
|	42	41	-FCER
|	44	43	-FONL
|	46	45	-FTAD1
|	48	47	-FFAD
J5	50	49	-FHISP

The prefix "F" denotes Formatter Interface Signals.

4.9.3 Formatter Interface Description

4.9.3.1 Addressing - The TU80 Formatter/Control module monitors the interface signals -FFAD, -FTAD0 and -FTAD1, and compares them to levels predetermined by switch settings on the module. The appropriate levels must be maintained for the duration of an operation.

4.9.3.2 Mode of Operation - The TU80 operates in either start/stop mode or streaming mode.

- Start/Stop Mode - The TU80 operates similar to conventional tape transports. It accelerates the tape at 25 ips or when a command is received and stops the tape within the Interblock Gap (IBG).

- Streaming Mode - Tape motion continues without loss of time due to starting and stopping, if the next command is received during the command reinstruct time. The TU80 maintains 25 or 100 ips speed through the IBG, anticipating the next command. If a command is received within the reinstruct time, there is no loss of time due to starting and stopping. If commands arrive after command reinstruct time or are discontinued, the tape unit will go through a recovery cycle.

4.9.3.3 Command Set

- Write Command - This command causes the TU80 to accelerate tape and start transferring data. The data transfer continues until the Last Word command is given from the controller. The TU80 continues to move tape to perform read-after-write check.

  In the start/stop mode, tape decelerates after each block. The next command will not be executed until the TU80 has completed its stop.

  In the streaming mode, if the following Write command is received during reinstruct time (see Table 4-17), the tape unit will continue the tape motion and write the next block. Otherwise, tape will decelerate. If the Write command is received after reinstruct time, the command will not be executed until the recovery cycle is completed.

- Write File Mark Command - This command causes the TU80 tape transport to start the tape and write the proper file mark pattern on tape.

- Erase Commands

  1. Fixed Erase - This command causes a 3.6 inch length of tape to be erased. The ID burst will be written when an Erase command is given from BOT.

  2. Controlled Erase - This command causes the tape transport to accelerate the tape and erase tape continuously until the "Last Word" signal from the controller is set true. This terminates the erase operation. The ID burst will be written when an Erase command is given from BOT.

  3. Data Security Erase - This command causes the tape transport to erase tape at 100 IPS from its present position to a position approximately 10 feet past End of Tape marker. The ID burst will be written when command is given from BOT.

- Read Forward Command - This command causes tape to be accelerated to normal operating speed. The next logical record of data encountered.

  If data is not detected after 25 feet of tape motion, it will terminate the operation by decelerating the tape and resetting Formatter Busy status. An error condition will be set as a result of the time-out. File Mark testing is performed during read operation.

  In start/stop mode, tape is decelerated after each block. The next command will not be executed until the stop is completed.

  In streaming mode, if the following Read command is received during the reinstruct time, tape motion continues and the next block of data is read. Otherwise, the TU80 will decelerate the tape. If the Read command is received after the reinstruct time, the command will not be executed until the recovery cycle is completed.

- Read Reverse Command - Similar to Read Forward, but with tape motion in the reverse direction. Consecutive records may be read in reverse "on-the-fly". The TU80 will stop tape motion and set low speed mode when the BOT signal is present during any reverse operation.

- Space Forward Command - This operation is similar to a Read Forward except that no read strobe signals are generated and no read data is supplied to the controller. Error checking is not performed on the read data. However, File Mark testing is performed.

- Space Reverse Command - This operation is similar to the Space Forward operation except that tape moves in the reverse direction.

- File Mark Search Commands - These commands cause a continuous Read Forward or Read Reverse in "on-the-fly" mode. Tape motion ceases when a File Mark is read with the head correctly positioned. When combined with a Space command, data transfer and error detection is inhibited.

- Rewind Command - This command causes the selected TU80 to rewind to BOT. The tape unit defaults to start/stop mode after Rewind. The command is ignored if the unit is already at BOT.

- Off-Line Command - This command causes the tape unit to go Off-Line, Rewind and Unload tape.

- On-Line Command - This command causes the tape unit to go On-Line if tape is loaded.

- High Speed Select Command - When received with a Read or Write-type command, this command causes a change from start/stop to streaming mode before executing Read or Write-type command. This command may delay first Read or Write command by 640 milliseconds.

- Long Gap Command - Forced by the host adapter with a Write-type command, this command causes the tape transport to be set for Long Gap in streaming mode. In start/stop mode, the gap will be 0.8 inch.

- Channel Loopback Command - This is a diagnostic command used to loopback the interface write data lines to read data lines. The TU80 generates Demand Write Data Strobes and loops back the write data from the interface to the read data lines until the Last Word signal is received. The Formatter Busy and Data Busy signals are reset when the last data byte is transmitted. The data transfer rate is at the present transport speed.

- Sense Read Command - This command transfers sense information to the controller. The sense transfer is similar to a read operation at low speed of a fixed length record except that no tape motion is involved. The TU80 generates a read strobe for every sense byte transferred. Eight (8) bytes of sense information are transferred (refer to Table 4-2). The unit need not be on-line (but must be selected) to execute a Sense Read command.

- Controlled Backspace Command - This command causes tape to accelerate the tape in the reverse direction and start issuing Demand Write Data Strobes. The TU80 has no maximum restrictions on the space length. The Demand Write Data Strobes continue at the data rate until the Last Word command is given from the controller. Tape motion will continue until an IBG is detected. This will terminate the operation. No read data is sent to the controller and no error checking is performed. File Mark testing is not performed for this operation. This operation is similar to a write operation except that no data is recorded on tape.

4.9.4 Status and Sense Information

4.9.4.1 Status Information - The status bits are set when their respective setting condition occurs. The setting conditions are detailed as follows in this section. The TU80 need not be on-line (but must be selected) to transfer sense bits.

- Formatter Busy - When a command is transferred to the Formatter, this signal goes active on the trailing edge of FGO and is reset when the Formatter has completed the last Go command.

- ID Burst Detect - This line is pulsed if the identification burst on the tape is detected when the tape operation is a read or a read-after-write from BOT.

- Hard Error

  1. This line is set as the result of one of the following conditions being detected during execution of a command:

     - Vertical Parity Error without associated drop-out
     - False Preamble Detection
     - False Postamble Detection
     - Excess Skew
     - Multi-track Error
     - Parity Error on channel interface
     - Identification Error on read-after-write
     - Noise Error
     - Equipment Check
     - Read Time-out
     - Device Sense Error
     - Loop Write-to-Read Error
     - Illegal Command
     - Reverse into Load Point
     - Single Track Correction on Write Command

  2. Should the error condition be detected while FDBY is set, then FHER is pulsed with a minimum pulse of 10 us. If FDBY is not set, then FHER is set and will be reset on receipt of the next GO command or when Formatter Enable is reset.

- Corrected Error - This line is pulsed while FDBY is set when single track error correction is performed during execution of a Read command.

- File Mark - This line is pulsed during any Read/Write type command when a File Mark pattern is detected.

- On-Line

  1. Set when the tape transport is placed On-Line by the operator or On-Line command and tape is loaded.

  2. Reset at the successful initiation of the Off-Line command or any time that the transport goes Off-Line.

- Rewind

    1. Set when a Rewind or Off-Line command is issued to the tape transport.

    2. Reset when the transport has completed the operation.

- File Protect - A signal which, when true, indicates that a tape without a write enable ring is mounted on the tape transport.

- Load Point (Beginning of Tape)

    1. Set when the tape is located with its Load Point (BOT marker) over the BOT sensor in the start/stop mode.

    2. When in streaming mode at Load Point, the BOT marker will not be under the sensor, but Load Point status will still be set.

    3. Reset when the BOT marker moves off the BOT sensor in the forward direction.

    4. The streaming mode recovery cycle will not effect the status of Load Point.

- End-of-Tape (EOT)

    1. Set and latched when the selected transport has detected the End-of-Tape marker in the forward direction.

    2. The streaming mode recovery cycle will not affect the status of the EOT.

    3. Reset when passing over trailing edge of EOT in reverse direction, other than a streaming mode recovery cycle.

- High Speed - Set to indicate that the tape transport is in high speed streaming mode.

- Data Busy - True during the active execution of all commands initiated by FGO. No new command may be given while Data Busy is true.

- Ready - TU80 transport is loaded and ready to accept On-Line or Sense commands.

4.9.4.2 Sense Data - The TU80 has 8 bytes of sense data available to the system upon command request (Sense Data Transfer). Table 4-2 presents a summary of sense byte definition. A more detailed description of sense data is as follows:

o Sense Byte 0

7 - Unit Exception	- Set when single track error correction is performed during read operation.
6 - Unit Check	- Set when Bit 0, 1, 2, 3, 4 or 5 of this sense byte is set.
5 - Command Overrun	- Set if command is received while Data Data is true (also sets sense byte 0 bit 0).
4 - Data Check	- Set when Postamble Error is detected. - Excessive skew is detected. - When PE ID Burst is not correctly recorded while writing from BOT. - When PE ID Burst is not detected while reading from BOT. - When noise is detected during read-after-write check on Erase command. - When Multi-drop is detected. - When no data is detected (Read Time-out Error). - When readback data does not occur when expected on Write Tape Mark command, or tape mark is not written correctly during Write Tape Mark command. - Uncorrectable parity errors are detected. - One track in error during write operation.
3 - Equipment Check	- Set when internal hardware malfunctions are detected. - Write Transfer Check. - Parity error is detected on channel in data. - Gap Control is not detected within defined window. - Positioning is not detected within defined window.
2 - 0	
1 - Intervention Required.	- Set when TU80 is not Ready.

- Sense Byte 1 (Last Command Issued)

  7 - Long Gap
  6 - Undefined
  5 - High Speed Select
  4 - Erase
  3 - Write File Mark
  2 - Edit
  1 - Write
  0 - Reverse

- Sense Byte 2 (Tape Status)

  7 - EOT
  6 - BOT
  5 - High Speed
  4 - Positioning/Ramp
  3 - File Protected
  2 - Rewinding
  1 - On-Line
  0 - Ready

- Sense Byte 3

7 - Gap Control	- Set when there is a Hardware Failure. This condition also sets sense byte 0 bit 3 (Equipment Check).
6 - Write Hardware Check	- Set when there is a Hardware Failure. This condition also sets sense byte 0 bit 3 (Equipment Check).
5 - Channel In PE	- Set when parity error is detected on data received from channel. This condition also sets sense byte 0 bit 3 (Equipment Check). Addition of a jumper negates this status and causes correct parity to be generated. However, if the TU80 generates parity, there will not be any integrity checking of data lines from channel, any channel data error will be written onto tape as an undetected write error.
4 - Position Check	- Set when there is a Hardware Failure. This condition also sets sense byte 0 bit 3 (Equipment Check).
3 - Device Response Check	- Set when communication error has occurred between two microprocessors.

2 - 0

1 - Illegal Command - Set when Illegal Command Sequence is detected, for example: a Read Reverse command is decoded with tape unit at BOT or decoded command has Write and Reverse bits set. This condition also sets sense byte 0 bit 7 (Command Reject).

0 - File Mark Detected - Set when a tape mark is detected during a Read or Space command.

o Sense Byte 4

7 - TIE 4 - Track In Error 4.

6 - No Track Pointer - Set when parity error is detected with no pointer set. This condition also sets sense byte 0 bit 4 (Data Check).

5 - Multi-drop - Set when a Multi-drop (more than one pointer) is detected. Data is not correctable. This condition also sets sense byte 0 bit 4 (Data Check).

4 - Postamble Error - Set when Postamble error is detected. This condition also sets sense byte 0 bit 4 (Data Check).

3 - Uncorrectable Data - Parity error that cannot be corrected. Error has no pointer or more than one pointer.

2 - PE ID Check - Set when PE ID is not correctly recorded while writing from BOT, or PE ID is not detected while reading from BOT. This condition also sets sense byte 0 bit 4 (Data Check).

1 - Noise - Set when noise is detected during read-after-write check on Erase command, or IBG is not detected at End of Record. These conditions also set sense byte 0 bit 4 (Data Check).

0 - Time-out - Set when no data is detected within 25 feet of tape. This condition also sets sense byte 0 bit 4 (Data Check).

- Sense Byte 5 - These bits indicate the tracks for which pointers are on at the end of the last operation.

7 - TIE 2	- Track In Error 2
6 - TIE 8	8
5 - TIE 1	1
4 - TIE 9	9
3 - TIE 3	3
2 - TIE 5	5
1 - TIE 6	6
0 - TIE 7	- Track In Error 7

- Sense Byte 6

- Fault Symptom Code	- Fault Code Representation for internally detected failure mode.

- Sense Byte 7 - Marginal Device Indication

7 - 25 IPS Slow Down Ramp	Support Level Interpretation Only
6 - 25 IPS Slow Up Ramp	
5 - 25 IPS Speed	
4 - 100 IPS Speed	
3 - 25 IPS Fast Down Ramp	
2 - 100 IPS Fast Down Ramp	
1 - 25 IPS Fast Up Ramp	
0 - 100 IPS Fast Up Ramp	Support Level Interpretation Only

Table 4-2. TU80 SENSE BYTE SUMMARY

MSB LSB

SENSE BYTE	BIT 0	BIT 1	BIT 2	BIT 3	BIT 4	BIT 5	BIT 6	BIT 7
0	Command Reject	Inter-vention Required	0	Equipment Check	Data Check	Over-run	Unit Check	Unit Exception
1	Reverse	Write	Edit	Write File Mark	Erase	High Speed Select		Long Gap
2	Ready	On-Line	Rewind	File Protect	Position-ing Ramp	High Speed	BOT	EOT
3	File Mark Detect	Illegal Command	0	Device Response Check	Position-ing Check	Channel In Parity Error	Write Hardware Check	Gap Control Check
4	Read Time-out	Noise Check	PE ID Check	Uncorrec-table Data	Postamble Error	Multi-drop	No Track Pointer	TIE 4
5	TIE 7	TIE 6	TIE 5	TIE 3	TIE 9	TIE 1	TIE 8	TIE 2
6	FAULT SYMPTOM CODE							
7	MARGINAL DETECTION INDICATOR (See Text)							

4.9.5 Signal Description

All TU80 Formatter interface lines are defined low-true.

4.9.5.1 Lines To The TU80 Formatter

- -FFAD: Formatter Address. This line must correspond to the address switch setting.

- -FTAD0, -FTAD1: Transport Address. These lines must correspond to the address switch setting.

- -FGO: Initiate Command. This signal is used to strobe the following command lines on the trailing edge:

1. FREV	5. FEDIT
2. FWRT	6. FLGAP
3. FWFM	7. FHISP
4. FERASE	

- -FREV: Reverse/Forward. This signal is used to encode Go commands. See Table 4.3.

- -FWRT: Write/Read. This signal is used to encode Go commands. See Table 4.3.

- -FWFM: Write File Mark. This signal is used to encode Go commands. See Table 4.3.

- -FERASE: Erase. This signal is used to encode Go commands. See Table 4.3

- -FEDIT: Edit. This signal is used to encode Go commands. See Table 4.3 (Note: Edit commands are not supported by the TU80.).

- -FLGAP: Long Gap. This line is always asserted by the host adapter.

- -FLOOP: Loopback. When true, the TU80 will generate Demand Write Data Strobes, and loopback the write data from the controller to the read data lines to the controller until the Last Word signal is received. The Formatter Busy and Data Busy signals will be reset once the last read data byte is transmitted. The data transfer rate is determined by the present speed mode of transport.

- -FHISP: High Speed Select. If this line is true when Read or Write command is issued, the TU80 will read or write at high speed. If the line is false, the TU80 will read or write low speed. Should unit be in opposite speed mode when command is issued, the TU80 will first change speed with a delay of up to 640 milliseconds and then execute the command at the desired speed.

- -FREW: Rewind. This signal (minimum 1.0 microsecond pulse) causes the selected transport to rewind to BOT. The -FRWD signal is asserted during the Rewind operation. Formatter Busy is not set during a Rewind.

- -FOFL: Off-Line and Rewind. This line must be held true for a minimum of 1.0 microsecond. It causes the TU80 to go Off-Line, Rewind and Unload tape. Formatter Busy is not set.

- -FLOL: On-Line. This signal causes the selected TU80 to go On-Line. It must be held true for a minimum of 1.0 microsecond. Formatter Busy is not set.

- -FWD0-7, -FWDP. These lines transmit data to the TU80. -FWD0 is the most significant.

- -FFEN: Formatter Enable. This signal, when false, causes the formatter to be held in an initialized state. It is independent of -FFAD. Resetting Formatter Enable may be used to terminate run-away operations caused by missing last word.

- -FLWD: Last Word. During Write and Controlled Erase, this line, when true with -FWD0-7, -FWDP, indicates that character being strobed into Formatter is the last of the record.

Table 4-3 presents a correspondence between the signal lines strobed by the -FGO line and the command to be executed.

Table 4-3. TU80 FORMATTER INTERFACE COMMANDS

COMMAND	LOOP	REV	WRT	WFM	ERASE
Read Forward *	L	L	L	L	L
Read Reverse *	L	H	L	L	L
Write *	L	L	H	L	L
Write File Mark	L	L	H	H	L
Erase (Variable)	L	L	H	L	H
Erase (Fixed)	L	L	H	H	H
Data Security Erase	H	L	H	H	H
Space Forward	L	L	L	L	H
Space Reverse	L	H	L	L	H
Controlled Backspace	L	H	H	L	H
File Search Forward	L	L	L	H	L
File Search Reverse	L	H	L	H	L
File Search Forward (Ignore Data)	L	L	L	H	H
File Search Reverse (Ignore Data)	L	H	L	H	H
Read Sense	H	H	L	L	H
Data Loopback	H	H	H	H	H

L = Low = False
H = High = True

* FLGAP is also strobed during these command transfers, indicating the setting of a Long Gap Length (see Table 3-4).

4.9.5.2 Lines From The TU80 Formatter

- -FFBY: Formatter Busy. Only goes true when -FGO command is received. Remains true until completion of command execution.

- -FDBY: Data Busy. Goes true during active execution of all commands initiated by -FGO. When searching file marks, Data Busy will go true during each record. A new command may be given when Data Busy goes false for an "on-the-fly" operation. "On-the-fly" commands must be the same read/write mode and same tape direction. All other commands are accepted after Data Busy goes false, but will not be executed until the previous command is completed.

- -FID: PE Identification Burst Detected

- -FHER: Hard Error. This line is set low if any error has been detected. Should the error be detected while FDBY is set, then FHER is pulsed with a minimum pulse of 10 us. If FDBY is not set, then FHER is set and will be reset on receipt of next Go command or when Formatter Enable is reset.

- -FCER: Corrected Error. This line is pulsed while FDBY is set when single track error correction is performed during execution of a Read command. Minimum pulse width is 10 us.

- -FFMK: File Mark Detected. This line is pulsed while FDBY is set during any Read/Write type command when a File Mark pattern is detected.

- -FRDY: TU80 Ready. This line, when true, indicates that unit is loaded. The Ready line will go false during a Rewind.

- -FONL: TU80 On-Line

- -FRWD: Rewind. This line, when true, indicates that a Rewind is being executed.

- -FEOT: End-of-Tape

- -FFPT: File Protect

- -FLDP: Load Point

- -FHSPD: High Speed. When true, indicates selected unit is in the streaming mode, high speed. When false, it indicates start/stop mode, low speed.

- -FPOS: Positioning. This line is set to indicate that the tape unit is Positioning.

- -FDWDS: Demand Write Data Strobe. This line consists of a pulse for each character to be written onto tape. The pulse width of signal -FDWDS is equal to 1/2 of the data rate. The first data character should be available on the write data input lines within 40 character periods after the -FDBY signal has been set true, and remain true until the trailing edge of the first -FDWDS signal.

  Succeeding characters must then be placed on these lines within one-half of a character period after the trailing edge of each -FDWDS signal. During a Write File Mark command, the required File Mark pattern is generated internally by the Formatter and the -FDWDS signal is not used. During erase operation (variable length), this line will also be used. However, no data are transferred or written onto tape. The controller may use this line to determine the length of tape to be erased.

- -FRSTR: Read Data Strobe. This line consists of a pulse for each character of read information to be transmitted to the M7454 Controller interface and should be used to sample the read data lines -FRD0-7, -FRDP. The pulse width of this signal is a minimum of 1 usec. The average time between pulses on the -FRSTR line is given by:

  $$\frac{1}{S \times D} \quad \text{Where S = Tape Speed (ips) and D = 1600 bpi}$$

  The customer controller interface must be able to accept the whole block of data at the specified data rate.

  Due to bit crowding, tape speed variation and signal drop-out correction (PE), the M7454 Controller interface must be able to receive characters at a rate which can vary between twice the nominal rate and half the nominal rate.

- -FRD0-7, -FRDP: Read Data. These 9 lines transmit read data from the Formatter to the M7454 Controller. Each character read from tape is available by sampling these lines in parallel with the -FRSTR. Data will be placed on the read data lines at least 0.5 usec prior to the leading edge of the -FRSTR pulse. The data remains on the read data lines for at least 0.5 usec after the trailing edge of the -FRSTR pulse. Sense data is also transmitted on this bus analogous to the read data rate at low speed.

4.10 SYSTEM AND TIMING CONSIDERATIONS

4.10.1 Motion Characteristics

The transport has two operational modes: start/stop and streaming modes. Selection of either mode is made by the transport through the Adaptive Velocity Control (refer to Appendix B). After a rewind operation, the transport automatically reverts to the start/stop mode.

In the following discussions, read operations represent all read-type operations such as read, space and search. Similarly, write operations represent all write-type operations such as write data, erase and write file mark.

At 100 ips, the TU80 performs only in streaming mode. At 25 ips, the TU80 may run in start/stop or streaming modes.

4.10.1.1 Start/Stop Mode - In the start/stop mode, the transport accelerates the tape when a command is received and stops tape within the IBG. Figure 4-33 illustrates start/stop mode motion characteristics. The figure is drawn so that points A thru E represent the position of the read head for read operations and the write head for write operations.

- Read Operations - After a block has been successfully traversed, the tape will be brought to a complete stop to await the next command. The microprocessor will delay the subsequent start if the time, since the last start, is less than 80 ms.

- Write Operations - Tape control is exactly the same as in the read; the 80 ms restriction also applies. Note that the normal IBG written in this mode is 0.8 inch.

Table 4-4. MOTION CHARACTERISTICS

Start/Stop Distance (Nominal)	
Low Speed Start/Stop Mode	0.25 inch
Low Speed Streaming Mode	0.5 inch
High Speed Streaming Mode	8.0 inches
Data Transfer Rate (Avg. Over Block)	
Low Speed Modes	40 kilobytes/second
High Speed Mode	160 kilobytes/second
Write Interblock Gap Size	
1. Short Gap	
a. Low Speed Start/Stop Mode	0.8 inch nominal
b. Low Speed Streaming Mode	0.6 inch nominal, 1.2 inches maximum
c. High Speed Streaming Mode	0.6 inch nominal 1.2 inches maximum
Read Interblock Gap Size	
Minimum - All Modes	0.5 inch (NOTE 5)
Maximum - Streaming Mode	1.2 inches (NOTE 6)
Write Access Time (Nominal)	
Low Speed Start/Stop Mode	22 millisecs (NOTE 7)
Low Speed Streaming Mode	70 millisecs
High Speed Streaming Mode	175 millisecs
Read Access Time (Nominal)	
Low Speed Start/Stop Mode	24 millisecs (NOTE 7)
Low Speed Streaming Mode	66 millisecs
High Speed Streaming Mode	175 millisecs
Reposition Time (nominal, NOTE 1)	
Low Speed Streaming Mode	221 millisecs
High Speed Streaming Mode	670 millisecs
Position Time (nominal, NOTE 2)	
Low Speed Streaming Mode	155 millisecs
High Speed Streaming Mode	495 millisecs
Reinstruct Time (Nominal, NOTE 3)	
1. Low Speed Streaming Mode	
a. Write	14 ms for 0.6 inch gap, 38 ms for 1.2 inch (NOTE 6)
b. Read	20 ms for 0.5 inch gap, 24 ms for 0.6 inch 48 ms for 1.2 inch

Table 4-4. MOTION CHARACTERISTICS (Cont'd)

Reinstruct Time (Cont'd)	
2. High Speed Streaming Mode	
a. Write (for 0.6 inch nominal gap)	3.5 millisecs
b. Write (for 1.2 inch gap)	9.5 millisecs
c. Read (NOTE 4)	12.0 millisecs
3. Start/Stop (25 ips)	
a. Write	0 millisecs (NOTE 8)
b. Read	0 millisecs (NOTE 8)

NOTE 1: This is the total time required for accessing first byte of data for a command received immediately after command reinstruct time.

NOTE 2: This is the total time required to recover from a command over-run and return to stopped condition to await next operation.

NOTE 3: This is the total elapsed time from completion of a command execution to the latest point in inter-record gap, at which the transport can accept another command without a recovery cycle.

NOTE 4: If a block is detected before the command is received, the transport will Reposition. If the command is received before the next block is detected, the transport will read the next record without Reposition. The maximum reinstruct time during a Read operation is 12 milliseconds.

NOTE 5: Unit will read minimum ANSI gaps in all modes.

NOTE 6: In streaming modes, the unit will reposition if no reinstruct is received before the next block is encountered or, if the tape has moved 1.2 inches (this is independent of unit gap selection).

NOTE 7: If the previous Read or Write command occurred less than 80 ms prior to new command, this time will be increased by the difference between 80 ms and the actual time since the previous Read or Write.

NOTE 8: In low speed start/stop mode, the tape will be brought to a full stop after each record regardless of the reinstruct period.

o Other Start/Stop Motion Characteristics - Whenever a change from read-to-write mode is experienced (forward direction), a "jog" operation is performed to position the erase head within the IBG. The time to execute the jog operation is nominally 191 milliseconds. When changing from write to read reverse or rewind, a forward jog to erase a full gap is inserted by the transport. This insures that there is no glitch in the initial gap when the write head is turned off. Time to execute the forward jog is 120 milliseconds.

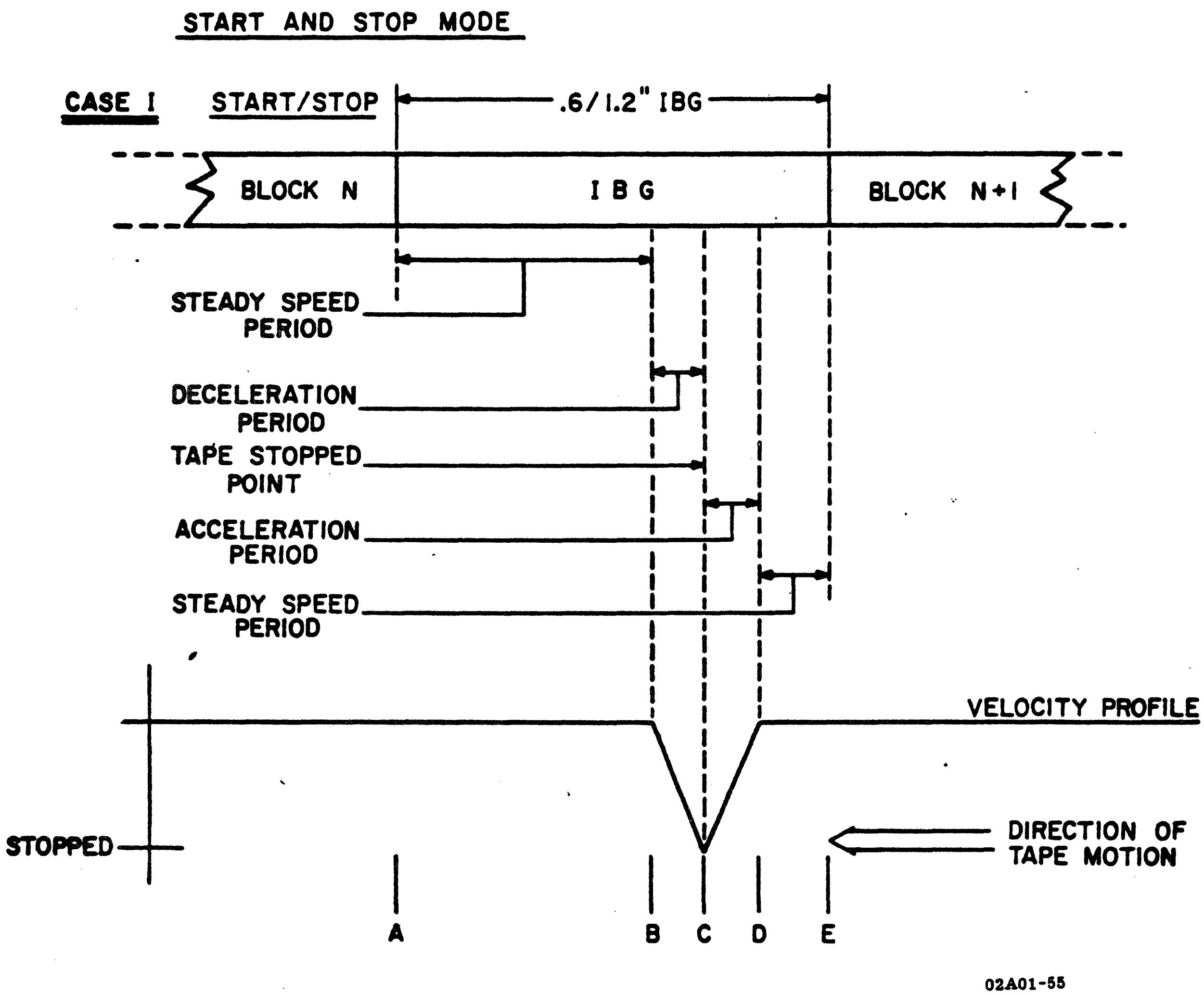


Figure 4-33. START/STOP TAPE MOTION CONTROL

4.10.1.2 Streaming Mode - The streaming modes are high performance operating modes designed to accommodate continuous transfers of many data blocks to or from tape. Unlike the start/stop mode, tape acceleration and deceleration cannot be accomplished within the interblock gap (IBG). In order to efficiently utilize the streaming mode, tape motion must be sustained by commanding successive data operations. This is accomplished by issuing subsequent commands to the transport during the time the transport is traversing the IBG. (This command window is referred to as the command reinstruct time.) If a follow-up command is not received during the reinstruction interval, a repositioning cycle is required. (A Reverse command can be received during the initial down ramp and will be executed without going through the complete repositioning cycle.) For example, assume that the transport has just completed a write data operation. If the normal IBG length of 0.6 inch is required to be written, then the system has 3.5 milliseconds (ms) (0.6 inch/100 inches per second) to respond with a subsequent Write command in order for streaming mode to be sustained. If the subsequent Write command is not received within 9.5 msecs., the transport repositions itself in anticipation of the next streaming mode command. This repositioning cycle time is defined in Table 4-4.

Three sequences of events, which generally describe the motion characteristics of the transport in streaming mode, are as follows:

- Case 1 - Command Received During Reinstruction Interval
- Case 2 - Command Received During Repositioning Cycle
- Case 3 - Command Received Following Repositioning Cycle

These three sequences are applicable to both forward and reverse operations and are described on the following pages individually. First, a more general discussion of streaming mode motion characteristics is presented.

Refer to Figure 4-34. In order for the transport to perform a data operation on Block N + 1 from a stopped position (point E), it must first accelerate and be up to speed at point F as referenced to the read head in the case of a read operation, or erase head in the case of a write operation. For the case where the transport has just completed a data operation on Block N and a repositioning cycle is required, the transport begins the repositioning cycle at point B and traverses path BCDE. The transport then positions itself at point E in anticipation of the next operation. The transport presumes the next operation to be a streaming mode operation on Block N + 1. A sequence chart is presented in Table 4-5 which identifies transport streaming mode motion sequences for combinations of previous and present command issuances. In all cases, the next command is received during the reinstruct time. This chart refers to the diagram of Figure 4-34.

Table 4-5. Streaming Mode Motion Sequence Chart

PREVIOUS COMMAND	FORWARD READ	REVERSE READ	WRITE
Forward Read	Path ABF	Paths ABC, CHDG	Path ABCDEF
Reverse Read	Paths HDE, EABF	Path HDG	Paths HDE, EABF
Write	Not Recommended	Paths ABC, CHDG	Path ABF

The above mentioned three streaming mode sequences designated Cases 1, 2 and 3 apply to both read and write operations. A parameter table is presented in Table 4-4 which specifies key parameter with respect to the following discussions.

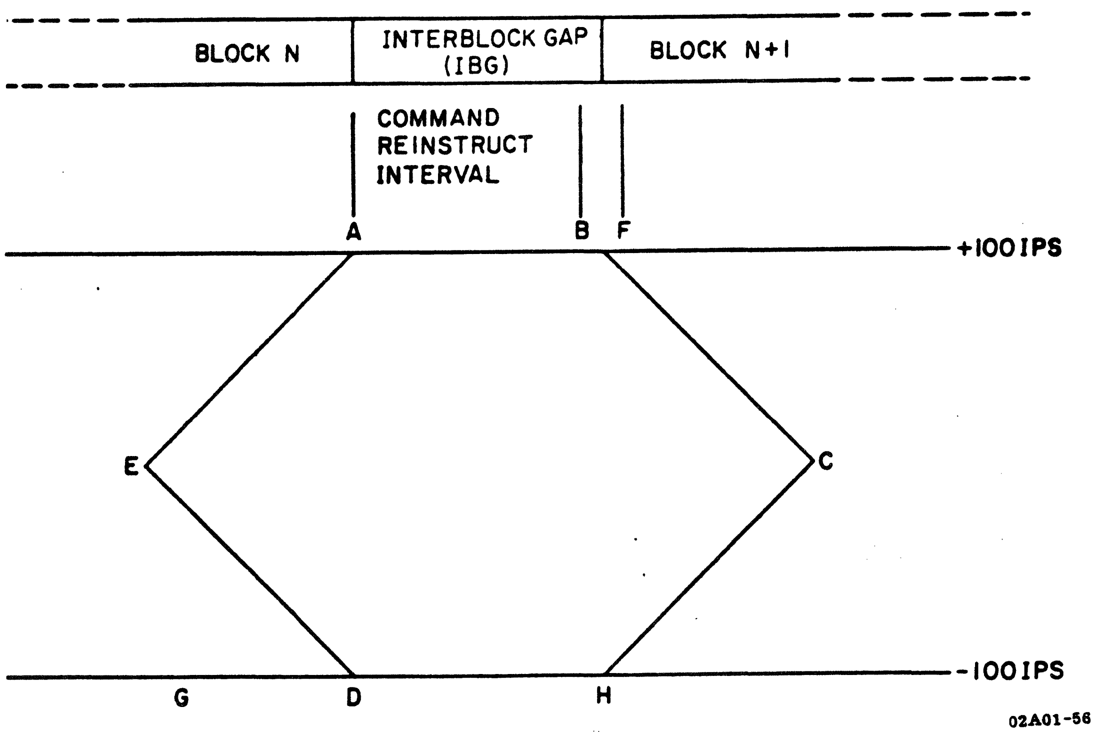


Figure 4-34. STREAMING MODE VELOCITY DIAGRAM

o Case 1 - (Non-Stop) Command Received During Reinstruction Interval. A command is received sometime during the command reinstruct period following the data operation on Block N. Note that the velocity profile at the bottom of the figure indicates that 100 ips velocity is maintained without interruption through the processing of Block N and N + 1.

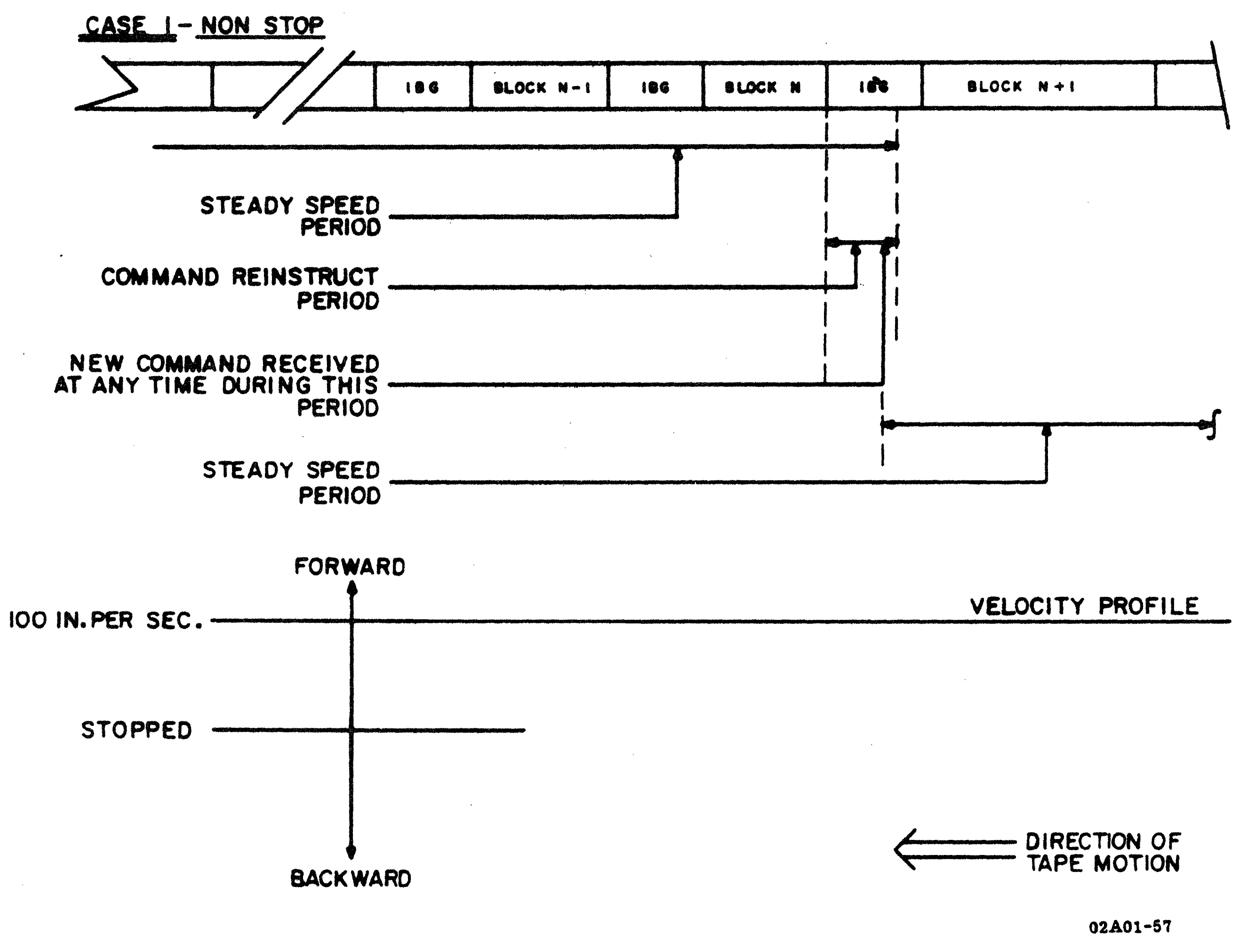


Figure 4-35. TAPE MOTION CONTROL - CASE 1

o Case 2 - (Momentary Stop) Command Received During Repositioning Cycle. A command is not received during the command reinstruct period, but is received during the repositioning cycle. Figure 4-36 illustrates the sequence of events with respect to transport motion and command transfer.

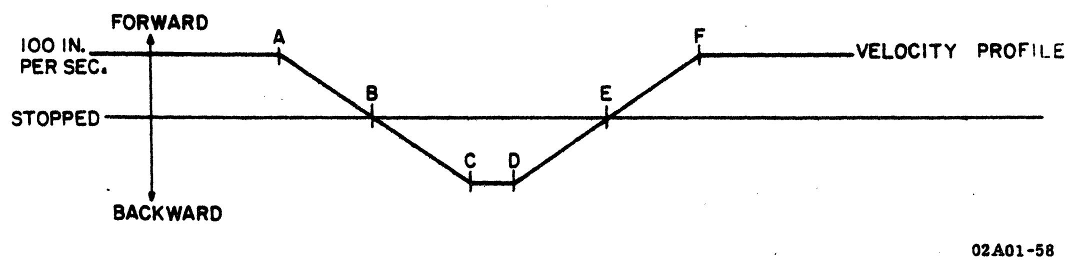


Figure 4-36. TAPE MOTION CONTROL - CASE 2

The velocity profile illustrates the tape velocity characteristics. Looking at the diagram of Figure 4-37, it shows that tape stops only momentarily to change direction. The velocity profile identifies the time sequence of events. The correspondence between the time and distance portrayals in sequence is as follows:

EVENT	VELOCITY PROFILE POSITION
Steady Speed Period	Up to Point A
Forward Motion Deceleration	A-B
Tape Motion Stopped Momentarily	B
Reverse Motion Acceleration	B-C
Full Speed Reverse Motion	C-D
Reverse Motion Deceleration	D-E
Tape Motion Stopped Momentarily	E
Forward Motion Acceleration	E-F
Steady Speed Forward Through Data Block N + 1	Point F and On

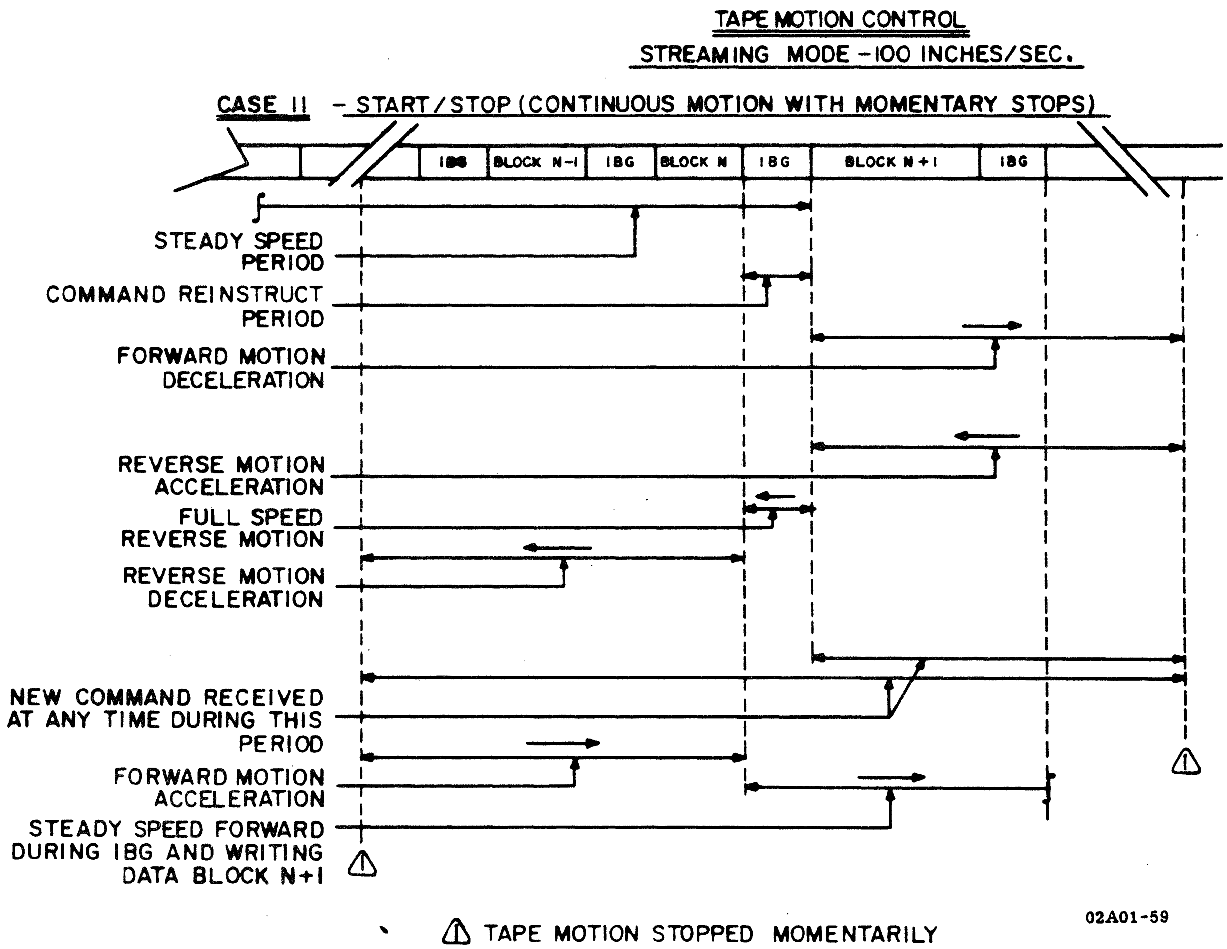


Figure 4-37. TAPE MOTION CONTROL - CASE 2 (Cont'd)

- Case 3 - (Wait For Command) Command Received Following Repositioning Cycle. Case 3 is very similar to Case 2 except that the subsequent command is not received until the tape has come to rest at point E1. The tape is not accelerated until time E2 when the new command is received. Other than for this delay in receiving the next command, the correspondence between time and distance portrayals is the same for Cases 2 and 3. Refer to Figure 4-38.

EVENT	VELOCITY PROFILE POSITION
Steady Speed Period	Up to Point A
Forward Motion Deceleration	A-B
Tape Motion Stopped Momentarily	B
Reverse Motion Acceleration	B-C
Full Speed Reverse Motion	C-D
Reverse Motion Deceleration	D-E1
Tape Motion Stopped While Awaiting New Command	E1-E2
Forward Motion Acceleration	E2-F
Steady Speed Forward Through Data Block N + 1	Point F and On

Important to note is that the transport performs all repositioning without system or interface controller intervention.

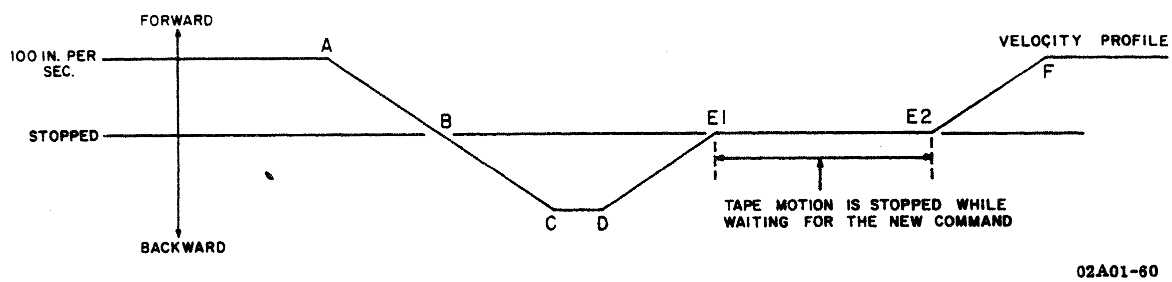


Figure 4-38. TAPE MOTION CONTROL - CASE 3

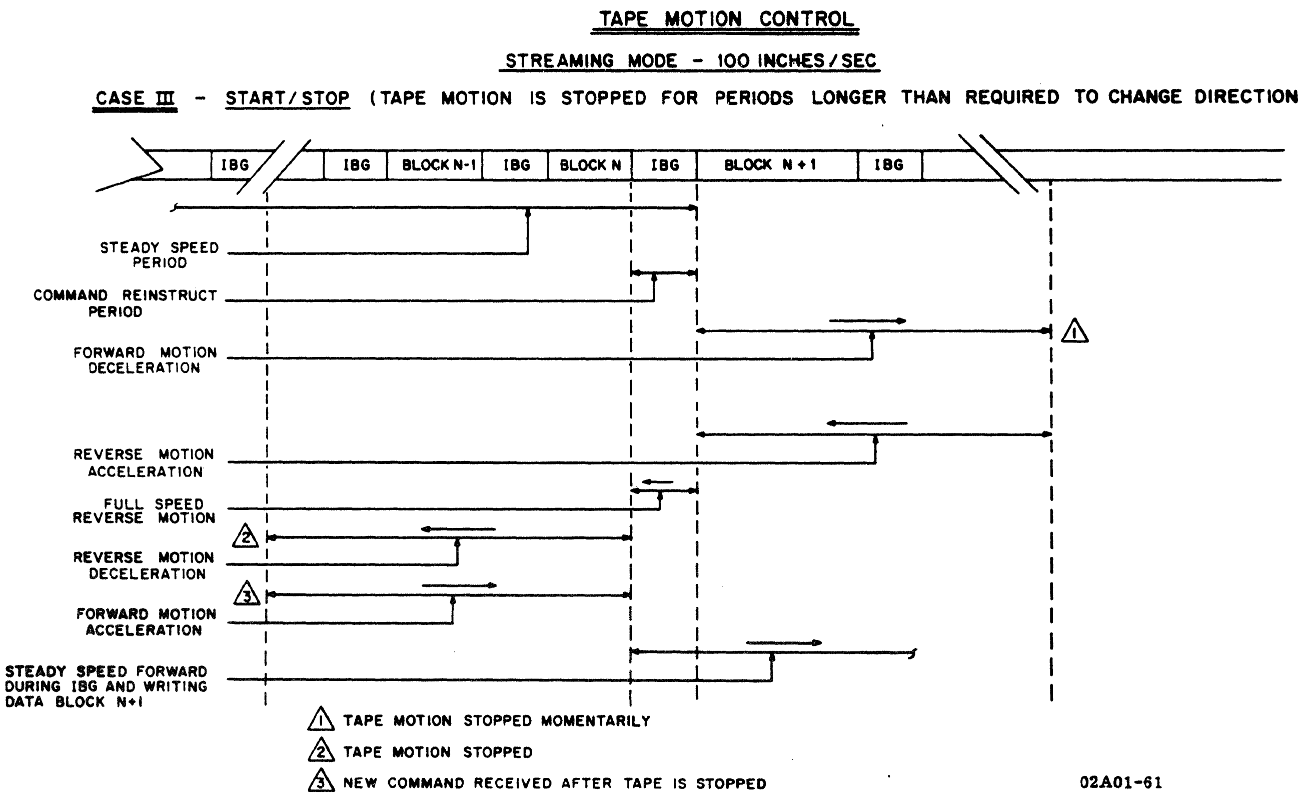


Figure 4-39. TAPE MOTION CONTROL - CASE 3 (Cont'd)

4.10.1.3 25 IPS Mode Control - The transport will automatically switch between 25 ips streaming mode and 25 ips start/stop mode in response to system usage. Essentially, when repositioning becomes excessive in streaming mode, rather than continue to 'thrash', the transport will switch to start/stop mode. The benefits of this change are significant; if the system cannot reinstruct to keep the unit streaming, a 221 millisecond reposition cycle is required before processing of next block can occur. In start/stop mode, the access time is reduced to 64 millisecond worst case (if previous block = 1 byte) and 24 millisecond if previous block was greater than 1.6K bytes long (see Note 2).

The transport will switch back to streaming mode when the command Reinstruct Time consistently reduces to a value that would allow streaming.

NOTES

1. As to avoid 'jog' delays, mode switching is done at 25 ips rather than when stationary. In essence, a mode switch takes effect at the end of the block in process.

2. If the time to traverse the preceding block, plus the reinstruct time, exceeds 60 ms, the access time will be 22 ms for Write and 24 ms for Read. The access time will be increased by the difference between 60 ms and the time to traverse the preceding block, plus the reinstruct time, if above criteria is not met.

4.10.1.4 Adaptive Velocity Control - Rather than selecting 25 ips mode when low speed is commanded, the transport enters a mode, whereby the most optimum speed will be chosen to match system requirements. If 100 ips mode gives the best throughput, then this mode will be used; the same applies to 25 ips streaming and 25 ips start/stop modes. This choice of operating mode will be done automatically and does not require any involvement by the system. This feature allows the transport to run under standard 1/2 inch tape software, and yet offer the advantage of streaming.

NOTE

1. The unit will respond to a Set 100 ips command in the normal manner.

4.10.2 Command Classification

The transport command set is categorized into five categories dealing with the type of command being executed. They are as follows:

- o Motion Control: Rewind, Speed Mode Change
- o Mode Control: On-Line, Off-Line/Rewind
- o Data Operations: Read, Write
- o Read Sense: Sense Data Transfer
- o Data Loopback: Write-to-Read Data Channel Loopback

Command Categories 1 and 2 are associated with transport control; i.e., Rewind and On-Line/Off-Line are primarily transport related. These commands are transferred by the controller by pulsing the associated interface line. Command categories 3 thru 5 are associated with the formatting/data transfer function of the transport. These commands are transferred via the -FGO strobe sampling of the interface lines identified in the transport interface section of this manual. Speed Mode Change is also strobed by -FGO, but is classified as a Motion Control command.

4.10.2.1 Interface States - There are several states within which the transport may reside during execution of data operations. These states are described in this section with respect to command transfer and interface signal conditions. Refer to Figures 4-40 thru 4-44 for an illustration of time representation of States B thru H discussed below.

- o State A - In this state, the transport is Off-Line (-FONL = False) and Selected (-FTAD0, -FTAD1); the formatter is selected (-FFAD) and enabled (-FFEN). On-Line, Data Loopback, and Sense Read commands may be issued. A Sense Read can be performed, but transport status is not available.

  In each of the following states, the transport is On-Line, Selected and Ready (-FRDY); the formatter is Selected and Enabled.

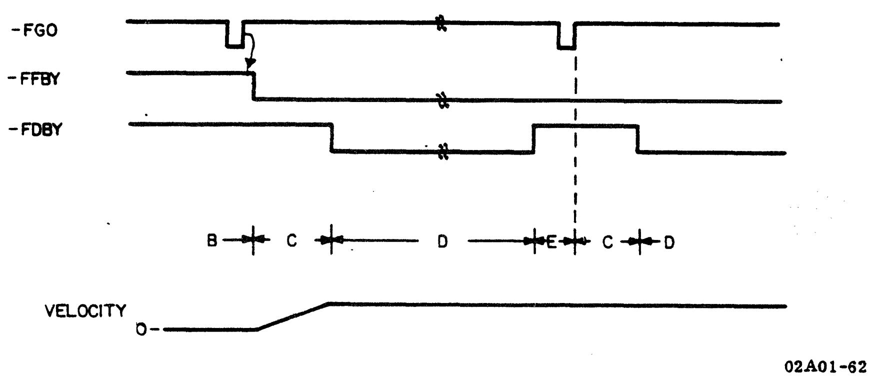


Figure 4-40. START/STOP - NEW COMMAND RECEIVED DURING REINSTRUCT

- o State B - In this state, a Command Type 1, 2, 3, 4 or 5 may be issued. Refer to Command Classification for description of command categories. Figures 4-40 thru 4-44 illustrate the transfer of a Type 3 command. For both streaming and start/stop modes, this state and its next state are the same following receipt of the FGO command.

- State C - In this state, a Type 3 command has been received. This state is identical in both the streaming and start/stop modes and is identified by the conditions of signal lines -FFBY and -FDBY. This state is entered upon receipt of the -FGO command and exited when the transport is up to speed or positioned at the beginning of the data block. No new commands should be issued while in this state.

- State D - This state represents the data transfer cycle. This state is entered upon assertion of the -FDBY signal and exited upon negation of -FDBY. -FDBY is only asserted while -FFBY is asserted. No new commands should be issued while in this state. This state is identical in both streaming and start/stop modes.

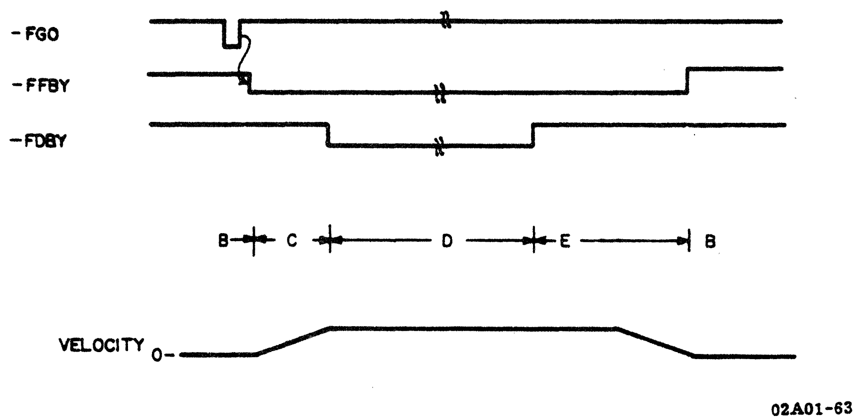


Figure 4-41. START/STOP - NO NEW COMMAND RECEIVED

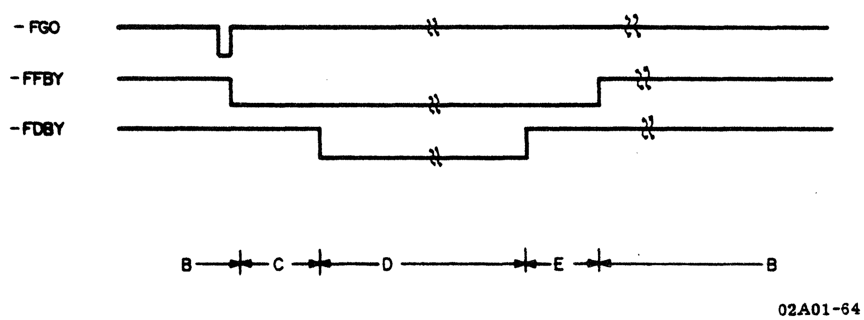


Figure 4-42. STREAMING - NO NEW COMMAND RECEIVED

- State E - This state is the reinstruct interval. Receipt of a follow-up command identical to the previous -FGO command continues tape motion at either low or high speed in streaming mode. Refer to Figures 4-40 and 4-44.

- State F - This state is unique to the start/stop mode. In this state, a new command was not received during the reinstruction interval (State E) and, consequently, tape is being decelerated to a stop. Any command issued during this time is not acted upon until State B is re-entered following the stopping of tape.

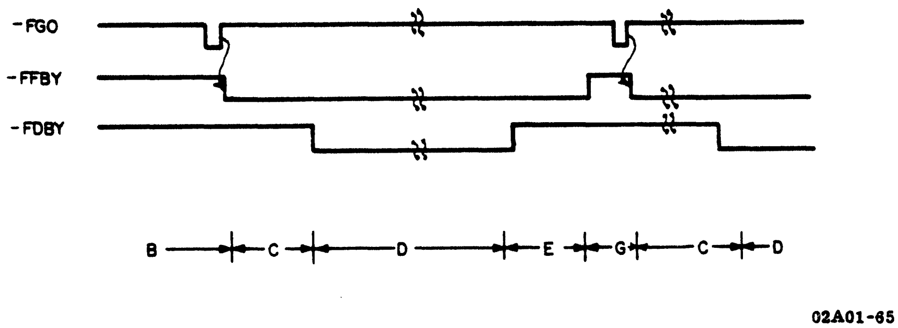


Figure 4-43. STREAMING - NEW COMMAND RECEIVED DURING REPOSITIONING

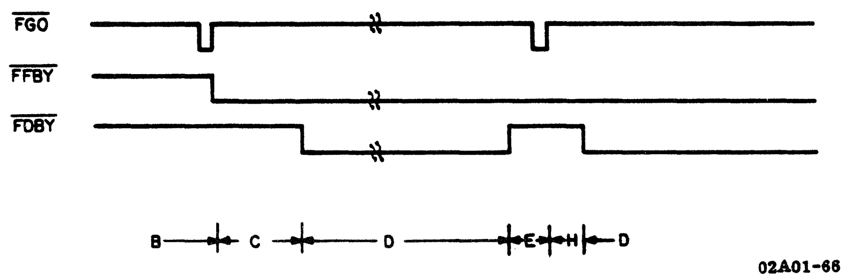


Figure 4-44. STREAMING - NEW COMMAND RECEIVED DURING REINSTRUCT

- State G - This state is unique to streaming mode. This state is entered at the expiration of reinstruct interval (State E) and represents repositioning cycle. State G is exited either upon receipt of a Type 3 command or upon completion of repositioning cycle. Refer to Figures 4-42 and 4-43.

- State H - This state is unique to the streaming mode. It is entered upon receipt of a follow-up command which continues streaming mode. In State H, -FFBY remains asserted. This state is exited upon assertion of -FDBY, indicating the beginning of the next data block.

5.1 GENERAL

This portion of the maintenance section contains instructions on how to remove and replace all field replaceable parts or assemblies. Location and identification of assemblies can be referenced to the Parts Identification Manual.

Reference into the Removal/Replacement Procedures is primarily via the diagnostic test documentation and fault code interpretation found in the TU80 Pathfinder (EK-OTU80-SV). Verification tests follow each of the replacement procedures so that the integrity of the replaced assembly can be insured, prior to returning the transport to an on-line status.

The Removal/Replacement Procedures follow a concept of modular (assembly) replacement only. Individual circuit troubleshooting or assembly repair are not recommended and are, therefore, not within the scope of this manual.

Unless otherwise specified, all procedures assume that tape has been unloaded, the transport is powered down, and the input power cord is disconnected.

The second portion of this section (paragraph 5.4) describes the TU80 diagnostic test procedures and the system tests used for both troubleshooting and operational verification of the TU80 Subsystem. Corrective action in the diagnostic section is of a general nature and should not be used exclusively for TU80 troubleshooting. Refer to the TU80 Pathfinder (EK-OTU80-SV) for more detailed procedures, test descriptions, and fault isolation.

5.2 ACCESS TO COMPONENTS

Components located at the underside of the tape deck can be accessed for maintenance purposes by first placing the tape deck in the maintenance position. Using Figure 5-1 for reference, proceed as follows:

1. Place the top cover in the fully opened position.

2. Using a 5/32 inch Allen wrench, open the front door.

3. Using a straight slot screwdriver, rotate the pawl fastener on the front left corner of the tape deck one-quarter turn counterclockwise.

4. While pressing down on the front of the tape deck, pull the spring-loaded tape deck latch out. With the latch extended, pull the tape deck upward and allow the front of the tape deck to raise.

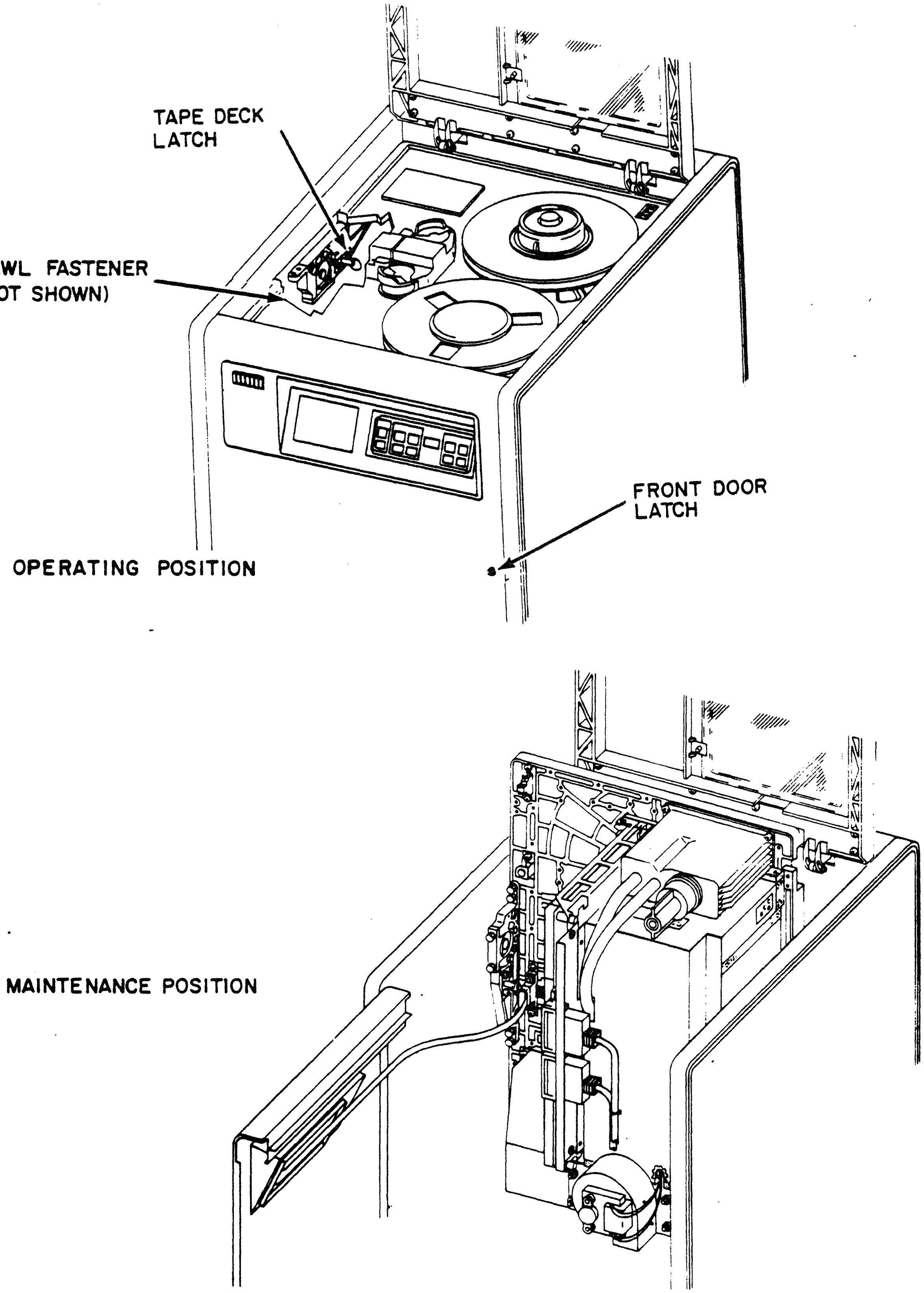


Figure 5-1. TU80 MAINTENANCE ACCESS 02A01-67

5 Release the tape deck latch and manually tilt the tape deck vertically until the latch engages and the tape deck is locked in the vertical position.

NOTE

Use care not to snag or chafe the control panel cable or any other cables when positioning the tape deck.

6. To return the tape deck to the operating position, release the tape deck latch and manually place the deck in the horizontal position until the latch engages. Secure the tape deck by turning the pawl fastener clockwise.

5.2.1 Top Cover Interlock Switch Bypass - When servicing the TU80, a Field Service Engineer may be required to operate the unit and run diagnostic tests with the top cover open. To bypass the safety interlock switch, insert the bypass tool (supplied in the TU80 CD Kit) into the interlock latch. This keeps the interlock switch depressed, simulating the "top cover closed" condition. Refer to Figure 5-1A.

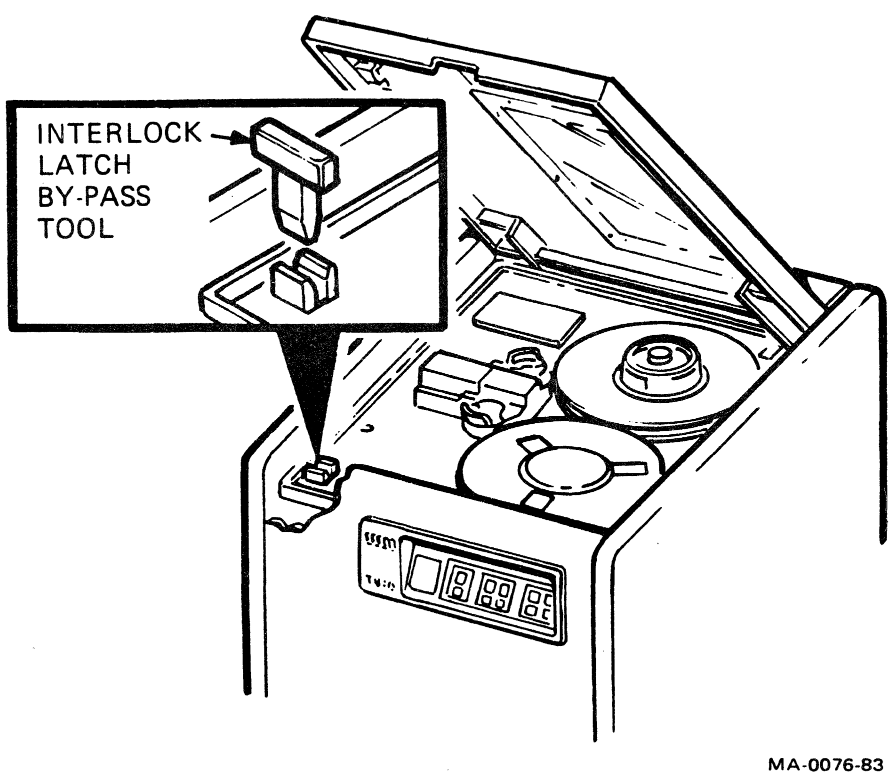


Figure 5-1A. COVER INTERLOCK BYPASS

5.3 REMOVAL/REPLACEMENT PROCEDURES

Table 5-1. REMOVAL/REPLACEMENT INDEX

5.3.1 Protective Acoustic Cover

Removal

1. Place the tape deck in the maintenance position.
2. Loosen the two screws securing each I/O interface cable connector until the connector can be removed from the logic cage bracket connector.
3. Remove both pneumatic tubes from the Pneumatic Filter Box Assembly.
4. Remove the four hex nuts securing the Cooling Fan Assembly. With the cooling fan wires still connected, position the assembly away from the acoustic cover.
5. Remove three nuts and two screws securing the cover and remove the cover assembly.

Replacement

1. Place the acoustic cover in position such that the pneumatic tubes and cooling fan wires are placed in the feed-thru holes.
2. Secure the cover with three nuts and two screws.
3. Reinstall the cooling fan and secure to the power supply cover with four hex nuts.
4. Reattach the two pneumatic tubes to the Pneumatic Filter Box Assembly. Make sure that the IN and OUT tubes are connected to the proper position.
5. Reconnect the I/O interface cables to the logic cage connector bracket.
6. Return the tape deck to the normal operating position.

5.3.2 Tape Cleaner Assembly

Removal

1. Remove the tape path and magnetic head covers from the tape deck.

2. Loosen the two pan head screws and remove the cleaner assembly from the tape deck.

3. Remove screws, lockwashers and cover plate from the blade housing.

4. Slide the platform assembly out away from the tape cleaner assembly.

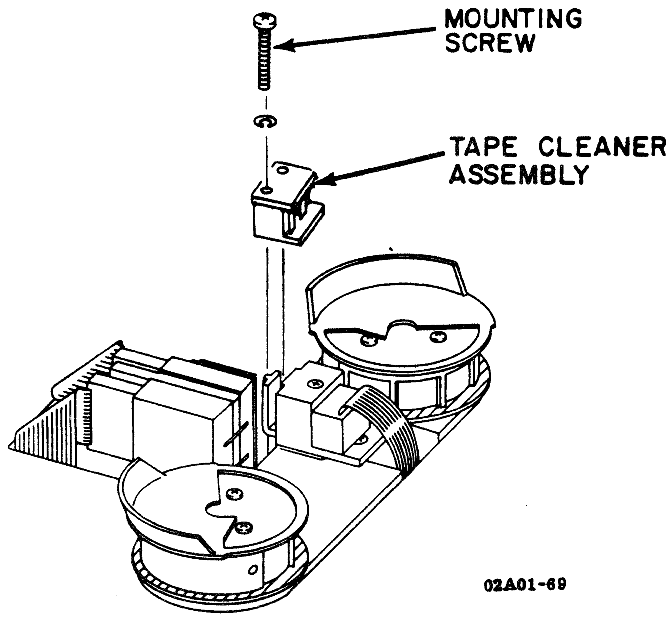


Figure 5-2. TAPE CLEANER

CAUTION

Handle the assembly with care. The cleaner blades are both brittle and sharp.

NOTE

The defective tape cleaner must be replaced as a complete assembly.

5.3.2 Tape Cleaner Assembly (Cont'd)

Replacement

1. Inspect the cleaner blades for damage. If the blades are chipped or damaged, replace the entire assembly.
2. If the blades are not damaged, clean the platform and reinstall. When installing platform, make sure that the flanges are such that the platform fits firmly inside cleaner assembly.
3. Install the cover plate, two washers and mounting screws.
4. Position the assembly onto the guide pins on the tape deck and tighten the screws.
5. Reinstall the tape path and magnetic head covers.

Verification Check

1. No functional checks are necessary.

5.3.3 Top Cover Interlock Switch

Removal

1. With the tape deck in the maintenance position, remove the four labeled slip-on connectors from the interlock switch connectors. (If any wires are not labeled, identify and mark each wire for reassembly.)

2. Remove two mounting screws securing the switch plate to the tape deck. Remove the switch and switch plate.

3. Depress the top and bottom release tabs on the switch to separate switch from the switch plate.

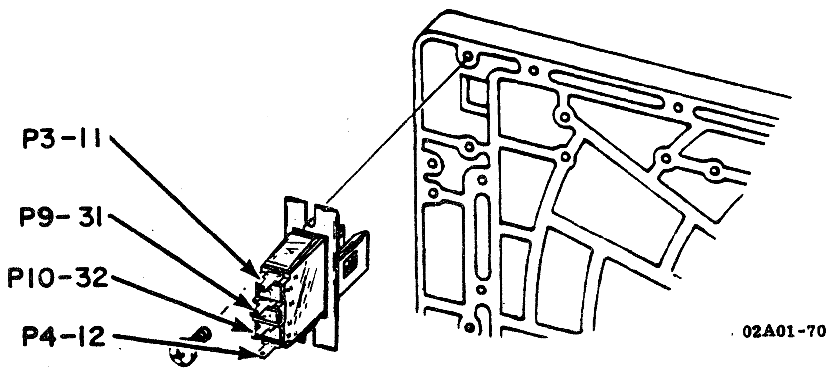


Figure 5-3. TOP COVER INTERLOCK SWITCH (MAINTENANCE VIEW)

Replacement

1. Assemble the switch to the switch plate.

2. Position the switch assembly on the rear of the tape deck so that connector numbers on the switch correspond to the numbers stencilled on the tape deck.

3. Insert two hex mounting screws. Position the top cover door so that the interlock switch can be aligned with the actuating stud on the door. Tighten the switch mounting screws when the center of the switch front is aligned with the actuating stud.

4. Attach the slip-on connectors to appropriate studs of the interlock switch. Refer to Figure 5-3 for wire and connector positions.

Verification Check

1. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

5.3.4 File Protect Sensor

Removal

1. Remove the tape reel from the supply hub.
2. Remove four mounting screws and the file protect sensor cover plate from the tape deck.
3. Remove the mounting screw and washer securing the file protect sensor to the tape deck.
4. Detach connector W3P6 from the sensor and discard the sensor.

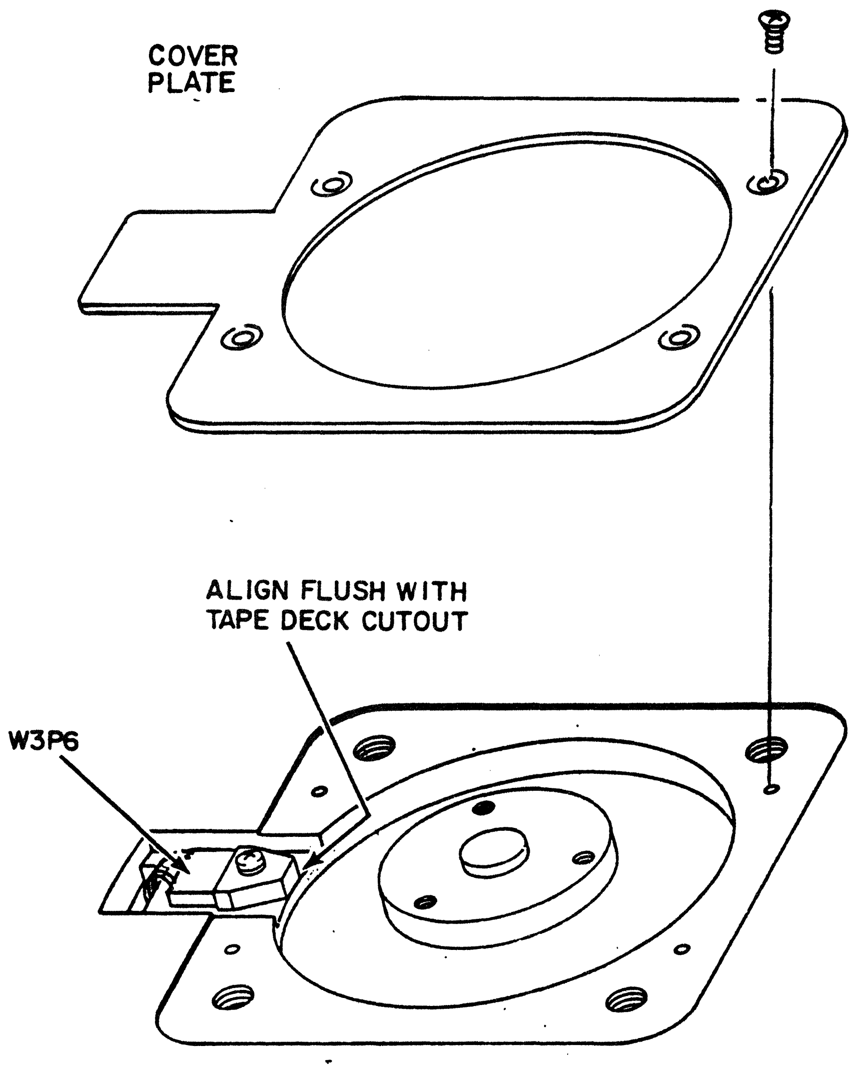


Figure 5-4. FILE PROTECT SENSOR ALIGNMENT

5.3.4 File Protect Sensor (Cont'd)

Replacement

NOTE

Refer to Figure 5-4 for sensor alignment and cable plug connection.

1. Place the sensor on the tape deck and secure with the mounting screw and washer.

2. Attach the W3P6 cable plug to the sensor pins.

3. Reinstall sensor cover plate and secure to the tape deck with four mounting screws.

Verification Checks

1. Thread a write enabled tape and perform a load operation. Observe that the FILE PROT LED is extinguished.

2. Unload tape and remove the write enable ring. Thread tape, perform a load operation, and observe the FILE PROT LED to be illuminated.

5.3.5 EOT/BOT Sensor Assembly

Removal

1. Remove the tape path and magnetic head covers from the tape deck.

2. Disconnect the W3P1 plug from the EOT/BOT assembly.

3. Remove the flat head phillips mounting screw from the assembly base-mount and then lift the assembly from the tape deck.

NOTE

The defective sensor must be replaced as a complete assembly.

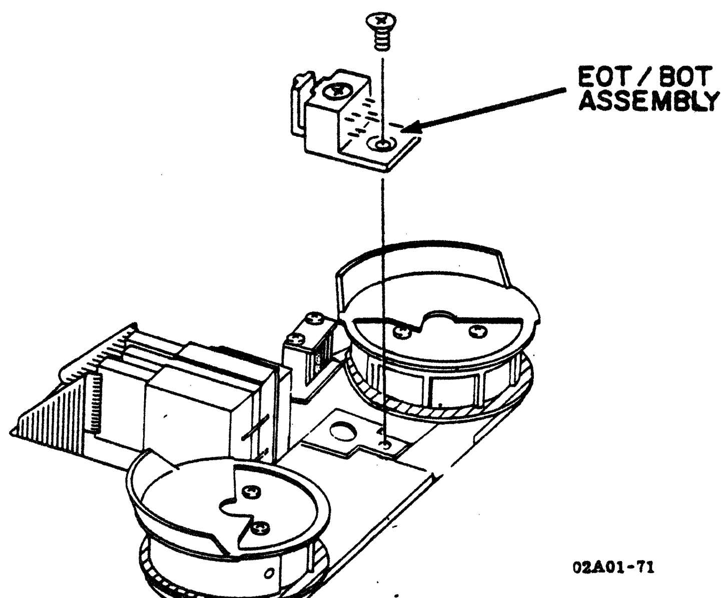


Figure 5-5. EOT/BOT SENSOR

Replacement

1. Position the EOT/BOT assembly onto the tape deck and install the flat head mounting screw.

2. Thread tape onto the take-up reel and adjust the EOT/BOT assembly so that the assembly is aligned perpendicular to the tape.

5.3.5 EOT/BOT Sensor Assembly (Cont'd)

3. Tighten the flat head mounting screw.

4. Reattach the W3P1 plug to the assembly connector as shown. If excess cable exists, position the cable so that the excess is at the rear of the tape deck.

5. Install the tape path and magnetic head covers.

Verification Checks

NOTE

If available, use a 600 foot reel of tape with properly installed EOT/BOT markers to reduce test time.

1. Load a reel of tape onto the supply hub and thread tape so that the BOT marker is located before the EOT/BOT assembly.

2. Perform a load operation and observe that the tape loads and positions itself at the BOT marker (the BOT indicator illuminates).

3. Execute Field Service Test #44 to verify operation of the EOT sensor.

5.3.6 Hub Assembly - Take-Up Reel

Removal

1. Remove four mounting screws from the take-up reel hub cover and remove the cover from the hub assembly.
2. Remove three allen screws, lockwashers and plain washers securing the reel to the motor shaft assembly.
3. Remove the take-up reel from the transport.

Replacement

CAUTION

If a new reel is being installed, inspect the reel edges for burrs or cracks that could cause tape damage.

1. Perform Removal procedure in reverse order.

Verification Checks

1. Manually rotate the tape reel to ensure that the reel does not contact tape deck.
2. Load a known good reel of tape and observe the reel during tape motion. Tape should not contact the reel flanges.

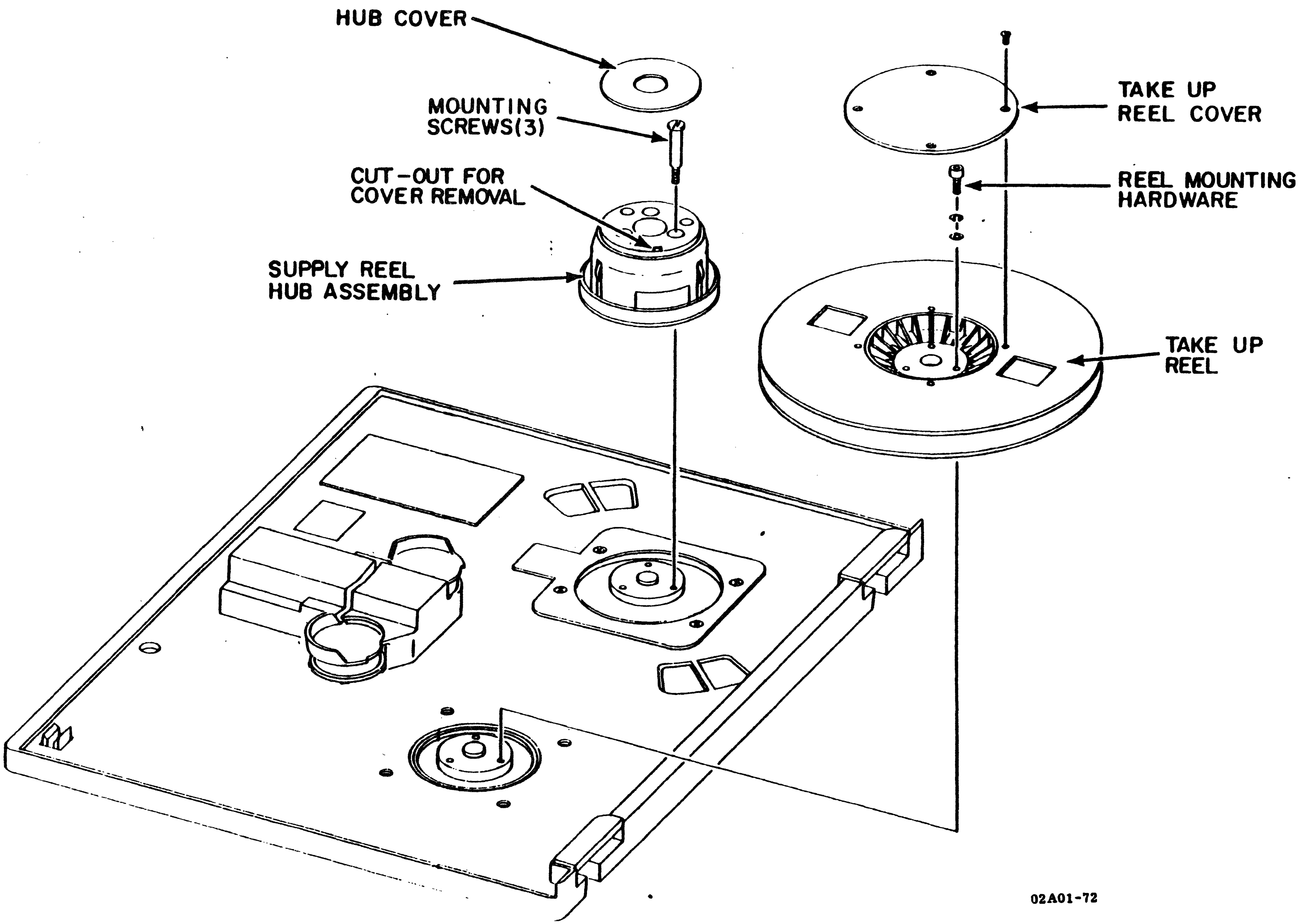


Figure 5-6. Take-Up Reel/Supply Hub Assemblies

5.3.7 Motor Assembly - Take-Up Reel

Removal

1. Perform the Removal procedure for the Hub Assembly - Take-up Reel.
2. Place the tape deck in the maintenance position and remove the acoustic cover (paragraph 5.3.1).
3. Detach the W4P2 connector from the tach assembly on the take-up motor.
4. Detach the B3P1 connector from the Power Amplifier Module (connector J1 on the power amplifier).
5. Remove four mounting screws securing the motor to the tape deck. Remove the motor from the transport.

Replacement

NOTE

The reel motor and tach must be replaced as an assembly.

CAUTION

When installing the motor, make sure there are no loose wires between the motor mounting plate and tape deck.

1. Position the motor on rear of the tape deck so that the B3P1 cable extends from lower right. Secure the motor with four mounting screws.
2. Connect B3P1 to J1 on the Power Amplifier Module.
3. Connect W4P2 to the tach assembly on the motor.
4. Reinstall the acoustic cover and return the tape deck to the operating position.
5. Perform the Replacement procedure for the Hub Assembly - Take-up Reel.

Verification Check

1. Thread tape (not loaded) and execute Operator Diagnostic Test #01.

5.3.8 Hub Assembly - Supply Reel

Removal (Refer to Figure 5-6)

1. Press the center button on the hub to put the hub into the unlatched position.
2. Locate the slot opening on the periphery of the cover. Insert a small blade screwdriver into the slot and twist to unsnap the cover from the hub assembly.
3. Place the hub assembly in the latched position by depressing the cam carrier.

CAUTION

Make sure that the hub is latched before proceeding with further removal. If the hub is unlatched, piece parts may disassemble.

4. Remove three large shoulder screws from the cam carrier. The hub assembly can then be removed from the tape deck.

Replacement

1. Position the hub assembly onto the motor shaft assembly and secure with three large shoulder screws.
2. Install the cover on the face of the hub assembly.

Verification Checks

1. Mount the tape reel onto the hub assembly. Reel should mount easily onto the hub and against the bottom flange.
2. Latch the reel onto the hub. Make sure the reel is securely fastened.
3. Load a known good quality tape and observe the reel during tape motion. Tape should not contact the reel flanges.
4. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

5.3.9 Motor Assembly - Supply Reel

IMPORTANT

The supply reel motor assembly is not supplied as part of the spare parts list: the spared take-up reel motor assembly must be disassembled and the motor used as a replacement for the supply motor.

Removal

1. Perform the Removal procedure for the Supply Reel Hub Assembly (paragraph 5.3.8). Place the tape deck in the maintenance position and remove the acoustic cover.

2. Detach the B1P1 connector from J3 on the Power Amplifier Module.

3. Remove the four mounting screws and tach cover from the motor.

4. Detach the W3P5 connector from the tach assembly on the motor.

5. Remove four mounting screws securing the motor to the tape deck. Remove the motor from the tape deck.

6. Remove the mounting screw and the sensor from the mounting plate on the supply reel motor. Retain for reuse.

7. Loosen two set screws securing the tach to the motor shaft and remove the tach from the shaft. Retain for reuse.

8. Remove four screws securing the mounting plate and remove the plate from the supply reel motor. Retain for reuse.

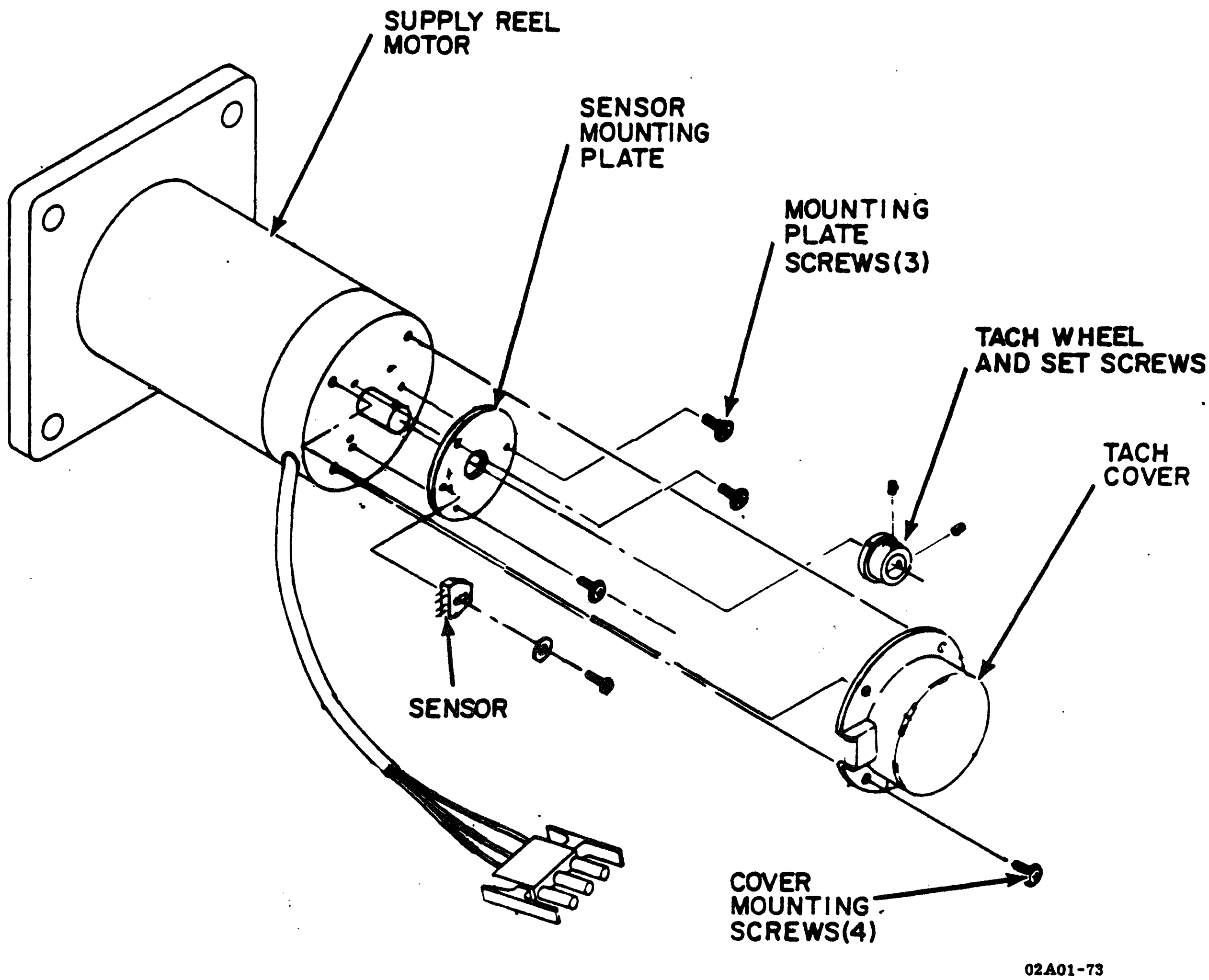


Figure 5-7. SUPPLY MOTOR ASSEMBLY

5.3.9 Motor Assembly - Supply Reel

Removal (Cont'd)

9. Disassemble the spared Take-Up Reel Motor Assembly as follows: (Refer to Figure 5-8)

   a. Remove two mounting screws and the tach cover from the motor assembly.

   b. Remove two mounting screws securing the tach sensor to the reel motor. Remove the tach sensor from the reel shaft and the tach wheel.

   c. Loosen the set screw and remove the tach wheel from the motor shaft.

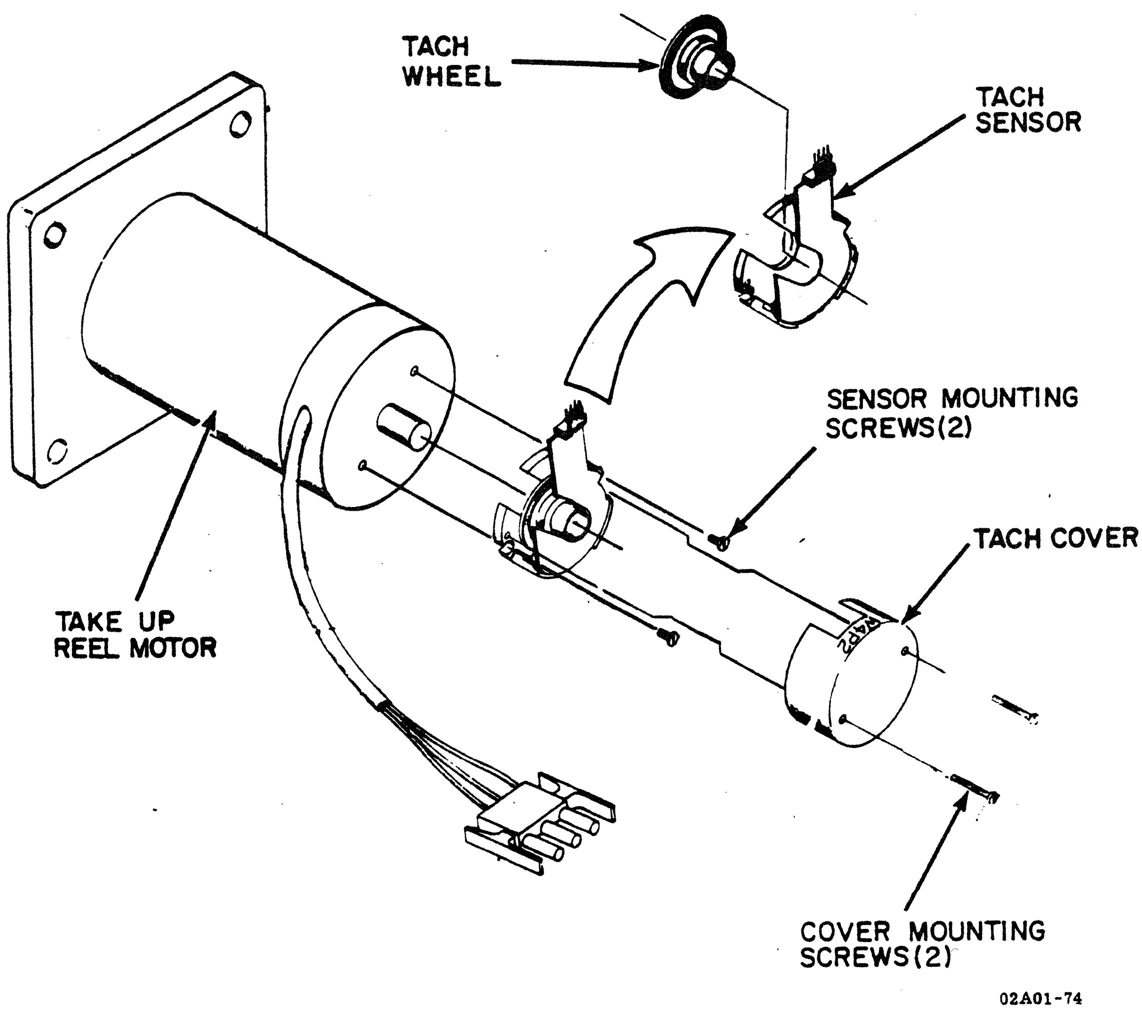


Figure 5-8. TAKE-UP REEL DISASSEMBLY

5.3.9 Motor Assembly - Supply Reel (Cont'd)

Replacement

1. Place the mounting plate (from step 8 of Removal) onto the rear of the new motor and secure with four mounting screws.

2. Assemble the sensor and tach wheel (from steps 6 and 7 of Removal) onto the motor mounting plate and shaft as shown in Figure 5-9 and adjust per paragraph 5.3.10 Replacement.

CAUTION

When installing the new motor, make sure there are no loose wires between the motor mounting plate and the tape deck.

3. Position the motor on the rear of the tape deck so that the B1P1 cable extends from the right. Secure the motor with four mounting screws.

4. Connect B1P1 cable to J3 on the Power Amplifier Module.

5. Attach the W3P5 connector to the tach sensor pins as shown in Figure 5-9.

6. Install the tach cover and secure with four mounting screws.

7. Reinstall the acoustic cover and return the tape deck to the operating position.

8. Perform the Replacement procedure for the Hub Assembly - Supply Reel.

Verification Check

1. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

5.3.10 Tach and Sensor - Supply Motor

Removal

1. Place the tape deck in the maintenance position.
2. Remove four mounting screws and the tach cover from the supply motor.
3. Detach the W3P5 connector from the sensor pins.
4. Remove the mounting screw and the sensor from the mounting plate.
5. Loosen two set screws securing the tach to the motor shaft and remove the tach.

Replacement (Refer to Figure 5-9)

1. Insert the tach wheel on the motor shaft. Position the tach for a 0.030 ± 0.005 inch clearance between the tach and the sensor mounting plate.
2. Install the sensor on the mounting plate and position for a clearance of 0.150 ± 0.01 inch between the sensor and the tach. Tighten the sensor mounting screw.

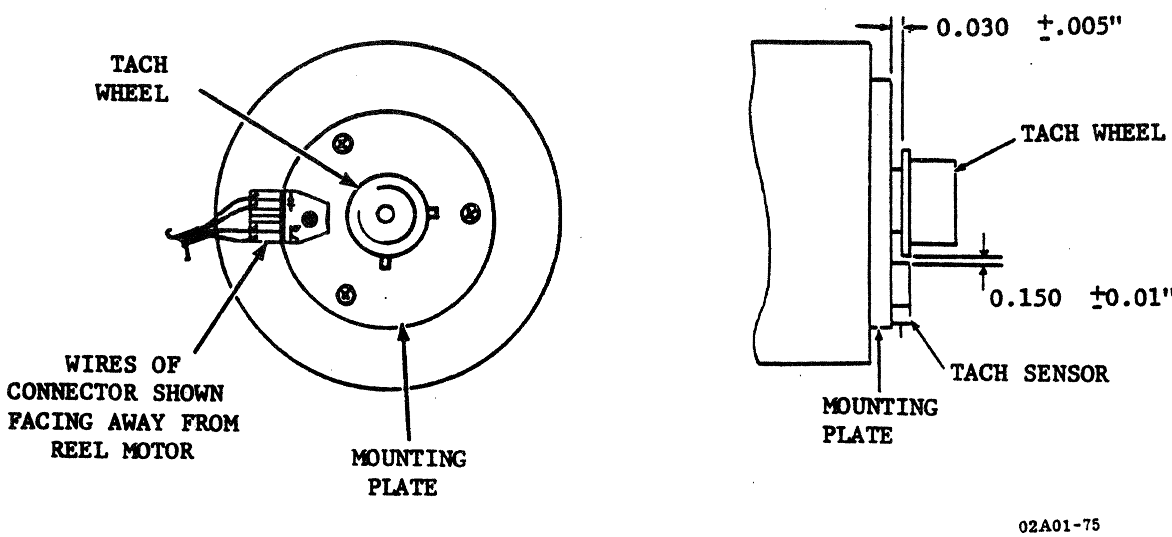


Figure 5-9. TACH WHEEL/SENSOR ALIGNMENT

5.3.10 Tach and Sensor - Supply Motor

Replacement (Cont'd)

3. Attach the W3P5 connector to the sensor pins.

4. Install the tach cover and secure with four mounting screws.

5. Return the tape deck to normal operating position.

Verification Check

1. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

5.3.11 Air Bearing Sensor - Front and Rear

Removal

NOTE

Replacement parts for air bearing assembly are contained in Refurbishment Kit P/N 29-24359. This kit contains an upper and lower spring guide, sensor, and a small and large "O" ring. If sensor is being replaced, it is recommended that upper and lower spring guides and large and small "O" rings also be replaced.

1. Place the tape deck in the maintenance position and remove the acoustic cover.
2. Remove the P1 connector from the sensor pins.
3. Remove the socket head mounting screws and washers from the air bearing assembly (the tape path cover on the top of the tape deck will hold the air bearings in place at this time).
4. Return the tape deck to the operating position.
5. Remove the tape path cover and lift the air bearings away from the tape deck.
6. Remove the "O" ring from the air bearing housing.
7. Remove two socket head screws and washers securing the sensor to the rear of the air bearing. Remove the sensor and the small "O" ring from the bearing housing.
8. Replace the upper and lower spring guides as described in paragraph 5.3.12.

Replacement

1. Insert a new small "O" ring in the aperture at the rear of the air bearing housing.
2. Position the sensor on the air bearing so that the connector pins are positioned towards the outside of air bearing. Secure the sensor with mounting screws and washers.

5.3.11 Air Bearing Sensor

Replacement (Cont'd)

3. Insert a large "O" ring into the aperture at the rear of the air bearing housing.

4. Place the air bearing assembly onto the tape deck using locating pin for positioning. Install the tape path covers to hold the air bearings in position.

5. Place the tape deck in the maintenance position. Secure the air bearings with mounting screws and washers.

6. Reattach the connector to the sensor pins. Refer to Figure 5-10 for pin orientation.

7. Return the tape deck to the operating position.

Verification Check

1. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

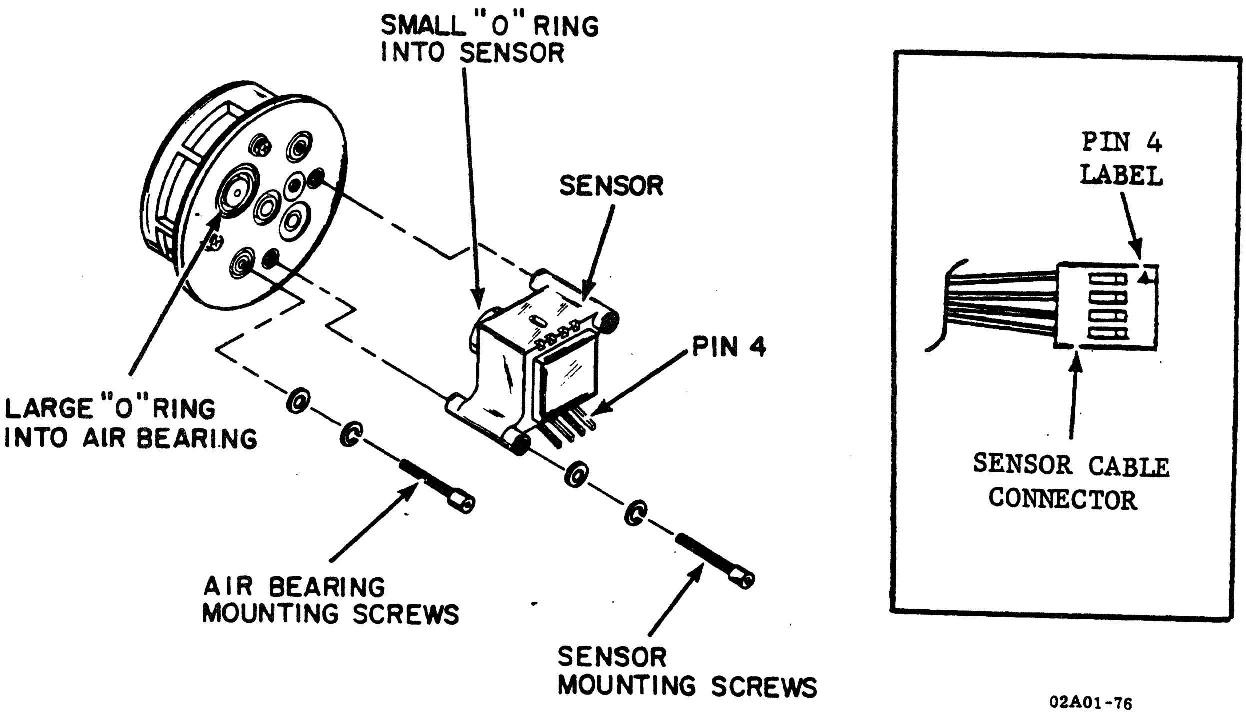


Figure 5-10. AIR BEARING SENSORS

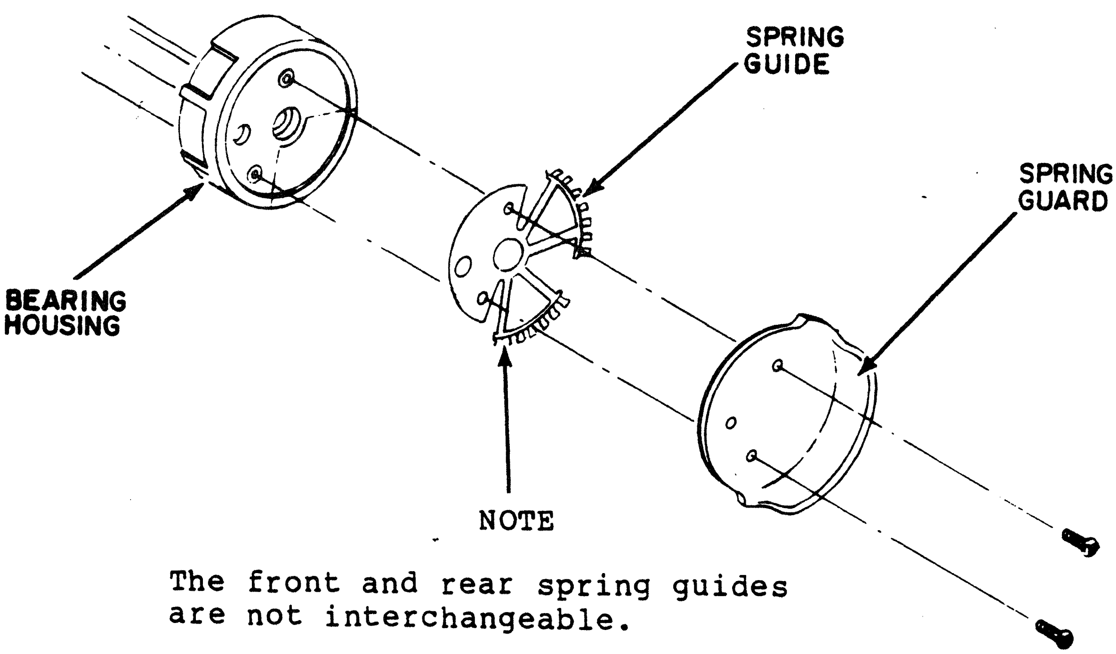
5.3.12 Air Bearing Spring Guide - Front and Rear

Removal

NOTE

Replacement parts for the air bearing assembly are contained in Refurbishment Kit P/N 29-24359. This kit contains an upper and lower spring guide, sensor, and a small and large "O" ring. If a spring guide is being replaced, it is recommended that both upper and lower guides be replaced.

1. Remove the tape path and magnetic head covers from the tape deck.
2. Remove two phillips head screws securing the rear spring guide and guard to the bearing housing.
3. Remove the spring guard and guide from the housing.
4. Repeat steps 2 and 3 to remove the front spring guide.



NOTE

The front and rear spring guides are not interchangeable.

Figure 5-11. AIR BEARING SPRING GUIDE

5.3.12 Air Bearing Spring Guide (Cont'd)

Replacement

1. Place the new rear spring guide (P/N 29-24218) and guard into the bearing housing. Holes for mounting screws provide positive alignment of both piece parts to the housing.

2. Secure the guide with two phillips head screws.

3. Repeat steps 1 and 2 using spring guide (P/N 29-24226) to replace the front spring guide.

4. Reinstall the tape path and magnetic head covers on the tape deck.

Verification Checks

1. With tape threaded, but no loaded, execute Operator Diagnostic Test #01.

2. Visually observe tape for no tape edge damage.

5.3.13 Pneumatic Pump Assembly

Removal

1. Place the tape deck in the maintenance position.
2. Detach the two pneumatic tubes from the Filter Box Assembly.
3. Remove the acoustic cover to access the pneumatic pump (refer to paragraph 5.3.1).
4. Detach the P1 connector from W4P4 on the power supply.
5. Remove the pneumatic tube connected from the tape deck nipple to the pneumatic pump.

NOTE

Detach any wiring that may interfere with removal of the Pneumatic Pump Assembly.

6. Remove four mounting screws securing the pneumatic assembly to the tape deck. Carefully withdraw the assembly from the transport.

Replacement

1. Position the Pneumatic Pump Assembly to the rear of the tape deck and secure with washers and mounting screws.
2. Reattach the pneumatic tubes from the compressor to the tape deck nipple.
3. Attach the P1 connector to W4P4 on the power supply. Reattach any wiring that was disconnected prior to Removal procedure.
4. Reinstall the acoustic cover and reattach the two pneumatic tubes to the Filter Box Assembly.

NOTE

Make sure that the IN and OUT tubes are attached to the proper nipples.

5. Return the tape deck to the operating position.

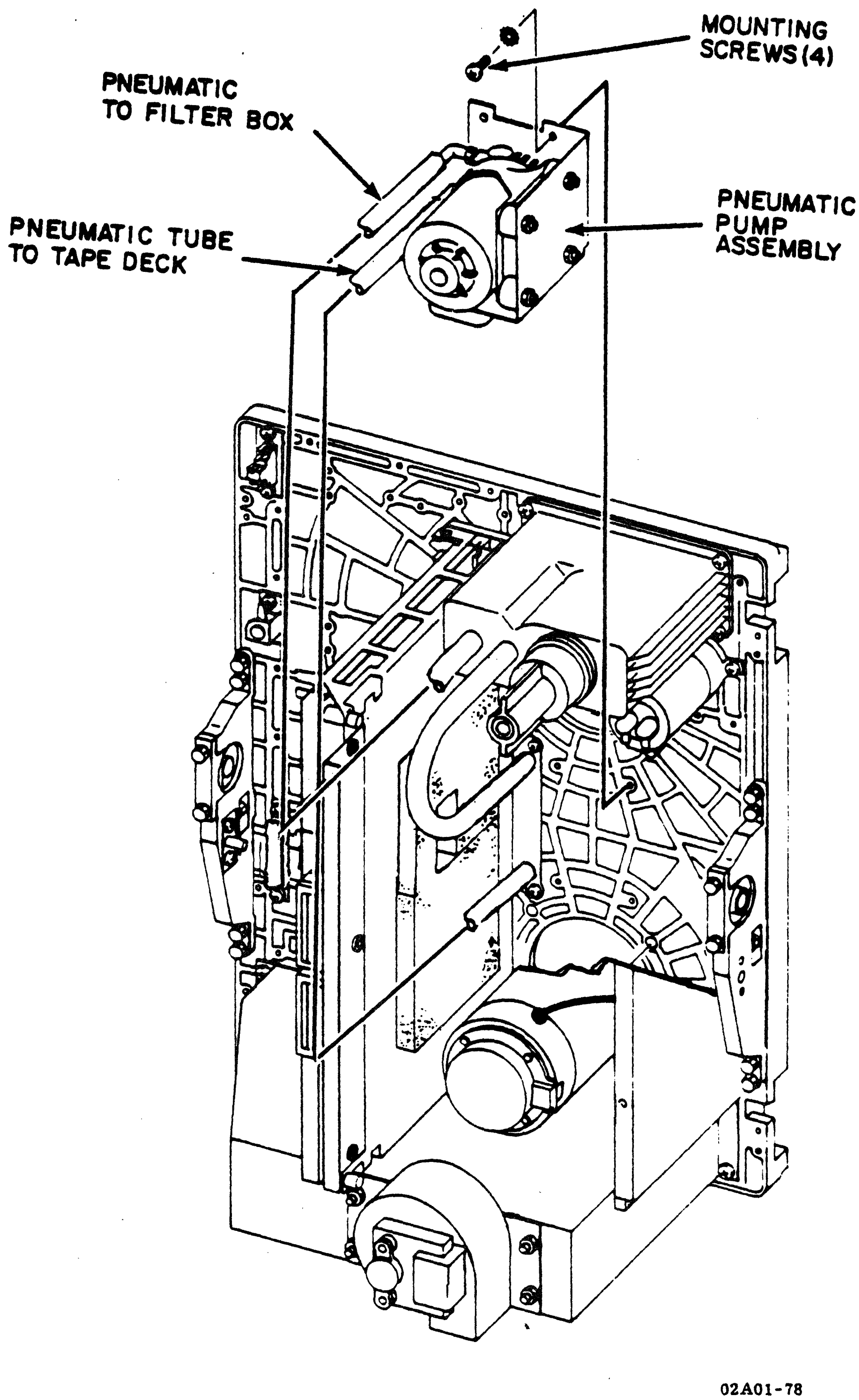


Figure 5-12. PNEUMATIC PUMP ASSEMBLY

5.3.14 Pressure Regulator and Filter Assembly

Removal

NOTE

If only the pressure regulator is being replaced, perform Removal steps 1 and 2, Replacement steps 4 and 5, and Verification Check. If the filter is being replaced, perform entire Removal/Replacement and Verification Check procedures.

1. Place the tape deck in the maintenance position.
2. Remove the pressure regulator by unscrewing the regulator from Filter Box Assembly.
3. Remove the two pneumatic tubes from the IN and OUT nipples on the filter box.
4. Remove four mounting screws securing the filter box and remove the filter box from the tape deck.
5. Remove the filter from the filter box.

Replacement

1. Position the filter into the filter box.
2. Secure the filter box to the tape deck with four mounting screws.
3. Install the two pneumatic tubes on the IN and OUT nipples.
4. Screw the pressure regulator clockwise onto the filter box assembly.
5. Return the tape deck to the operating position.

Verification Check

1. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

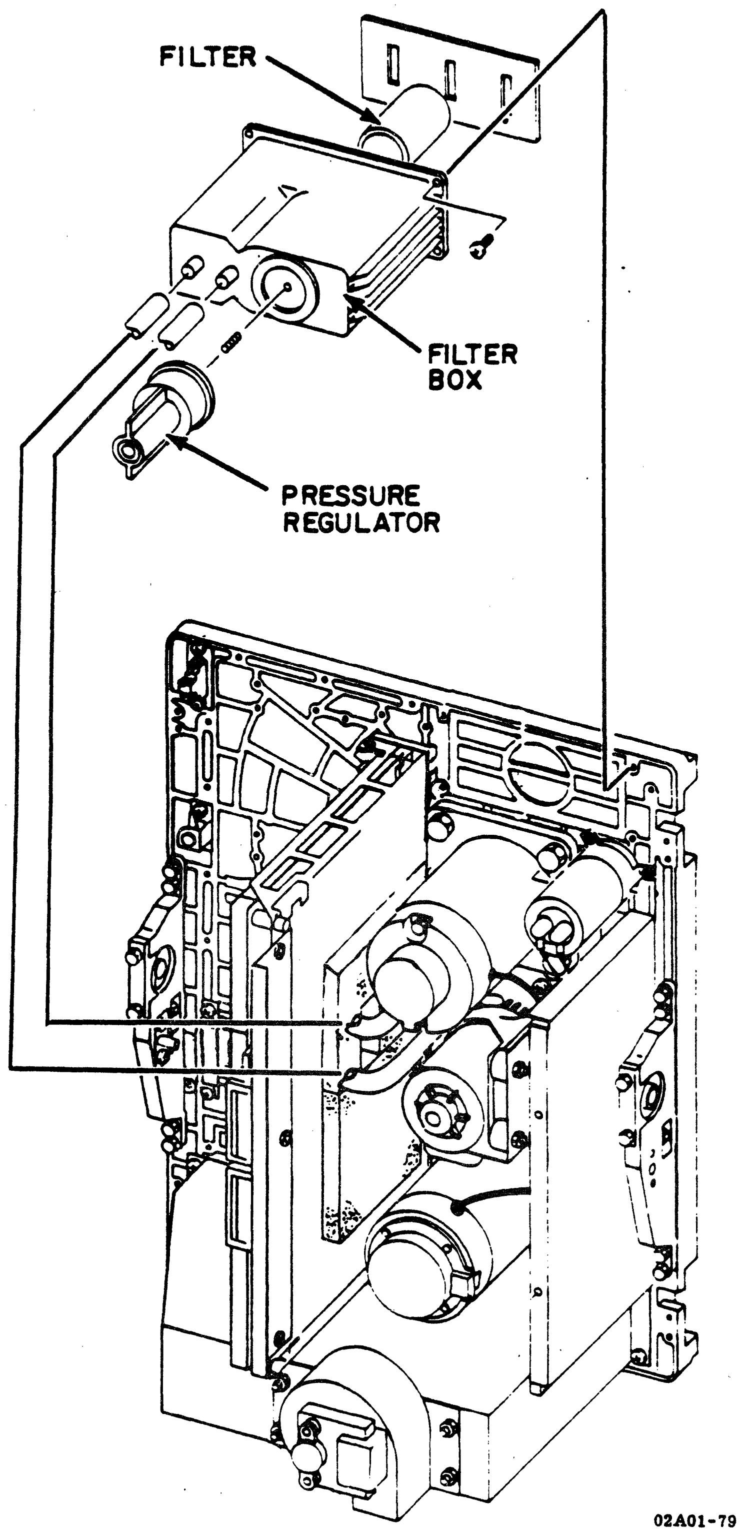


Figure 5-13. FILTER BOX ASSEMBLY

5.3.15 Magnetic Head Assembly

CAUTION

The magnetic head and two write resistors (R224/R225) are matched components. If the head is being replaced, the write resistors must be replaced also. Resistors are supplied with the new head and are labeled with the head serial number, resistor "R" number (R224 or R225), resistor value, and equivalent write current and DC voltage.

NOTE

When replacement of the magnetic head is indicated, it is recommended that the tape cleaner assembly also be replaced.

Removal

1. Remove the tape path and magnetic head covers from the tape deck.
2. From the top of the tape deck, detach the read head connector W6P1, write head connector W5P1, and erase head wires P3/P4 from the magnetic head.

NOTE

Before removing the head, tape a piece of soft, non-sticking material across recording surface.

3. Place the tape deck in the maintenance position and remove the acoustic cover (paragraph 5.3.1).
4. Move the read, write, and erase connectors away from the magnetic head.

5.3.15 Magnetic Head Assembly

Removal (Cont'd)

CAUTION

Refer to Figure 5-14 for location of head mounting screws. DO NOT loosen the factory head alignment screws.

5. Loosen the four head mounting screws. Hold the head against the tape deck while removing the four mounting screws, lockwashers, and flatwashers.

6. Carefully withdraw head fı

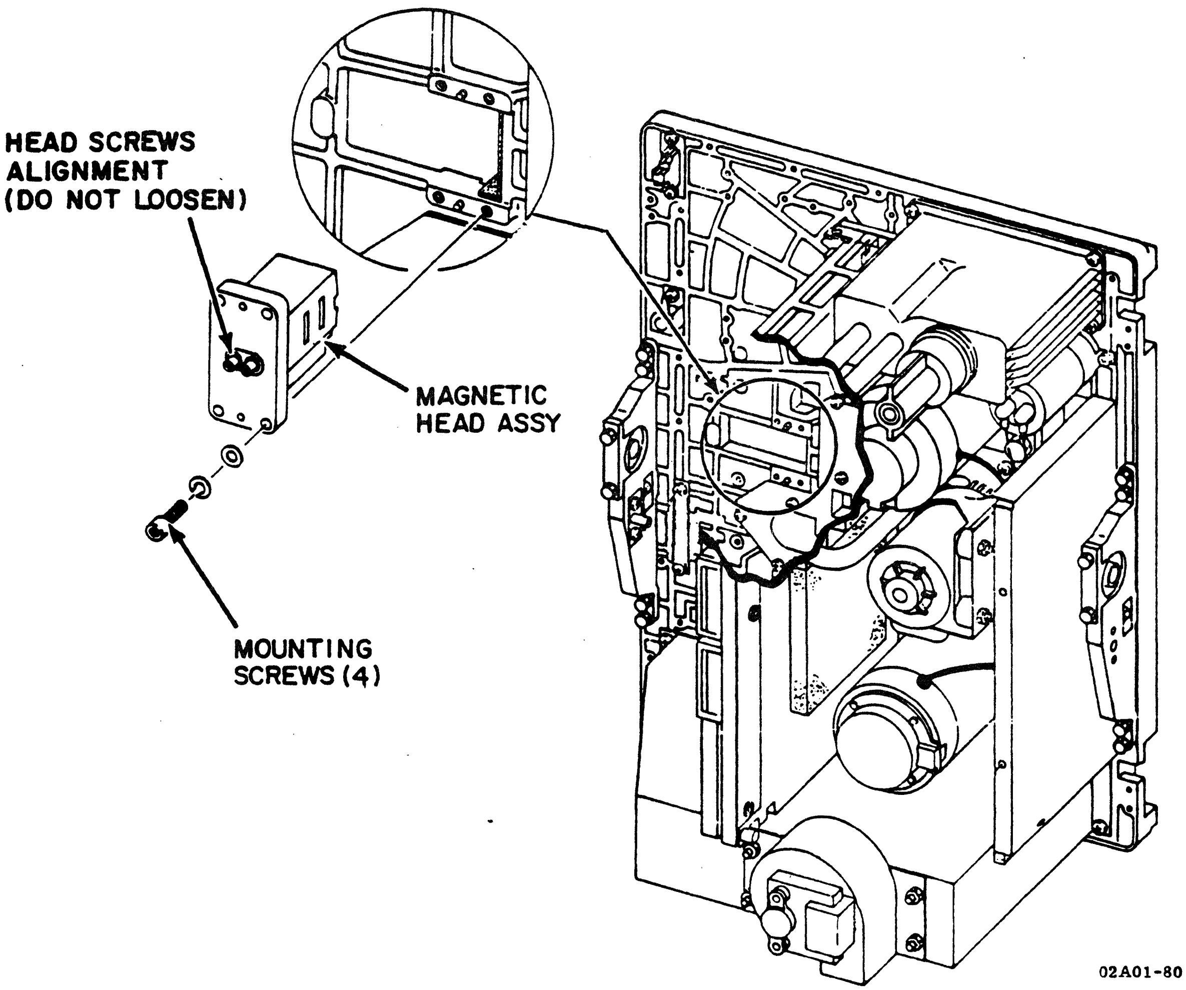


Figure 5-14. MAGNETIC HEAD ASSEMBLY

5.3.15 Magnetic Head Assembly

Removal (Cont'd)

7. Remove write resistors R224 and R225 from the Read/Write/Servo Module at location F17. Resistors can be removed without removing the module from the logic cage.

NOTE

Keep the magnetic head and the write resistors together as a package, if the head is being returned to factory.

Replacement

1. Install new write resistors R224 and R225 onto Read/Write/ Servo Module. Refer to Figure 5-16 for resistor locations.

NOTE

Before installing the magnetic head, insure that the recording surface is protected with soft material.

2. Install the magnetic head through the tape deck and position the mounting surface onto the guide pins.
3. While holding the head in place, insert flatwashers, lockwashers, and mounting screws. Tighten the four mounting screws.
4. Place the read and write/erase cables through the tape deck.
5. Reinstall the acoustic cover and place the tape deck in the operating position.
6. From the top of the tape deck, attach the read, write and erase connectors to the magnetic head (see Figure 5-15). Remove the recording surface covering.

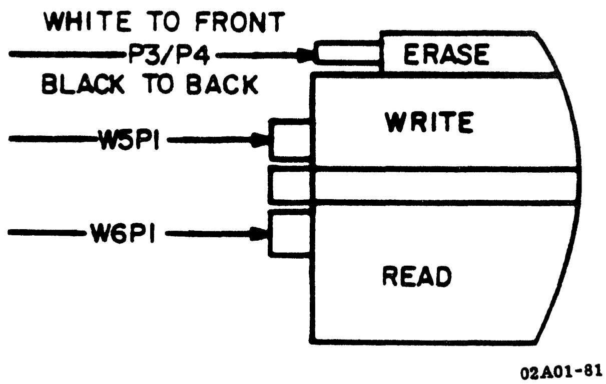


Figure 5-15. MAGNETIC HEAD CONNECTORS

Verification Checks

1. Clean the magnetic head recording surface with a soft lint-free cloth moistened with tape transport cleaner (TUC01). Wipe the recording surface in the same direction as tape motion. Reinstall the tape path and magnetic head cover.

2. Load a good quality, write enabled scratch tape and execute Field Service Test #18 to move tape away from BOT. Press RESET to stop tape after approximately 5 seconds.

3. Move the jumper plug at location 13E on the Read/Write/ Servo Module from the normal W3 position to the test W4 STORE.

4. Execute Field Service Test #31.

5. After the test is successfully completed (display 00), return the jumper plug from the W4 STORE to the normal W3 position before the unit is powered down.

6. With tape still threaded, but not loaded, execute Operator Diagnostic Test #01.

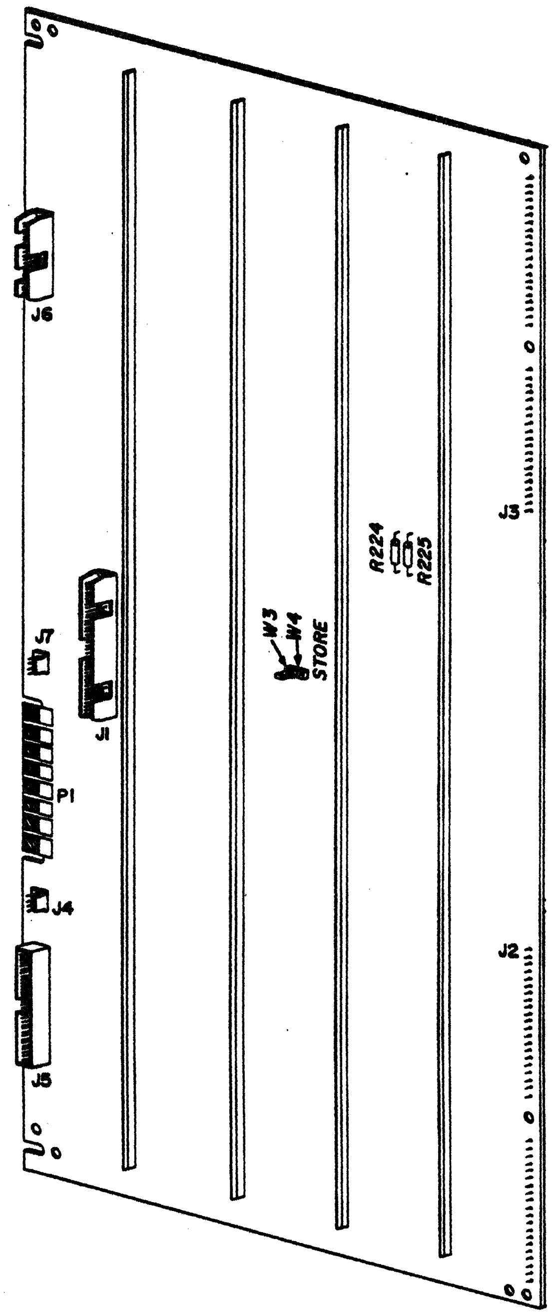


Figure 5-16. READ/WRITE/SERVO MODULE

5.3.16 Control Panel Assembly

Removal

1. Place the tape deck in the maintenance position.

2. Loosen the top and bottom thumb screws on the logic rack bracket and swing modules open to access the component side of the Formatter/Control module.

3. Remove the control panel cable connector from P7 of the Formatter/Control module.

4. Remove the cable from any cable restraints on the tape deck and cabinet frame.

5. Remove the four mounting screws and ground strap from the control panel bracket.

6. Remove the bracket from the door assembly.

7. Remove the push-in clips securing the control panel to the mounting bracket. The control panel and cable can then be removed.

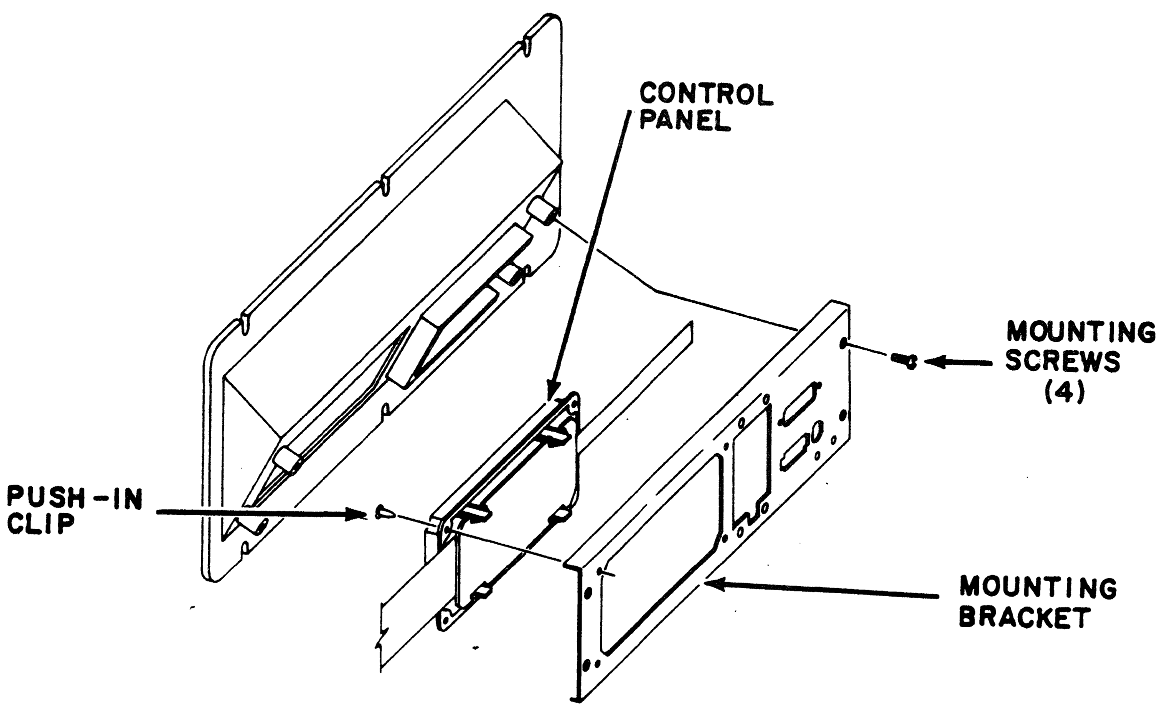


Figure 5-17. OPERATOR PANEL ASSEMBLY

Replacement

1. Position the control panel on the mounting bracket such that the ribbon cable and ground strap feed through the bracket opening.

2. Align the mounting holes in the control panel with the holes in the bracket and secure the control panel with four push-in clips.

3. Place the control panel and bracket in position on the door assembly and install the four mounting screws with one of the screws used to secure the ground strap.

4. Route the control panel ribbon cable across the door assembly and tape deck and attach the cable connector to P7 of the Formatter/Control module. Secure the cable with restraints as required to prevent cable interference with the door assembly or other tape deck components.

5. Place the logic modules to the normal operating position and secure to the logic rack bracket with the top and bottom thumb screws.

6. Return the tape deck to the normal operating position.

Verification Check

1. Thread tape (do not load) and run Operator Diagnostic Test #01.

5.3.17 Cooling Fan Assembly

Removal

1. Place the tape deck in the maintenance position.
2. Remove four hex nuts and washers and withdraw the fan assembly from the mounting studs.
3. Remove the acoustic cover, detach W4P5 connector from the power supply, and remove the cooling fan.

Replacement

1. Perform Removal procedure in reverse order.

Verification Check

1. Power the transport on and check for air flow from the fan.

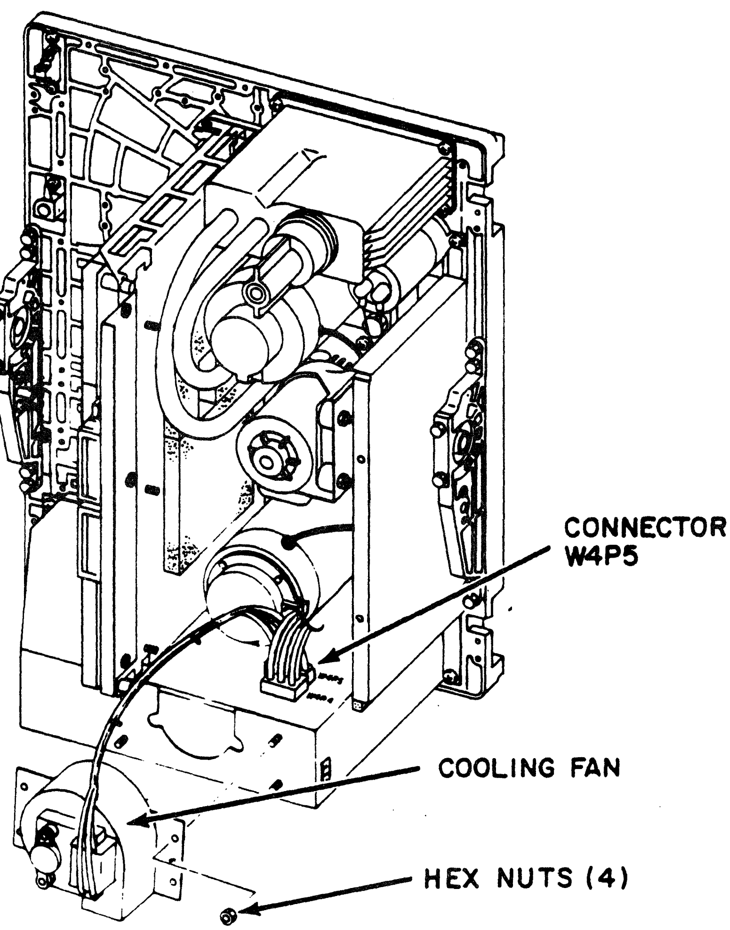


Figure 5-18. COOLING FAN ASSEMBLY 02A01-84

5.3.18 Power Supply

Removal

1. Tilt the tape deck into the maintenance position (paragraph 5.2).
2. Disconnect the power cable from the power supply.
3. Remove the Cooling Fan Assembly (paragraph 5.3.17).
4. Detach W4P4, W2P1 and W7P1 connectors from power supply.
5. Place the tape deck in the operating (horizontal) position.

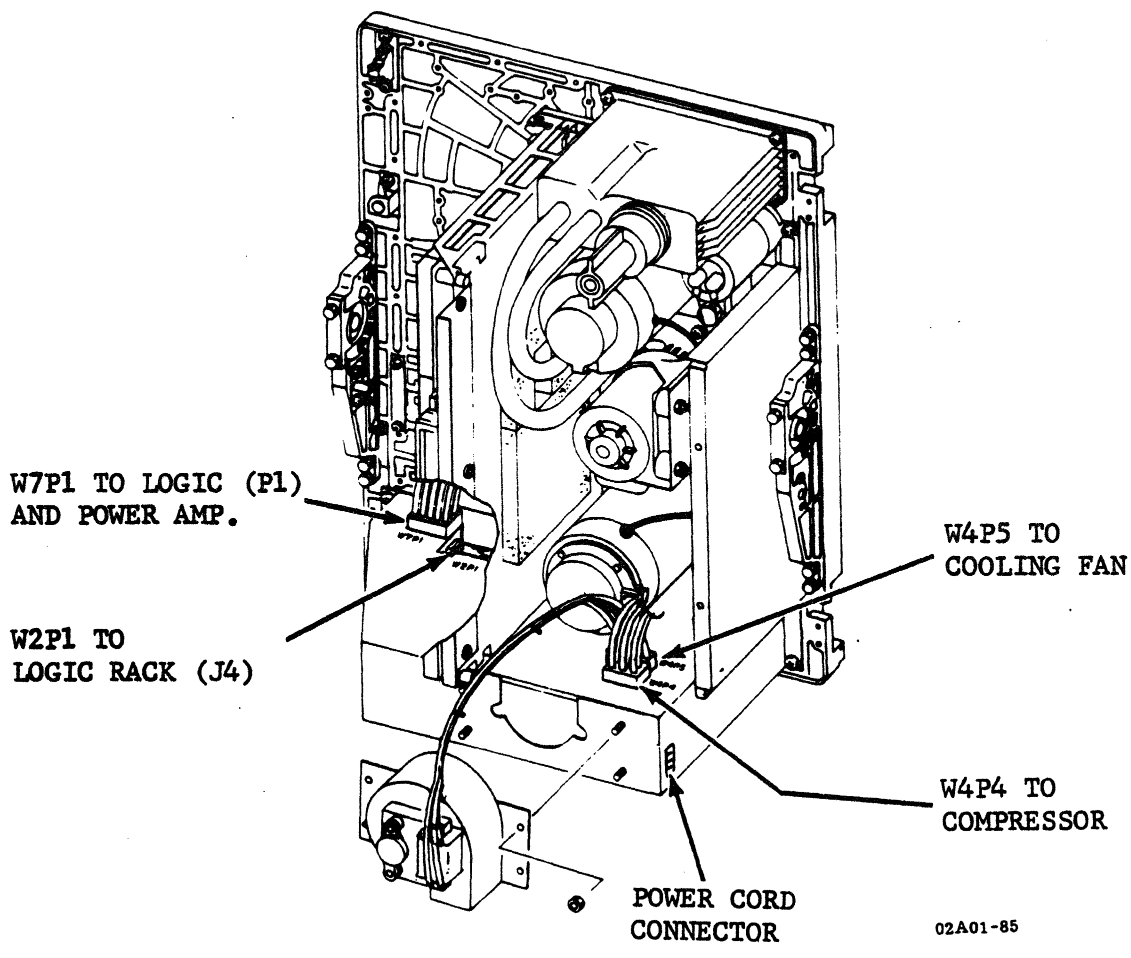


Figure 5-19. POWER SUPPLY CONNECTORS

5.3.18 Power Supply

6. Open the rear door of the cabinet.

7. Remove the frame stabilizing bar by removing mounting screws.

CAUTION

The power supply is attached to the tape deck by four screws. The two screws on the left are located in slots so that power supply can be slid out from under these screws for removal.

The power supply weighs approximately 4.1 Kg (9 lbs.).

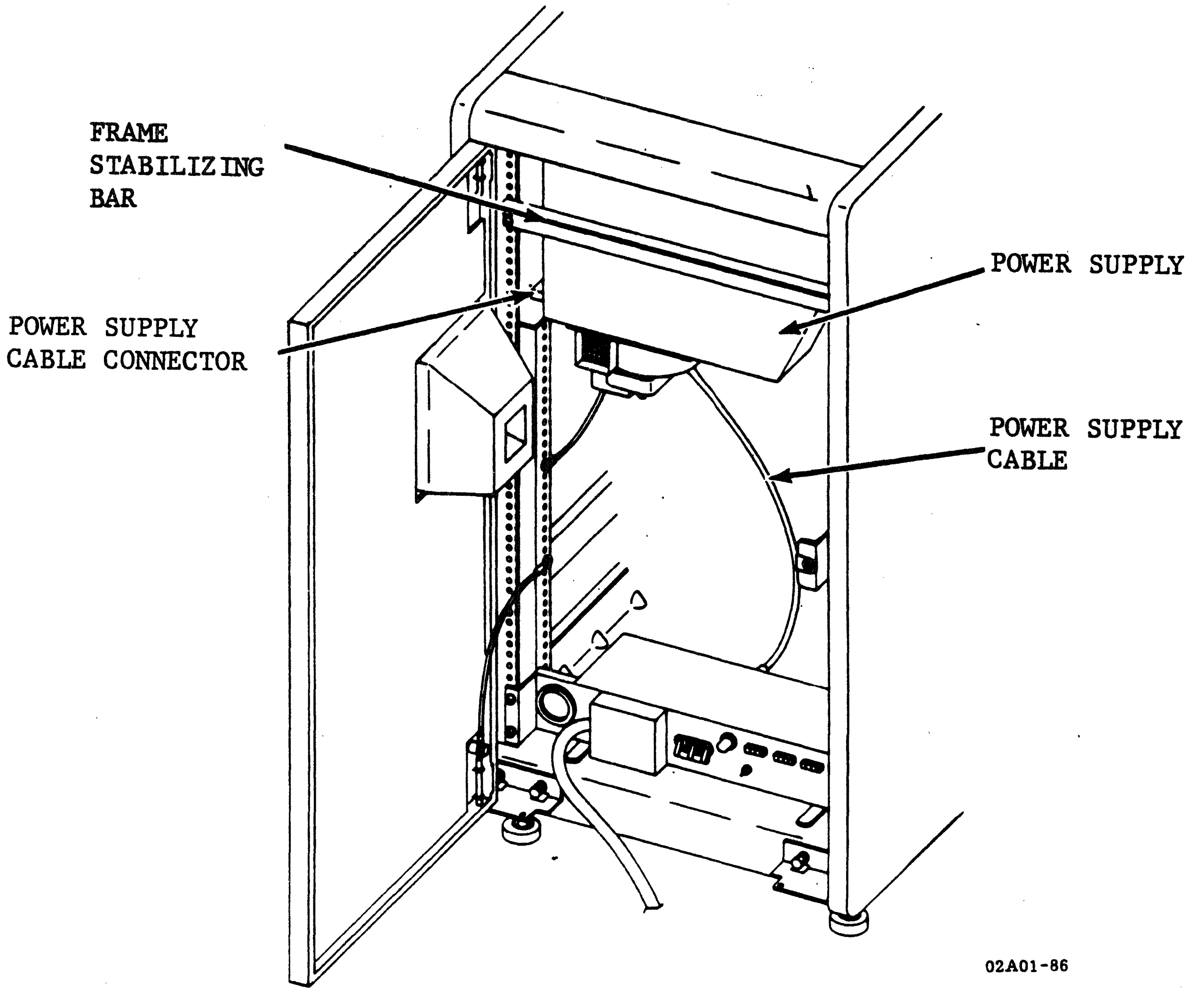


Figure 5-20. POWER SUPPLY (REAR CABINET VIEW)

5.3.18 Power Supply

Removal (Cont'd)

8. Loosen, but DO NOT REMOVE, the two mounting screws on the left side of the power supply.

9. Remove the two mounting screws on the right side of the power supply while supporting the power supply from the bottom.

10. Slide the power supply out of the slots on the left, and carefully remove the power supply from the cabinet.

Replacement

NOTE

If a new power supply is being installed, remove the cover and observe the position of Voltage Select Card (below). The position of this card must correspond to input voltage as defined on the equipment identification plate. The ends of the card are stencilled with "120V" and "220V" and indicating arrows. Make sure the card is connected to match the input voltage.

The card can be disconnected, turned upside down, and reconnected to the Main Power Supply Module if required.

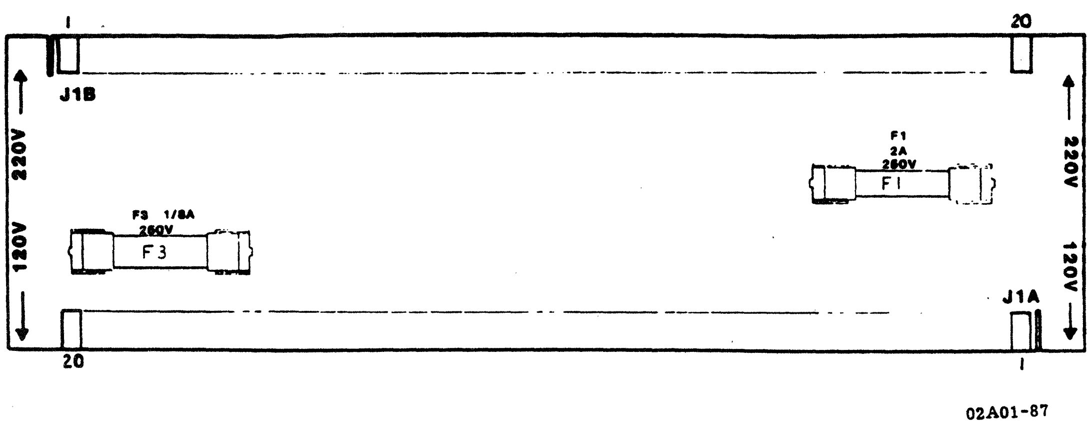


Figure 5-21. VOLTAGE SELECT CARD

5.3.18 Power Supply

Replacement (Cont'd)

1. From the rear of the transport, position the mounting slots on the left side of the power supply under the two loosened mounting screws.

2. Insert and tighten the two mounting screws on the right side of the power supply.

3. Tighten the two mounting screws on the left side.

4. Install the frame stabilizing bar and secure with the mounting screws. Close the rear cabinet door.

5. Tilt the tape deck into the maintenance position.

6. Attach W4P4, W2P1, and W7P1 connectors to the power supply.

7. Install the Cooling Fan assembly (paragraph 5.3.17).

8. Connect the power cable to the power supply.

Verification Checks

1. DC Voltage Checks - Using a digital voltmeter for all DC voltage measurements, connect the ground lead of the meter to either pin 4 or 6 of the power connector on the Read/Write/Servo Module (labeled P1 on board). Connect the other meter lead to the points listed to test all DC voltages. See Figure 5-19.

DC VOLTAGES AND TOLERANCES

LOCATION	VOLTAGE	TOLERANCE
P1-5*	+ 5V	± 2% (4.90 to 5.10)
P1-2*	- 15V	± 10% (-13.5 to -16.5)
P1-3*	+ 15V	± 10% (+13.5 to +16.5)
P1-7*	+ 25V	± 10% (22.5 to +27.5)
P1-8*	- 6V	± 10% (-5.4 to -6.6)
J4-6**	+ 38V	± 10% (+34.2 to +41.8)

* P1 is the power connector on Read/Write/Servo Module.
** J4 is the power connector on Power Amplifier Module.

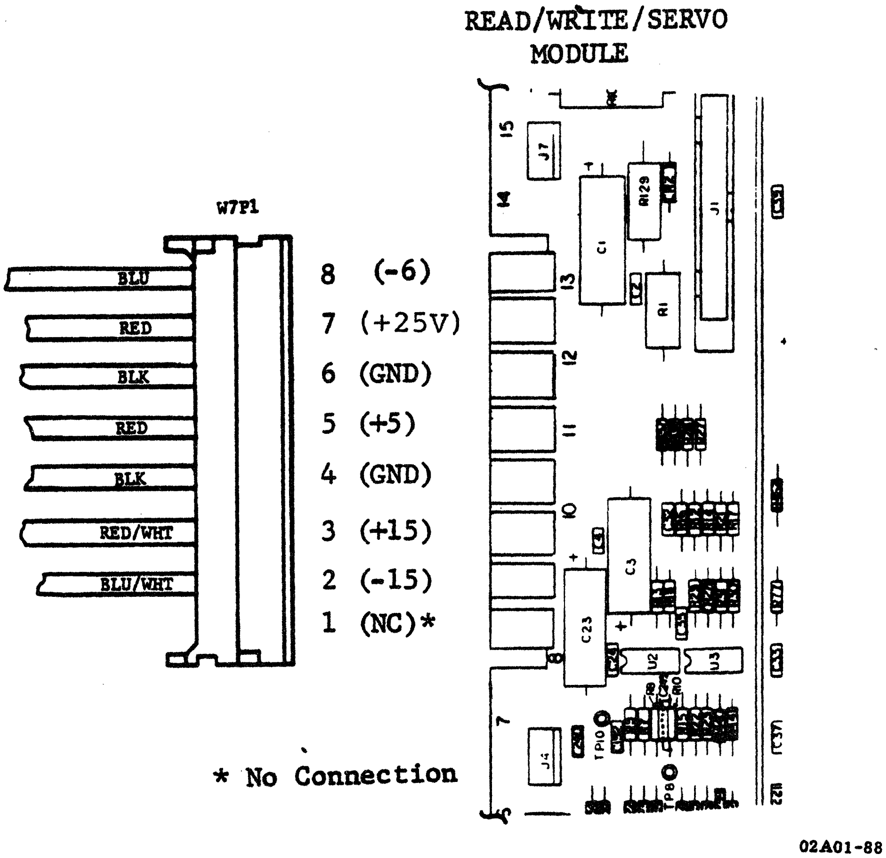


Figure 5-22. DC VOLTAGE CHECKS

5.3.19 Read/Write/Servo Module

Removal

1. Place the tape deck in the maintenance position.

2. Detach connectors J1 and J4 thru J7 from the Read/Write/ Servo Module. (J2 and J3 are the module-to-module connectors detached in step 3.)

3. Loosen the two thumb screws (Figure 5-24) and separate the Read/Write/ Servo Module from the Formatter/Control Module. Avoid undue stress on the modules by loosening the thumb screws alternately and separating the modules as the screws are loosened.

4. Loosen and back out only the top screws (see Figure 5-24) of each hinge. Loosen bottom screws one-half turn (do not remove). Hold the module in place while loosening the screws.

5. Remove the Read/Write/Servo Module from the logic cage.

Replacement

NOTE

> If a new module is being installed, remove the R224 and R225 Write Resistors from the removed module and insert the resistors into the new module. (Refer to Figure 5-23.)

1. Insert the module into the top and bottom hinge slots of the logic cage. Make sure the module is fully inserted into the hinge slot and P1 rear connector.

2. Attach the outside connectors J2 and J3 of both modules and secure with the two thumb screws.

3. Insert the top screw of top and bottom hinges to lock the module into position. Make sure all four hinge screws are snug.

4. Attach the cable connectors to the module as shown below:

J1 - W5P2 Connector (Write/Erase Heads)
J4 - W1 Cable (Supply Reel Tension Sensor)
J5 - W3P8 Connector (BOT/EOT Sensors, Cover Interlock, Power Amp, Tachs)
J6 - W6P2 Connector (Read Head)
J7 - W9 Cable (Take-Up Reel Tension Sensor)

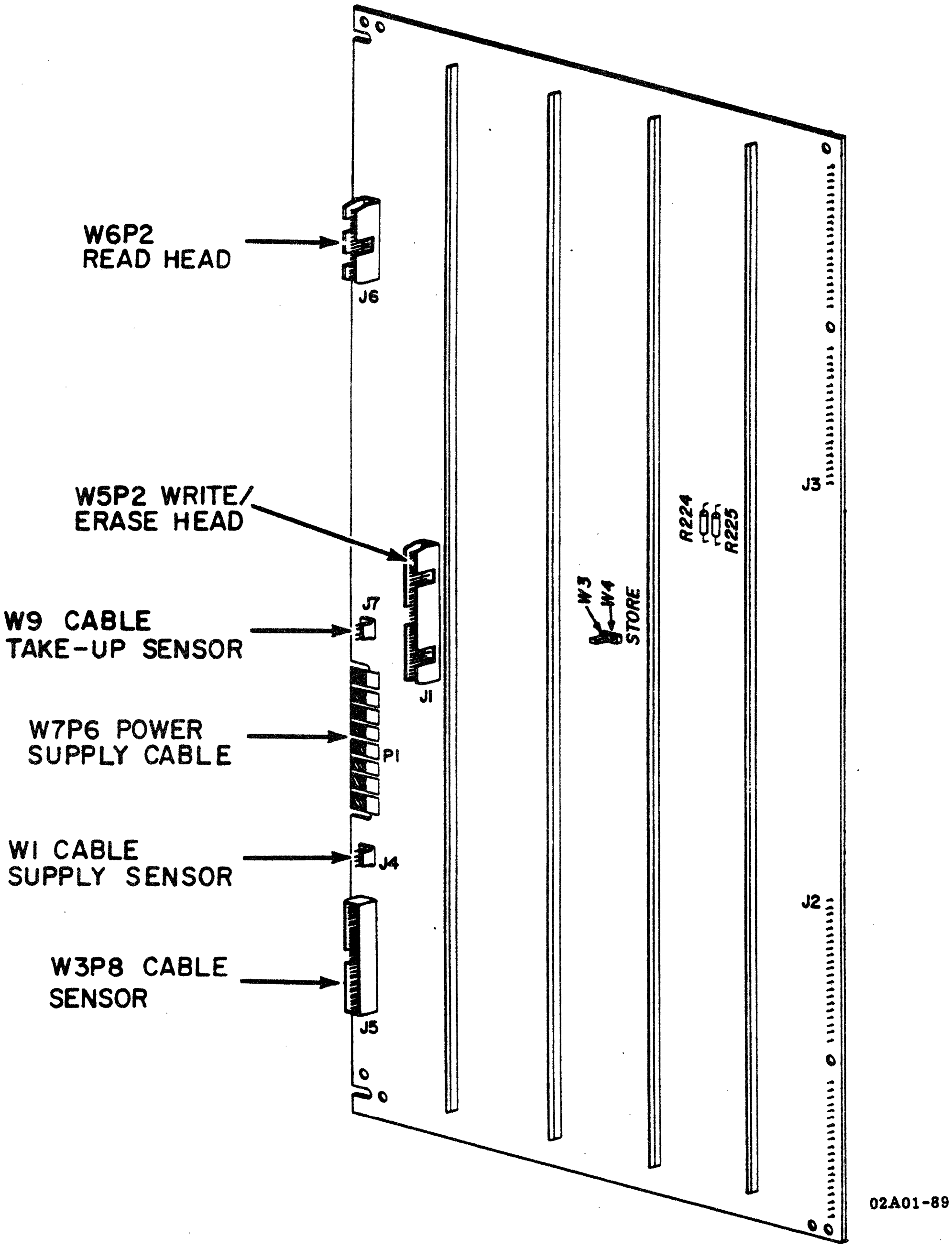


Figure 5-23. READ/WRITE/SERVO MODULE

5.3.19 Read/Write/Servo Module (Cont'd)

Verification Checks

1. Move the jumper plug at location 13E on the Read/Write/ Servo Module from the W3 to W4 (STORE) position.

2. Place the tape deck in the operating position.

3. With tape not threaded, execute Field Service Test #37.

4. Execute Field Service Test #48.

5. Load a good quality, write enabled tape.

6. Execute Field Service Test #18 to move the tape away from BOT. Press RESET to stop tape motion after approximately 5 seconds.

7. Execute Field Service Test #31.

8. After the test is successfully completed (display 00), return the jumper plug from the W4 (STORE) to W3 position before the unit is powered down.

9. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

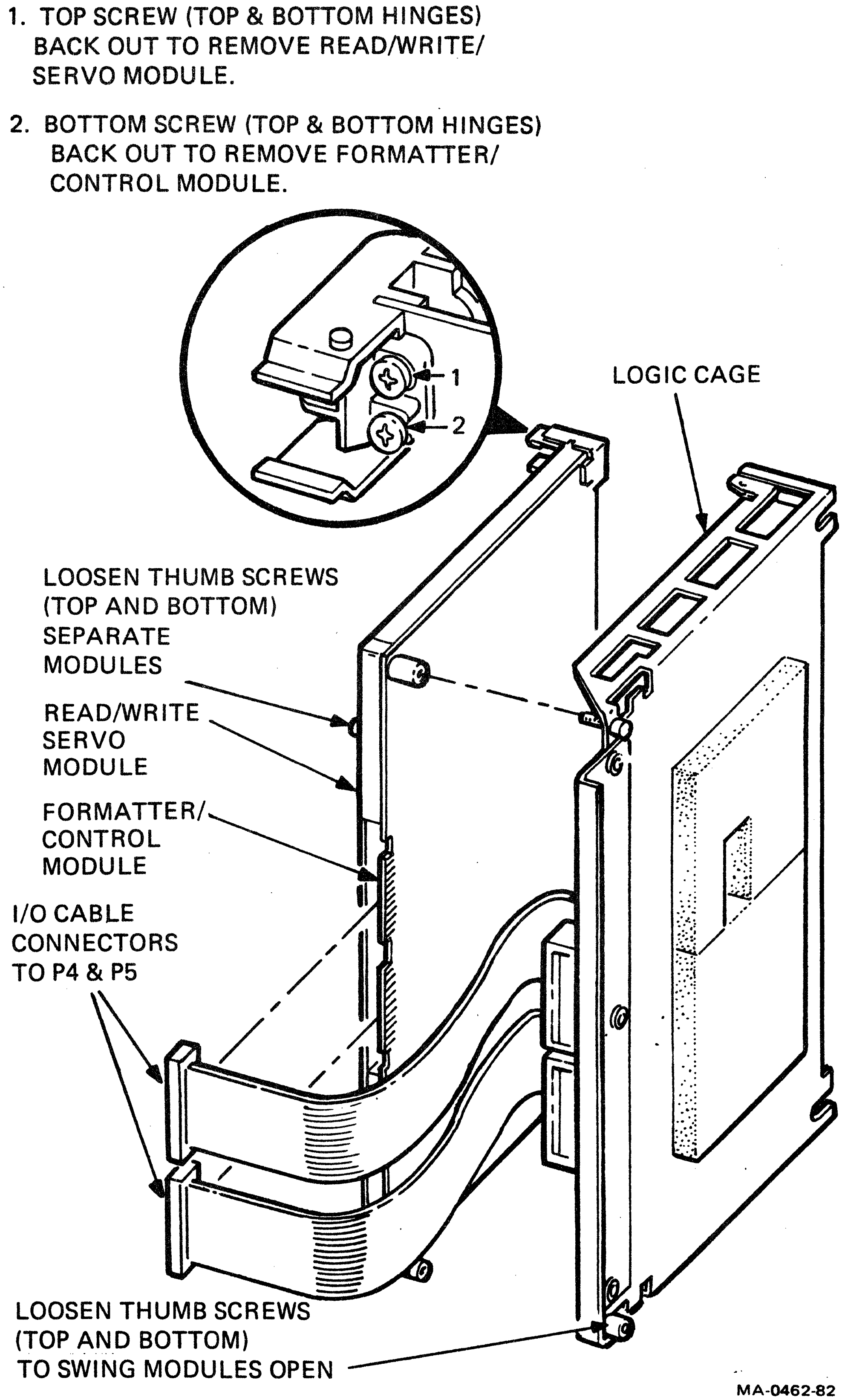


Figure 5-24. LOGIC MODULE REMOVAL/REPLACEMENT

5.3.20 Formatter/Control Module

Removal

1. Place the tape deck in the maintenance position.

2. Loosen the two thumb screws securing the module to the logic cage bracket (see Figure 5-24). Swing the modules open to access the component side of the Formatter/ Control Modules.

3. Remove the I/O cable connectors from P4 and P5 of the module as shown in Figure 5-24.

4. Remove the cable connectors from P6 and P7 of the module.

5. Loosen the two thumb screws and separate the Read/Write/ Servo and Formatter/Control Modules. Avoid undue stress on the modules by loosening the thumb screws alternately and separating the modules as the screws are loosened.

6. Loosen and back out (do not remove) the bottom screw of the top and bottom hinges. Hold the Formatter/Control Module while loosening the hinge screws.

7. Remove the Formatter/Control Module from the logic cage and the rear P1 connector.

NOTE

> Prior to installing a new module, place the four-segment DIP switch at location 21D to OFF position. Also ensure that the jumpers at location 16E are in the same position as in the removed module. Refer to Appendix B.

Replacement

1. Insert the module into the top and bottom hinge slots of the logic cage. Make sure that the module is fully inserted into the hinge slot and the P1 rear connector.

2. Attach outside connectors P2 and P3 of the Formatter/ Control Module to J2 and J3 of the Read/Write/Servo Module and secure with the two thumb screws.

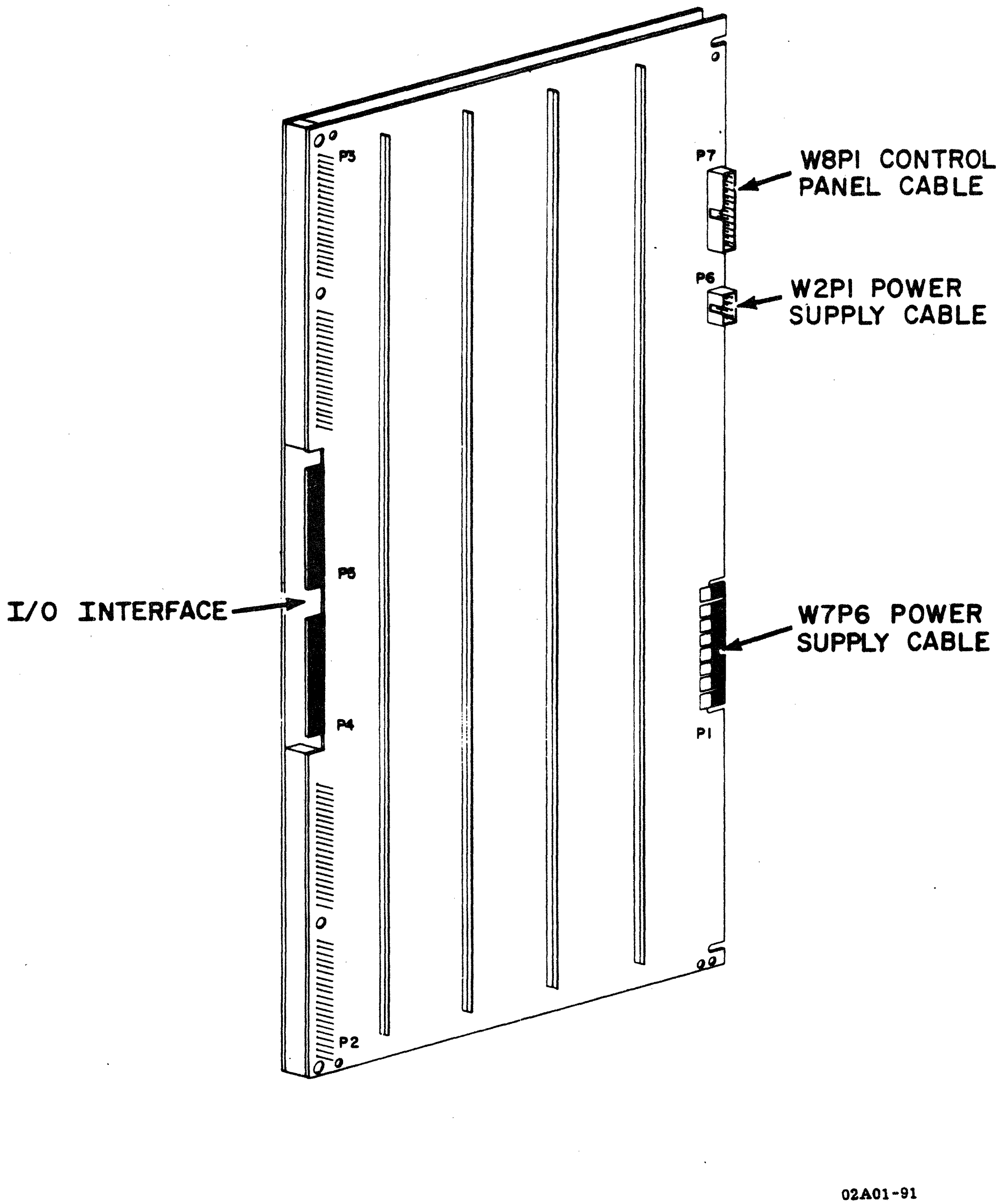


Figure 5-25. FORMATTER/CONTROL MODULE

5.3.20 Formatter/Control Module

Replacement (Cont'd)

3. Insert the bottom screw of the top and bottom hinges to lock the module in position.

4. Reattach the W2P1 cable to P6 and W8P1 cable to P7 of the Formatter/Control Module.

5. Place the modules in a closed position and align the thumb screws with the screw slots. Secure with the two thumb screws.

6. Reattach the I/O cable connectors to P4 and P5 of the Formatter/Control module.

7. Place the tape deck in the operating position.

Verification Check

1. With tape threaded, but not loaded, execute the Operator Diagnostic Test #01. If test 01 cannot be run, perform the Troubleshooting Procedures 1001 thru 1003 as explained in the TU80 Pathfinder.

5.3.21 Power Amplifier Module

Removal

1. Place the tape deck in the maintenance position and remove the acoustic cover (paragraph 5.3.1).

2. Detach the following connectors from the Power Amplifier Module:

   J1 - B3P1
   J2 - W3P7
   J3 - B1P1
   J4 - W7P2

3. Remove three screws along the outside edge of the module to release the module from the mounting assembly. Remove the module.

Replacement

1. Insert the Power Amplifier Module into the mounting assembly. The inside of the mounting assembly has metal slots to receive the module.

2. Secure the module by installing the three screws along the outside edge.

3. Install the connectors as follows:

   J1 - B3P1 Connector (Take-Up Reel Motor)
   J2 - W3P7 Connector (Read/Write/Servo Module)
   J3 - B1P1 Connector (Supply Reel Motor)
   J4 - W7P2 Connector (Power Supply)

4. Reinstall the acoustic cover and return the tape deck to the operating position.

Verification Check

1. With tape threaded, but not loaded, execute Operator Diagnostic Test #01.

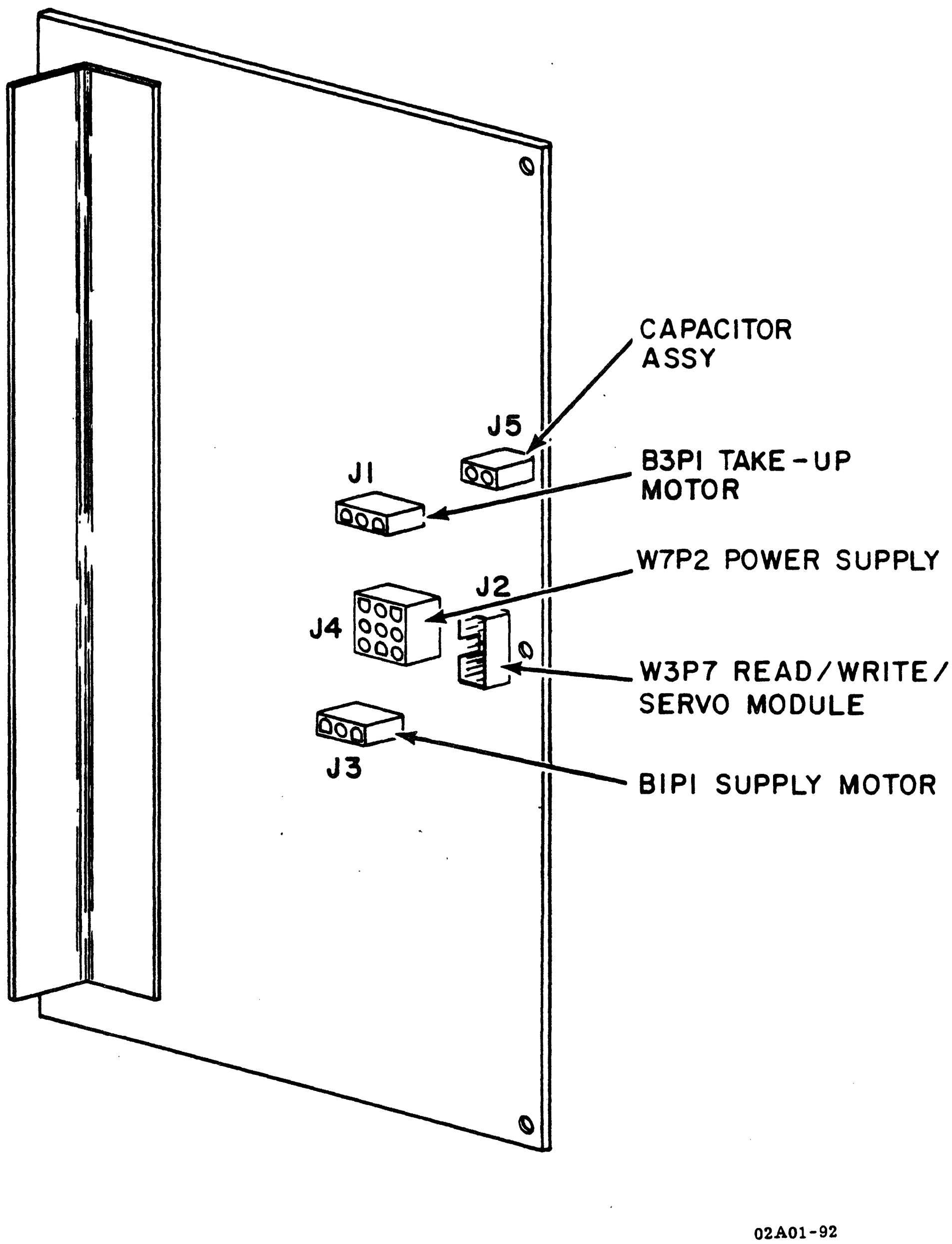


Figure 5-26. POWER AMPLIFIER MODULE

5.3.22 Capacitor Assembly

Removal

1. Place the tape deck in the maintenance position and remove the acoustic cover.

2. Detach capacitor connector from J5 of the Power Amp Module.

CAUTION

DO NOT remove protective terminal caps located on top of the capacitor during the removal or replacement procedures.

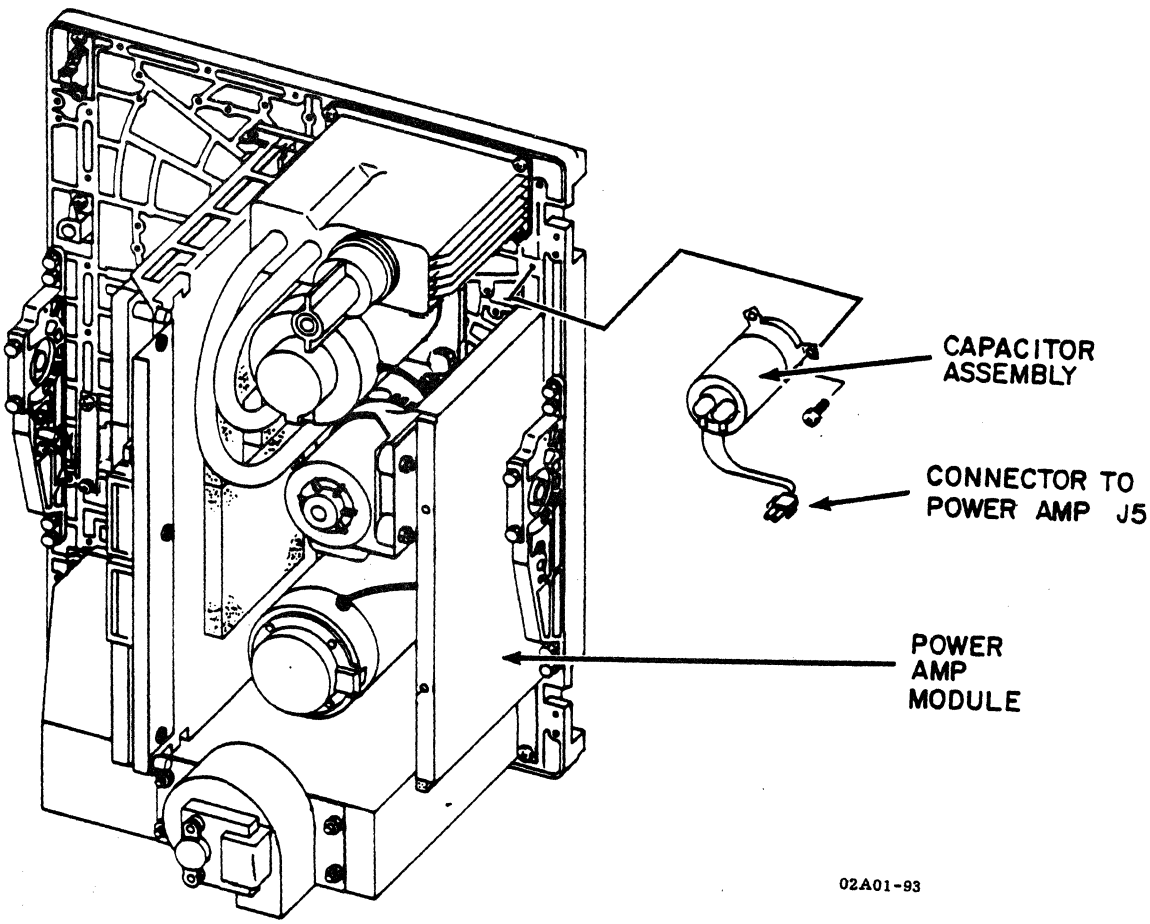


Figure 5-27. CAPACITOR ASSEMBLY

5.3.22 Capacitor Assembly

3. Remove three screws from the capacitor mounting assembly. Remove capacitor assembly.

<u>Replacement</u>

1. Mount the replacement capacitor assembly as shown in Figure 5-27 and install three screws. Tighten securely.

2. Install capacitor connector to J5 of the Power Amp Module.

<u>Verification Check</u>

1. Thread tape (not loaded) and run Operator Diagnostic Tests #01 and #02.

5.4 TU80 DIAGNOSTICS AND TROUBLESHOOTING

5.4.1 General

Note To Field Service Representative:

When reporting to the site, obtain as much information from the operator and operating system, as available. Fault Codes, the frequency at which they occur and, if possible, the operation in progress at that time, are all things which should be considered prior to execution of the diagnostics. If the fault is intermittent, the information received from the operator and operating system may be instrumental in directing you to the appropriate test to duplicate the fault condition.

Complete information on troubleshooting, diagnostic procedures, and diagnostic test descriptions is given in the TU80 Pathfinder Manual (EK-OTU80-SV) provided in the CD Kit.

5.4.2 Resident Diagnostics

TU80 Resident Diagnostics consists of the Operator Diagnostics and Field Service Diagnostics.

NOTE

Make sure that the TU80 power cord is plugged in and the transport is energized (the power switch is ON) before starting any diagnostic routine.

The diagnostic tests designed into the TU80 are the off-line tests initiated through the control panel. There are no build-in on-line diagnostics, however, the host CPU is capable of monitoring TU80 status through the Status Transfer command. A Channel Loopback command is also provided to exercise the formatter logic of the TU80.

Although on-line diagnostics are not part of the TU80, the control microprocessor tests for many operational fault conditions while running on-line. These conditions are indicated as fault codes appearing on the control panel display. The fault condition is indicated by illumination of the RESET indicator and appropriate fault code being displayed.

5.4.2.1 Corrective Fault Code Matrix - When the fault condition is recorded, consult the Fault Code Matrix (Table 5-2) and corresponding corrective action tables in the TU80 Pathfinder to determine if an operator action (A, B, or C) is required. If the fault still persists after an appropriate action, consult the tables for the list of FRU's that may be required to be replaced.

The Fault Code Matrix lists all malfunctions or fault codes and possible assemblies which may cause the fault condition. The purpose of this table is to provide a list of related assemblies prior to reporting to the customer site. Assemblies listed under the individual malfunction or fault codes are arranged in a "most probable fault" order. In addition to the assemblies listed, the table may direct the service personnel to request the operator to perform Operator Diagnostic Test #02 or #03.

When on-site, consult and use the TU80 Pathfinder (Troubleshooting Procedures and Diagnostic Tests) to isolate and correct the malfunction.

5.4.2.2 Operator Troubleshooting - Before running any tests, check the following to isolate as easily correctable external malfunction:

1. Make sure that the tape has a BOT marker.
2. If a write operation is to be performed, make sure that the tape reel has the write enable ring installed.
3. Verify that the tape path is clean.
4. Verify that the power switch is ON (1).
5. In case of power failure, verify that the power controller circuit breaker is ON.
6. Make sure that the top cover door is closed and latched.

5.4.2.3 Diagnostic Mode Operating Instructions - To get into the diagnostic mode and initiate the Operator or Field Service ("CE Tests") Diagnostic Tests, use the diagnostic panel as follows:

1. To recall the Operator Diagnostic Test (01, 02, 03), press the TEST switch. 01 will be displayed. Use the STEP switch to increment it by one each time STEP is pressed. Then press EXECUTE to initiate the test.

Table 5-2. FAULT CODE MATRIX (OPERATOR TEST #01)

FAULT CODE / FAILING ASSEMBLY	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Test Successful	X																													
Latch Hub Correctly													A										A			A				
Thread Tape Correctly												A		A	A			A												A
Clean Head/Tape Path		A	A	A	A	A	A	A	A														B			B				
Change Tape		B	B	B	B	B	B	B	B						B		A	B					C			C				B
Close Door											A																			
Run Test #02 (See NOTE)																							X		X		X			
Run Test #03 (See NOTE)					X		X																							
Read/Write/Servo		2	2	2	1	1	1	1	1		2	2	1	3	2	2	2	1	2		2	2	4	1	2	2	4	1	1	2
Formatter/Control		3	3	1	2	2	2	2	2							3	3	2	1											
Power Supply														2																
Power Amplifier					4		4																5		3	4	3			
Operator Panel																1														
Pneumatic Pump														1																
Filter														4																
Supply Air Bearing																					1									
Take-Up Air Bearing																						1								
Head (Amplitude Error)		1	1																											
Head (Data Reliability)				3	3	3	3	3	3		3																			
Supply Motor/Tach													3										3		1		2	2		
Supply Hub													2				4						1			1				
Take-Up Motor/Tach					5		5																2			3	1			
EOT/BOT Sensor												1			1															1
Door Switch											1																			
File Protect Sensor																	1													
Pressure Regulator														5																

NOTE: Tests 02 and 03 should not be used unless Test 01 directs their use. These tests may fail if run Stand-alone.

Table 5-2. FAULT CODE MATRIX (Cont'd)

FAULT CODE / FAILING ASSEMBLY	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Test Successful																																
Latch Hub Correctly																																
Thread Tape Correctly																																
Clean Head/Tape Path	A	A																	A													
Change Tape																			B													
Close Door																																
Run Test #02 (See NOTE)	X	X					X																									
Run Test #03 (See NOTE)			X																													
Read/Write/Servo	1	1	2	1	1	1	1											1	1		1	1	2	1	1	1	1	1				
Formatter/Control																					2						2	2	1	1	2	2
Power Supply																																
Power Amplifier	2	2	1				2																									
Operator Panel																															1	1
Pneumatic Pump	4	4	4				4																									
Filter	5	5	5				5																									
Supply Air Bearing	7	7					7																									
Take-Up Air Bearing	8	8					8																									
Head (Amplitude Error)																																
Head (Data Reliability)																									2							
Supply Motor/Tach																			2				3									
Supply Hub																																
Take-Up Motor/Tach	3	3	3	2		2	3												3				1									
EOT/BOT Sensor																																
Door Switch																																
File Protect Sensor																																
Pressure Regulator	6	6	6				6																									

NOTE: Tests 02 and 03 should not be used unless Test 01 directs their use. These tests may fail if run Stand-alone.

2. To recall the Field Service Diagnostics, press and hold the CE switch, then press the TEST switch.

   a. The DIAGNOSTICS indicator illuminates.
   b. The two-digit display indicates 00.

   Press the STEP switch.

   a. Display number increments by one each time the STEP switch is pressed, or will increment automatically if the STEP switch is held pressed. The display can show 00 thru 09.

   b. To select the required test number, use the STEP and TEST switches. When you press the TEST switch after the STEP switch, the number is multiplied by ten.

      Example: Test 39 is required.

o Press the CE and Test switches.	Display: 00
o Press the STEP switch three times.	Display: 03
o Press the TEST switch.	Display: 30
o Press the STEP switch until 9 is displayed.	Display: 39

   Press the EXECUTE switch to initiate the test.

After the fault code appears on the display, you can recall the sub-fault code by pressing the CE switch. The sub-fault code will be displayed as long as the CE switch is held pressed.

5.4.2.4 Resident Test Descriptions - Resident Diagnostics include the Power-on Health Check, M7454 UNIBUS Module Self-Test, Operator Tests #01 thru #03, and Field Service Tests and Troubleshooting Procedures. The Field Service Diagnostics are described and listed in the TU80 Pathfinder.

5.4.2.4.1 Power-on Health Check - This self-test diagnostic checks ac power and the functionality of the control panel and major logic modules.

To start the Health Check, press the LOGIC-ON pushbutton (assume that the power switch is ON). The two-digit display should momentarily show 00, the LOGIC-OFF indicator should go off and the following indicators should go on momentarily: BOT, RESET, ON-LINE, DIAGNOSTIC, and SELECT. The LOGIC-ON and FILE PRO indicators hould go on and remain on.

NOTE

If a fault code appears on the display, press the RESET and LOGIC-OFF keys to clear the display. Then press LOGIC-ON again to repeat the Health Check.

If the fault code reappears, refer to the on-site Troubleshooting Procedures and Field Service Diagnostic Tests (see the TU80 Pathfinder) to isolate failure.

5.4.2.4.2 Basic Operator Test #01 - This test checks basic transport functions and tape motions including BOT/EOT tape motion, read data, and write data. A write enabled, known good quality tape should be used for this test. Test runs to completion in approximately 10 minutes (with a 2400 foot long tape).

o Pre-Test Conditions

1. Power switch and LOGIC-ON are ON (Power-up Health Check is successful); digital display is blank.

2. Tape is threaded through the tape path and onto the take-up reel, but NOT LOADED.

3. The top cover is closed and latched.

o Test Procedure

1. Press the RESET switch.

2. Press the TEST switch on the diagnostic portion of the control panel.

   a. The DIAGNOSTICS indicator illuminates.
   b. 01 is indicated on the digital display.

3. Press the EXECUTE switch.

   a. Test starts with display panel incrementing from 00, 11, 22 thru 99, verify that all segments of numerical display are functioning.

   b. Verify that all indicators except LOGIC-OFF, BOT, and SELECT are illuminated.

- o Test Successful - If the test runs to completion, the TU80 performs a REWIND/UNLOAD operation and 00 is indicated on the digital display with the RESET indicator illuminated.

- o Test Unsuccessful - If the test is unsuccessful, the diagnostic program halts and a numerical code appears on the display with the RESET indicator illuminated. Record this number and refer to the Pathfinder Manual in the CD Kit for further actions.

5.4.2.4.3 Optional Operator Tests

NOTE

Tests 02 and 03 should not be used unless Test 01 directs their use. These tests may fail if run stand-alone.

The optional tests are 02 and 03. They may be performed by the user on your request.

Test 02 checks tape tension characteristics. Test 03 checks the operation of the velocity servo loop and Take-up Motor/Tach Assembly. When Test 01 calls for Test 02 or 03 to be executed, refer to the Pathfinder Manual for further information.

5.4.2.4.4 M7454 Resident Diagnostic - The M7454 UNIBUS Adapter Module performs its own resident diagnostic routine at the system power-up. (To run this self-test, the host CPU must be turned off/turned on.) The M7454 diagnostic resides in the on-board programmable ROM and checks only the M7454 module without ay tape motion or interface testing. The self-diagnostic checks the M7454's microprocessor, sequencer, data paths, and buffer area. Successful test completion is indicated by the illuminated LED indicator on the module.

5.4.2.4.5 M7454 Status Checking

- o TU80 Turnkey Configuration - When the M7454 (and TU80) fails during new system configuration (PDP-11 or VAX), the host will configure around the TU80 not recognizing it. An appropriate error message will appear on a computer console terminal.

- o TU80 Add-On Configuration

  1. If a TU80 is added to a PDP-11 system, the host system must be reconfigured by an operator using an applicable SYSGEN routine. If the M7454 fails during SYSGEN, the host would not be able to access the TU80 and an appropriate error message will be displayed on the console terminal.

  2. If a TU80 is added to a VAX system, the host will automatically configure the unit into the system. If the M7454 fails at that time, the host would be unable to access the TU80 and an appropriate message will appear on the terminal.

- o On-Line Failure - If the M7454 fails during normal on-line operation, the host will lose communication link with the TU80. The error message will be entered in the system error log. When the operator tries to recall the TU80, the appropriate error message will appear on the operator's terminal indicating the "not found" status of the device.

  To check the TU80 operating status and localize the failed module, reset the unit and perform the system power-up procedure to run the M7454 internal diagnostic. Then place the TU80 on-line and try to access the transport through the host. If the fault condition persists, replace the M7454 module.

5.4.3 PDP-11 Based Diagnostics

5.4.3.1 PDP-11 Front End Diagnostics (CZTUW, CZTUX, CZTUY, CZTUZ) - This is a four-part complex test that checks the subsystem in all basic modes of operation and tests the interface bus, I/O silo, and TU80 transport logic.

- o CZTUW

TST : 001	Initialize #1
TST : 002	RAM Test
TST : 003	Command Reject Test
TST : 004	Write Characteristics Test
TST : 005	Volume Check
TST : 006	Completion Interrupt Test
TST : 007	Basic Packet Protocol Test
TST : 008	Non-Tape Motion Command Test
TST : 009	DMA Memory Addressing Test
TST : 010	Initialization After Write Characteristic Test
TST : 011	Basic Write Subsystem Memory Test

- CZTUX

TST : 001	FIFO Exercizer Test
TST : 002	Initialize #4 Test
TST : 003	Off-line Reject and Rewind Test
TST : 004	Basic Write Data Test
TST : 005	Basic Read Data (Forward and Reverse) Test
TST : 006	Manual Intervention Test
TST : 007	Configuration Typeout Test
TST : 008	Scope Loops Test

- CZTUY

TST : 001	Space Records Test
TST : 002	Rereads Test
TST : 003	Write Data Retry Test
TST : 004	Write Tape Mark Test

- CZTUZ

TST : 001	Write Tape Mark Retry Test
TST : 002	Skip Tape Marks Test
TST : 003	No-Op and Initialize Test
TST : 004	Erase and Operation Incomplete Test
TST : 005	Test of Operation At EOT Test
TST : 006	Function Tuning Test

5.4.3.2 PDP-11 Data Reliability Diagnostic (CZTUV) - This test simulates a 'typical customer' operating environment and check data integrity when operating in both the start/stop and streaming modes. It is mainly a data confidence test.

- Data Reliability Program Tests

Test 1 :	Basic Functions
Test 2 :	Data Reliability
Test 3 :	Streaming Test
Test 4 :	Write Compatibility/Write Utility
Test 5 :	Read Compatibility/Read Utility
Test 6 :	Operator Selected Sequence

NOTE

For Program Control Flags, refer to Diagnostic Listing.

5.4.3.3 Operating Instructions For PDP-11 Based Diagnostics

1. Load XXDP + monitor.

   a. Enter date.

2. Answer hard-core questions.

   a. 50 Hz? Y or N
   b. LSI? Y or N

   This is XXDP + Type H or H/L for details (Help File).

   [Receive XXDP + prompt (dot)]

3. Enter R (space) program name. The program may be CZTUV or CZTUW, CZTUX, CZTUY, CZTUZ.

   The operator entry should look like this: [•R ZTUV??]

4. Receive DR prompt.

5. Enter the appropriate command.

   For example: DR STA to start the test.

6. Change HW (L)? (Y or N) - Answer must be 'Y' to run the diagnostic.

7. Change SW (L)? (Y or N)

NOTE

Refer to the Diagnostic Listing for specific program problems and instructions. No hard errors allowed.

- Hardware Parameters - The following are the TU80 base address and vector assignments:

  TSSR ADDRESS (172522)?
  VECTOR (224)?

  Example of Commands - STA/TES:2/FLA : IDU : LOE

  Example Meaning - Start Test 02, inhibit dropping unit and loop on error.

- Software Parameters - Refer to Diagnostic Listings.

5.4.4 VAX-Based Diagnostic

5.4.4.1 VAX Front End Diagnostic (EVMBD, EVMBE) - These tests check the subsystem in all basic modes of operation and test the TU80 transport's logic, interface bus, and I/O silo.

5.4.4.2 VAX Data Reliability Diagnostic (EVMAA) - This check is designed to thoroughly check out the tape subsystem. It allows the operator to test the TU80 on-line without bringing the system down. The diagnostic consists of the qualification test and Data Reliability Test.

- Data Reliability Test Sections

```
Test 1 :    Qualification Test
Test 2 :    Data Reliability Test
Test 3 :    Multi-Drive Test
Test 4 :    Conversation Mode Test
Test 5 :    Streaming Test
```

5.4.4.3 Operating Instructions For VAX-Based Diagnostics

1. Load the Diagnostic Supervisor (ECSAA, ENSAA, or ESSAA).

NOTE

ECSAA is used on VAX 11/750
ESSAA is used on VAX 11/780
ENSAA is used on VAX 11/730

2. Attach and select a device to be loaded in one of two ways:

   a. Prompt Mode

```
DS  Attach
Device Type?  TU80
Device Link?  DW0
Device Name?  TUA0
CSR?  772520 *
Vector?  224
BR?  5
```

* Base Address (TU80's starting address is 772522).

b. Explicit Mode

    DS Attach TU80DW0TUA07725202245

3. Load and start the diagnostic in one of two ways:

   a. Example #1

      DS Load EVMAA or EVMBD
      DS Start/Switches

   b. Example #2

      DS Run EVMAA (or EVMBD)/Switches

   No hard errors are allowed.

NOTE

For Control Flags, refer to Diagnostic Listings.

APPENDIX A - M7454 UNIBUS ADAPTER MODULE

A.1.0 GENERAL

The M7454 module is a standard quad-size card which fits into a standard Small Peripheral Controller (SPC) slot in a UNIBUS backplane of the host CPU.

The M7454 functions as the Interface Controller for the TU80 Tape Subsystem. The module controls command decoding and sequencing, data fetching and storing, and data transmission to and from the tape transport. The M7454 interfaces the tape transport to a VAX or PDP-11 host system. It communicates with the host CPU using the TS11 packet protocol for command and data transfer.

NOTE

Consult the Programming Chapter in the TU80 User Guide for detailed protocol and programming information.

Transport -- Adapter Interface is through the set of two parallel interface lines which provide command and status lines and bi-directional data transfer.

A.1.1 System Configuration

Depending on the Operating System (OS) and the host system's configuration and data throughput, the host CPU can support up to four TU80 Tape Subsystems. Each TU80 transport is radially connected to the CPU through the dedicated UNIBUS Adapter Module (M7454) and Interface Cable Assembly (Figure A-1).

A.1.2 M7454 Module Physical Description

The M7454 module is a complete on-board interface controller with microprocessor, memory, clock, I/O, and data paths (refer to Figure A-2 for component locations). Main controller elements are described in the following paragraphs.

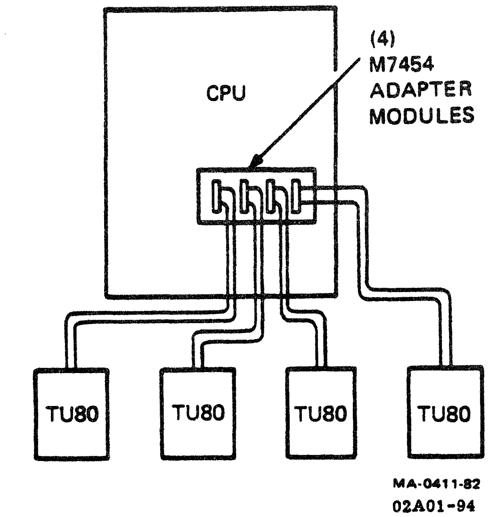


Figure A-1. MAXIMUM TU80 CONFIGURATION

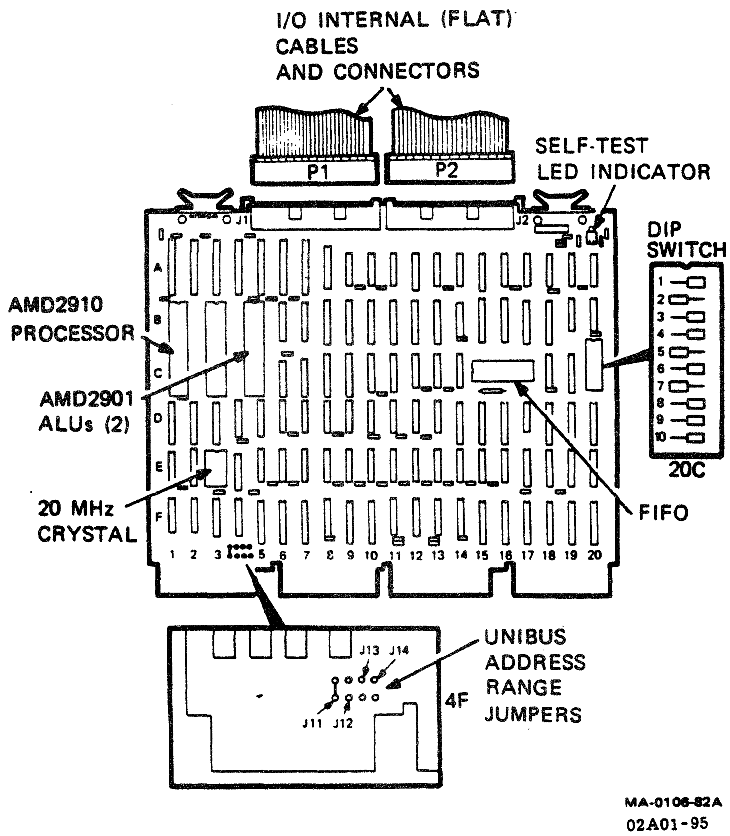


Figure A-2. M7454 UNIBUS ADAPTER MODULE

The controller is constructed around two AMD 2901 ALU and one 2910 controller processor chips (locations 1B, 3B, 5B). The 2910 chip and seven PROM chips (1A--7A), with 1K x 56 bits of control microprogram storage, constitute an operation sequencer. Controlled by the stored microprogram, this sequencer regulates and sequences command and data transfer operations within the TU80 subsystem. Self-test Diagnostic also resides in the control PROM and is initiated at the system power-on to check the M7454 module. LED indicator in the top right corner of the board lights on if the module self-test is successful. In addition, the processor is supported by the internal clock on the 20 MHz crystal and 256-byte RAM used as the data accumulator.

A 1K byte FIFO (First-In, First-Out) buffer (location 15C) helps to eliminate data delays and overruns providing I/O data buffering.

The UNIBUS address selection for the TU80 subsystem is performed with the help of the 10-position DIP switch in location 20C. Switch setting is discussed in Section 2 - INSTALLATION of this manual.

Four jumpers in location 4F are factory-set (with J11 in). The jumpers are used to select the UNIBUS range and base address (772520). The standard starting address is 772522_8.

DO NOT MOVE JUMPERS WHEN YOU ARE ON VAX OR PDP-11 SYSTEM.

A.2.0 PHYSICAL INTERFACE

When inserted into the SPC slot of the CPU backplane, the M7454 module establishes a host-transport UNIBUS interface. Table A-1 contains the host I/O signals.

The communication link between the M7454 and transport formatter consists of a set of 54-conductor ribbon (flat) and external shielded (round) cables with the overall interface link length of no more than 6.1 m (20 feet). Interface cabling is discussed in Section 2 - INSTALLATION of this manual.

On the M7454 module, J1 and J2 I/O connectors (Figure A-2) provide the interface lines as listed in Tables A-2A and A-2B.

* AMD -- Advanced Micro Device Corp.

Table A-1. M7454 CONTROLLER/UNIBUS INTERFACE LINES

BUS PIN	MNEMONIC	DESCRIPTION
CA1	NPG IN	Nonprocessor grant in
CB1	NPG OUT	Nonprocessor grant out
CD2	D15L	Data line bit 15
CE2	D14L	Data line bit 14
CF2	D13L	Data line bit 13
CH2	D12L	Data line bit 12
CH1	D11L	Data line bit 11
CJ2	D10L	Data line bit 10
CK2	D09L	Data line bit 9
CL2	D08L	Data line bit 8
CM1	D07L	Data line bit 7
CN2	D04L	Data line bit 4
CP2	D05L	Data line bit 5
CR2	D01L	Data line bit 1
CS2	D00L	Data line bit 0
CT2	D03L	Data line bit 3
CU2	D02L	Data line bit 2
CV2	D06L	Data line bit 6
DD2	BR7L	Bus request 7
DE2	BR6L	Bus request 6
DF2	BR5L	Bus request 5
DH2	BR4L	Bus request 4
DJ2	BR OUT	Bus request out
DK2	BG17	Bus grant bit 7 in
DL1	INIT L	Initiate
DL2	BG07	Bus grant bit 7 out
DM2	BG16	Bus grant bit 6 in
DN2	BG06	Bus grant bit 6 out
DR2	BG15	Bus grant bit 5 in
DR2	BG05	Bus grant bit 5 out
DS2	BG14	Bus grant bit 4 in
DT2	BG04	Bus grant bit 4 out
DW2	BGIN	Bus grant in
DV1	BGOUT	Bus grant out
EC1	A12L	Address bit 12
ED2	A15L	Address bit 15
ED1	A17L	Address bit 17
EE1	MSYNL	Master sync
EE1	A16L	Address bit 16
EF1	A02L	Address bit 2
EH1	A016	Address bit 1
EH2	A00L	Address bit 0
EJ1	SSYNL	Slave sync
EK1	A14L	Address bit 14
EK2	A13L	Address bit 13
EL1	A11L	Address bit 11

Table A-1. (Cont'd)

BUS PIN	MNEMONIC	DESCRIPTION
EN2	A08L	Address bit 8
EP1	A10L	Address bit 10
EP2	A07L	Address bit 7
ER1	A09L	Address bit 9
EU1	A06L	Address bit 6
EU2	A04L	Address bit 4
EV1	A05L	Address bit 5
EV2	A03L	Address bit 3
EJ2	C0L	Control bit zero
EF1	C1L	Control bit one
FG1	BBSY	Bus busy
FJ1	NPS	Nonprocessor request
FF1	ID05	Interrupt vector bit 5
FF2	ID06	Interrupt vector bit 6
FH1	ID07	Interrupt vector bit 7
FK1	ID08	Interrupt vector bit 8
FM1	INTR	Interrupt
FT2	SACK	Select acknowledge
CN1	DCLO	DC Power low

Table A-2A. M7454 CONTROLLER/FORMATTER INTERFACE LINES

J1 SIGNAL	RETURN	MNEMONIC	DESCRIPTION
2	1	FFBY	Formatter Busy
4	3	FLWD	Last Word
6	5	FWD4	Write Data 4
8	7	FGO	Initiate Command
10	9	FWD0	Write Data 0
12	11	FWD1	Write Data 1
14	13		Not Used
16	15	FLOL	Load On-Line
18	17	FREV	Reverse/Forward
20	19	FREW	Rewind
22	21	FWDP	Not Used
24	23	FWD7	Write Data 7
26	25	FWD3	Write Data 3
28	27	FWD6	Write Data 6
30	29	FWD2	Write Data 2
32	31	FWD5	Write Data 5
34	33	FWRT	Write/Read
36	35	FRTH2	Read Threshold 2
		FLGAP	

Table A-2A. (Cont'd)

J1 SIGNAL	RETURN	MNEMONIC	DESCRIPTION
38	37	FEDIT	Edit
40	39	FERASE	Erase
42	41	FEFM	Write File Mark
44	43	FRTH1	Read Threshold 1
		Spare	
46	45	FTAD0	Transport Address 0
48	47	FRD2	Read Data 2
50	49	FRD3	Read Data 3

Table A-2B. M7454 CONTROLLER/FORMATTER INTERFACE LINES

J2 SIGNAL	RETURN	MNEMONIC	DESCRIPTION
1		FRDP	Read Data Parity
2		FRD0	Read Data 0
3		FRD1	Read Data 1
4		FLDP	Load Point
6	5	FRD4	Read Data 4
8	7	FRD7	Read Data 7
10	9	FRD6	Read Data 5
12	11	FHER	Hard Error
14	13	FFMK	File Mark
16	15	FCCG/ID	CCG/IDENT
18	17	FFEN	Formatter Enable
20	19	FRD5	Read Data 5
22	21	FEOT	End of Tape
24	23	FOFL	Off-Line
26	25	FNRZ	NRZI
28	27	FRDY	Ready
30	29	FRWD	Rewinding
32		FFPT	File Protect
34	33	FRSTR	Read Strobe
36	35	FDWDS	Demand Write Data Strobe
38	37	FDBY	Data Busy
40	39		Not Used
42	41	FCER	Corrected Error
44	43	FONL	On-Line
46	45	FTAD1	Transport Address 1
48	47	FFAD	Formatter Address
50	49	FDEN	Speed/Density Select

A.3.0 SUBSYSTEM FUNCTIONAL DESCRIPTION

TU80 operates using the TS11 packet protocol by transmitting certain command/status/data information in a packet of several 16-bit words. This information is stored/retrieved in defined buffer locations in the host memory. Data is transmitted and stored in record format. Record parameters are software-controlled by the host OS.

The functions listed in Table A-3 make up the TU80 Subsystem Command Set. These commands utilize "Command Packets" stored in the computer system's memory to operate the transport and transfer data. Some commands have various sub-commands termed "modes".

Table A-3. TU80 ASSIGNED COMMAND MODES

COMMAND NAME	MODE NAME/DESCRIPTION
GET STATUS	Get Status (update the Extended Status registers in the message buffer in memory).
READ	-- Read Next (Forward) -- Read Previous (Reverse) -- Reread Previous (Space Reverse, Read Forward) -- Reread Next (Space Forward, Read Reverse)
WRITE CHARACTERISTICS	Load Message Buffer Address and Set Device Characteristics.
WRITE	-- Write Data -- Write Data Entry (Space Reverse, Erase, Write Data)
POSITION	-- Space Records Forward -- Space Records Reverse -- Skip Tape Marks Forward -- Skip Tape Marks Reverse -- Rewind
FORMAT	-- Write Tape Mark -- Erase -- Write Tape Mark Retry (Space Reverse, Erase, Write Tape Mark)
CONTROL	-- Message Buffer Release -- Rewind and Unload -- Clean Tape (Handled as a NO-OP)
INITIALIZE	Controller/Drive Initialize

Table A-3. TU80 ASSIGNED COMMAND MODES (Cont'd)

COMMAND NAME	MODE NAME/DESCRIPTION
WRITE SUBSYSTEM MEMORY	Diagnostic Function - Allows test sequences and data patterns to be entered into the controller.

A.3.1 Packet Protocol

Protocol (format used to transfer command and data) uses two types of packets:

1. Command Packets
2. Message Packets

Commands are not written to the TU80's UNIBUS registers (Figure A-3). Instead, command pointers, which point to a "Command Packet" somewhere in CPU memory space, are written to the TSDB register of the M7454 module. The command pointer used in the TU80 to retrieve words in the memory is called the Command Packet. The Command Packet can be up to four 16-bit words long and it instructs the system as to the function to be performed. These words contain any function parameters such as bus address, byte count, and modifier flags.

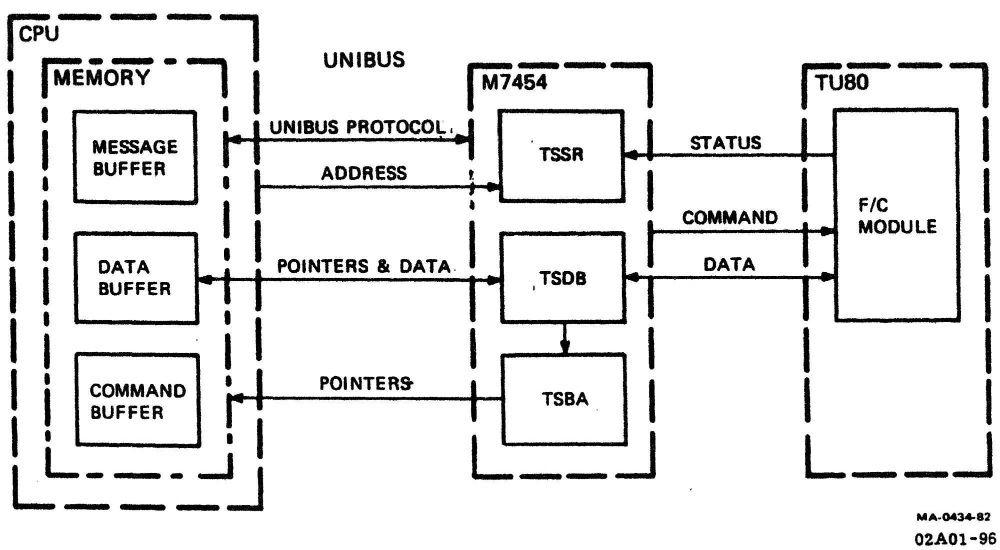


Figure A-3. PACKET PROTOCOL COMPONENTS

The host uses message packets to obtain TU80 status information. Message packets are seven 16-bit words long, beginning with the header word which provides a status message.

The command and message packets and data are stored in memory buffer areas of the host CPU.

A.3.2 UNIBUS Registers

These CPU buffers are pointed to by the contents of the M7454 UNIBUS Registers to find out where the needed information is located in the host memory (Figure A-3). The TU80 Register Summary is shown in Figure A-4.

The M7454 controller has three UNIBUS Registers: Data Buffer (TSDB), Bus Address (TSBA), and Status (TSSR).

REGISTER \ BITS	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
TSBA (R/O)	A15	A14	A13	A12	A11	A10	A09	A08	A07	A06	A05	A04	A03	A02	A01	A00
TSDB (W/O)	P15	P14	P13	P12	P11	P10	P09	P08	P07	P06	P05	P04	P03	P02	P17	P16
TSSR	SC S			RMR S	NXM 4/5	NBA S	A17 S	A16 S	SSP S	OFL S			TC2 S	TC1 S	TC0 S	
RBPCR	C15	C14	C13	C12	C11	C10	C09	C08	C07	C06	C05	C04	C03	C02	C01	C00
XST0	TMK S/2	RLS 2	LET 2	RLL 2	WLE 3/6	NEF 3	ILC 3	ILA 3	MOT S	ONL S/1/3	IE S	VCK S/3	PED S	WLK S/3/6	BOT S/2/3	EOT S/2
XST1	DLT 4		COR S					RPB 4			IPO S/4				UNC 4	MTE 4
XST2	OPM S				TU80	WCF 7		DTP S	DT7 S	DT6 S	DT5 S	DT4 S	DT3 S	DT2 S	DT1 S	DT0 S
XST3	TRANSPORT ERROR CODE 7	7	7	7	7	7	7	7		OPI 6	REV S		DCK S/6			RIB 2

Termination Class Codes:

0 = Normal Termination
1 = Attention Condition
2 = Tape Status Alert
3 = Function Reject
4 = Recoverable Error - Tape Position = One record down tape from start of function
5 = Recoverable Error - Tape not removed
6 = Unrecoverable Error - Tape position lost
7 = Fatal Controller Error

Fatal Class (FC) Codes (in TSSR): (NOT USED)
NON-TERMINATION CLASS CODE: S= STATUS

MA-2845B
02A01-97

Figure A-4. TU80 REGISTER SUMMARY

A.3.2.1 TSDB - The TSDB is an 18-bit register that is parallel loaded from the UNIBUS or the controller itself. A 16-bit portion of this register is used as a word buffer register: It is written into by the CPU to initiate an operation, and it is written into by the controller to store data to be transmitted to UNIBUS memory during an NPR cycle. Two transfers are for maintenance purposes (byte transfer, DATOB at high byte or low byte), and the third is for the normal (word) operation (DATO) to initiate an operation. This register is write-only and is not cleared at subsystem initialize or bus initialize.

A.3.2.2 TSBA - The TSBA is an 18-bit register that is parallel loaded from the TSDB every time the TSDB is loaded. TSDB bits 15-2 load into TSBA bits 15-2, TSDB bits 1 and 0 load into TSBA bits 17 and 16, and zeros are loaded into TSBA bits 1 and 0 (thereby, specifying a Module-4 address). TSBA bits 17 and 16 are displayed in TSSR bits 9 and 8, respectively. The register is incremented or decremented by two for DMA word transfers, or by one for DMA byte transfers.

1. The TSBA can be used as a command pointer to the "functional device registers" (command and message buffers). These are located somewhere in UNIBUS address space. The contents loaded into the TSDB when the TU80 in the bus slave is considered the command pointer. In this mode, the TU80 receives data (command buffer words) and stores them internally on the module for storage and/or execution.

2. The TSBA can be used as a data pointer (bus address for NPR), pointing to data buffer areas located somewhere in the UNIBUS address space. In this mode, the controller loads the TSBA with data pointer information from internal storage. The contents are then used to point to data buffer areas while transferring tape data between CPU memory and tape transport.

A.3.2.3 TSSR - The TSSR is a 16-bit read/write register than can be updated only from the transport or M7454 internal logic. It cannot be modified from the UNIBUS except only for 3 bits that are cleared when the TSDB is loaded. In this register, major system status can be observed.

It can be read with or without the transport connected to the M7454.

A.3.3 TU80 Subsystem Operation

Before the TU80 can begin to function, a command packet must be assembled in the CPU's system memory. In every case, the packet must be comprised of four words, even though not every command requires all four words.

The command packet may be considered to be assembled of three remote device registers: (see Figure A-5)

1. Command Register (CMDR)
2. Data Pointer (DPR)
3. Byte Count Register (BPCR)

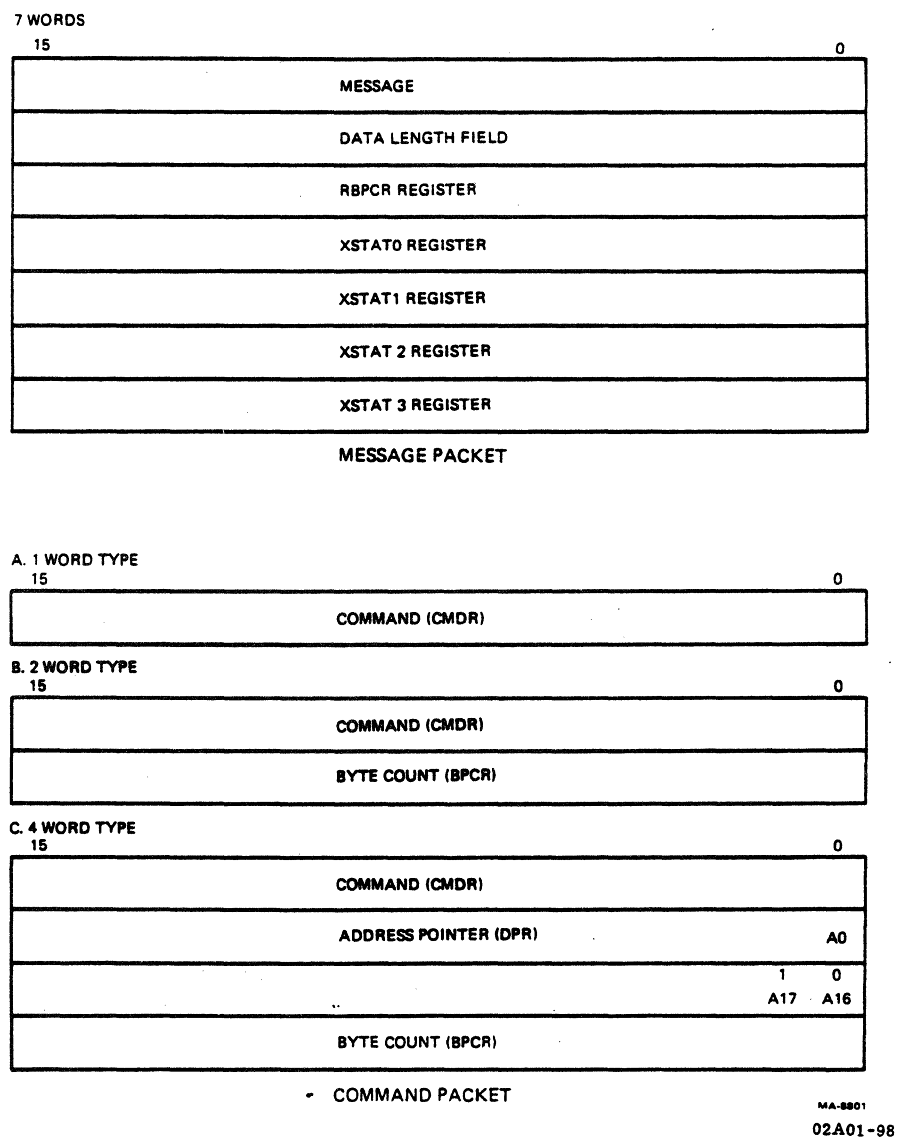


Figure A-5. EXAMPLE OF PROTOCOL PACKETS

- Command Pointer - Must be an address on a module-4 boundary (i.e., beginning at octal 0, 4, 10, 14, etc.).

- Data Pointer - Is comprised of two word locations:

  1. CMDR + 2: Low order address word (A15:00)
  2. CMDR + 4: High order address word (A17, A16)

- Positive Byte Counter Register - Can be located at:

  1. CMDR + 6: Data operation (DPR required)
  2. CMDR + 2: Non-data operation (DPR is not required)

The DPR is eventually loaded into TSBA to be used as the UNIBUS address for Non-Processor Request (NPR) transfers. The BPCR is used to indicate the number of bytes (8 bits of data per byte) to be moved to or from the tape transport during a data transfer. It is also used to specify the number of records in a Space Record command or number of files in a Skip Tape Marks command. The CMDR specifies the function to be executed by the subsystem.

In on-line mode, the M7454 controller is run under a specific microcode subroutine which initiates a sequence of events throughout the subsystem.

The M7454 initiates three types of transfers to execute host commands:

1. Data Out (DATO)
2. Non-Processor Request Data Out (NPR DATO)
3. Non-Processor Request Data In (NPR DATI)

TU80 operation can be described through read and write functions (see Figure A-6).

A.3.3.1 Read Operation - If read forward operation is commanded by the host CPU, the following "Read-a-Word-at-a-time" sequence occurs (assuming the tape is loaded and the tape transport is on-line).

The host loads the command pointer into the M7454 (DATO). The M7454 reads the command packet, including the data buffer address (NPR DATI). Then the controller orders the tape transport to read data from tape in the forward direction by placing the appropriate command on the control lines of the transport interface bus and issuing a strobe pulse (RSTR).

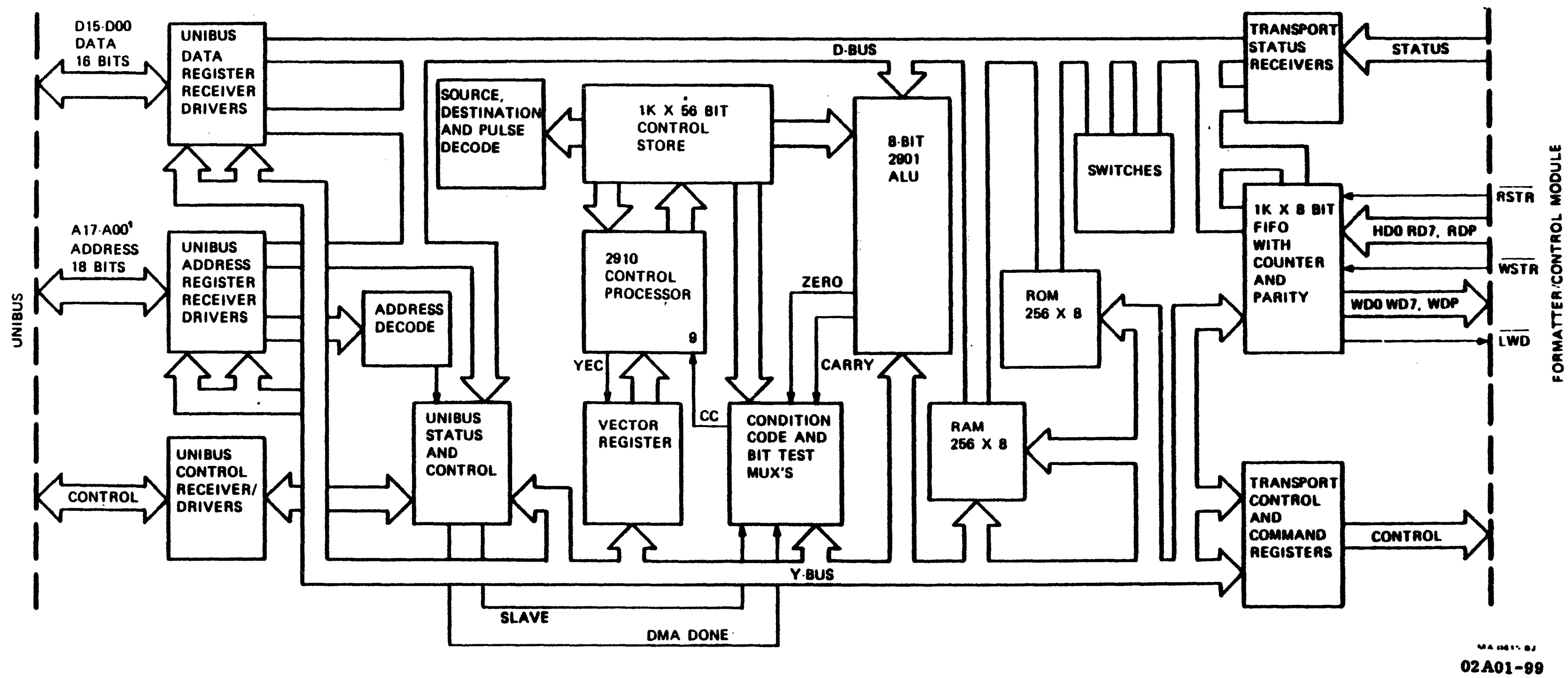


Figure A6. M7454 FUNCTIONAL BLOCK DIAGRAM

The transport receives the command and becomes "busy". The tape transport control system directs tape to move in forward direction, accelerate to an internally-specified speed, and position itself at the record to be read. When the record is found, the read logic is enabled and receives data from the read head. The read data output of the read head (IR0--IR7) is checked by the formatter for vertical parity errors. If any such error is detected, the error recovery logic in the transport's formatter module is enabled to take appropriate corrective action. If a single-bit data error (i.e., single or dead track error) occurs and can be corrected, "on-the-fly" correction is performed automatically by the formatter logic.

The resulting verified data, along with the parity bit, is transmitted over the read data lines (RD0-RD7, RDP) to the M7454 module and is clocked into the FIFO buffer. The interface controller performs another parity check, and an error flip-flop is set if an error is detected. The output of the FIFO is monitored by the controller microprogram. When a byte is available, it is removed from the FIFO and stored in the RAM within the controller.

When an entire word (2 bytes) is assembled, it is transferred to the host memory via the UNIBUS under DMA control (NPR DATO). The operation continues until the tape transport has read the entire record and the controller has transferred the data to the host memory, or until a fatal error is detected.

Since all data transfers in the TU80 subsystem are performed in the record format, the host OS specifies the maximum allowable record length or byte count and stores it in the BPCR register. During a read operation, the M7454 controller compares the contents of the BPCR and RBPCR (Residual Byte Count Register). If the byte count is positive (or the record read is shorter than the specified BPCR), it indicates that the complete record is read in the host memory and the Read can continue on a new command from the host. If the byte count becomes negative (i.e., the record read is longer than the specified BPCR), the read operation stops at "0" byte count and the excessive data bytes are truncated and lost to the host. This is the error condition, and the error flag is set up in the host to initiate the software-controlled data recovery procedure.

The read operation is completed by the M7454 controller by updating the contents of its TSSR register and storing an updated message packet in the CPU message buffer (NPR DATO).

A.3.3.2 Write Operation - If a write operation is commanded and the request is granted, the host fills a data buffer in its UNIBUS space with the data to be written on tape. Then the host moves the command pointer to the TBSA on the M7454 (DATO). The M7454 controller receives the command packet, including the data buffer address, one word at a time (NPR DATI). Using the obtained data buffer address, the M7454 controller fetches either all or part of the data block to be written from the CPU memory and fills the FIFO. The controller then issues a write command to the tape transport. The tape is moved in forward direction and accelerated to a specified speed under the internal microprocessor control. When the tape is up to the nominal speed and properly positioned, the tape transport formatter starts to clock the data out of the FIFO by activating a strobe signal (WSTR). Parity bit is also generated by the controller at the FIFO output.

The write data and parity are transmitted to the formatter over the Write Data Lines (WD0--WD7, WDP). The formatter encodes the input data and transfers it to the write head (IW0--IW7, IWP) to be recorded on tape (NPR DATI).

To check the data validity, the transport also reads the written data from the tape with its read-after-write head and verifies the parity; if an error occurs, the M7454 controller is notified via one of the status lines of the interface bus. During the Write, the controller keeps the FIFO supplied with data from its RAM which, in turn, receives its data from CPU memory, 2 bytes at a time. When the entire data block has been entered into the FIFO, the controller allows the FIFO to be completely emptied by the transport. When the empty condition is detected, logic at the FIFO output transmits a signal (LWD) to the tape transport to signal the end of the data. The tape transport writes a "postamble" on tape and continues reading the data from tape. When all operations are complete, the transport signals the controller which, in turn, completes the operation by supplying an updated message packet to the host (NPR DATO) and updating its own TSSR. The tape transport and controller now work in parallel: The tape transport continues to move tape and eventually brings it to a stop, and the controller can be instructed to process another command buffer, possibly specifying another Write. If the new command is indeed another Write, and if it is initiated within the transport's "reinstruct" time, tape will not slow down or stop. Rather, the new command will be immediately processed and tape will "stream".

APPENDIX B - TAPE TRANSPORT CONFIGURATION SELECTION

OPTION	COMPONENT/LOCATION	COMMENTS
Channel Parity Check	W1 Location 18C Positions 1 and 2	As Shipped (Standard) - Parity bit transferred with data.
	Positions 2 and 3	Optional - Use if parity bit is not transferred with data.
Short Gap	W3 Location 16D	
Variable Short Gap (0.6 inch to 0.9 inch)	Positions 1 and 2	As Shipped (Standard).
Fixed Short Gap (0.6 inch)	Positions 2 and 3	Optional.
Long Gap	W4 Location 16C	
Variable Long Gap (0.6 inch to 1.2 inch)	Positions 1 and 2	As Shipped (Standard).
Fixed Long Gap (1.2 inch)	Positions 2 and 3	Optional.
Adaptive Velocity Control (AVC) (See Note)	W5 Location 16E Positions 1 and 2	Optional - Disables AVC Select.
	Positions 2 and 3	As Shipped (Standard) - Enables AVC.
Formatter	Location 21D	As Shipped (Standard).
Address 0	S1 - OFF	
Transport	Location 21D	As Shipped (Standard).
Address 0	S2 - OFF S3 - OFF	

NOTE

Jumper W5 - Adaptive Velocity Control. When this standard feature is envoked, rather than selecting 25 ips mode when low speed is commanded, the transport will enter a mode, whereby, the most optimum speed will be chosen to match system requirements. If 100 ips mode gives the best throughput, then this mode will be used; the same applied to 25 ips streaming and 25 ips start/stop modes. This choice of operating mode will be done automatically by the transport and does not require any involvement by the system. This feature allows the TU80 to run under standard DIGITAL 1/2 inch tape software and yet, offer the advantage of streaming. With this option enabled, the unit will respond to a Set 100 IPS command in the normal manner.

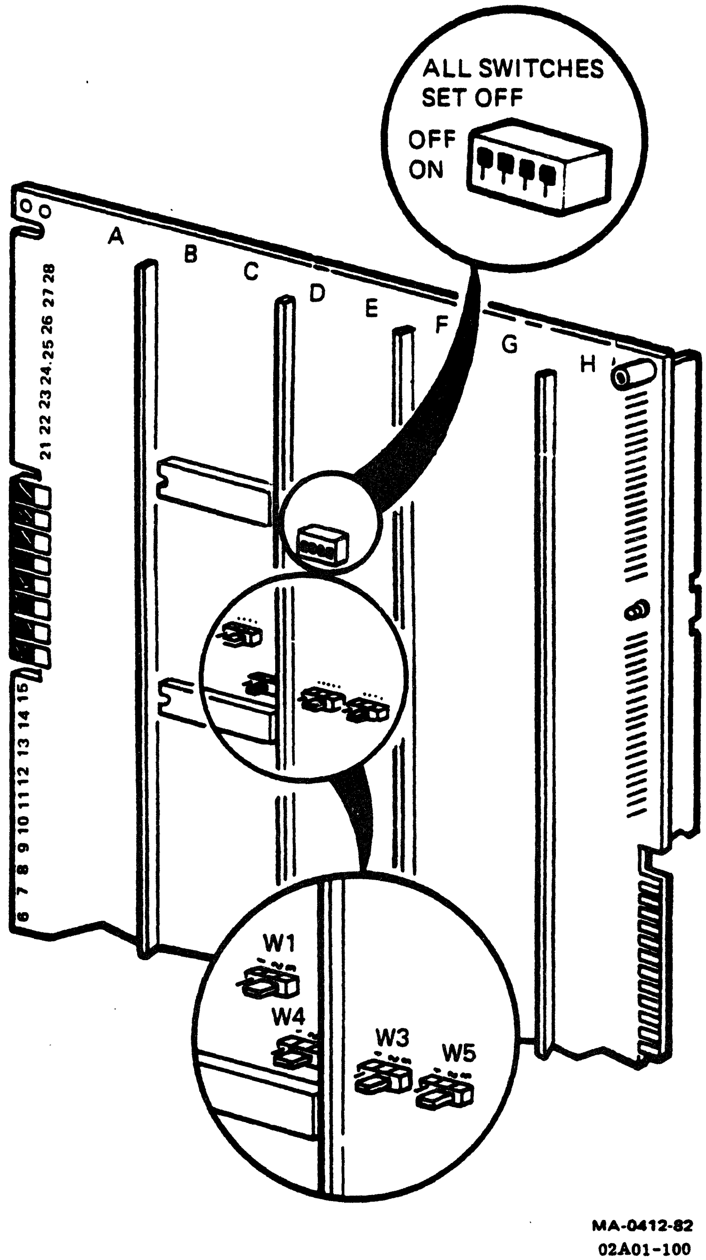


Figure B-1. FORMATTER MODULE - CONFIGURATION SELECTION COMPONENTS

APPENDIX C - APPLICABLE DOCUMENTATION

C.1.0 APPLICABLE DOCUMENTATION

The documents listed below are applicable to the TU80 subsystem and are available through the local DIGITAL Sales and Service Office or the Accessories and Supplies group. Refer to the ordering information in the TU80 User Guide.

- TU80 Subsystem User Guide, EK-OTU80-UG
  Contains the functional overview, installation, operating, and programming information.

- TU80 Pocket Service Guide, EK-OTU80-PS
  Provides a quick reference to maintenance and repair procedures for the trained service personnel.

- TU80 Technical/Service Manual, EK-OTU80-TM
  Contains the system functional description, installation and acceptance procedures, and theory of operation maintenance information.

- TU80 Pathfinder, EK-OTU80-SV
  Contains test documentation (troubleshooting procedures, diagnostic tests, fault checks, and sub-fault codes) for use by training/service personnel.

- TU80 Illustrated Parts Breakdown, EK-OTU80-IP
  Provides a listing and illustrations of replaceable parts.

- 874 Power Controller, EK-00874-IP

Also, use applicable manuals and hardbooks for the appropriate PDP-11 or VAX Computer Systems and Processors.

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MEMORANDUM

TO: CIRCULATION (SEE BELOW)
FROM: MIKE HUDGELL, SOFTWARE SERVICES, EPSOM
SUBJECT: TO STREAM OR NOT TO STREAM
DATE: 23RD FEBRUARY 1984

We have had many queries from customers and salesmen regarding the TU80 streaming performance. This memo will hopefully clarify the situation.

SOFTWARE	MACHINE	TU80 PERFORMANCE
VMS	11/730	The TU80 will not stream
VMS	11/750	During BACKUP with the /BUFFER_COUNT parameter set to 5 it will stream MOST of the time. At other times it will not stream.
VMS	11/780	The TU80 will stream most of the time running VMS utilities
RSTS/E	any	The TU80 will not stream (nor will TSV05).
RSX-11M RSX-11M+	11/70 & 11/44	The TU80 will stream sometimes if machine is lightly loaded.
RSX-11M RSX-11M+	other	The TU80 will not stream

Hope this clears things up.

Regards,

MIKE HUDGELL

Circulation:

All Salesmen and SUM'S
Gerry Gardener
Ross Macadam
Advisory specialists
Norton Hawes
Colin Gregory
Len Elkington

TU80 TAPE SUBSYSTEM TECHNICAL MANUAL
EK-0TU80-TM-001

Your comments and suggestions will help us in our continuous effort to improve the quality and usefulness of our publications.

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The Documentation Products Directory and the DECdirect Guide contain information on the remainder of DIGITAL's technical documentation.

Copies of the above Directory and Guide, as well as additional copies of this document, are available by writing or calling:

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Accessories and Supplies Group
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