Educational Services

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TU80/81 OPERATION AND SERVICING

STUDENT GUIDE

digital

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TU80/81 Operation and Servicing

Student Guide

Prepared by Educational Services
of
Digital Equipment Corporation

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COURSE GUIDE

INTRODUCTION

TU80/81 Operation and Servicing is a self-paced course. A self-paced course lets you take the course in the way that best fits your study habits. If you have any questions about this type of course, read How to Take a Self-Paced Course (EY-DX037-ID-001).

You should take about three days to complete this course. The course map (Figure 1) shows in which order you should take the lessons.

This course includes a video tape designed to supplement the self-paced material in the Student Guide. There are two sections of tape, which you should view separately. The first section introduces the TU81 streaming tape transport. View this section just before you start the physical functional lesson. The second section shows the removal and replacement steps for each procedure you will perform in the lab. View this section just before you start the Removal and Replacement lesson.

This course has two tests. The first test is after the Theory of Operation lesson. The second test is at the end of the course, after the Installation lesson.

The Course Administrator has given you all the documentation and equipment necessary to complete this course. Occasionally, students share resources. The Course Administrator will tell you if this is necessary.

The most important thing to remember while you take this course is to answer every question you have about the TU80/81.

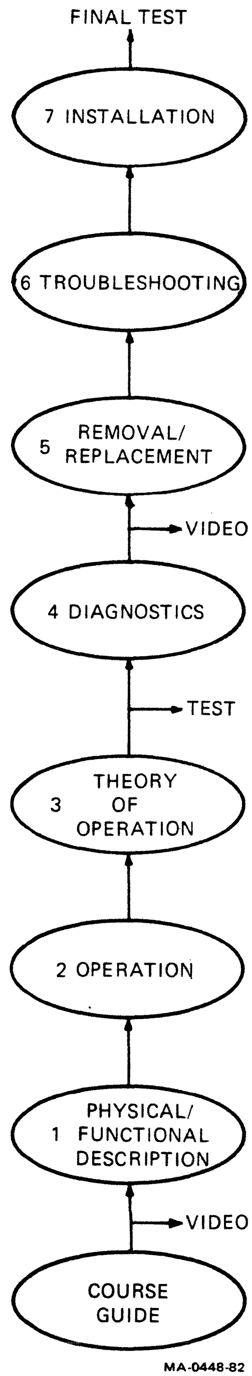

Figure 1   TU8Ø/81 Course Map

PREREQUISITES

You must satisfy the following requirements before taking this course.

1. Complete the Magnetic Recording and the Tape Concepts courses.

2. Complete the Static Awareness and Module Handling Procedures course.

3. Have experience in using VAX diagnostics.

If you have not satisfied these requirements, tell the Course Administrator now. Before continuing the course, you must take the Prerequisite Test on pages 6 and 7.

COURSE GOAL AND LIMITATIONS

This course's goal is to give Field Service representatives the knowledge and skills they need to maintain and repair the TU80 or TU81 subsystem. The course refers throughout to the TU81, but points out the TU80 differences when applicable.

This course includes the following topics.

Operation
Diagnostic operation and interpretation
Removal and replacement procedures
Functional overview
Troubleshooting to the field replaceable unit level

This course does not cover skills related to diagnostic programming, related system software, or troubleshooting to the chip or transistor level.

COURSE ORGANIZATION

This course is divided into seven lessons as shown in Figure 1.

Each lesson includes the following information.

Introduction
Objectives
Course lesson
Performed or written practice exercises

Throughout this course, certain sentences begin with a blank space as follows.

____ Press the UNLOAD switch to remove tape from the tape path, then wind the tape on the supply reel.

This is an activity sentence. You must then perform the activity described in the sentence. No other instructions are provided unless needed for a specific activity.

You may want to check off these sentences as you complete each activity.

Do not skim through an activity sentence. Read each sentence carefully. You can overlook many small but important bits of knowledge by skimming parts of a course.

TOOLS AND ACCESSORIES

You need the following tools and accessories to complete this course.

Medium phillips screwdriver
Small phillips screwdriver
Medium flat-blade screwdriver
Set of allen wrenches
11/32 inch nutdriver
9/16 inch socket, 6-inch extension, and ratchet handle
TUC01 Magtape Cleaning Kit
Known good tape (preferably a 600-foot tape)
Velostat Kit

NOTE

All TU81 modules are static sensitive. You must use the Velostat Kit when handling these modules.

The Course Administrator provides these tools and accessories.

____ Get the tools from the Course Administrator.

You do not have to use an oscilloscope in this course. However, if you want to look at specific signals, you can get an oscilloscope from the Course Administator.

TU81 POCKET SERVICE GUIDE

You should use the TU81 Magnetic Tape Subsystem Pocket Service Guide (EK-ØTU81-PS) while taking this course.

The pocket service guide was not written to be a learning tool. It was written for you to use in the field to complement the knowledge you gain in this course.

To help you do your job better, add your own notes into the pocket service guide. Everyone needs some reminders while in the field. The pocket service guide is the perfect place to add notes; it is the one document you always have in the field.

DOCUMENTATION

The introduction chapter in the pocket service guide contains a complete list of TU81 documents and their order numbers. This course refers you to many of these documents.

The Course Administrator provides all the documents for this course.

PREREQUISITE TEST

1. Match each term with the correct description.

Terms	Description
F ____ Record	a. For tape loaded on any tape transport, this part of the tape is closest to the observer.
E ____ Frame	b. A reflective strip placed on the nonoxide side of the tape against the reference edge.
A ____ Reference edge	c. A reflective strip placed on the nonoxide side of the tape, against the nonreference edge.
B ____ BOT marker	d. Eight tracks of data plus one track of vertical parity.
D ____ 9-track recording	e. A single bit in each track across the width of a magnetic tape.
G ____ Interrecord gap	f. A series of consecutive tape characters.
C ____ EOT marker	g. A length of erased tape used to separate records or blocks.

2. Reversing current flow in the recording head wire coil changes the recording heads, ____b____.

   a. Retentivity
   b. Polarity
   c. Permeability
   d. Shape

3. Magnetic tape consists of three layers: base, binder, and ____b____.

   a. An oily substance
   b. An oxide coating
   c. A MOS substrate
   d. A plastic facing material

4. In a computer system, what provides the communication paths between the processor, memory, and peripheral devices?

   a. Input
   b. Output
   c. Interface
   d. Bus

5. What indicates the address of the next instruction in a program?

   a. Program counter
   b. General purpose register
   a. Status register
   d. Arithmetic logic unit

6. Where do microprocessor controllers store the device's operating routines?

   a. Microprocessor
   b. ROM
   c. Input buffer
   d. Output circuit

7. What is the first step in troubleshooting any device?

   a. Replace the faulty assembly.
   b. Run diagnostic tests.
   c. Look up the error code.
   d. Analyze the problem.

8. The binary number 100011101111 converts to what octal number?

   a. 10733
   b. 4357
   c. 4335
   d. 1004636

9. What does the horizontal axis on an oscilloscope measure?

   a. Pink noise
   b. Voltage
   c. Time period
   d. Resistance

10. What does the vertical axis on an oscilloscope measure?

   a. Pink noise
   b. Voltage
   c. Time period
   d. Resistance

INTRODUCTION

This lesson introduces the TU81 hardware components. A functional description overview is included at the end of the lesson to help you understand how the components relate to each other.

You do not disassemble anything as part of this lesson. However, to gain access to some components you may have to remove a cover or open a door. At the end of this lesson you should know where each TU81 component is located and what it looks like.

NOTE

DO NOT power up any part of the TU81 subsystem during this lesson.

This lesson is an introduction to the TU81 hardware components. Later lessons should answer any questions you form during this lesson.

OBJECTIVES

1. Use the TU81 subsystem specifications list to identify specified technical parameters.

2. Locate and identify the TU81 subsystem physical components.

3. Describe any TU81 subsystem component's function.

4. Describe how the TU81 subsystem reads and writes.

TU81 SUBSYSTEM

The TU81 subsystem is a magnetic tape transport for one-half inch tape, used on VAX computers. Computer Peripherals, Inc. (CPI) in Norristown, Pennsylvania manufactures the TU81 for Digital. CPI is a subsidiary of Control Data Corporation (CDC). The host interface module is the M8739 LESI (low end storage interface). The TU81 magnetic tape transport, interface module, and connecting cables comprise the TU81 subsystem.

Often in TU81 documentation, the terms transport and TU81 are used interchangeably. However, this course defines the different groups of components as follows.

- Transport - includes all the components attached to either side of the tape deck and the control panel.
- TU81 - includes the transport, power controller, and cabinet.
- TU81 Subsystem - includes the TU81, interface cables, and M8739 Low End Storage Interface (LESI) module.

The TU81 is designed primarily for use as a data back-up device where large amounts of data are recorded or read in a continuous stream at a fast data transfer rate.

The TU81 operates in either streaming or start/stop mode. In streaming mode the TU81 can read or write data at 75 inches per second (ips) or 25 ips. In start/stop mode the TU81 operates at 25 ips only.

The data transfer rate determines the mode implemented within the TU81. The mode used is transparent to the host and operator. The Theory of Operation lesson explains both modes.

The TU81 subsystem has the following features.

- Microprocessor transport control
- Internal microdiagnostics
- No tension arms or vacuum columns for tape buffering
- No capstan
- No scheduled preventive maintenance by Field Service
- No adjustments or alignments
- On-the-fly single-track (PE mode) or dual-track (GCR mode) error correction
- ASCII diagnostic port

SPECIFICATIONS

Table 1 lists the most commonly used TU81 specifications. Note the speed, recording methods, and recording densities.

CAUTION
Only use tape on a TU81 that meets ANSI and Digital tape standards. Other tapes, such as back-coated tape, cause problems such as tape slippage, auto-load failures, false EOT and BOT sensing, and the need for more frequent drive cleaning. Your Unit Manager can tell you where to find a copy of these standards.

Table 1 TU81 Specifications

Recording methods	Phase encoded (PE) Group coded recording (GCR)
Recording densities	
PE	1600 bits/inch (bpi)
GCR	6250 bpi
Rewind speed	200 inch/second (ips) (~2.5 minute/2400 foot of tape)
Tape	
Width	1/2 inch
Length	2400 feet maximum
Thickness	1.5 millimeter
Tracks	9
Capacity	
PE	40 megabytes
GCR	140 megabytes
Tape speed	
Start/stop	25 inches/second (ips)
Streaming	75 ips or 25 ips
Data transfer rate	
PE low-speed mode	40 kilobytes/second
PE high-speed mode	120 kilobytes/second
GCR low-speed mode	156 kilobytes/second
GCR high-speed mode	469 kilobytes/second
Weight	280 pounds (drive and cabinet)
Dimensions	
Height	41.6 inches
Width	21.5 inches
Depth	30.0 inches
Operating temperature	50^{o}F to 104^{o}F

Specifications tables provide answers for many of your and your customer's questions. Refer to the TU81/TA81 Technical Manual (EK-TUA81-TM) for a complete list of specifications.

MAJOR EXTERNAL COMPONENTS

You start working directly with the TU81 in the following paragraphs. You will not remove any FRUs or power up the TU81 in this lesson.

You can use the TU81 for the rest of the course without permission from the Course Administrator. If another student is taking the course, you must share the TU81. Work out a schedule that accomodates both of you.

> NOTE
>
> The next sentence is an activity sentence, signified by the blank space at the beginning. You must complete that activity immediately with no further directions. Place a check in the blank space after you complete the activity. Activity sentences appear throughout this course.

____ Open the TU81 top cover by pushing back on the latch (Figure 1). The transport is under the top cover.

Identify the following TU81 components (Figure 1).

__✓__ Cabinet
This is a Digital H9643 cabinet.

__✓__ Transport
This is made up of the tape deck and all attached components.

__✓__ Tape Deck (Casting)
The cast tape deck is the base for mounting the transport components.

____ Control Panel
This panel has switches and indicators for all customer and Field Service TU81 operations.

__✓__ ASCII Port Test Panel
This panel (next to the control panel) has an I/O connector for the RS232-compatible terminal (including Digital's hand-held terminal), a power outlet and a fuse. You can use this port and the ASCII terminal to perform diagnostic routines.

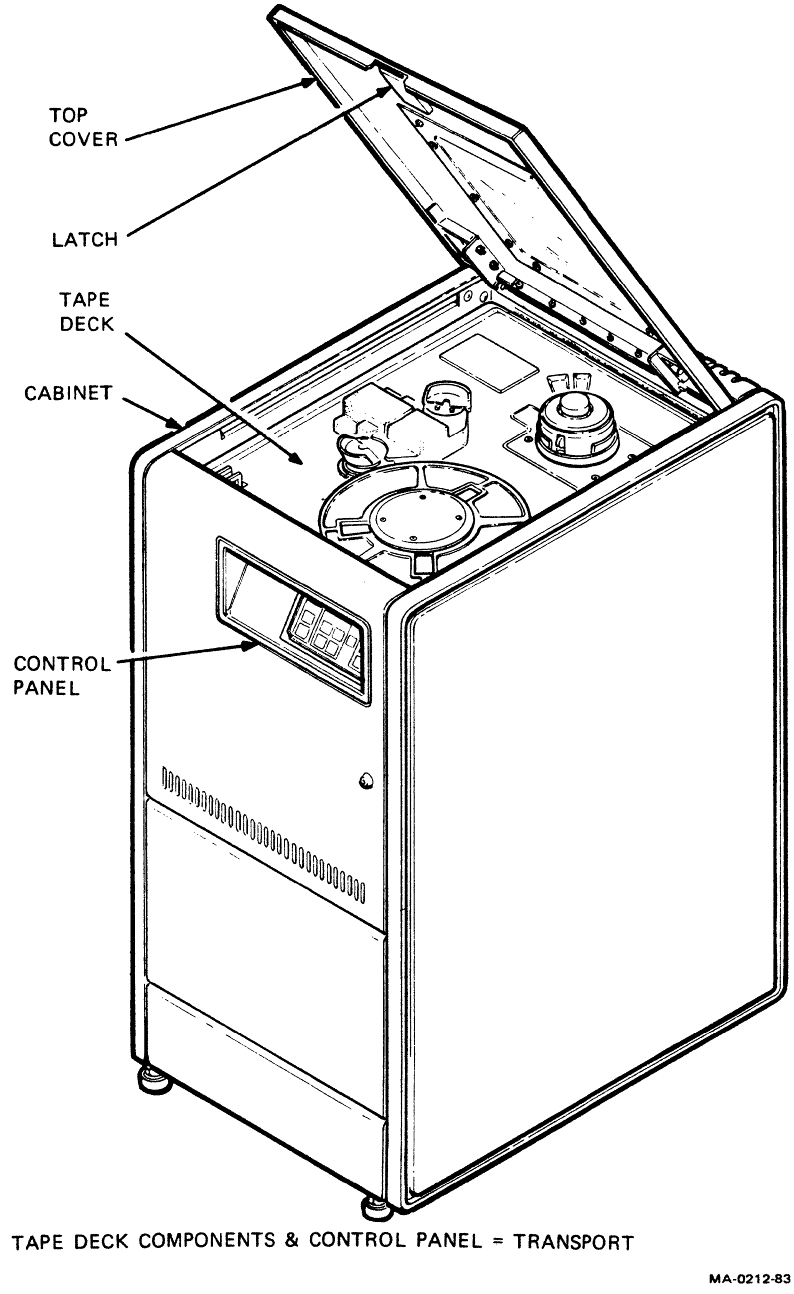

Figure 1 TU81 Major Assemblies (Front)

____ Open the TU81 rear door (Figure 2). You may need a hex-key to unlock the door.

Identify the following TU81 component (Figure 2).

____ **Power Controller**
This controller, used in the United States, is a standard Digital 874 controller with eight ac output plugs. Other controllers may be used in other parts of the world.

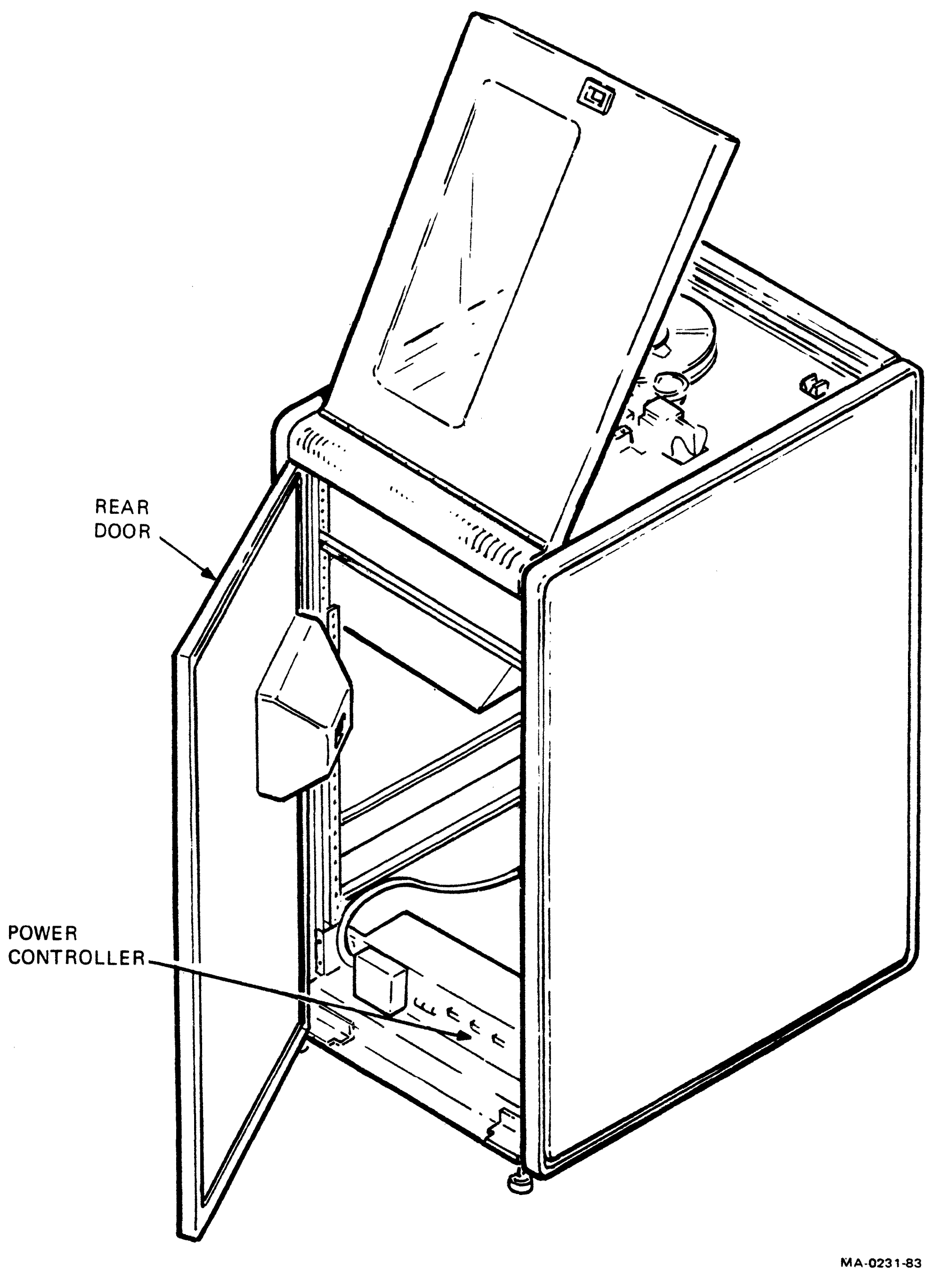

Figure 2 TU81 Major Assemblies (Rear)

TRANSPORT COMPONENTS (TOP)

Identify the following transport components on top of the tape deck (Figure 3).

____ **TU81 On/Off Switch**

This switch powers up the TU81 power supply. The customer usually leaves this switch in the on position so that TU81 power is controlled by the host on/off switch.

____ **Supply Hub**

This hub holds the supply reel (not shown). The supply hub is connected to the supply reel motor shaft.

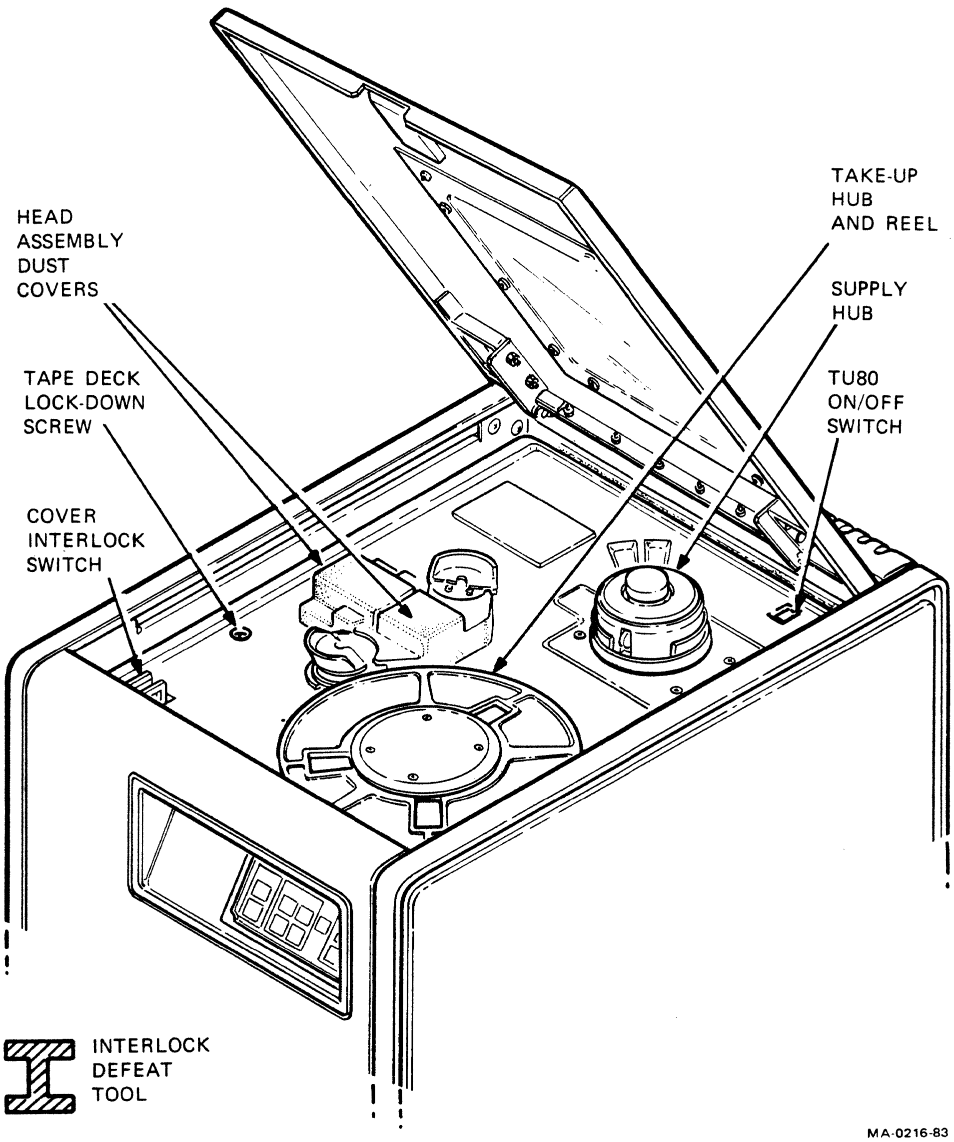

Figure 3 Transport Components (Top)

____ Take-Up Hub and Reel
This reel, also called fixed reel, is part of the hub assembly and is not removable. The hub assembly is connected to the take-up reel motor assembly.

____ Cover Interlock Switch
This switch must be enabled for you to operate the TU81. You must close and latch the top cover to enable this switch.

The Interlock Defeat Tool is included in the CD kit. Only a Field Service representative should use this tool. Push this tool into the interlock switch and turn it 90 degrees to operate the TU81 with the top cover open.

____ **Tape Deck Lock-down Screw**
This screw holds the tape deck secure when the TU81 is operating. If this screw is not tight, the tape deck can vibrate, causing errors and operator annoyance.

____ Head Assembly Dust Covers (Two)
These covers keep the head assembly components clean.

TAPE PATH COMPONENTS

The tape path components include the head assembly components, the air bearings, and the reels.

____ Remove the two head assembly dust covers by pulling them straight out. This reveals the head assembly components.

Identify the following components (Figure 4).

____ Tape Cleaner
This pulls unwanted particles off the passing tape. There are two blades on the tape cleaner; one blade for each direction of tape movement. A pump within the TU81 pulls air through the port between the two blades. This suction pulls the unwanted particles collected by the blades into a filter.

____ Beginning of Tape/End of Tape (BOT/EOT) Sensor Assembly
This assembly senses the BOT and EOT markers on the tape. The TU81 uses these markers to identify tape position. This assembly also contains a reflective strip opposite the sensors. When the BOT and EOT sensors sense this strip at the same time, a signal is generated to notify the TU81 that there is no tape in the tape path (absence-of-tape, or AOT).

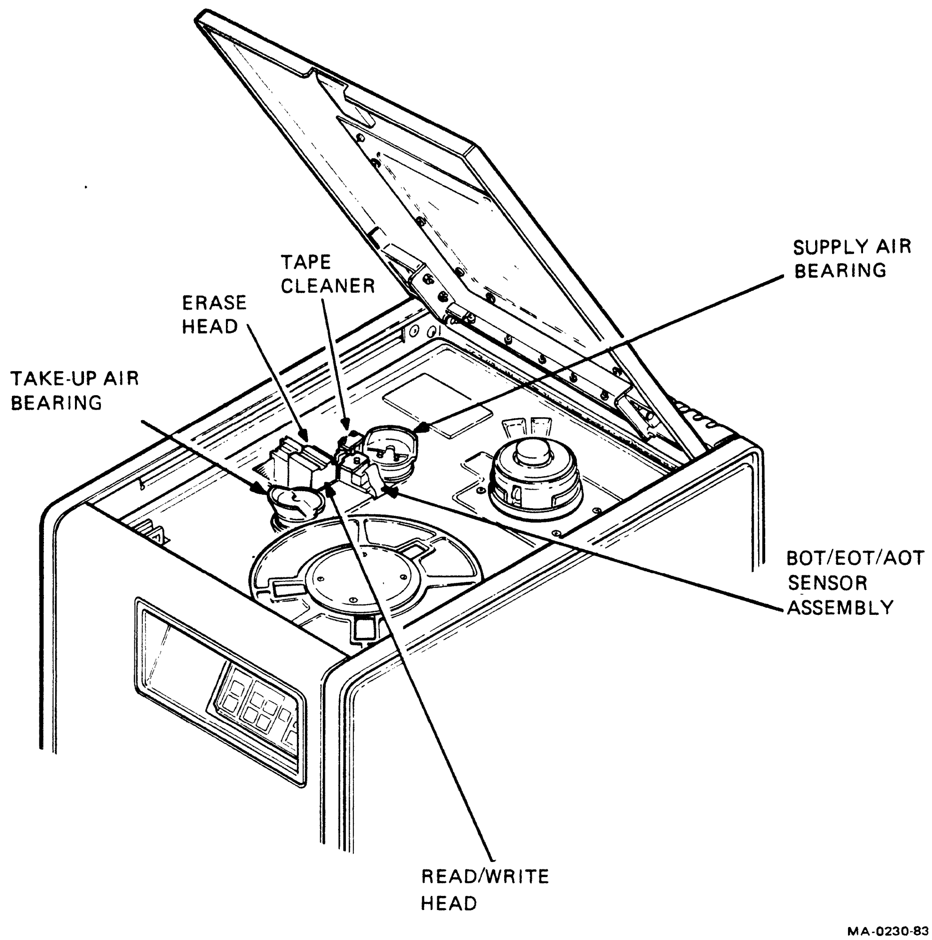

Figure 4   TU81 Tape Path Components

Erase Head

This head crosses the full width of the tape. During a write function, the erase head erases the tape by dc saturation before the tape crosses the write head.

Read/Write Head

This is a dual-gap head. A single assembly contains 18 coils: 9 coils for writing, and 9 coils for reading.

_____ Supply Reel Air Bearing and Take-up Reel Air Bearing
These guide the tape across the heads and help maintain correct tape tension across the heads. Figure 5 is a close-up of an air bearing.

Air blows out the small holes in the bearing surface. The air provides a cushion for the tape to travel on to reduce the friction coefficient. The guide spring limits side-to-side tape movement.

The tension servo operates as follows. Air comes out the small holes and reflects off the tape back through the single large hole on the surface of the air bearing. A transducer in each air bearing monitors the air pressure through the large hole. A signal based on the amount of pressure sensed by the transducer is sent to the control logic. This signal, along with other logic signals, turns the supply reel the correct speed in order to maintain correct tape tension. This process eliminates the need for tension arms or vacuum columns.

_____ Install the two dust covers.

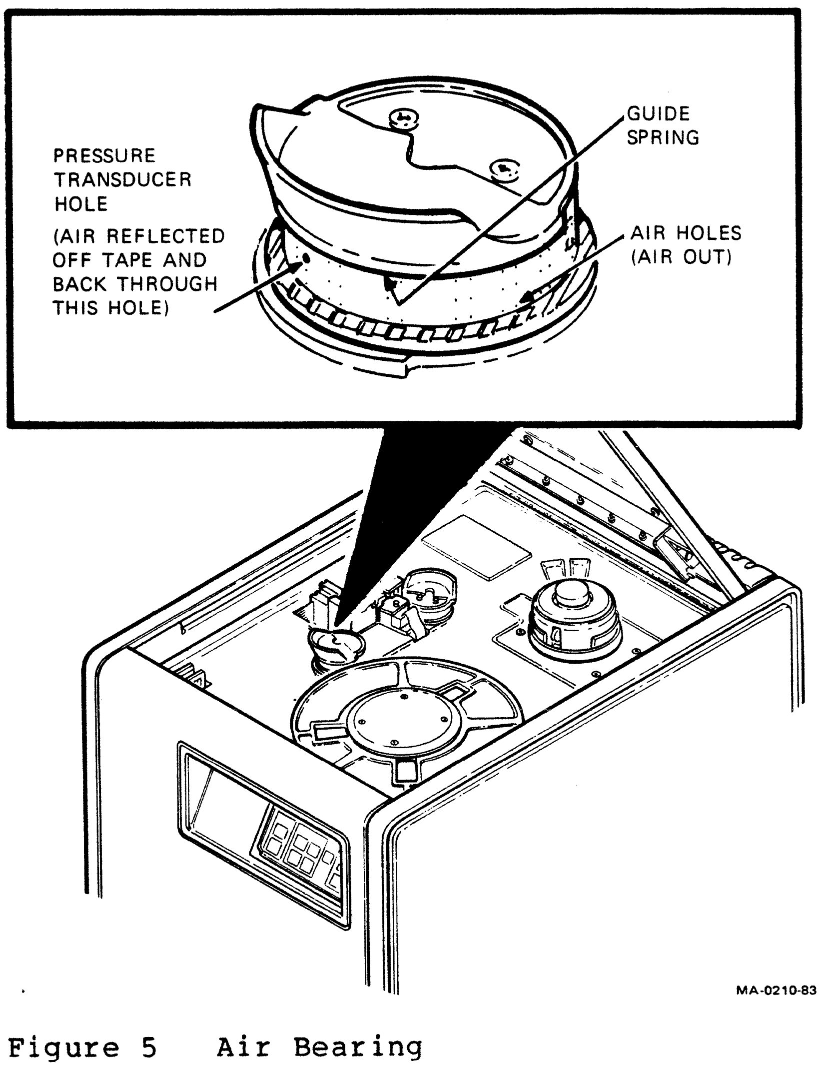

Figure 5 Air Bearing

TRANSPORT COMPONENTS (BOTTOM)

This section describes how to gain access to and identify the transport components on the bottom of the tape deck. Do the following steps to gain access to the bottom of the tape deck.

____ 1. Open the front door of the cabinet (Figure 6). You may need a hex-key to unlock the door.

The tape deck pivots 90 degrees for servicing. This allows the Field Service representative easy access to remove components. You can keep the tape deck in the horizontal (operating) or vertical (servicing) position with the tape deck release latch.

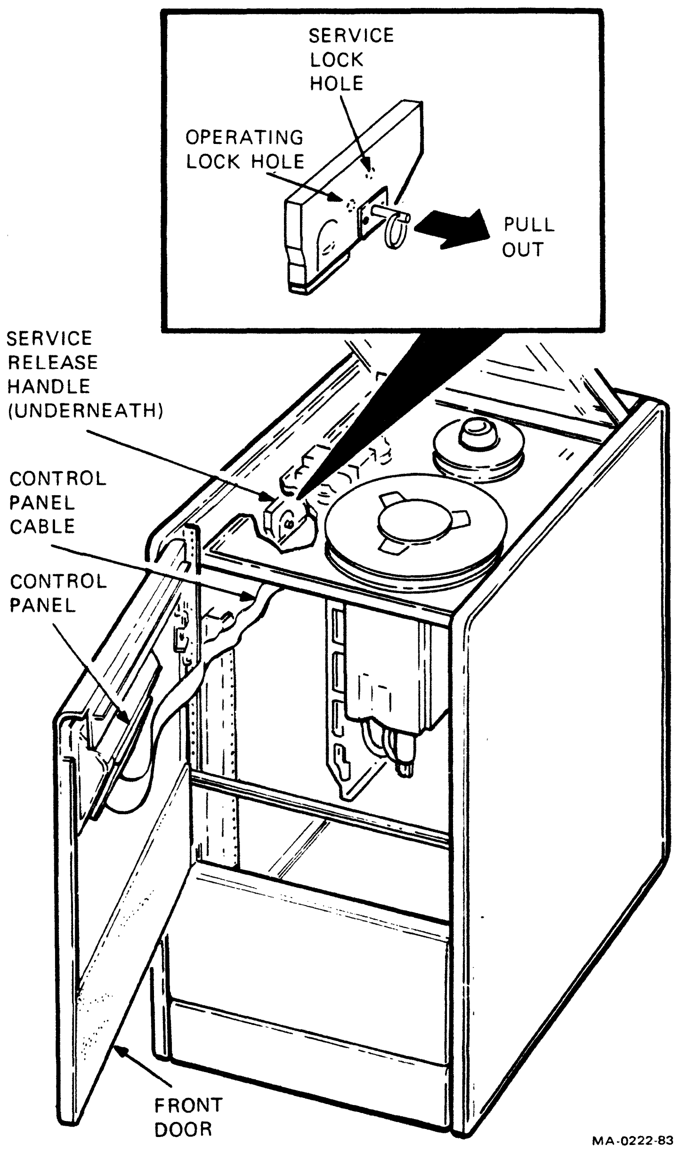

Figure 6 Service Release Handle

____ 2. Turn the tape deck lock-down screw one-half a turn to partially release the tape deck.

CAUTION
Power must be off at this time.

Tape Deck Release Latch and Handle

Do the following steps to gain access to the components under the tape deck.

____ 1. Pull out the tape deck release latch (Figure 6 detail) from the operating lock hole by reaching through the front of the TU81, around the control panel cable, and pulling out the service release handle.

The shaft of the tape deck release latch goes through a hole in the cabinet frame. When you pull on the handle, it will release easier if you move the tape deck slightly up or down. This action takes pressure off the shaft.

____ 2. Grasp the front edge of the tape deck and move it up. (Figure 7). Be careful not to damage the control panel cable.

____ 3. Make sure the tape deck is moved up a full 90 degrees and has snapped into the latch (Figure 6).

The TU81 is now in service position.

To put the tape deck back in operating position, pull out the latch handle and lower the tape deck back to its original position. Make sure the tape deck snaps into the tape deck lock.

Leave the tape deck in the service position for now.

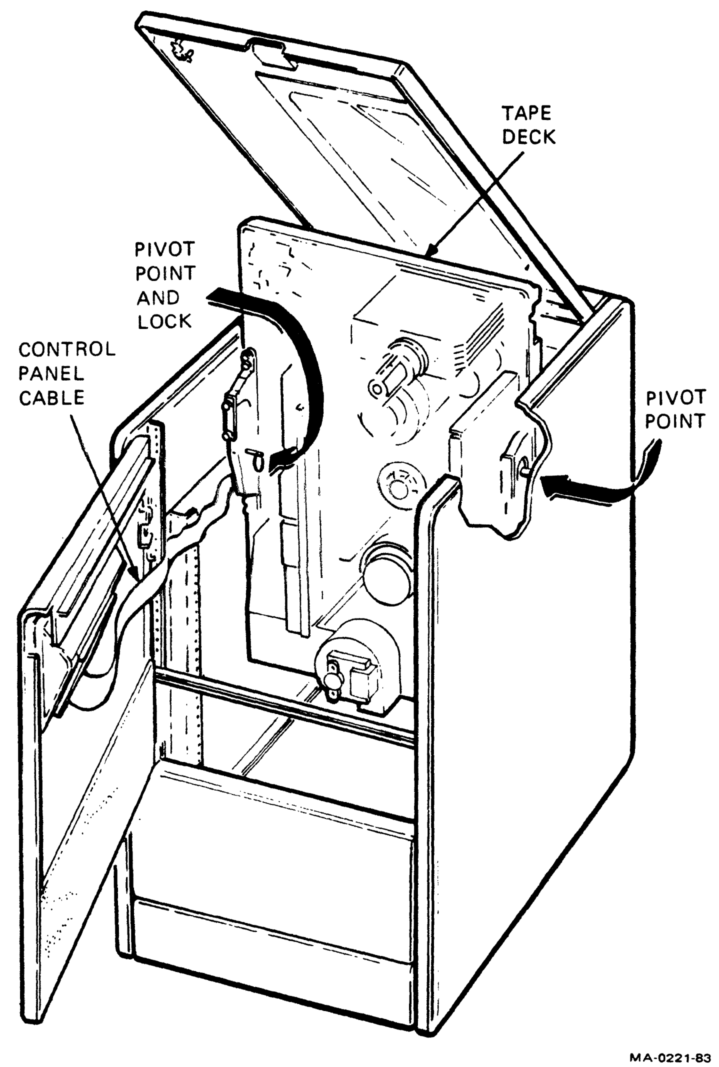

Figure 7 Rotating the Tape Deck

Identify the following transport components, which are located on back of the tape deck (Figure 8).

____ **Power Supply**
This accepts input ac voltage and converts it to +5, -6, +15, -15, and +25 dc voltages for the transport. If the power supply delivers an incorrect voltage, it must be replaced.

The on/off switch on top of the tape deck is the circuit breaker for the power supply.

____ **Cooling Fans (Two)**
There are two fans for cooling the TU81. A centrifugal fan is attached to the power supply and an axial fan is mounted on the front cabinet frame. These fans cool everything in the cabinet.

NOTE
There is a temperature sensor on the card cage. If the upper temperature limit is exceeded, an error code is generated.

____ **Acoustic Cover**
This cover suppresses noise. It covers the reel motors, tachometers, and compressor. The cover also helps direct the flow of cool air past the components.

Do the following step to remove the acoustic cover and gain access to the reel motors and the compressor (Figure 8).

WARNING
Some of the components under the acoustic cover can cause severe shock if touched when power is on.

Make sure power is off before you remove the cover.

____ Remove the mounting hardware from the acoustic cover and remove the cover.

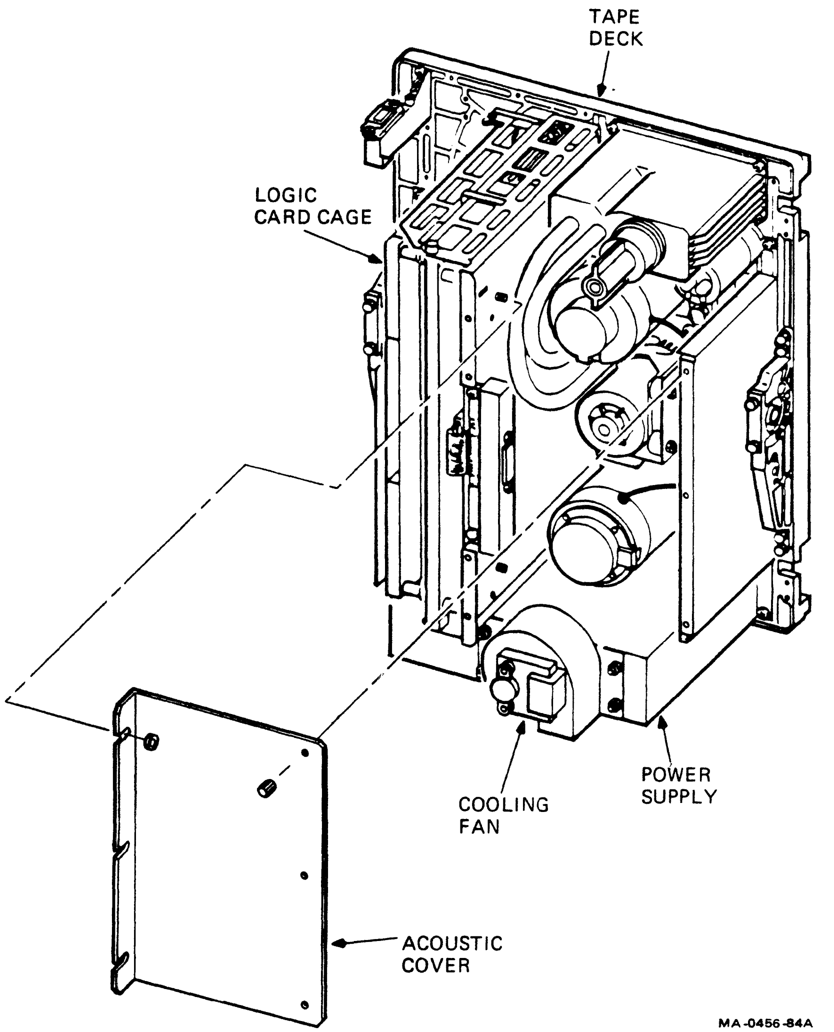

Figure 8 Transport Components (Bottom)

Identify the following components.

____ **Power Amplifier Module**
This module (Figures 9 and 10) receives low voltage analog signals from the servo module and sends a higher voltage to the reel motors. The outputs vary depending on the requirements of the velocity (take-up reel) and tension (supply reel) servo systems.

____ **Take-Up Reel Motor**
This take-up reel motor (Figure 9) turns the take-up reel. It is a permanent-magnet dc motor.

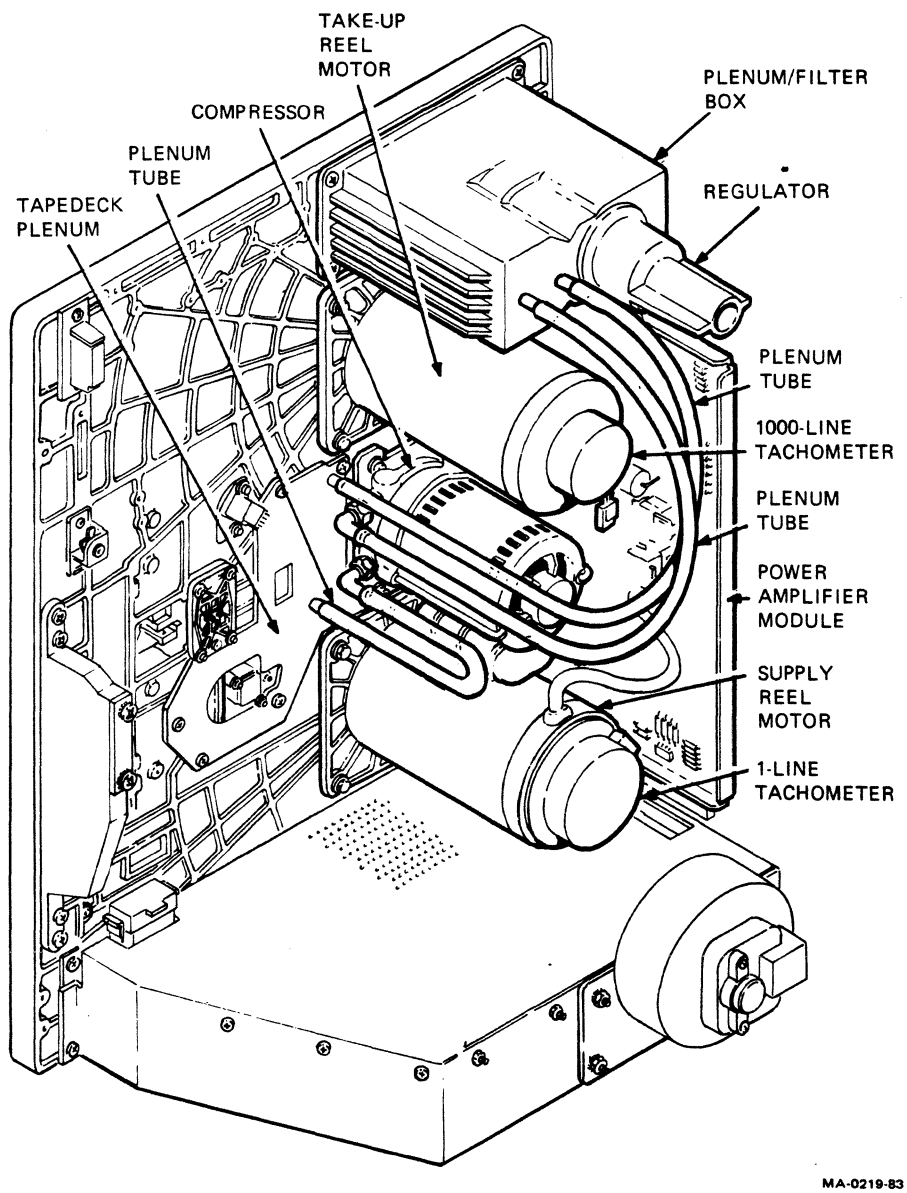

Figure 9 Transport Components (Cover Removed)

1000-Line Tachometer
This tachometer is under a cover on back of the take-up reel motor. It is a 2-phase tachometer.

The microprocessor uses the 1000-line tachometer signal to calculate a correct demand velocity for the take-up reel. The demand velocity is amplified by the power amplifier module and sent to the take-up reel motor. The reel motor turns to maintain tape velocity. This velocity servo function eliminates the need for a capstan.

Supply Reel Motor
This motor (Figure 9) turns the supply reel. It is a permanent-magnet dc motor. This motor, along with the air bearings, maintains correct tape tension. Review the earlier description of air bearings to learn how this works.

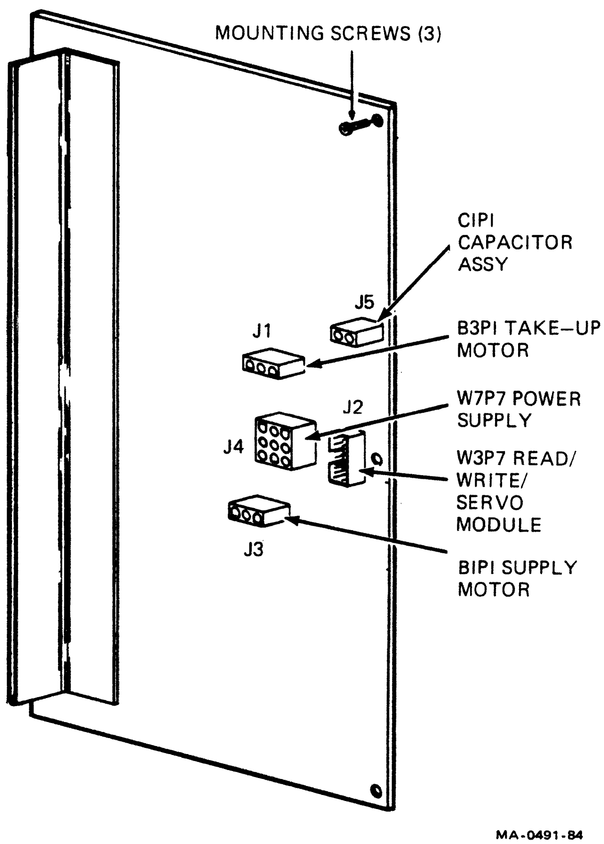

Figure 10 Power Amplifier Module

1-Line Tachometer
The 1-line tachometer is on back of the supply reel motor.

The 1-line tachometer counts supply reel revolutions. The count, one per revolution, starts at BOT when you load tape. As the tape moves forward, the count increments. As the tape moves reverse, the count decrements.

The logic uses the count in two ways. First, it tracks how much tape has wound off of the supply reel. This information is used during rewinding to determine when to slow down for BOT. As the count gets near zero, the tape velocity decreases.

Second, the count is used to determine when to recalculate the radius of tape on the take-up reel. The radius changes every revolution and is used in the demand velocity calculation. Every eight supply reel revolutions (eight counts), the demand velocity is recalculated using a new radius to maintain the correct tape velocity.

Identify the following five components, which comprise the air system between the tape cleaner and the air bearings (Figure 11).

Plenum Box and Filter
This box contains a 2-micron filter to clean the air in the air system.

Regulator
This is attached to the plenum box. The regulator maintains the correct air pressure by bleeding off excess air.

Plenum Tubes (Three)
These tubes connect components of the pressurized air system.

Tape Deck Plenum
This plenum, along with the plenum tubes, connect components of the pressurized air system.

Compressor
This supplies all air vacuum and pressure needed by the TU81. Vacuum is applied to the tape cleaner port, and pressure is applied to the air bearings. The compressor automatically shuts off if the transport is idle for more than one minute.

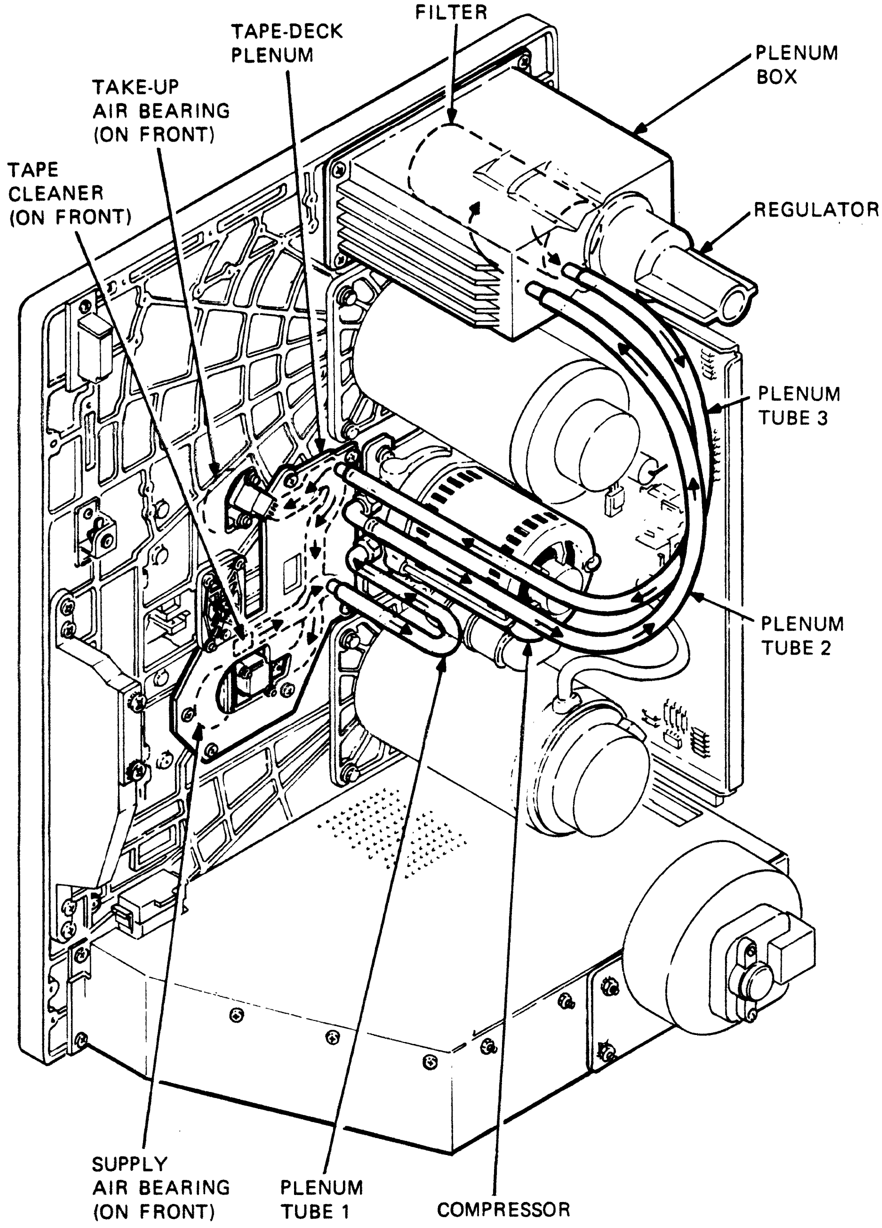

Figure 11 Vacuum/Pressure Air System

Do the following step to become familiar with the complete TU81 air system.

____ 1. Follow the air path through the TU81 as you read the following description (Refer to Figure 11).

First, air is pulled into the tape deck plenum through the tape cleaner port.

NOTE

The tape deck plenum is made up of casting slots covered by a metal plate. The edge is sealed with a special glue (gasket cement).

Second, air goes through the tape deck plenum and enters plenum tube 1, which is under the compressor.

Third, air exits the tube as it is pulled (vacuum or negative pressure) into the compressor.

Fourth, air is pushed out of the compressor (pressure) and enters plenum tube 2.

Fifth, air exits the tube and enters the plenum box where it is filtered and regulated.

Sixth, filtered/regulated air is pushed out of the plenum box into plenum tube 3.

Seventh, air exits the tube and enters another part of the tape deck plenum.

Eighth, the pressurized air exits the tape deck plenum and the transport through the air bearings.

____ 2. Reinstall the acoustic cover by setting it in place and tightening the mounting hardware.

Identify the following components.

____ Logic Card Cage
This consists of two racks which contain six modules (Figure 8). From right to left, these modules are the TMSCP interface controller, write formatter, read formatter, servo/control, read amplifier, and write driver (Figure 12).

____ Tape Mass Storage Control Protocol (TMSCP) Interface Controller Module
This module contains the intelligence to control TU81-to-host data interchange. It provides an external interface to the M8739 module, an internal interface to the TU81 formatter, and the interface microprocessor to handle all I/O tasks.

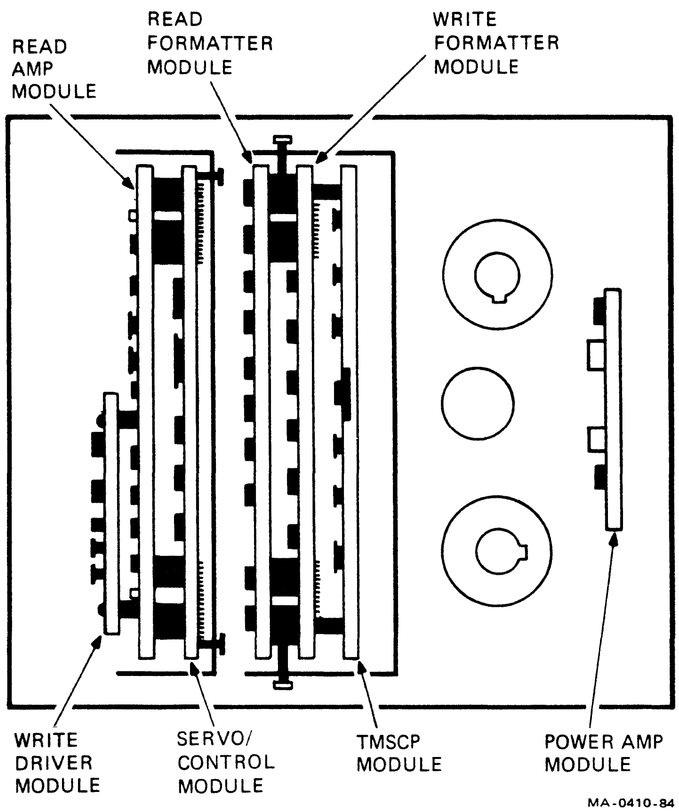

Figure 12 TU81 Module Locations

Write Formatter Module
This module receives commands from the MSCP interface module and converts them into data transfer and tape motion instructions. Data received from the host via the TMSCP Interface is converted into phase encoded (PE) or group coded recording (GCR) format for the write driver module.

Read Formatter Module
This module receives data read from tape from the read amplifier module. Read data is error-verified and corrected, converted, and passed to the host through the TMSCP interface.

Servo/Control Module
This module operates the servo mechanisms that control tape movement. Its microprocessor and microprogram ROMs control the reel motors to maintain constant tape speed and tension. The servo/control module also receives and executes commands from the write formatter module and the control panel.

Read Amplifier Module
This module detects the read data and amplifies the low voltage read-back signal. It selects the appropriate circuit, depending on tape speed and recording mode. It also converts the analog signal to a digital logic level for use in the transports control and formatter portions.

____ Write Driver Module
This module converts the digital data received from the formatter to analog write current for writing data on tape. It contains control circuits to generate the required voltages and currents used internally to perform the write data function.

M8739 Module
ALSO CALLED LESI

NOTE

The M8739 module is in the host system's UNIBUS backplane. The Installation lesson covers this module.

Do not remove the module at this time.

The M8739, which is also called the low end storage interface (LESI) UNIBUS adapter module (Figure 13), provides the external physical connection between the UNIBUS and the TMSCP controller in the TU81. The M8739 helps the TMSCP controller handle the data I/O.

The M8739 is a quad-height module, which plugs into a small peripheral controller (SPC) slot in the UNIBUS backplane. Every TU81 needs one M8739 to connect to the host.

____ Trace the path of the cable that connects the M8739 to the TU81 (Figure 14).

The Installation lesson covers module configuration.

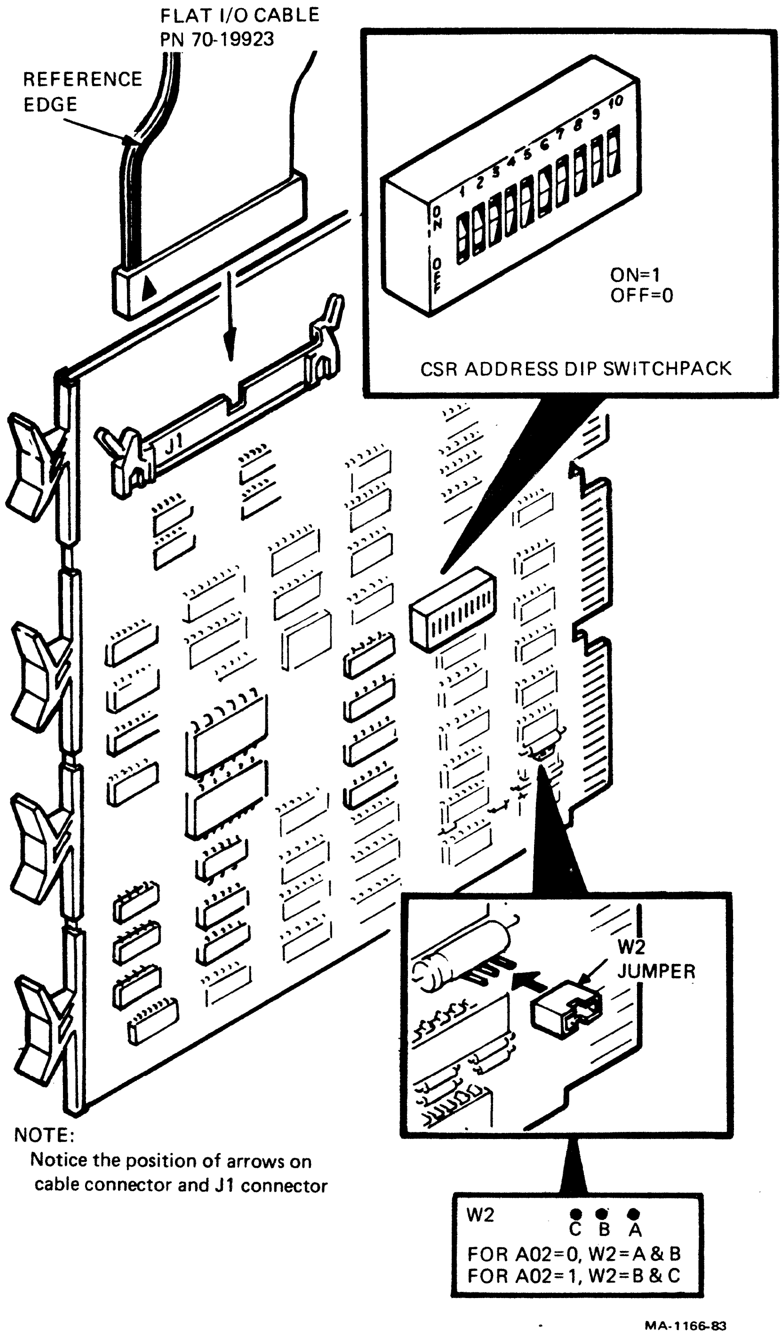

Figure 13 LESI UNIBUS Adapter Module

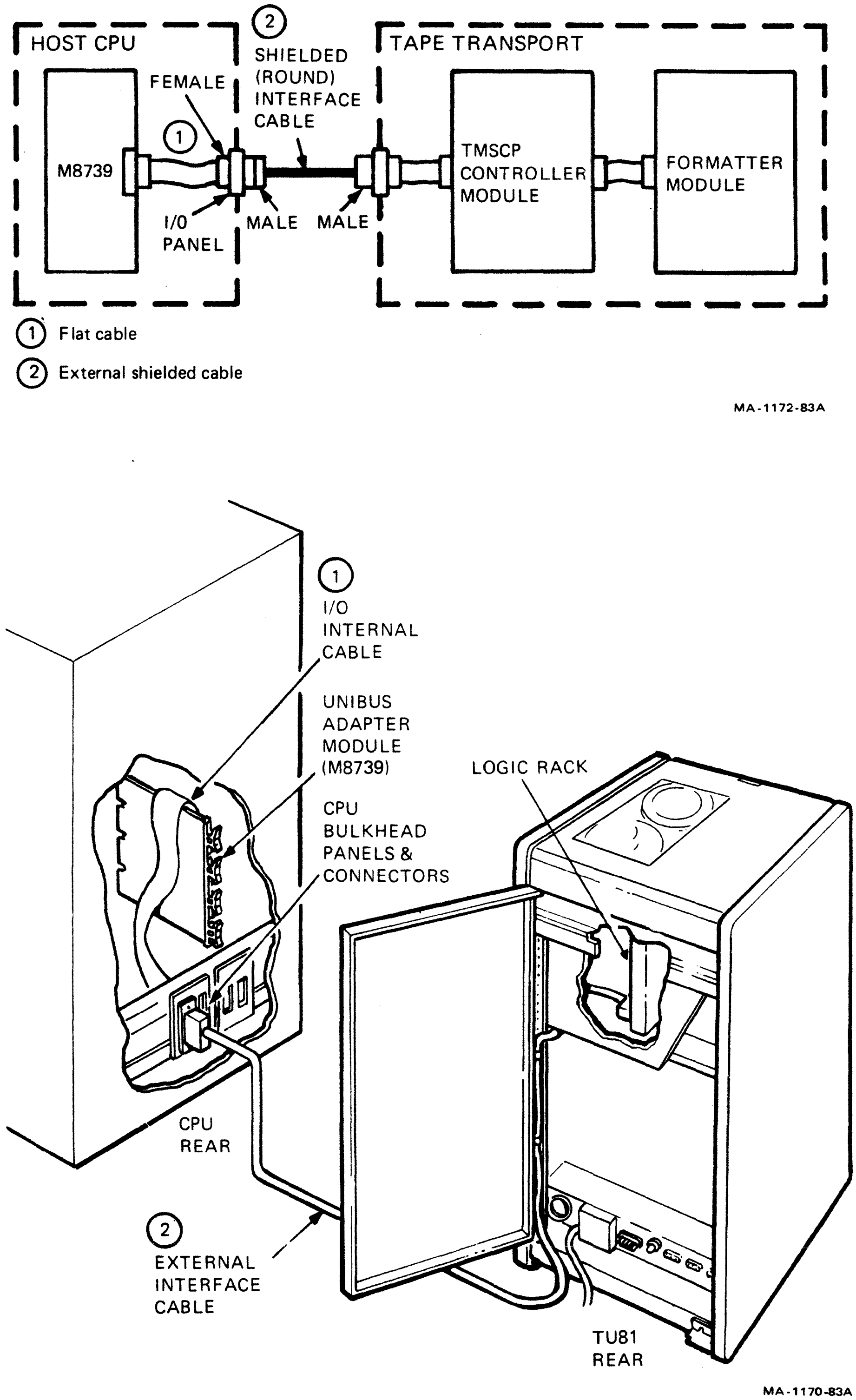

Figure 14 TU81 Interface Cabling

TU81 FUNCTIONAL DESCRIPTION

You have identified all the TU81 components. This section describes how these components work together to read or write data.

A general description of the TU81 functional routines follows. Refer to Figure 15 throughout this section.

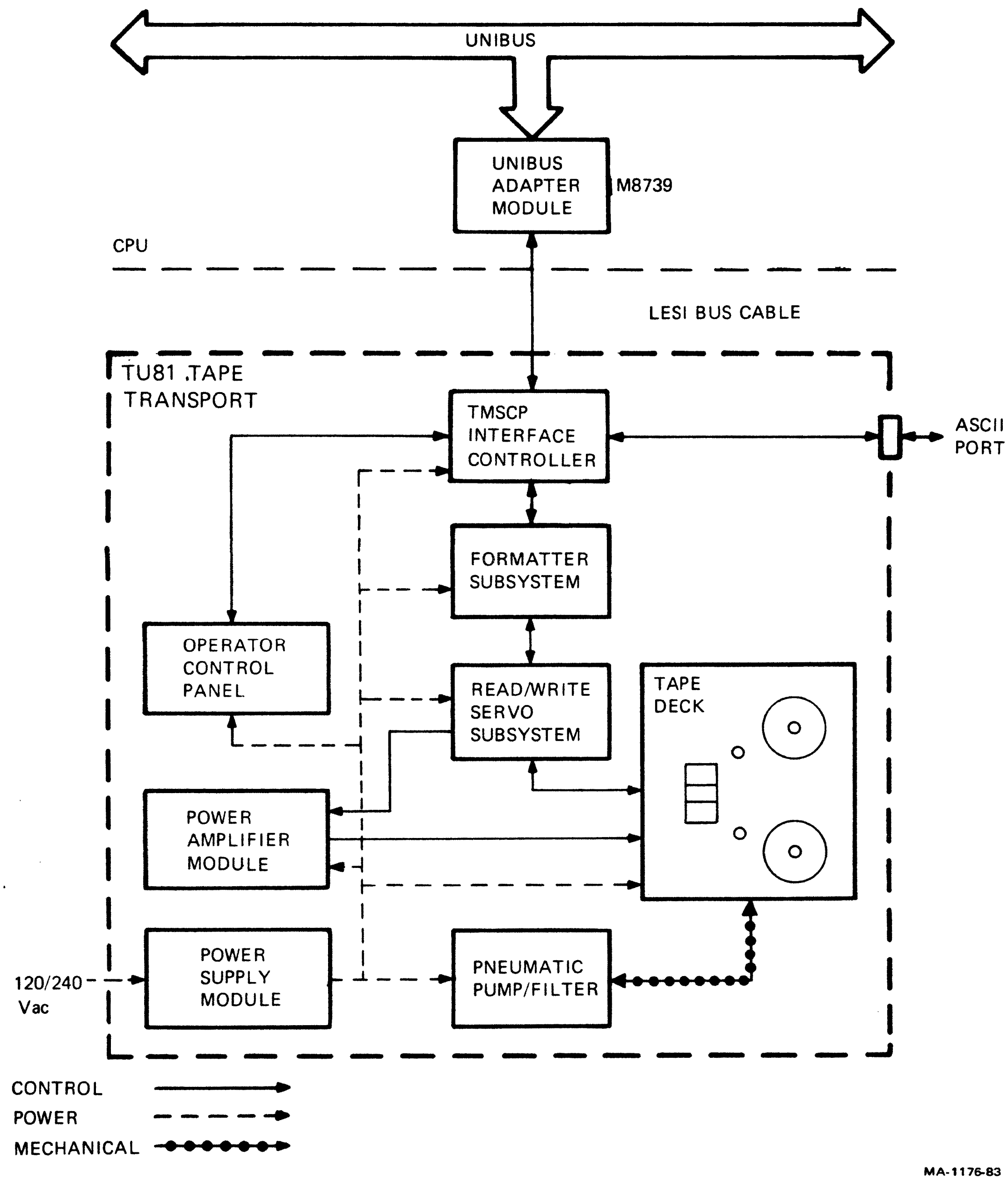

Figure 15 TU81 Basic Block Diagram

The TU81 subsystem has a microprocessor on the TMSCP interface controller, another on the write formatter, a third on the read formatter, and a fourth on the servo/control module. Each module has its own microcode programs, which work together with the microprocessor.

The TMSCP microprocessor sets command lines in the write formatter. Then, the write formatter microprocessor sets command lines in the servo/control module. The command lines for each module cause the corresponding microprocessor to set in motion the correct microcode sequence for that module.

So, each module controls its own functions, but these functions must be initiated by an external program control source. This way, all TU81 events are coordinated.

The M8739 connects the TU81 with the host. It passes commands and data to the TMSCP interface controller and status and data to the host.

The TMSCP interface controller module controls the sequence of functions throughout the transport. The write formatter module changes write data from binary to PE or GCR format. The read formatter changes read data from PE or GCR format to binary. The write formatter module monitors servo/control module interrupts and timing interrupts during read/write functions.

The servo/control module coordinates and puts in sequence the logic functions that control tape movement by monitoring the air bearing sensors and the reel motor tachs to maintain constant tape tension and speed. It also executes commands from the write formatter and responds to control panel interrupts (when the operator pushes a button).

The following events complete a read/write function. The TU81 must be on-line and have tape loaded, and tape must be moving at operating speed.

Write Command

Data comes from the host through the M8739 to the TMSCP interface controller. Then, data goes through the write formatter's write encoder, where it is amplified and sent, via the write driver module, to the write head to be recorded onto tape.

Read Command

Data comes from the tape through the read head. Then, data is amplified on the read amplifier, formatted on the read formatter, and sent by the TMSCP Interface Controller to the host via the M8739.

SUMMARY

The TU81 is used on VAX hosts. It can operate in streaming mode at 25 or 75 ips, or in start/stop mode at 25 ips. The TU81 microcode determines the mode depending on data throughput speed. The TU81 uses phase encoded (PE) recording at 1600 bits/inch (bpi) or group coded recording (GCR) at 6250 bpi.

The main TU81 components are listed in the following paragraphs. You should know the following things about each component.

1. Location
2. Identity
3. Function

If you have doubts or questions about any component or other information, go back to the lesson and find the answers before you start the next lesson.

The TU81 includes the following five major external components.

Cabinet
Transport
Tape deck (casting)
Control panel
Power controller

The following transport components are located on top of the tape deck.

TU81 on/off switch
Supply hub
Take-up hub and reel
Cover interlock switch
Head assembly dust covers (two)

The following tape path components are located on the tape deck under the dust covers.

Tape cleaner
BOT/EOT assembly
Erase head
Read/write head
Supply and take-up air bearings

The following transport components are located on bottom of the tape deck.

Power supply
Cooling fan
Acoustic cover
Logic card cage
TMSCP interface controller module
Write formatter module
Read formatter module
Servo/control module
Read amplifier module
Write driver module

The following components were visible after you removed the acoustic cover.

Power amplifier module
Take-up reel motor
1000-line tachometer
Supply reel motor
1-line tachometer
Plenum box
Filter/regulator
Plenum tubes (three)
Tape deck plenum
Compressor

The M8739 module is the UNIBUS adapter, or interface, for the TU81. It resides in the host and connects to the TU81 by interface cabling. The M8739 helps the TMSCP controller handle data I/O.

The TU81 subsystem is microprocessor controlled. The TMSCP controller, write formatter, read formatter, and servo/control modules each have a microprocessor to control their functions.

The TU81 modules perform the following functions.

TMSCP Interface Controller

Handles all I/O tasks
Interfaces to the M8739
Interfaces to the write and read formatters
Puts TU81 events in sequence
Services interrupts

Write and Read Formatters

Format and encode data
Serves as interface with the servo/control, read amplifier, and write driver modules

Servo/Control

Operates servo mechanisms that control tape movement
Controls the reel motors to maintain constant tape speed and tension
Responds to inputs from the control panel

Read Amplifier

Detects and amplifies read data
Converts the analog read signal to a digital logic level

Write Driver

Converts digital data to an analog write current

This completes the Physical/Functional Description lesson for the TU81. The rest of this lesson covers physical/functional differences between the TU80 and TU81.

TU80 DIFFERENCES

The TU80 uses only phase encoded (PE) recording, which records at 1600 bpi.

The TU80 can read or write data at either 100 or 25 ips in streaming mode, or 25 ips in start/stop mode.

Table 2 lists the most commonly used TU80 specifications.

The TU80 logic card cage (Figure 16) contains only two modules: the formatter/control module (closest to the acoustic cover) and the read/write/servo module.

The read/write/servo module (Figure 17) operates the servo mechanisms that control tape movement. It also moves data onto and removes data from the tape at appropriate times. The read/write/servo module contains a microprocessor and microprogram ROMs.

The formatter/control module (Figure 18) formats and encodes data. It contains a microprocessor, which controls the sequence of transport functions, services interrupts from various transport areas, and controls the read/write/servo module operation. The formatter/control module also communicates with the M7454 via the parallel interface cables.

NOTE

The TU80 needs two interface cables to handle a large number of signals that go to the host interface.

The TU80 host interface module is the M7454 UNIBUS adapter module.

Table 2 TU80 Specifications

Recording method	Phase encoded (PE)
Recording density	1600 bits/inch (bpi)
Rewind speed	200 inch/second (ips) (~2.5 minute/2400 feet of tape)
Tape	
Width	1/2 inch
Length	2400 feet maximum
Thickness	1.5 millimeters
Tracks	9
Capacity	40 megabytes
Tape speed	
Start/stop	25 inches/second (ips)
Streaming	100 ips or 25 ips
Data transfer rate	
Start/stop	20 kilobytes/second
Streaming	160 kilobytes/second
Weight	280 pounds (drive and cabinet)
Dimensions	
Height	41.6 inches
Width	21.5 inches
Depth	30.0 inches
Operating temperature	50^{o}F to 104^{o}F

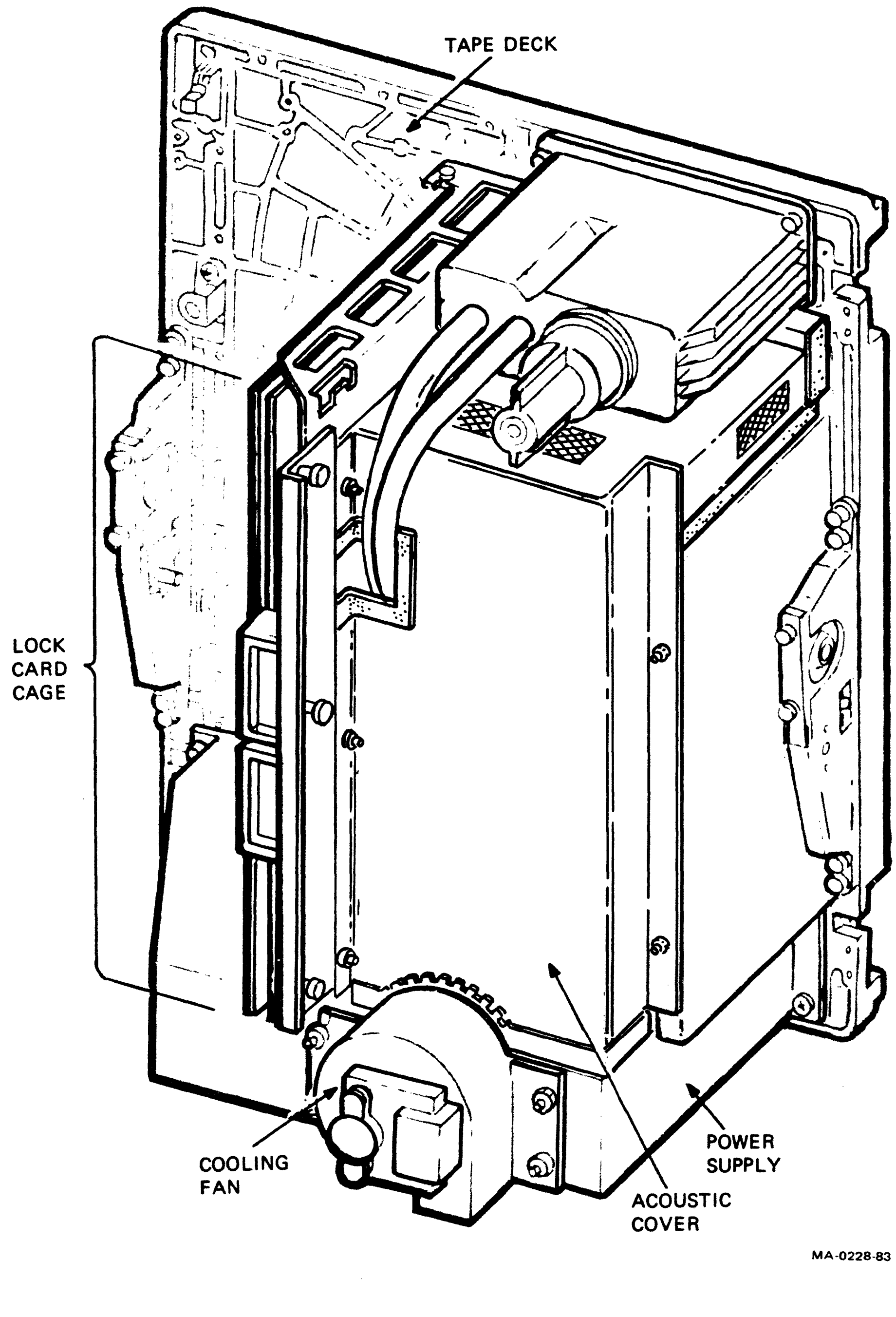

Figure 16 TU8Ø Transport Components (Bottom)

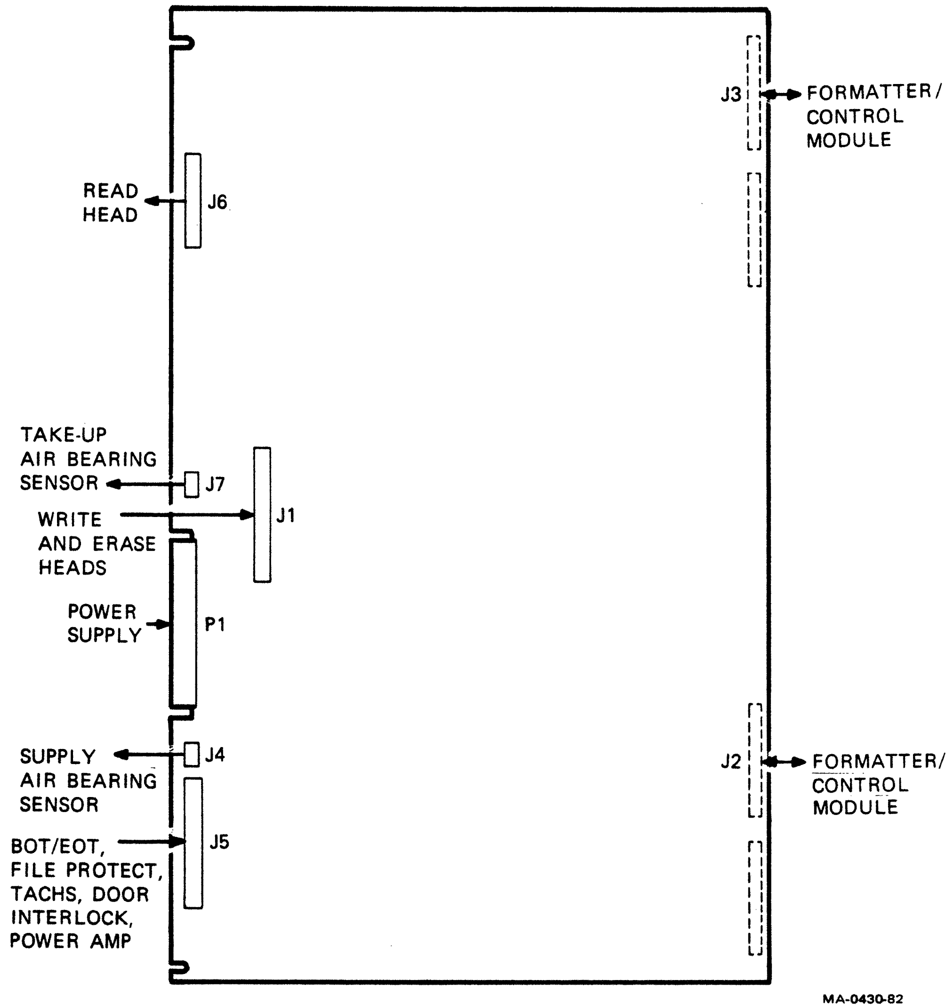

Figure 17 Read/Write/Servo Module

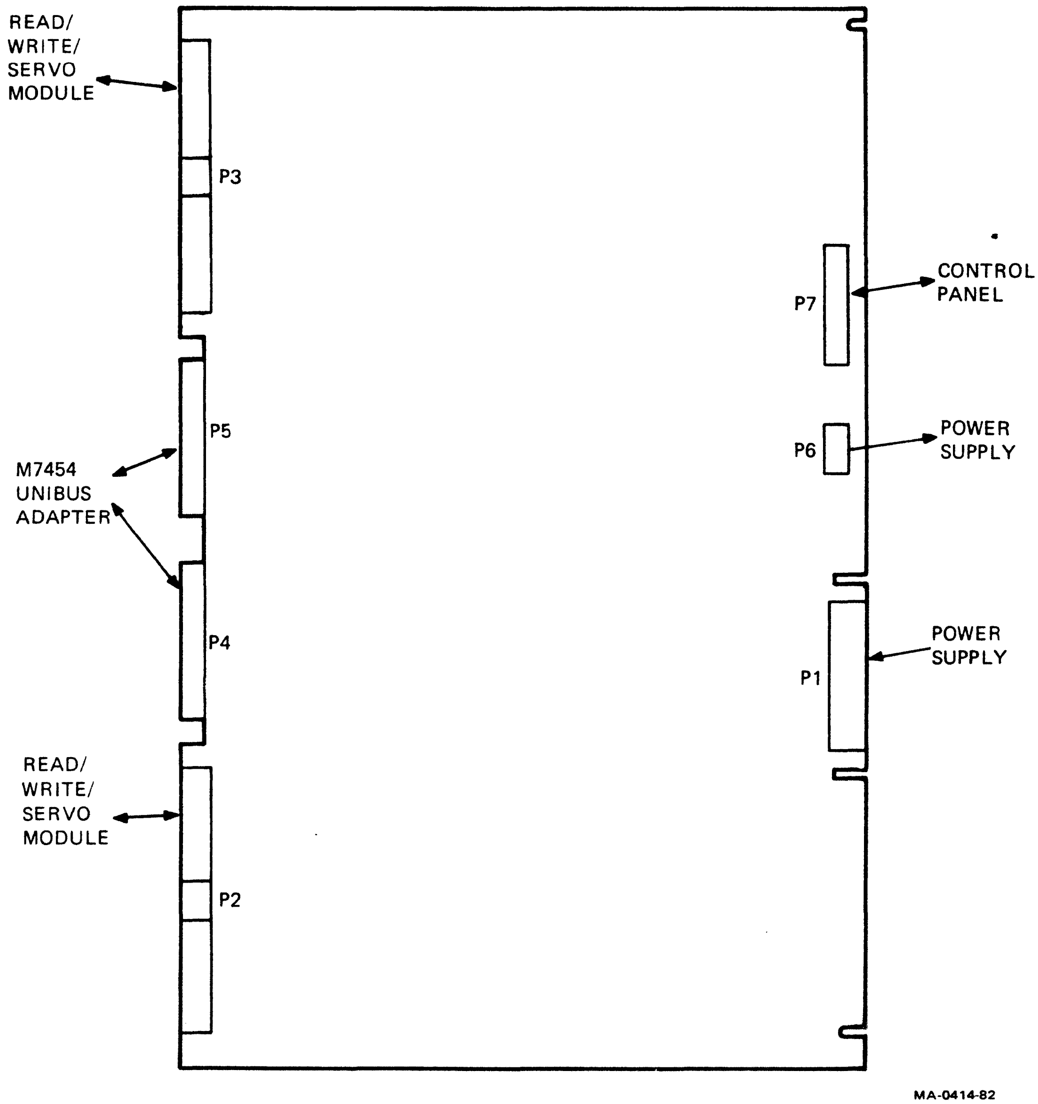

Figure 18 Formatter/Control Module

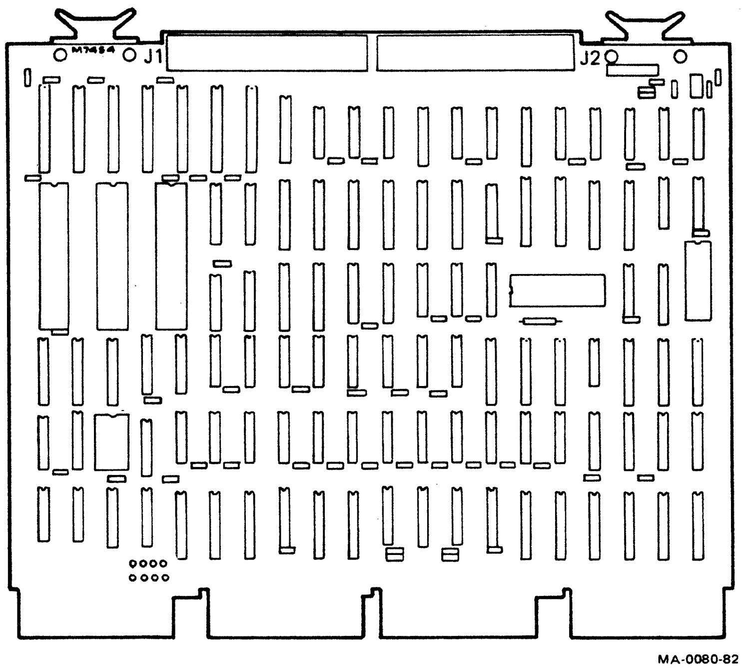

Figure 19 M7454, UNIBUS Adapter Module

The M7454 UNIBUS adapter module (Figure 19) connects the TU80 to a UNIBUS backplane.

The M7454 is a quad-height module, which fits into any standard small peripheral controller (SPC) slot in a UNIBUS backplane. The Installation lesson describes how to configure the module.

The M7454 module has its own internal microprocessor. The module runs a self-diagnostic program when powered up.

Every TU80 needs one M7454 to connect with the host. The host can be a VAX or PDP-11.

The M7454 communicates with the TU80 via parallel interface cables.

Two flat ribbon cables connected to the M7454 go to a bulkhead connector in the host cabinet. The two round interface cables go from the host cabinet to the TU80 cabinet, and connect to connectors on the logic card cage frame. From the connectors, two short flat ribbon cables connect to the formatter/control module (Figure 20).

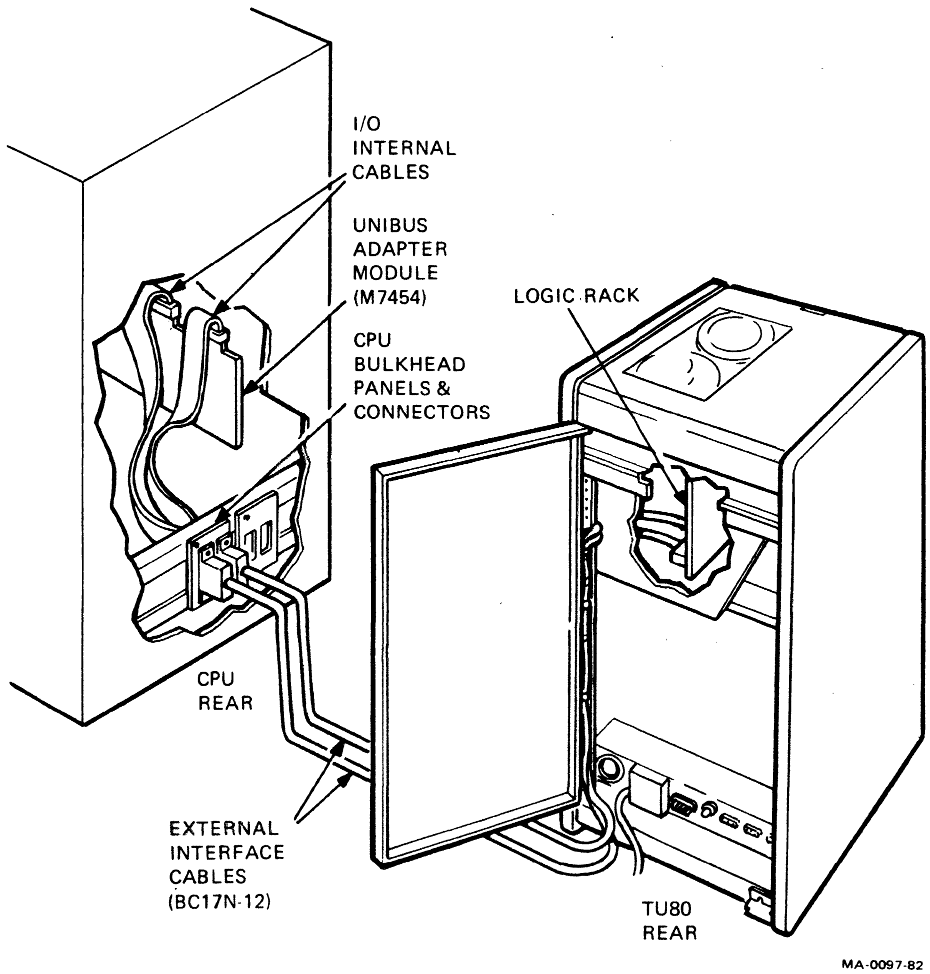

Figure 20 TU80 Interface Cabling

TU80 FUNCTIONAL DESCRIPTION

The rest of this lesson gives a general description of the TU80 functional routines. Refer to Figure 21 throughout this section.

The TU80 subsystem includes a microprocessor on the M7454, a second on the formatter/control module, and a third on the read/write/servo module. Each module has its own microcode programs, which work together with the microprocessor.

The M7454 microprocessor sets command lines in the formatter/control module. Then, the formatter/control microprocessor sets command lines in the read/write/servo module. The command lines for each module cause the corresponding microprocessor to set the correct microcode sequence in motion for that module.

So, each module controls its own functions, but an external program control source must initiate these functions. This way, all TU80 events are coordinated.

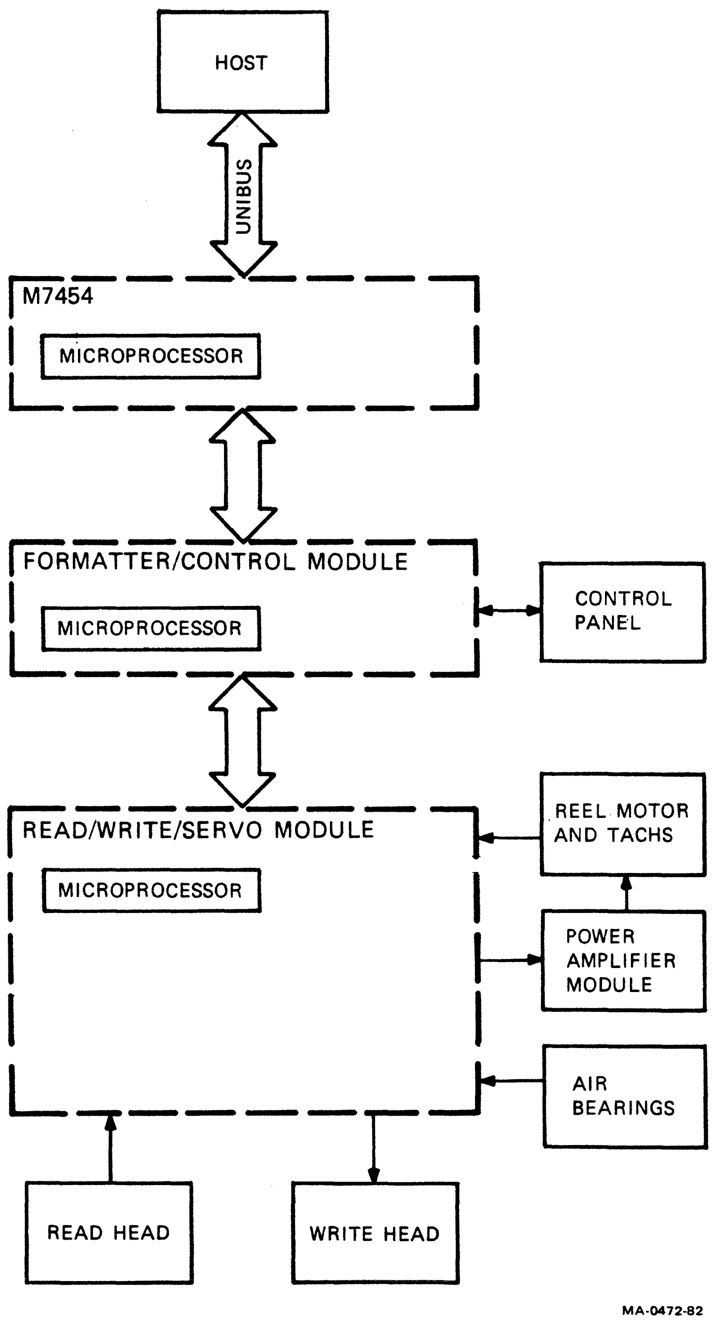

Figure 21 TU80 Basic Block Diagram

The M7454 controls the sequence of events throughout the TU80 subsystem. The M7454 connects the TU80 with the host.

The formatter/control module controls the sequence of functions throughout the transport. The formatter/control module changes read data from phase encoded (PE) to binary. It also encodes write data from binary to PE format. The module monitors control panel interrupts (when the operator pushes a button), read/write/servo module interrupts, and timing interrupts during read/write functions.

The read/write/servo module coordinates and puts in sequence the logic functions that read and write data on the tape. These functions include reading data from the head, writing data to the head, and reel movement (servo).

The following events complete a read/write function. The TU80 must be on-line and have tape loaded, and tape must be moving at operating speed.

Write Command

Data comes from the host through the M7454, goes through the formatter/control module's write encoder where it is amplified and sent, via the read/write/servo module, to the write head to be recorded onto tape.

Read Command

Data comes from the tape through the read head. Then, data is amplified, formatted on the formatter/control module, and sent to the host via the M7454 module.

TU80 SUMMARY

The TU80 is used on VAX and PDP-11 hosts. It can operate in streaming mode at either 25 or 100 ips, or in start/stop mode at 25 ips. The TU80 microcode determines the mode depending on data throughput speed. The TU80 uses phase encoded (PE) recording at 1600 bits/inch (bpi).

The M7454 module is the UNIBUS adapter, or interface, for the TU80. It resides in the host and connects to the TU80 by two interface cables. The M7454 defines the command requested by the host and sets command lines to the formatter/control module to initiate a TU80 response. The M7454 also passes data between the host and the TU80.

The TU80 subsystem is microprocessor controlled. The M7454, formatter/control and read/write/servo modules each have a microprocessor to control their functions.

The formatter/control module performs the following functions.

- Formats and encodes data
- Puts TU8Ø events in sequence
- Services interrupts
- Communicates with the M7454

The read/write/servo module performs the following functions.

- Amplifies data and communicates with the heads
- Controls tape movement

This completes the Physical/Functional Description lesson. Now go to the Operation lesson.

INTRODUCTION

This lesson describes how to perform all the TU81 operator functions. You will use many of these functions as a Field Service Representative.

You may not directly use some operator functions. However, the customer might use them and report the results to you. Therefore, you must be familiar with all the operator functions to best diagnose a problem.

OBJECTIVES

1. Clean the TU81 tape path.
2. Power up and power down the TU81.
3. Load tape and make the TU81 ready for on-line use.
4. Perform the operator diagnostics procedure.

TAPE MEDIA REQUIREMENTS

All Digital tape drive products are designed and manufactured for high performance and reliability. The tape media used must match this high performance and reliability.

The TU81 meets the format and recording requirements for 1/2 inch, 9-track magnetic tape set in American National Standards Institute (ANSI) standard X3.54-1976. The TU81's design requires that the magnetic tapes used on this tape drive strictly adhere to ANSI standard X3.40-1981. This standard defines the minimum physical and magnetic requirements for 1/2 inch wide magnetic tape. In addition to meeting ANSI requirements, all Digital recommended tapes must conform to Digital's magnetic tape specifications. This specification is used to evaluate and qualify magnetic tapes for Digital.

Digital constantly evaluates tape media to ensure a high quality product. So far, no back-coated magnetic tapes meet Digital's specification. Back-coated tapes can cause tape slippage, auto-load failures, false EOT and BOT sensing, and the need for more frequent drive cleaning due to the back-coating residue on the tape drive. Because of these problems, the TU81 tape drive does not support back-coated magnetic tapes.

To ensure the best performance and maximum reliability from the TU81 tape drive, use only magnetic tapes that meet both the ANSI requirements and Digital specification.

NOTE

You can get ANSI standards by contacting:

American National Standards Institute
1430 Broadway Street
New York, New York 10018
(212) 354-3300

Your Unit Manager can show you where to find a copy of the Digital specification.

The TU81 has a feature to sense when there is too much tape friction across the head. However, the drive is not shipped with this feature enabled. If you suspect this problem, which is called tape stiction, you must enable this feature by running Field Service Test 82. You will learn how to run Field Service tests in the Diagnostics Lesson. When this sensing feature is enabled, the unit identification flashes if too much tape friction is sensed across the head.

TAPE CARE

The operator is responsible for taking proper care of the tape. In order to avoid unnecessary calls, make sure the operator is aware of and accepts this responsibility.

The tape must be kept clean. Never let tape touch the floor or label it with any substance. Dirt can damage the tape and TU81 components.

Never place tape near machinery. Lines of magnetic force coming from many types of motors can erase data stored on tape.

The climate of the room in which the TU81 is located must be within specification. Table 1 in the Physical/Functional lesson lists the operating temperature as 5Ø°F to 1Ø4°F. This is correct for the TU81 specifiction. However, most tape media cannot be operated or stored at higher than 9Ø°F. You must store most older tape at even lower temperatures. A binding compound holds the iron-oxide coating to the mylar base of the tape. At higher temperatures this binding compound can migrate to the tape surface. This makes the surface bumpy, which produces error-prone tape.

The TU81 is only as good as the tape and the environment.

CLEANING THE TAPE PATH

Before you thread tape onto the TU81, always visually check the tape path components and perform any necessary maintenance.

The components that make up the TU81 tape path can collect dirt quickly, even with only a small amount of use. Both the environment and the quality of media affect this dirt build-up.

Digital recommends that the operator clean the tape path every eight hours of use. However, every eight hours may not be often enough in some cases. Make it a habit to check and, if necessary, clean the tape path every time you install a tape onto the TU81.

Tape path cleaning is the only preventive maintenance on the TU81, and is the customer's responsibility. As the Field Service representative, you should make sure that all your TU81 customers are aware of this responsibility and know how to perform the procedure correctly. The cleaning procedure is in the TU81/TA81 Magnetic Tape Subsystem User Guide.

To perform the following procedure, you need a Digital TUC01 magnetic tape transport cleaning kit. A small mirror may help you inspect some of the components.

____ 1. Remove the two head assembly dust covers from the tape deck.

CAUTION

Do not use alcohol on any component. Alcohol may damage the bonding agents within an assembly.

Use the smallest amount of Digital cleaning fluid necessary. Do not soak the swab or cloth. Do not let the fluid run onto areas not being cleaned.

You may use freon spray cleaner on the TU81. However, do not spray the cleaner directly on a component. Spray it on a swab or cloth first, then use that material to clean the component.

____ 2. Clean the tape-contacting surface of the following components (Figure 1). Use a foam-tipped swab moistened with cleaning fluid.

____ Reflective strip (AOT)
____ Tape cleaner blades

____ 3. Clean the tape-contacting surface of the following components (Figure 1). Use a lint-free cloth moistened with cleaning fluid and wipe in the direction of tape movement on each surface. For the read/write head, also wipe in the direction perpendicular to tape motion.

____ Supply air bearing
____ Erase head
____ Read/write head
____ Take-up air bearing

NOTE

You should clean the top cover of the tape deck, the deck surface, and the two-part head assembly dust cover as needed to avoid dust buildup.

Use any cleaner that is safe for painted surfaces.

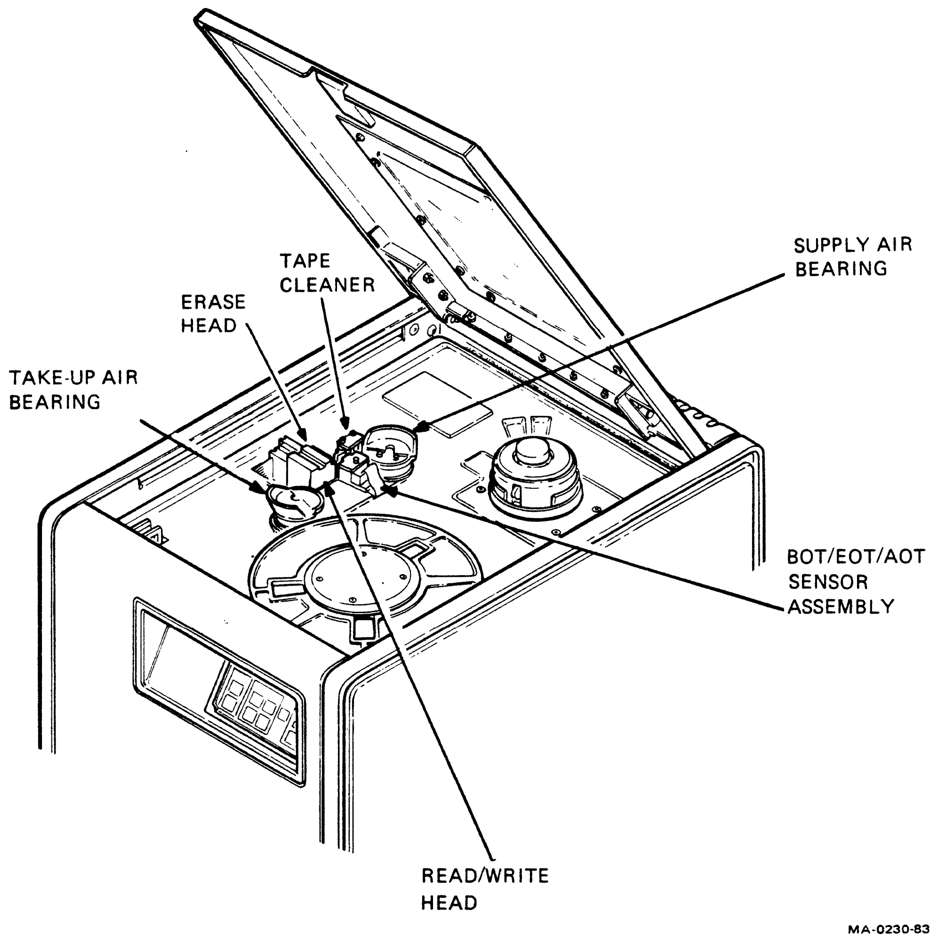

Figure 1   Tape Path Components to Clean

CONTROL PANEL

The TU81 operator uses control switches and status indicators on the control panel (Figure 2) to control and monitor the tape drive. The control panel is in the upper right corner on front of the cabinet.

The control panel consists of operating and diagnostic membrane switches, functional indicators, connectors, and a digital display indicator (three digit). The operator uses the switches and indicators on the left of the display during normal operations (diagnostics indicator off).

The operator uses switches and indicators on both sides of the digital indicator display during diagnostic operations (diagnostics indicator on).

The following paragraphs define each switch and indicator function.

Controller Fault (Contr Fault) Indicator

This indicator comes on to indicate a fault with either the M8739 UNIBUS adapter, the TMSCP interface controller, or the associated cables.

Controller Fault Switch

This switch resets the above fault condition.

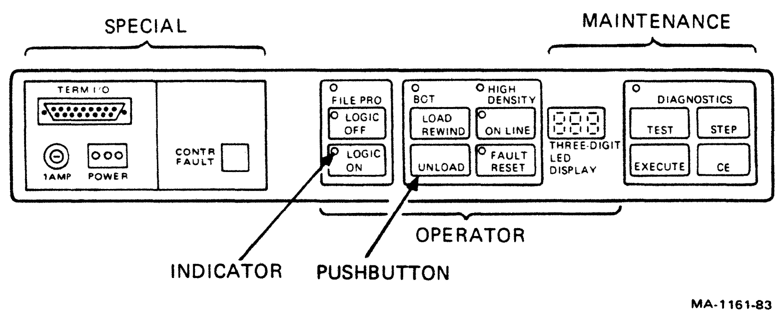

Figure 2 TU81 Control Panel

LOGIC ON Indicator

When this indicator is on, all transport circuitry is powered on and ready for use.

All control panel switches and indicators except the LOGIC OFF indicator can function only when the LOGIC ON indicator is on.

LOGIC OFF Indicator

This indicator comes on momentarily when you initially power up the TU81. This indicator then remains off, while the LOGIC ON indicator is on. If the LOGIC OFF indicator is on with the power switch on, a fault condition exists.

FILE PROTECT/(FILE PRO) Indicator

This indicator is on when there is no reel on the supply hub, or the reel on the supply hub has the write enable ring removed (Figure 3). The tape cannot be written on when this indicator is on.

HIGH DENSITY Indicator

This indicator comes on when the TU81 is in GCR mode.

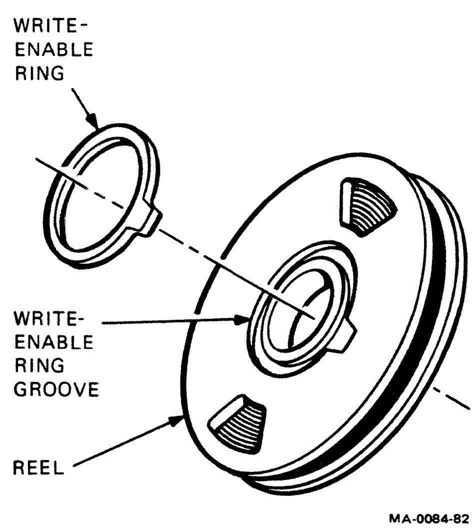

Figure 3 Write-Enable Ring

LOAD REWIND Switch

This switch has different functions under each of the following conditions.

Tape Not Threaded -- A fault code of 11 appears in the display and the transport does not function. Fault codes are explained later in this lesson.

Tape Threaded But Not Loaded -- Tape is loaded and stops at the BOT marker. If the tape does not have a BOT marker, a fault code is displayed.

Tape Loaded and Positioned At BOT -- Tape moves slightly forward and returns to BOT.

Tape Loaded and Not Positioned at BOT -- A BOT marker search is performed. The initial search is forward. A reverse search at 200 ips (rewind) follows if the marker is not found within 40 feet of tape.

BOT Indicator

The BOT indicator comes on when a BOT marker is positioned next to the BOT/EOT assembly.

ON LINE Indicator

When this indicator is on and tape is loaded, the host system can gain access to the TU81.

When this indicator is on, all switches except RESET are inhibited. Pressing RESET turns off the indicator and puts the TU81 off-line.

ON LINE Switch

Pressing the ONLINE switch when tape is loaded makes the TU81 available to the host system. The ONLINE indicator comes on.

You can press this switch while loading tape. The TU81 will go on-line immediately once it is loaded.

FAULT Indicator

The FAULT indicator is on when the digital display indicator contains a fault code or diagnostic termination code. The Diagnostic lesson explains these codes.

When this indicator is on, the control panel, except for the RESET switch, does not work.

You can clear the FAULT indicator by pressing the RESET switch.

RESET Switch

This switch has the following functions.

- Resets (clears) a fault code or diagnostic termination code.
- Turns off the FAULT indicator if it is on.
- Puts the TU81 off-line so it cannot be accessed by the host system.
- Stops a load or rewind operation instantly, and displays a fault code of 15. You can clear the 15 by pressing the RESET switch again.

UNLOAD Switch

This switch has different functions under each of the following conditions.

Tape Loaded and Positioned at BOT -- Tape unloads.

Tape Loaded and Not Positioned at BOT -- Tape reverses to BOT and unloads.

Tape Threaded Only -- Tape reverses and unloads.

The unload function operates at a slow speed. If there is a lot of tape on the take-up reel and you wish to unload tape, it is faster to press LOAD REWIND first and then UNLOAD.

Digital Display Indicator

A number in the digital display indicator signifies one of the following conditions.

- The 3-digit unit number is displayed when the TU81 is on-line, off-line, or in an unloaded powered-on state. Field Service enters the unit number from the control panel during installation. The Installation lesson describes that procedure.
- A 2-digit number preceded by an E is a fault code displayed during normal operation.
- A test number is displayed in diagnostic mode when the operator is loading a particular test.
- When a test completes successfully, the number ØØ is always displayed.

Diagnostic Switches

In normal operation, you do not use the four diagnostic switches on the right side of the control panel. The customer or Field Service representative uses these switches during testing only.

> **NOTE**
> Only the Field Service representative uses the CE switch. The Diagnostics lesson provides more information about the CE switch.

The following paragraphs define the function of the DIAGNOSTICS indicator and the TEST, STEP, and EXECUTE switches.

Diagnostics Indicator

This indicator comes on when either the customer or Field Service representative places the TU81 in diagnostic mode. This indicator stays on until you press RESET.

TEST Switch

Pressing this switch with tape threaded but not loaded puts the TU81 in Operator Diagnostics mode.

STEP Switch

Pressing this switch when a test number is displayed (in the digital display indicator) increments the test number by 1.

EXECUTE Switch

Pressing this switch when a test number is displayed starts that test and runs it to completion, or until an error occurs.

A 00 is displayed if the test runs to completion. A fault code (two digits with an E in front of them) is displayed if an error occurs.

All operator switch and indicator functions have been defined. The following paragraphs ask you to use the operator panel to perform the TU81 operator functions.

POWERING UP THE TU81

Do the following steps to power up the TU81.

____ 1. Make sure your TU81 is plugged into the Digital power controller (Figure 4).

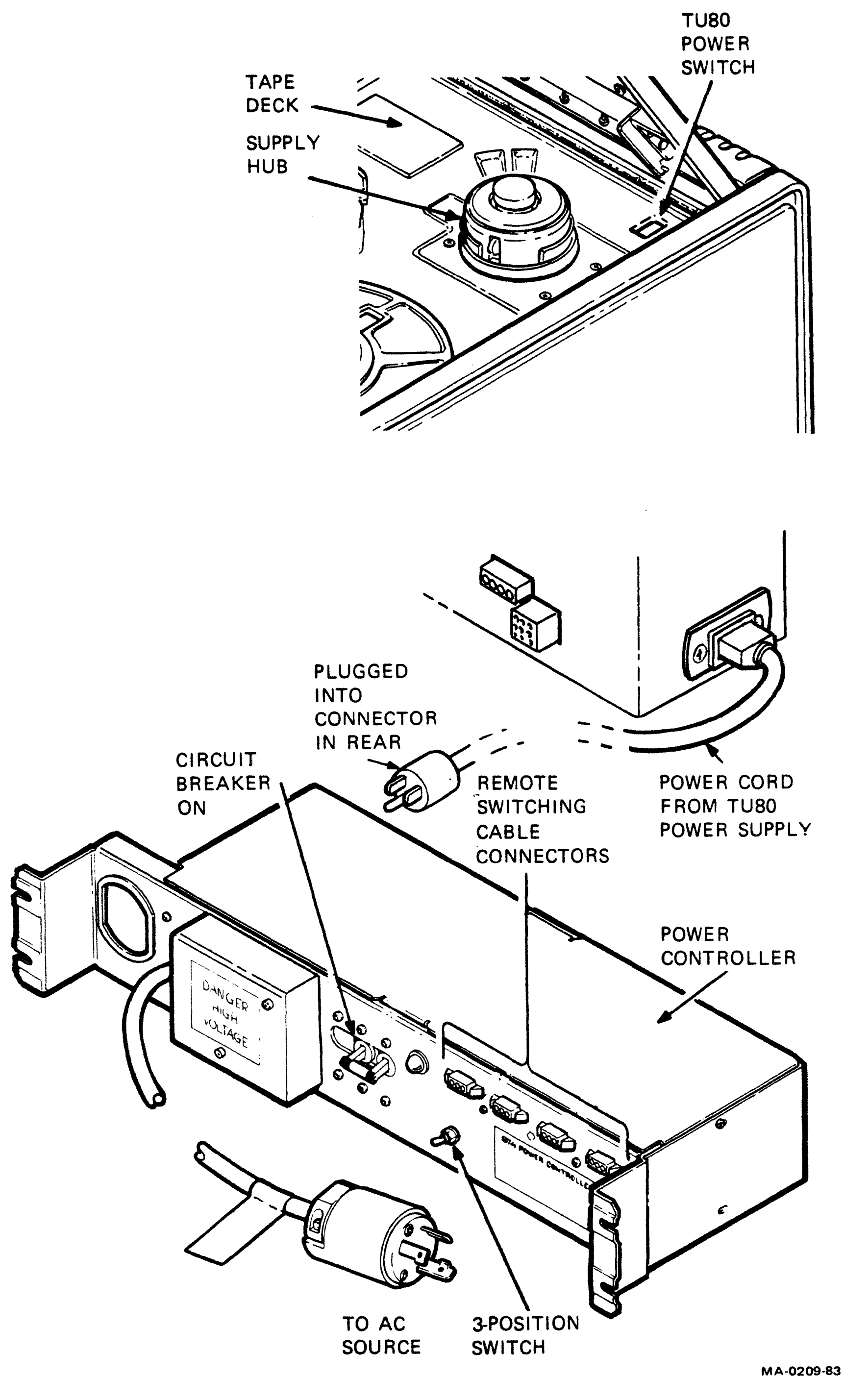

Figure 4 TU81 Power-Up Checks

____ 2. Make sure the Digital power controller is plugged into a circuit with 120 Vac at 60 Hz or 220 Vac at 50 Hz, and that the circuit breaker is on.

____ 3. Determine if a cable is plugged into any of the remote switching connectors on the power controller.

If a cable is plugged into a switching connector, and the cable also connects to the host, the TU81 is configured to power up remotely by the host on/off switch.

If a cable is not installed, the TU81 is configured to power up by the TU81 power switch.

____ 4. Check the position of the 3-position switch on the power controller.

The following positions are usually labeled next to the power controller switch.

REMOTE ON -- This position (left of center) only functions if a cable is installed at one of the remote switching connectors on the power controller. The cable must also be connected to the host. If there is no cable, this switch position functions as another off position.

With a remote switching cable correctly installed, this switch position lets the controller be powered on and off by the host on/off switch. That way you can turn on and off many power controllers, and their associated peripherals, with one host switch.

OFF -- This position (center) prevents the controller from supplying power.

LOCAL ON -- This position (right of center) lets the controller supply output voltages at all times, as long as the controller has ac input power provided and the circuit breaker is on.

____ 5. Make sure the power controller switch is in the LOCAL ON position.

LOCAL ON is the best position for you to use in this course since other students may need to use the host. However, at the customer site usually the 3-position switch is not in LOCAL ON.

Most TU81s are configured to be powered on and off through the host. A remote switching cable is installed, the 3-position switch is in the REMOTE position, and the TU81 power switch is usually left on. All the customer has to do is turn on the host and the TU81 is ready to use.

CAUTION

If a TU81 is configured to be powered up remotely, you cannot power it off with the host on/off switch if the three-position switch is in LOCAL.

____ 6. Turn on the TU81 by pressing the side labeled 1 on the TU81 power switch. This switch also functions as the TU81 circuit breaker. The power switch is under the top cover.

The power supply and cooling fan now come on. All indicators come on for a moment, then all indicators go off, except LOGIC ON (and FILE PRO if no write enabled tape reel is mounted on the supply hub).

NOTE

Whenever you set the power switch from Ø to 1, the TU81 performs a health check test. The indicators flash and ØØ appears for a moment in the display.

This test checks circuitry that can be checked without moving tape. This check is not comprehensive, but it does catch some basic errors.

When errors occur, the control panel's digital display indicator displays a fault code. Fault codes are explained later in this lesson.

All TU81 parts (power supply and transport) now have power. The TU81 is now powered up.

THREADING AND LOADING TAPE

With power applied to the TU81, do the following steps to thread and load tape.

____ 1. Make sure the tape path is clean before threading tape, and use a tape that has the write enable ring inserted.

NOTE
Pressing the center button on the face of the supply hub (Figure 5) unlocks the hub. Pressing the periphery ring locks the hub. When you install a tape reel, a locked hub holds the tape reel tight with no slippage, an unlocked hub leaves the tape loose.

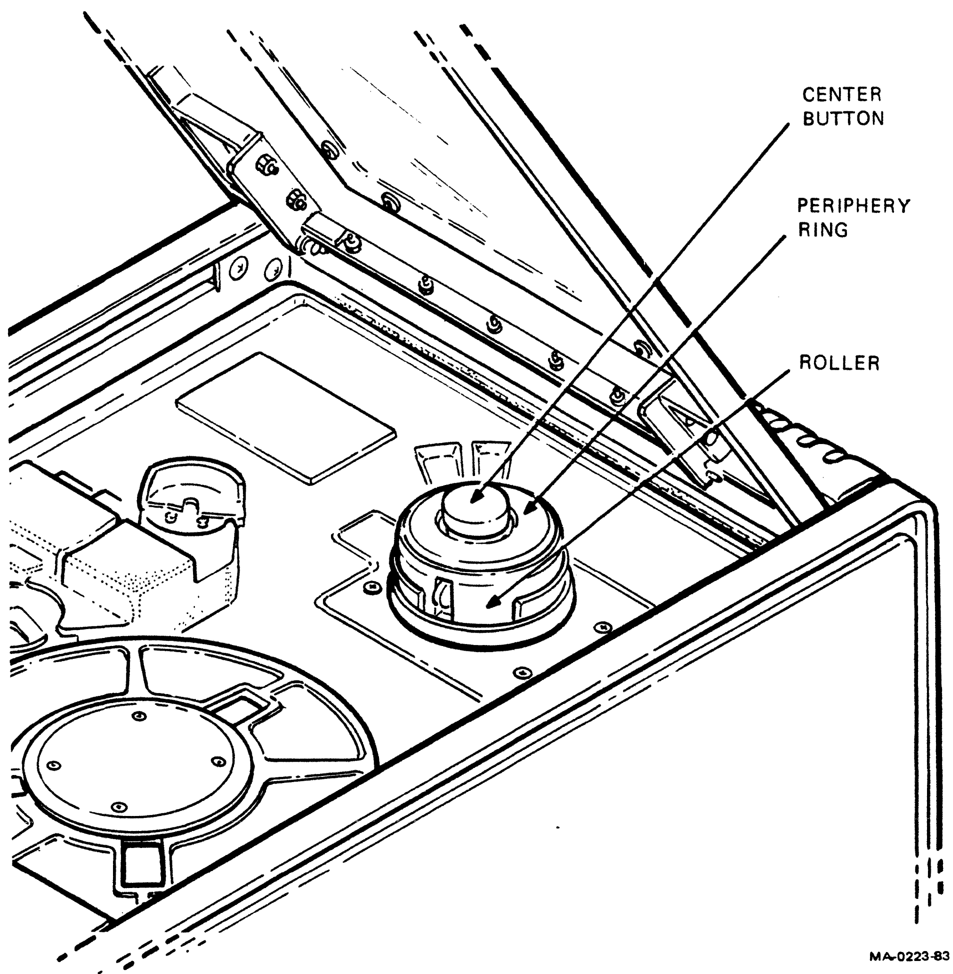

Figure 5 TU81 Supply Hub

_____ 2. Lock and unlock the hub several times. Always make sure the hub is fully locked when you install a tape reel, or errors may occur.

> **CAUTION**
>
> **If the hub is not completely locked, severe hub wear (grooves wear into the rollers) and tape destruction can occur.**

_____ 3. Remove the protective cover from the tape. There are many types of covers with different kinds of mechanisms. Go to the Course Administrator if you need help.

_____ 4. Unlock the supply hub.

_____ 5. Slide the tape reel over the supply reel hub so that the reel rests against the hub's rear flange.

_____ 6. Lock the reel on the hub by pressing on the hub's periphery ring.

_____ 7. Thread tape through the tape path as shown in Figure 6. Wind about four turns of tape onto the take-up reel. A threading diagram is also attached to the transport.

_____ 8. Close the top access cover. This sets the interlock cover latch and allows tape movement.

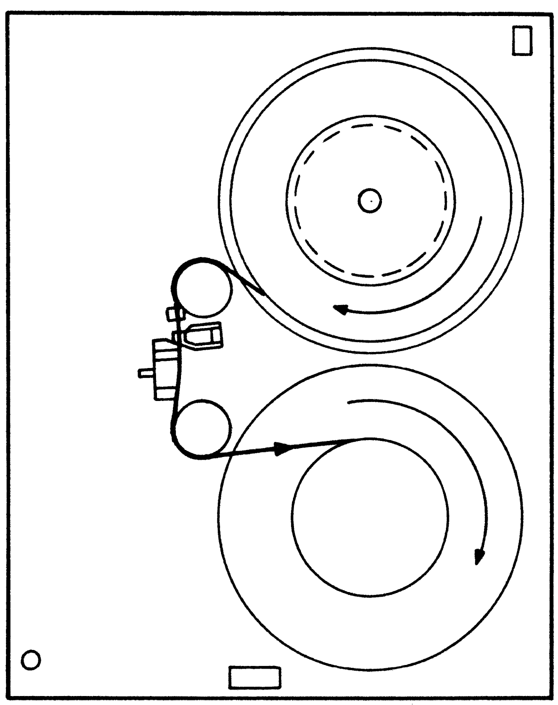

Figure 6 Threading Tape

____ 9. Press the LOAD REWIND switch to load the tape to the BOT marker.

____ 1Ø. Press the ON LINE switch to make the TU81 available to the host system. You can press this switch while tape is loading. The TU81 goes on-line at the end of the load sequence.

The TU81 is now loaded and ready for host system use.

UNLOADING TAPE

Do the following procedure to unload the tape.

____ 1. Press the RESET switch to put the TU81 off-line.

____ 2. Press the UNLOAD switch to remove tape from the tape path and wind it on the supply reel.

____ 3. Open the top access cover and press the center button on the face of the supply hub.

____ 4. Remove the supply reel. Always replace the protective cover on every reel of tape.

____ 5. Close the top access cover to keep dust and dirt away from the TU81 components.

____ 6. Power down the TU81 by pressing the side labeled Ø on the power switch.

OPERATOR DIAGNOSTICS

Any TU81 operator may observe, interpret, and even fix many common errors usually associated with magnetic tape subsystems.

The TU81 has elaborate internal diagnostics and software monitoring systems, which can help an operator solve a TU81 problem without help from Field Service.

The TU81 diagnostic and monitoring systems work as follows.

1. Upon powering up, the transport performs the power-up health check. This check tests the logic that can be tested without tape movement. The indicators flash on for a moment and ØØ flashes on the digital display indicator during this check. A fault code appears on the digital display indicator if an error occurs during the check.

2. During operation, errors are constantly monitored and reported throughout the TU81. These reports go to the host system, which tracks them by using the operating system error log. Some of these errors cause the TU81 to go off-line and display a fault code on the digital display indicator. Table 1 shows the corrective action to take whenever a fault code appears.

NOTE

Remember, this lesson describes only the operator's action for a problem. A Field Service representative would follow the procedures in the Diagnostic lesson.

What if an error occurs, but no fault code appeared? Or maybe the corrective action did not solve the problem. What should the operator do if several intermittent TU81 errors were reported in the error log, but no fault code appeared.

For any other TU81 error, the operator should try to run Operator Diagnostic Test Ø1. You can run this test at any time by using the following procedure. The operator should always perform this procedure before calling Field Service. Make sure all your customers use Operator Diagnostic Test Ø1.

Do the following steps to run Test Ø1.

____ 1. Power up the TU81.

If the power-up health check fails, a fault code is displayed. Then the operator would refer to Table 1 to find out how to respond to that fault code.

Also, with certain power problems, a fault code may not appear. The operator can only try to power up the TU81 again before calling Field Service.

____ 2. Clean the tape path before you load the tape. Intermittent read/write errors are often caused by dirt in the tape path.

____ 3. Thread, but do not load, a known good tape. Do not use the tape that was loaded when the error occurred.

NOTE

A standard amplitude tape or special test tape is not necessary when you test the TU81. Of course, you can use one if available.

Make sure your customers have a tape set aside for test purposes only.

____ 4. Press the RESET switch to clear the display of any fault code and put the TU81 off-line. If a fault code remains displayed, refer to Table 1 for more instructions.

____ 5. Press the TEST switch. The DIAGNOSTICS indicator comes on and 01 appears in the display. Operator Diagnostic Test 01 is now loaded.

____ 6. Press the EXECUTE switch to run the test.

During the test the display increments from 00 to 11 to 22 through 99. At the same time all indicators are on except LOGIC OFF, BOT, and HIGH DENSITY. This action verifies the display segments and indicator lights.

The test continues during various motion and read/write exercises. When you are using 2400 feet of tape, the test lasts for about 10 minutes.

Table 1 Operator Corrective Action For a Fault Code

Fault Code	Corrective Action/Explanation
01 -- 09	Clean the tape path.
10	Close and latch the top cover correctly.
11	Thread the tape.
12	Latch the supply reel hub correctly.
13	Thread the tape correctly.
14	Check for a BOT marker on the tape.
15	The RESET switch was pressed during operation.
16	Install a write enable ring on to the tape reel.
17	Check for a EOT marker on the tape.
18	Tape was loaded when Test 01 started. Thread the tape only.
20 -- 29	There are probably tape errors. Try a known good tape.
All others	Try to run Test 01. Report all fault codes to Field Service.

After the test successfully completes, the tape unloads and ØØ appears on the display.

If the test was successful, you probably solved the original problem by cleaning the tape path or changing the tape.

If the test is unsuccessful, a fault code appears on the display and the FAULT indicator comes on when the test fails. Refer to Table 1 for more instructions.

You can easily cause many of the errors listed in Table 1. For example, if you try to run Test Ø1 with tape unthreaded, a fault code of 13 appears.

___ 7. Fault codes 1Ø through 13, 15, 16, and 18 are also easy to cause. Try to cause them by referring to Table 1.

If the fault code cannot be corrected, the operator must contact Field Service and report the fault code.

You may have several questions about how Field Service representatives use this and other tests to diagnose and solve TU81 problems. Good, you should have some questions at this point. Remember however, this lesson covers the operator actions only. This way you, as a Field Service representative, can relate to problems the customer reports.

Remember your questions; the Diagnostic lesson should answer them.

___ 8. Unload the tape and power down the TU81.

SUMMARY

This lesson described how to operate the TU81.

You learned how to clean the tape path and following components.

Reflective strip
Tape cleaner blades
Supply air bearing
Erase head
Read/write head
Take-up air bearing

The operator panel includes the following elements.

Contr/Fault (controller/fault) indicator/switch
LOGIC OFF indicator
LOGIC ON indicator
FILE PRO (file protect) indicator
HIGH DENSITY indicator
LOAD REWIND switch
BOT indicator
ON LINE indicator/switch
FAULT indicator/RESET switch
UNLOAD switch
Digital display indicator (three digit)

You learned to thread, load, and unload tape.

You learned to run Operator Diagnostic Test Ø1. The operator can run Test Ø1 at any time, and must run Test Ø1 before calling Field Service to report a fault code.

This completes the Operation lesson for the TU81. The rest of this lesson covers how operating the TU8Ø differs from operating the TU81.

TU8Ø DIFFERENCES

The main differences to the operator between the TU81 and TU8Ø, is the power-up sequence and some of the switches and indicators on the operators panel (Figure 7).

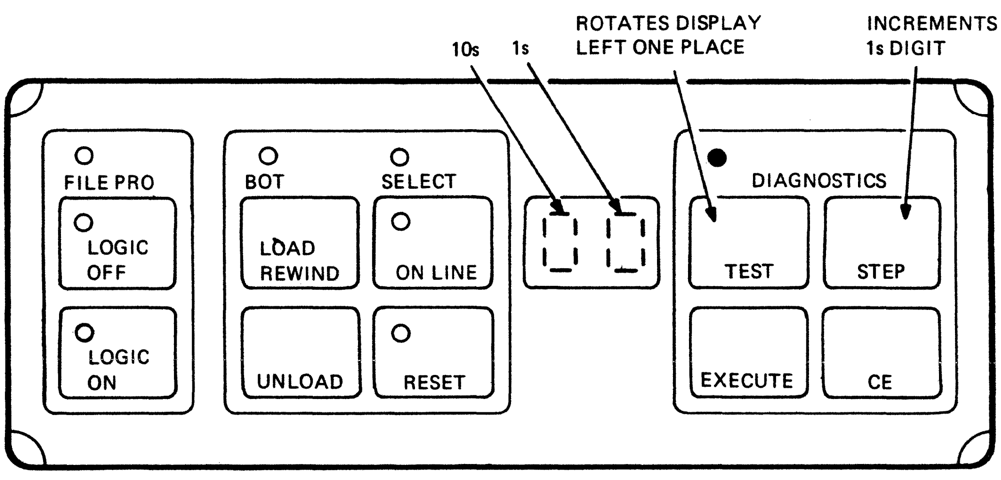

Figure 7   TU8Ø Control Panel

LOGIC OFF Indicator

The LOGIC OFF indicator signifies the following conditions.

Indicator On -- The power circuit breaker is on. No dc voltage is available to the transport circuits except to this indicator. The power supply generates dc standby voltages for its own TTL chips. AC is supplied to the cooling fan motor to start the fan turning.

Indicator Off (With No Other Indicators On) -- The power circuit breaker is off.

Indicator Off (With LOGIC ON Indicator On) -- All TU80 circuitry is on. The transport is ready to use.

LOGIC OFF Switch

If you press the LOGIC OFF switch, power is removed from the transport and the LOGIC OFF indicator comes on.

LOGIC ON Indicator

When this indicator is on, all transport circuitry is powered on and ready to use.

All control panel switches and indicators, except LOGIC OFF, function only when the LOGIC ON indicator is on.

LOGIC ON Switch

If you press the LOGIC ON switch when the power circuit breaker is on, the transport circuitry turns on to make the transport ready for use.

SELECT Indicator

The TU80 has a SELECT indicator instead of the HIGH DENSITY indicator. The SELECT indicator comes on when the TU80 is selected by the host system.

RESET Indicator

The TU80 has a RESET indicator instead of the FAULT indicator. The RESET indicator comes on when the Digital Display Indicator shows a fault code or diagnostic termination code.

Except for the LOGIC OFF switch and RESET switch the control panel does not work when this indicator is on.

You can clear the RESET indicator by pressing the RESET switch.

Digital Display Indicator

This indicator has a 2-digit display rather than three. The TU8Ø has no unit identifier. A number in the display signifies one of the following conditions.

- A fault code when in normal operation
- A test number in diagnostic mode when loading a test
- A test complete indication (always ØØ)

The TU8Ø has no CONTROLLER/FAULT switch/indicator.

POWER UP

When you turn on the power switch, the TU8Ø power supply enters stand-by condition. The cooling fan and LOGIC OFF indicator come on. The two transport logic boards do not have power yet. When you push the LOGIC ON switch, the TU8Ø performs the health check test. Now, all parts of the TU8Ø have power. The LOGIC OFF indicator goes off and the LOGIC ON indicator comes on.

This completes the Operation lesson. Now go to the Theory of Operation lesson.

THEORY OF OPERATION

INTRODUCTION

This lesson gives an overview of TU81 recording methods and operating modes, then describes tape mass storage control protocol (TMSCP), and gives an overview of the TU81 subsystem and software/firmware. This lesson also functionally describes each major field replaceable unit (FRU), using block diagrams for reference. The end of this lesson covers TU80 differences. Appendix A has additional information on GCR recording.

This lesson supplies only the TU80/81 theory information that is necessary in normal field repair. The theory chapter in the TU80 or TU81 Technical Manual describes each major component, timing diagrams, and flowcharts in detail.

OBJECTIVES

1. Identify and describe both TU81 recording methods.
2. Describe tape mass storage control protocol (TMSCP).
3. Identify what steps the TU81 performs to execute a command.
4. Identify the function of each block in a TU81 block diagram.

TU81 RECORDING TECHNIQUES

This lesson does not cover basic tape recording concepts. You should already know this information.

The TU81 uses both phase-encoded (PE) recording and group coded recording (GCR) and features the following recording parameters.

- 9 tracks
- 16ØØ bits/inch (bpi) in PE
- 625Ø bpi in GCR
- 32ØØ flux reversals/inch in PE (maximum)
- 9Ø42 flux reversals/inch in GCR (maximum)
- Forward and reverse read operation in start/stop mode
- Forward read operation only in streaming mode
- Forward write operation only
- Odd parity on track 4
- Single-track error correction in PE
- Dual-track error correction in GCR

PE Recording

PE recording (Figure 1) has a write current flux reversal for every recorded bit. The section of tape shown in Figure 1 is divided into six bit cells. A flux reversal is at the center of each cell. These cell-center reversals are the recorded bits on tape. The direction of the reversal determines whether the bit is a zero or one. A bit has been dropped if no flux reversal is at the center of a bit cell.

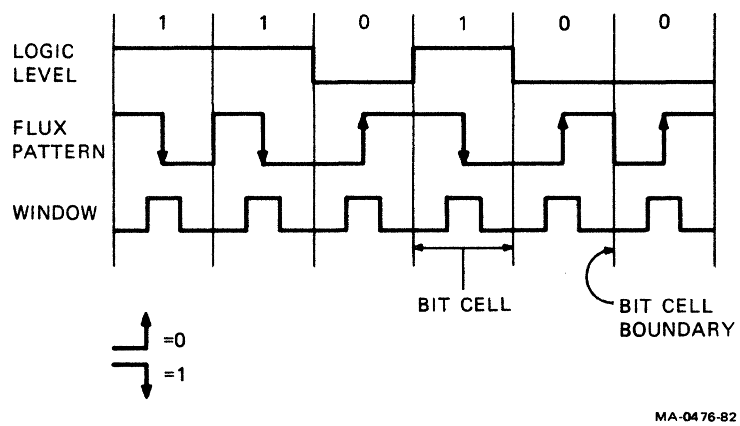

Figure 1 Phase Encoded (PE) Recording

If the same bit occurs twice in succession, a flux reversal occurs at the cell boundary. Cell-boundary reversals are called phase bits.

How does the logic know which reversals are data and which are phase bits? A clock signal, or window (Figure 1), that is synchronized to the flux reversals on tape determines whether the flux reversal is data. If a flux reversal occurs during a window pulse, then the logic recognizes that reversal as a data bit.

Figure 2 shows the tape format. The **leader** is for threading the tape. The **identification burst** (IDB) identifies a tape's format as PE. The **initial gap** (or **extended interrecord gap**) is between the BOT marker and the first record.

A record includes the following three sections.

Preamble
Data
Postamble

The preamble and postamble provide a flux pattern on which the read circuitry synchronizes before reading the data. The preamble is used during forward read operation, the postamble during reverse read operation. Data records between the preamble and postamble. An interrecord gap or extended interrecord gap is between each record.

A group of records handled as a single unit is called a block.

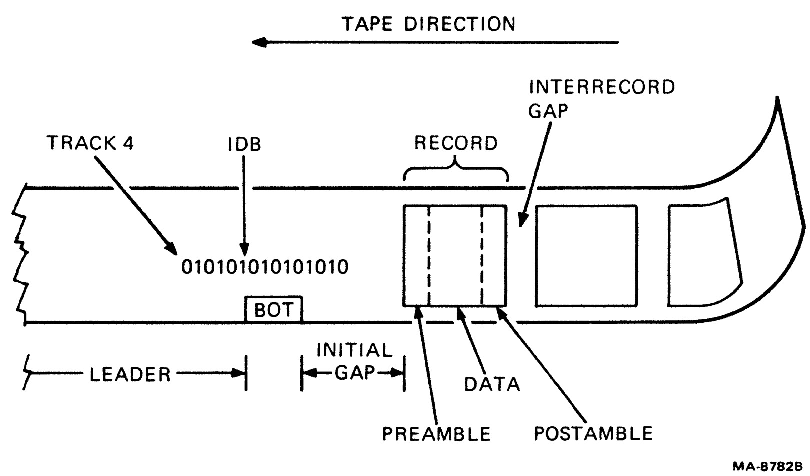

Figure 2 PE Format

GCR Recording

GCR is a type of NRZI (non-return to zero inverted) recording, with a coding scheme. With NRZI, a one is indicated by a positive or a negative flux change. A zero is indicated by the absense of a flux change (Figure 3). GCR uses the same recording technique. However, in GCR no more than two zeros can be recorded in succession on a given track. This limitation assures synchronization.

GCR avoids recording more than two successive zeros by translating four bits into five. Four bits can be grouped in any of 16 combinations from ØØØØ to 1111. There are 32 possible combinations of 5 bits. Combinations that begin or end with more than one zero, and those that contain more than two internally successive zeros, are not used to represent data.

After elimination 17 useful codes remain. The 11111 code is reserved for synchronization purposes. The remaining 16 combinations of 5 bits are correlated with the 16 combinations of 4 bits.

Each combination of four data bits, when grouped together for all nine tracks, is called a data subgroup. The five-bit coded information, when grouped together for all nine tracks is called a storage subgroup. Two subgroups constitute a group. Therfore, two data subgroups constitute a data group and two storage subgroups constitute a storage group.

During GCR recording, each group of four bits in sequence is translated (encoded) to the corresponding 5-bit combination. This 5-bit combination is recorded by the transport in NRZI mode. During reading, the opposite occurs; the 5-bit combination is translated (decoded) into the original 4-bit code.

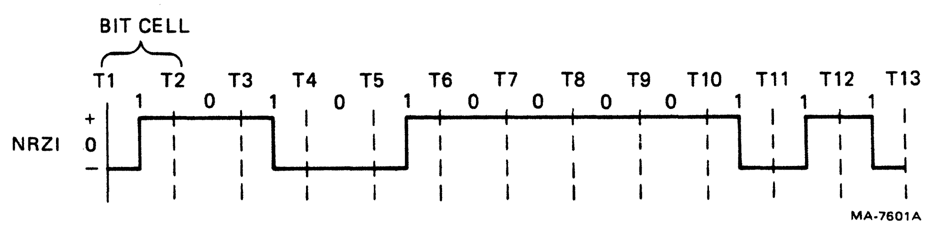

Figure 3 NRZI (Non-Return to Zero Inverted Recording)

Table 1 shows the translation codes for the 4-bit to 5-bit and 5-bit to 4-bit translations. Look up the 5-bit code for 1Ø1Ø. Note that the 5-bit code for 1Ø1Ø is Ø1Ø1Ø. In Figure 4, this is the data on one track of the first data subgroup written on tape.

Table 1 Translation Record Codes

4-Bit Data Value (Data Subgroup)	5-Bit Recording Value (Storage Subgroup)
ØØØØ	11ØØ1
ØØØ1	11Ø11
ØØ1Ø	1ØØ1Ø
ØØ11	1ØØ11
Ø1ØØ	111Ø1
Ø1Ø1	1Ø1Ø1
Ø11Ø	1Ø11Ø
Ø111	1Ø111
1ØØØ	11Ø1Ø
1ØØ1	Ø1ØØ1
1Ø1Ø	Ø1Ø1Ø
1Ø11	Ø1Ø11
11ØØ	1111Ø
11Ø1	Ø11Ø1
111Ø	Ø111Ø
1111	Ø1111

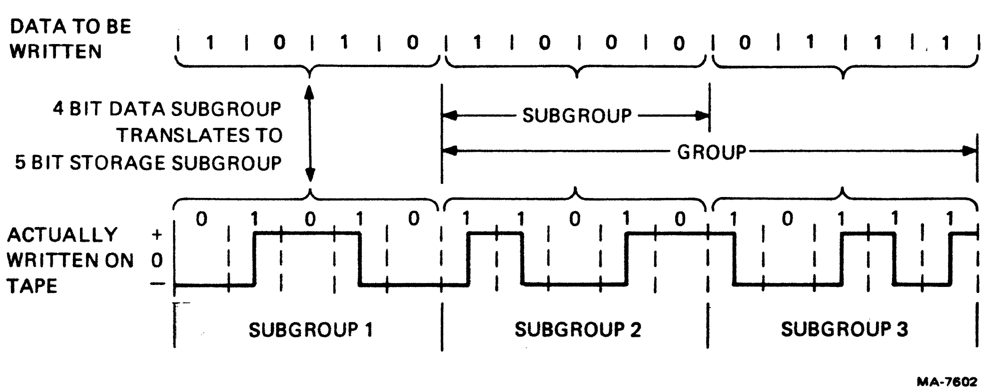

Figure 4 GCR Data Representation on Written Tape

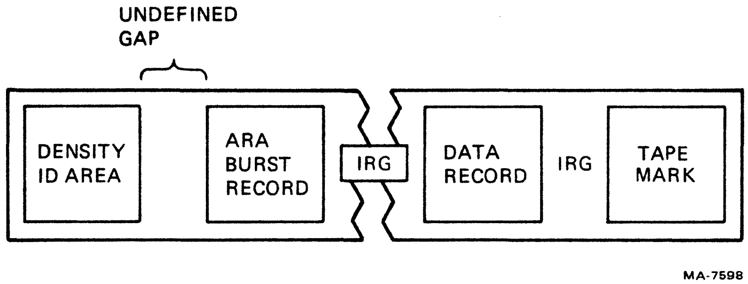

Figure 5 GCR Format

The following four types of information are written on a GCR tape (Figure 5).

Density identification (ID) area record
Automatic read amplification (ARA) burst record
Data record
Tape mark

The density ID burst identifies the tape's format as GCR. An undefined gap separates the density ID from the ARA burst. The ARA burst sets the gain on the read amplifiers and verifies that the transport can write on all nine tracks.

An interrecord gap (IRG) follows the ARA burst. Then, the first data record is written. Each data record is separated by an IRG. At the end of a file or tape, a tape mark is written. The tape mark serves the same purpose as it does on NRZI or PE tapes.

Each data record starts with a preamble and ends with a postamble. Appendix A, an optional lesson on GCR recording, describes in detail the parts that make up each type of GCR record.

Start/Stop Mode

Start/stop mode is the traditional operating mode for magnetic tape transports. For each record of data, the transport accelerates (ramps up) to speed, records or reads the record, and decelerates (ramps down) to wait for the next command. The deceleration may or may not reach zero ips (stop), depending on when the next command is received.

Ramp times are a very limiting factor for tape transports. In start/stop mode the tape must decelerate, wait for the next command, and accelerate within every gap. This means there are (many more than 15ØØØ) ramps when transferring data over a full 24ØØ-foot tape. So, ramp time must be short, to let the transport transfer data fast.

Ramp times can be handled in two ways. First, a very costly servo system can keep ramp times very short when the drive stops from high speed. Second, the tape operating speed can be lowered so that less expensive servo components still can achieve ramp times that stop the tape within the gap.

There is a way to have inexpensive, yet fast, transports which record in industry standard PE or GCR mode.

The answer is streaming mode.

Streaming Mode

Streaming mode does not stop between each record in the interrecord gap. The TU81 can read or write a full tape at 75 ips without slowing or stopping. Interrecord gaps are written while moving. A new command is received while tape is moving and within the gap.

This technique results in very fast data transfer using an inexpensive transport like the TU81. Under ideal conditions the TU81 can transfer a 2400-foot tape in less than 10 minutes.

However, conditions are not always ideal. Certain conditions limit the value of streaming mode.

Streaming Limitations

Streaming mode in the TU81 has the following limitations.

1. Slow data transfer rate

   The TU81 is designed mainly for streaming. Usually there are few ramps so the servo can be less powerful and the ramp times longer. Of course a lot of time is lost when many ramps are needed.

   Earlier you read that commands are received within the gap during streaming. This occurs only if the data transfer rate from the host is fast enough to keep data available at all times.

   Figure 6 shows the command reinstruct time within the interrecord gap. A command must be received within this time for the tape to continue streaming.

(1) HEAD IS PAST THE POINT IN THE GAP WHERE THE COMMAND MUST BE RECEIVED. RAMPS DOWN TO 0.

(2) RAMPS UP TO 75 IPS IN REVERSE TO REPOSITION.

(3) RAMPS DOWN AND STOPS BEFORE THE GAP TO WAIT FOR THE NEXT COMMAND.

(4) WHEN THE NEXT COMMAND IS RECEIVED, TAPE RAMPS UP (ACCESS TIME), ENTERS THE GAP AT 75 IPS, AND CONTINUES INTO THE DATA RECORD.

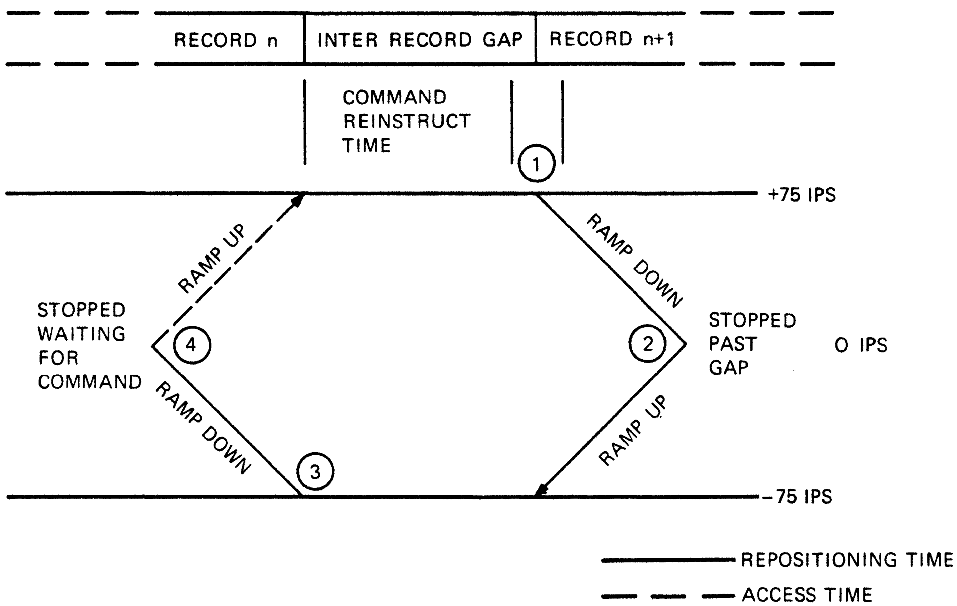

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Figure 6 Streaming Repositioning Cycle

If a command is not received in time, the tape must reposition because the long ramp time will take the tape past the gap. A reposition cycle (Figure 6), which is made up of the repositioning and access times, can take more than 700 msec to complete during streaming at 75 ips. That is a lot of time when compared with most start/stop transports, which take 2 to 16 msec to stop and start in the gap. It follows that the timing advantage of streaming is lost if a lot of repositioning occurs.

NOTE

Repositioning never occurs in start/stop mode. In start/stop mode, the tape can always stop within the gap.

A command will be late if new data is not ready to be delivered (if the data transfer rate is too slow).

The following three conditions can slow the data transfer rate.

- The transfer rate of the peripheral (usually a disk) that is sending data to or receiving data from a memory buffer.
- The priority architecture of the host system.
- The size of the host buffer that contains the data being transferred.

2. Nonsequential record tape operations

   There are still times when the records accessed are not stored sequentially on the tape. This situation occurs when only certain files are desired from the tape.

   A streaming transport is the slowest possible storage device if a job requires many short files from various points on a tape.

These limitations are the reason that the TU81 has three modes.

NOTE

The streaming chapter in the TU81 Technical Manual has more information on streaming.

TU81 OPERATING MODES

The TU81 operates in the following three modes.

1. Start/stop at 25 ips
2. Streaming at 25 ips
3. Streaming at 75 ips

The TU81 logic automatically selects the optimal mode by sampling the data transfer rate.

Why not operate all the time in streaming mode at 75 ips? Isn't this mode the fastest?

Not necessarily, streaming at 75 ips is the fastest mode only when the data rate is fast enough to send commands during command reinstruct time within the interrecord gap after each record.

TU81 Mode Selection

The TU81 microcode selects the optimal operating mode. The TU81 constantly monitors the host's data transfer rate. The logic selects the optimal operating mode according to the data transfer rate.

The data transfer rate is influenced by many factors in the host system. Some of these factors are the operating system, software organization, system architecture, and the peripheral (usually a disk) that is sending and receiving data.

The operator and host software have nothing to do with mode selection. However, sense bits inform the host which mode is selected.

Usually, the TU81 operates as follows.

- At 25 ips in start/stop mode when accessing nonsequential records from a tape and slow sequential record transfers.
- At 25 ips in streaming mode with sequential transfers and a low host data transfer rate.
- At 75 ips in streaming mode with sequential transfers and a high data transfer rate.

However, the mode may change at any time in order to maximize transfer rate.

This automatic mode selection clears up many software and timing problems normally associated with multi-mode tape transports.

Many TU81s are used only as back-up storage devices. This means that there is no random block access. Usually a complete tape is read onto or recorded from (dumped) another device. The TU81 is very fast in this situation and limited only by the data transfer rate of the interfacing host system.

PE Single-Track Error Detection and Correction

In PE mode, the TU81 performs single-track on-the-fly error detection and correction by using the parity track. Track 4 is the parity track. The parity track is written to provide a way to detect and correct tape data errors. During a read function, the read circuitry uses the parity track information to detect and correct data frames that have one track in error. When a parity error occurs, the TU81 makes the correction in the following two steps.

1. The TU81 determines which track has the error. Every track should have a transition during every data window (Figure 1). If there is no transition, the track has dropped a bit. If the amplitude of the signal falls below a specified value, a warning latch is set for that track. This type of track is a dead track. Also, the flux reversal that denotes the bit should occur approximately at cell-center. If the transition falls outside the acceptible window, a phase error signal is generated.

2. The TU81 determines whether a track dropped a zero or one. If a track has dropped a bit, the read circuitry checks the frame that contains that bit for odd parity (an odd number of ones).

If the number of ones is even, a one has dropped because the number of ones should be odd.

If the number of ones is odd, the number of ones is correct. Therefore, a zero has dropped.

The read circuitry then inserts the correct bit into the data frame.

NOTE

The read circuitry does not correct the tape, only the data stream in the logic.

If two or more transitions are lost in a frame (multitrack error), the error cannot be corrected.

GCR Single- and Dual-Track Error Dectection and Correction

In GCR mode, the TU81 performs single- and dual-track, on-the-fly error detection and correction by means of cyclic codes. The following three check characters are used in error detecting and reporting.

Error and correcting code (ECC) character
Cyclic redundancy check (CRC) character
Auxiliary cyclic redundancy check (AUX CRC) character

The ECC character is generated as the eighth byte of a data group. By using the ECC character, the TU81 can detect and correct single-track errors on-the-fly without using track pointers. The ECC character also detects dual-track errors, but has to use dead track pointers and phase error pointers to correct the errors.

The CRC and AUX CRC characters are generated from the data structure, and written into the structure, so that data validity can be checked after data is read. These characters only indicate the occurrence of one or more errors. They do not identify the location of the error(s), or correct the error(s). However, the host system is informed of the error occurrence so that the host can initiate a retry procedure.

TMSCP OVERVIEW

The TU81 tape subsystem conforms to the Digital Mass Storage Control Protocol (MSCP). MSCP is an asynchronous communications protocol. Tape-oriented MSCP (TMSCP) is the asynchronous I/O communication protocol used by a family of tape mass storage device controllers. TMSCP conforms to general MSCP. The host and the TMSCP interface/controller exchange commands and responses through messages structured with a general format. Data I/O is performed over the UNIBUS and the low-end storage interconnect (LESI) which is made up of a set of I/O cables and the LESI-UNIBUS adapter (M8739). The TMSCP interface/controller module contains the intelligence under microprocessor control that converts these messages to TU81 device specific commands and responses. The MSCP concept allows future devices to be interfaced to the host without new host-based driving software.

SUBSYSTEM OVERVIEW

Figure 7 is a block diagram of the TU81 subsystem. The tape transport is directly connected to a VAX CPU by a UNIBUS to LESI interconnect. The LESI adapter (M8739) resides in any small peripheral controller slot in the UNIBUS backplane. The LESI adapter relieves the controller of UNIBUS overhead such as supervising NPR transfers and generating interrupts. The LESI adapter also simplifies communication with the I/O page registers.

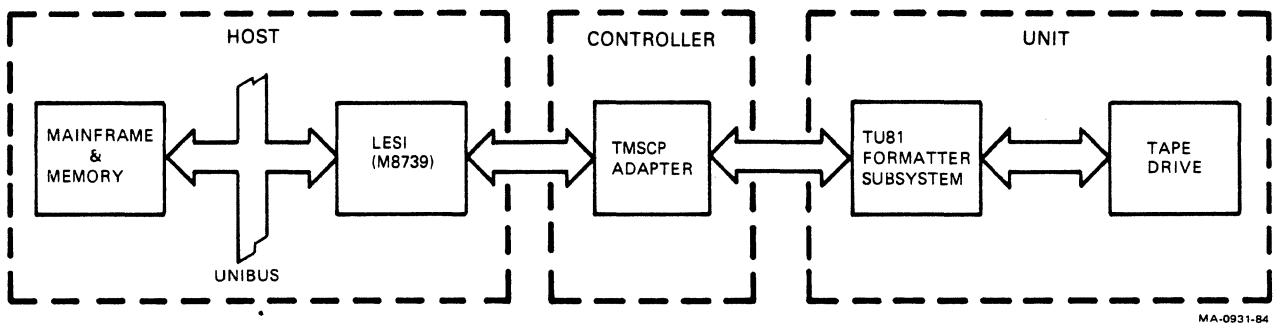


Figure 7 TU81 System Block Diagram

The TMSCP adapter contains the controller interface to the LESI adapter, the interface to the formatter, and the microprocessor-based intelligent controller. The controller fetches host-transmitted command messages and translates them to TU81 formatter commands. The controller also encodes TU81 formatter and drive status into messages, and delivers them to the host. Also, it supervises bidirectional data transfer between the host and unit.

The formatter receives commands from the controller and converts them to motion and data transfer operations for the drive. The formatter converts data from the host via the controller to PE or GCR format, and passes this data on to the drive. The formatter error corrects and converts data from the drive, and passes this data on to the host through the controller.

The tape drive is the physical transport itself with read/write electronics, servo control and panel switches. For MSCP definition, the formatter and drive are defined as the unit, and the TMSCP adapter as the controller.

SOFTWARE/FIRMWARE OVERVIEW

In a computer system that uses an MSCP mass storage subsystem, the I/O controller in the peripheral device contains the intelligence to perform the detailed I/O tasks. This arrangement lets the host send command messages (such as requests for reads and writes) to the I/O controller, and receive response messages back from the controller. The host does not address details such as device type, media geometry and format, error recovery, etc.

Host Architecture

The host uses two layers of software to communicate with the tape subsystem: a class driver and a port driver. The class driver is the higher software layer and controls the tasks to be performed. The class driver's knowledge of details is limited to the general device class (such as disk or tape) and the device capacity. The class driver is not involved with the communication link (I/O bus and adapter), controller, or exact device model being used.

The port driver is the lower software layer and is involved only with communication services such as passing messages over the communication link. The port driver is not aware of the messages' meaning and does not need to know the exact type of I/O controller or storage unit. However, the port drive is tailored to the type of I/O bus used in the subsystem. The LESI-adapter is driven by a UNIBUS port driver. Each driver (software layer) has its own level of resonsibilities, and shields the other from unnecessary load and details.

I/O Controller Architecture

In the device I/O controller there are also two corresponding layers of software. The lower layer is also a port driver, and like the host's port driver, is only involved with passing messages back and forth over the communication bus.

The higher layer of controller software is a TMSCP server. It constitutes the intelligence of the I/O controller and therefore defines the controller's functionality. The TMSCP server determines the number of devices and their type, geometry, unit number, availability, status, etc. The TMSCP server receives requests from and sends responses to the host. It performs the data handling and data I/O operations, and saves the data in the buffer if necessary.

The TMSCP server performs error detection and recovery, and reports any significant errors to the host. Because of this function, the host sees a perfect media, which is an important characteristic of an MSCP subsystem. That is, the host only must report errors to the higher layer software (user), since the TMSCP server performs all error recovery and media defect handling.

Figure 8 is the TU81 subsystem's software/firmware block diagram. The following paragraphs summarize each block's operation.

The class driver performs the following functions.

1. Establishes a connection with the TMSCP server via the host and controller port driver

2. Builds commands in message format to be delivered via the port driver to the TMSCP server

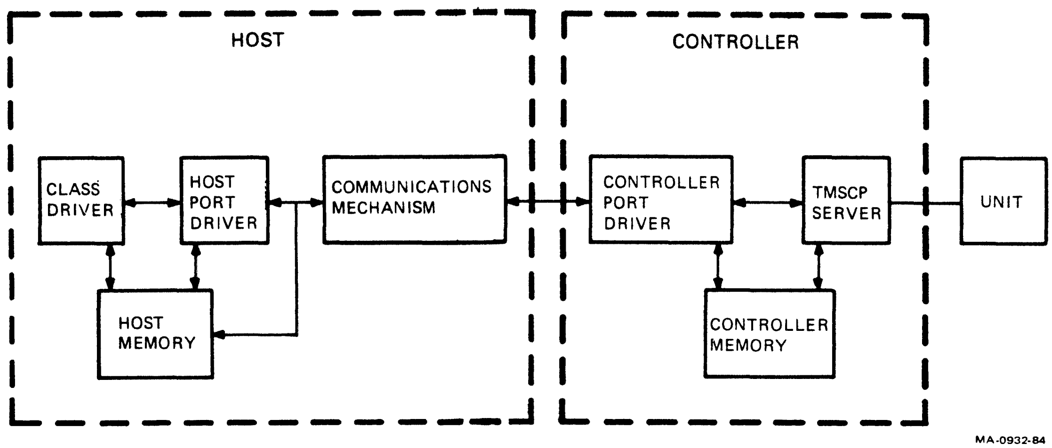


Figure 8 Software/Firmware Block Diagram

3. Receives response messages from the TMSCP server via the port driver

4. Interrogates the status from the response messages

5. Establishes the data buffer via the host port driver for bidirectional data transfers between the host memory and tape drive

The host port driver performs the following functions.

1. Initializes synchronization of the connection between the class driver and the TMSCP server via the controller port driver

2. Supervises the integrity of this connection by monitoring the communication mechanism for error conditions, and reestablishes connections on power fail

3. Establishes and supervises the communications area in host memory for bidirectional message transfers between the class driver and TMSCP server

4. Maintains control of the data buffer in host memory under direction of the class driver

5. Maintains the flow control of commands to the TMSCP server

The communications mechanism is the physical connection (hardware interconnect) between the host and the TU81 tape transport. This mechanism consists of the UNIBUS, LESI adapter, and associated logic in the host and controller to support the host and controller port drivers.

The controller port driver performs the following functions.

1. Responds to and supports the host port driver for initialization to establish the connection between the class driver and the TMSCP server

2. Performs diagnostic functions in the communications mechanism and controller to support the host port driver in maintaining the connection's integrity

3. Reports and defines all fatal error conditions detected during the port operation

4. Supervises delivery and receipt of command and response messages from the host port driver

5. Supervises the controller portion of bidirectional data transfers between the tape transport and host memory

The TMSCP server performs the following functions.

1. Receives command messages from the class driver via the port

2. Translates and interprets command messages into TU81 function commands

3. Transmits TU81 function commands to the formatter

4. Receives status information from the formatter

5. Encodes formatter and drive status information into response messages to be delivered by the controller port driver

HOST TO CONTROLLER COMMUNICATIONS

The host's class driver and the controller's TMSCP server route their messages through a path of corresponding port drivers and a hardware interconnect layer. The hardware interconnect (physical communication link) is the communication mechanism. (Figure 9).

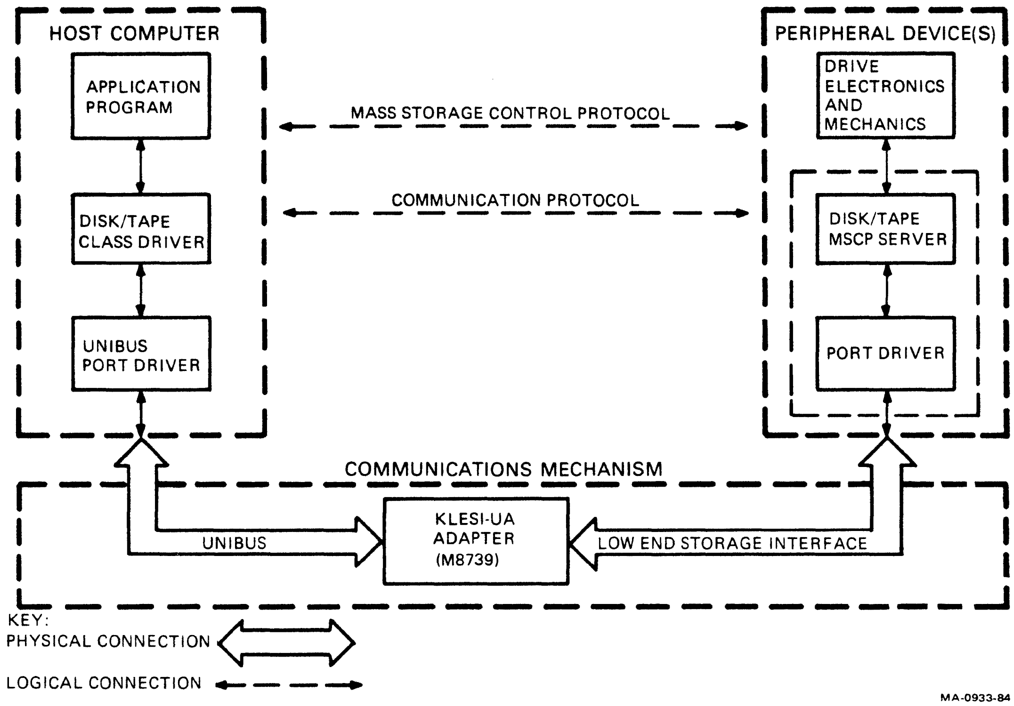


Figure 9 Communications Mechanism

Connection States

The state of the connection is directly equivalent to the state of the controller or TMSCP server with respect to the class driver. Controller states are as follows.

Controller-On-Line - This state exists only if the connection is established and functioning.

Controller-Available - This state exists if the connection is not established, it can be established.

Controller-Off-Line - This state exists if the connection is not established, and it cannot be set.

The following three types of communication services are used across the connection between a class driver and a MSCP server.

Sequential message communication service for TMSCP control messages

Datagram communication service for TMSCP error log messages

Block data communication service for data transfers between a host and device controller (the contents of a named buffer on one side of the link are transferred to a named buffer on the other side of the link).

A unit (TU81 formatter for example) can be in one of three states relative to each class driver (in a host) that is in the Controller On-Line state to an I/O controller (TMSCP server). The unit states are as follows.

Unit-Off-Line - If a formatter is off-line to an I/O controller, the addressed tape transport connected to the off-line controller is also off-line to a host.

Unit-Available - The tape transport must be powered up, on-line to the formatter, loaded, and ready to perform I/O when the host brings it on-line.

Unit-On-Line - With the formatter and the controller both on-line, the transport is ready to satisfy normal host requests, and the host has issued a successful on-line command.

Flow Control

The concept of flow control, which is used to control, buffer, and handle the data flow, is critical to MSCP.

Flow control provides data buffering and overflow control for sequential message and block data communication services. The datagram communication service does not use flow control. If no buffers are available, the incoming datagrams are discarded. The probability of datagram delivery is based on the ability of the receiver (i.e. the class driver) to always have the buffers queued for incoming datagrams.

When a potential receiving process queues a buffer for receiving messages on a connection, this buffer's presence is transmitted (via the underlying communications service) to the potential sending process at the other end of the connection. This message, while notifying the potential sender of the queued buffer, grants the sender a credit, which is the privilege to send the message. Therefore, the messages is only sent when the sender knows that the receiver has queued enough buffers.

Typical implementation of the flow control is based on the use of a counter in the port driver, which holds the process credit balance for each partner involved in the communication process. That is, the number of queued receive buffers minus the number of messages that have been sent. Every time the process's partner queues the receive buffer, a message is sent causing the counter to be incremented. Every time the message is sent, the counter is decremented. The messages may only be transmitted when the counter (credit balance) is greater than zero.

M8739 LESI Adapter

The M8739 LESI adapter is a quad-height module, which plugs into any small peripheral controller slot in the UNIBUS backplane. It connects the UNIBUS to the intelligent controller in the transport. The M8739 performs the following functions.

Enables the I/O controller to send and receive data (via direct memory access) to and from the host's memory

Enables the I/O controller to interrupt the host

Enables access to two UNIBUS registers: initialization and polling (IP), and status, address and purge (SA)

In the LESI interconnect, the M8739 is always a slave to the controller. The controller initiates all operations and the adapter responds upon completion of the command or data block transfer.

Refer to Figure 10 while you read the following paragraphs.

Data Transfers

Before initiating an NPR, the controller writes the host starting address for the NPR into the address register. The controller initiates the NPR by writing into the command register: "Do an NPR, with a direction bit and the word count." The address register increments with each data transfer that occurs on the host interface.

The M8739 transfers data to and from the controller in 16-word blocks. Multiple block transfers occur without reissuing the command or rewriting the starting address (except in byte mode). This is done by transferring 16 more data words into or from the adapter RAM. The DO NPR command restarts when the adapter detects an overflow of the word count. Each successive block transfer must start at RAM address 0 and be 16 words long. If a shorter block has to be transmitted at the end of the burst, DO NPR is cleared first, then the word count is modified before the controller reissues DO NPR and sets up the RAM. Multiple block transfers can be prevented by clearing DO NPR at the end of each block transfer.

Byte operation occurs in single byte transfers at the beginning and end of a record. All data inside the record is in word format and all word transfers are executed in block sizes specified by the Host. The adapter gives up the host bus at the end of every byte transfer. Therefore, after each single byte transfer, the controller writes the starting address and issues a new command.

Parity is generated and checked on both the controller and the host interfaces. The adapter informs the controller when the data block transfer is complete by asserting ATTENTION.

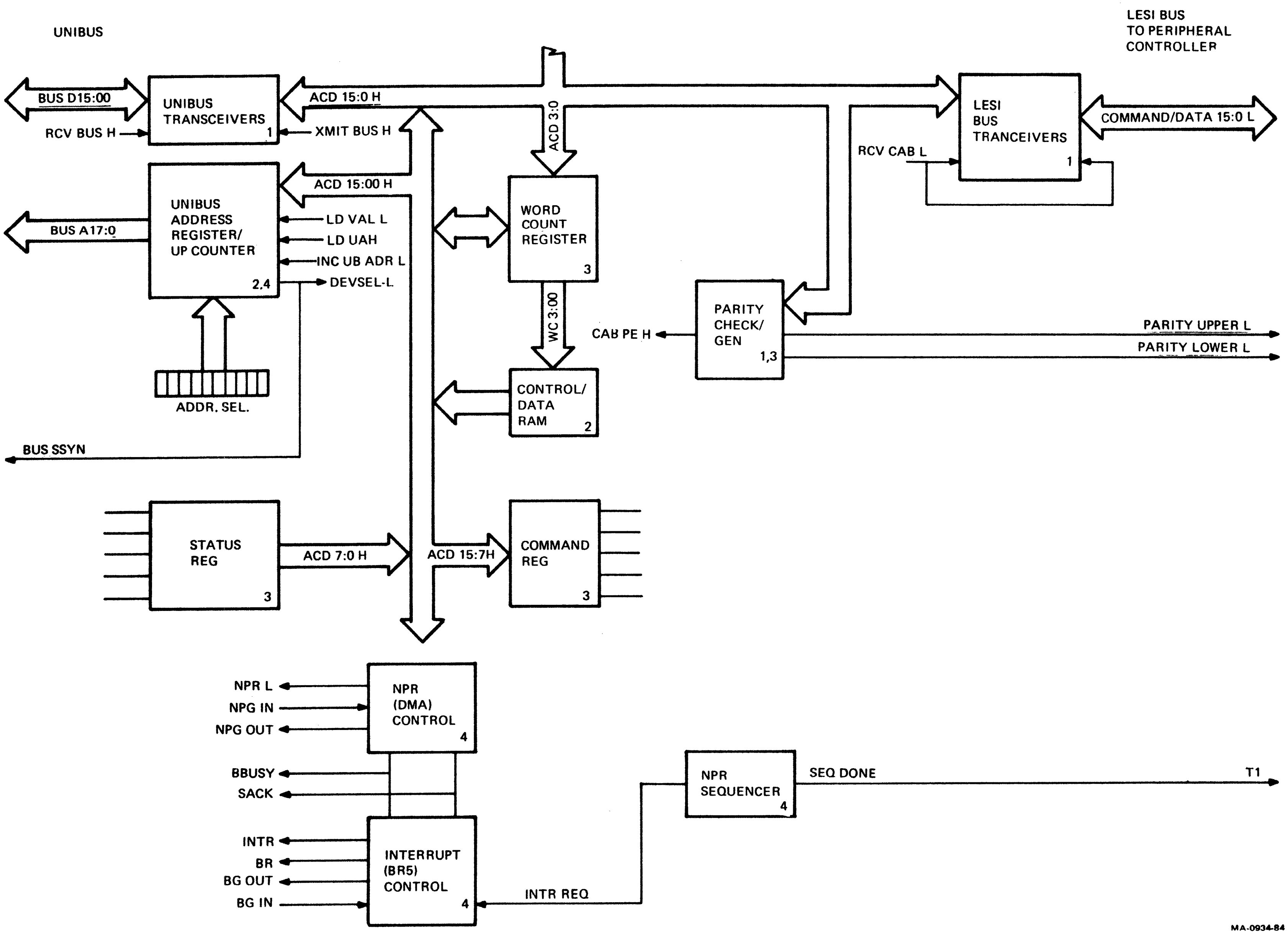


Figure 10   M8739 LESI Adapter Block Diagram

Interrupts

The adapter card also executes host interrupts. First, the controller writes the interrupt vector into RAM location zero, then initiates the interrupt by writing the DO INTERRUPT command into the command register with zero address and word count bits.

UNIBUS Registers

The M8739 adapter also operates as the host's slave device when it runs from the TMSCP contoller. The adapter holds two UNIBUS register addresses: initialization and polling (IP) and status, address and purge (SA), which are used to control the port.

IP Register Function

The host writing to IP causes a hard initialization of the port and controller.

The host reading from IP (when the port is operating) sets the POLL bit in the adapter status register.

SA Register Function

The host writing to SA during initialization sends host specific parameters to the port (adapter and controller).

The host reading from SA during initialization gets data and error information that relates to the initialization process.

The host reading from SA during normal operation gets status and fatal errors.

The host writing zeros to SA during initialization or normal operation signifies a successful adapter purge in response to a port initiated purge request.

TMSCP Interface Controller

Figure 11 is a block diagram of the TMSCP interface controller. The LESI adapter is the connection between the TMSCP interface controller and the host. The formatter interface is the connection between the TMSCP adapter card and the TU81 formatter. The microprocessor controller contains the microprocessor RAM memory, ROM memory, and support logic to translate MSCP protocol to TU81 specific functions.

Figure 12 is a block diagram of the TMSCP microprocessor controller. The microprocessor controls execution of the controller port driver firmware and TMSCP server firmware. The microprocessor also controls all hardware I/O via the peripheral interface adapters (PIAs) and latency buffer. The 16K x 9 ROM memory contains the microcode for the TMSCP server and port driver, as well as the additional functionality that is required internally. The 1K x 9 RAM memory provides temporary storage for command packets, end packets, and error log messages. It also provides scratch pad memory to support the ROM based firmware.

Complete Exercise 1 before you continue this lesson.

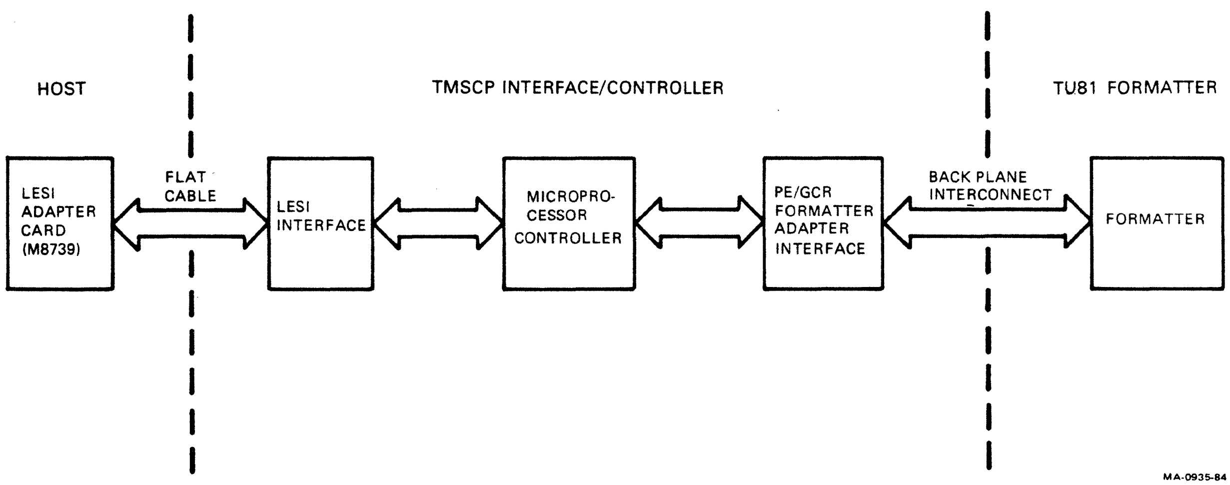


Figure 11 TMSCP Adapter Card

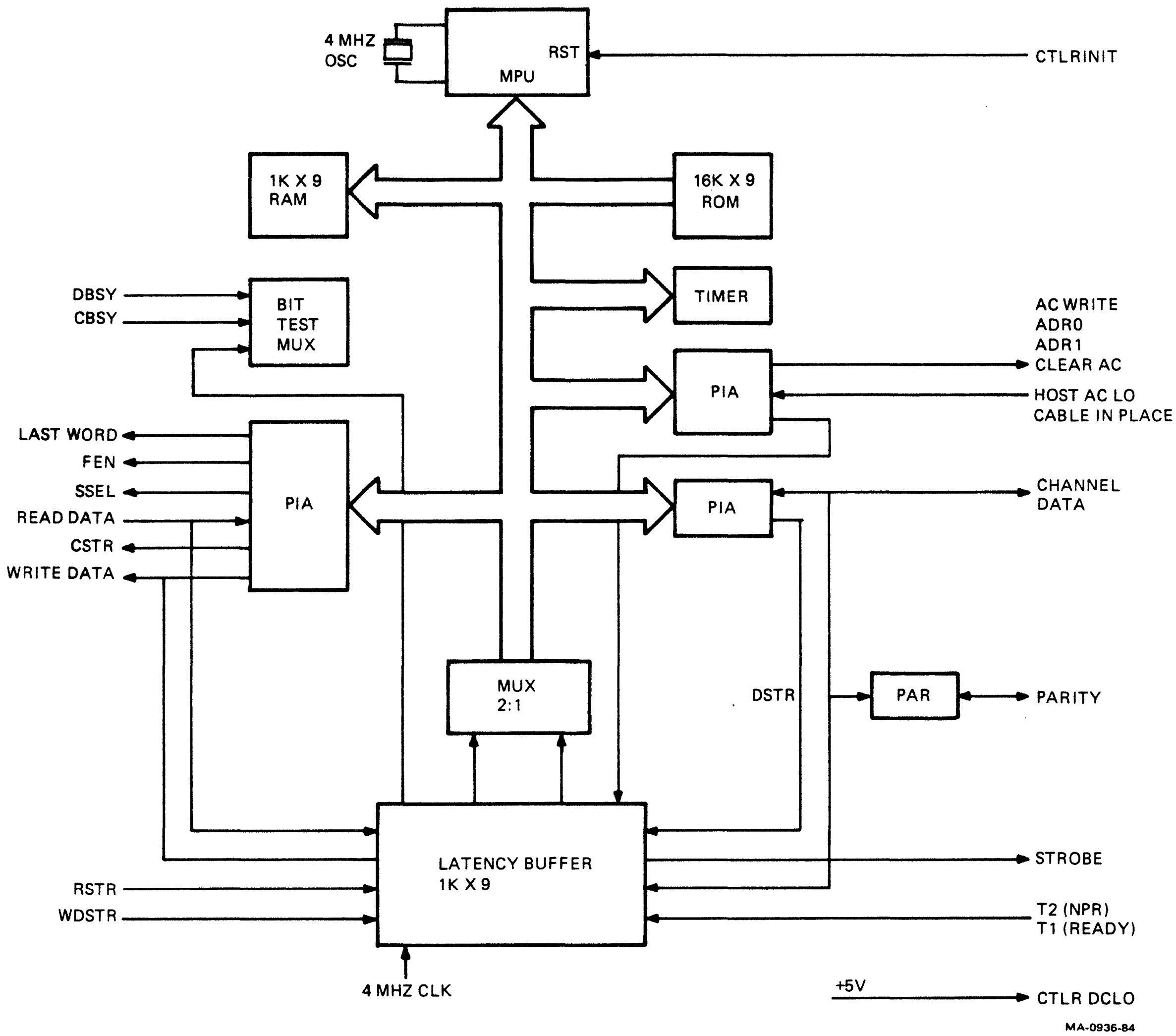


Figure 12 TMSCP Controller Block Diagram

EXERCISE 1

Fill in the blanks with the letter for the correct answer.

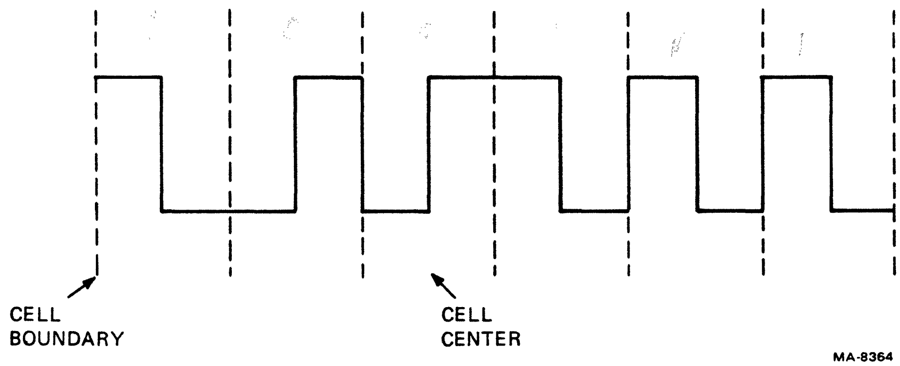


Figure 13 PE Data (Question 1)

1. The data string shown in Figure 13 is _________.

   a. 1 Ø Ø 1 1 1
   b. Ø 1 Ø 1 Ø 1
   c. Ø 1 1 Ø Ø 1
   d. 1 Ø Ø Ø 1 1

2. GCR mode allows error correction for up to _____ tracks simultaneously per block (each record) of data.

   a. 1
   b. 2
   c. 3
   d. 4

3. In GCR mode, every four data bytes (characters) translate into _____ bytes recorded on tape.

   a. 2
   b. 4
   c. 5
   d. 1Ø

4. Start/stop mode decelerates within every ________. Streaming mode can be slower than start/stop mode if the _______ is slow. The mode is selected automatically by the _______.

   a. Data transfer rate
   b. Record
   c. Operator
   d. TU81 microcode
   e. Interrecord gap
   f. Read/write head

5. One advantage of the MSCP concept is ____________________.

   a. Commands and responses are exchanged by messages structured with a general format.

   b. Future devices can be connected to the host without requiring new host-based driving software.

   c. The interface/controller module contains the intelligence to convert messages to device specific commands and responses.

   d. Data I/O is performed over the UNIBUS/Q-bus and the low end storage interconnect (LESI).

6. In the TU81 subsystem, the ________ performs the detailed I/O tasks.

   a. M8739
   b. Formatter
   c. TMSCP adapter
   d. LESI

This completes Exercise 1. Now check your answers on the next page.

EXERCISE 1 ANSWERS

Fill in the blanks with the correct letter.

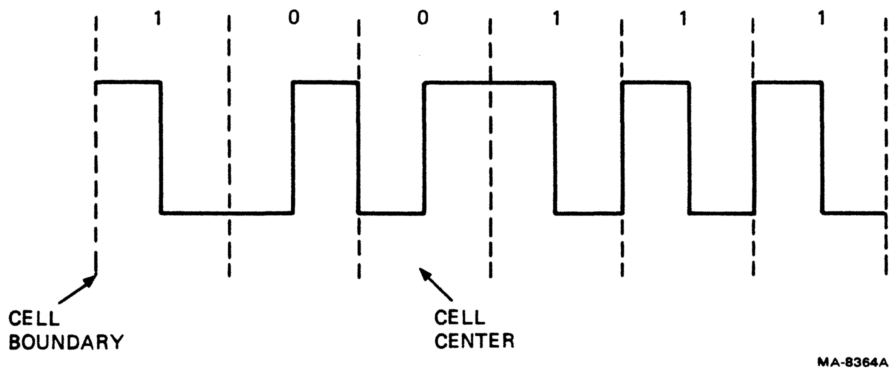


Figure 13 PE Data (Answer 1)

1. The data string shown in Figure 13 is ___a___.

   a. 1 Ø Ø 1 1 1
   b. Ø 1 Ø 1 Ø 1
   c. Ø 1 1 Ø Ø 1
   d. 1 Ø Ø Ø 1 1

2. GCR mode allows error correction for up to ___b___ tracks simultaneously per block (each record) of data.

   a. 1
   b. 2
   c. 3
   d. 4

3. In GCR mode, every four data bytes (characters) translate into ___c___ bytes recorded on tape.

   a. 2
   b. 4
   c. 5
   d. 1Ø

4. Start/stop mode decelerates within every ___e___. Streaming mode can be slower than start/stop mode if the ___a___ is slow. The mode is selected automatically by the ___d___.

   a. Data transfer rate
   b. Record
   c. Operator
   d. TU81 microcode
   e. Interrecord gap
   f. Read/write head

5. One advantage of the MSCP concept is ____b____.

   a. Commands and responses are exchanged by messages structured with a general format.

   b. **Future devices can be connected to the host without requiring new host-based driving software.**

   c. The interface/controller module contains the intelligence to convert messages to device specific commands and responses.

   d. Data I/O is performed over the UNIBUS/Q-bus and the low end storage interconnect (LESI).

6. In the TU81 subsystem, the ____c____ performs the detailed I/O tasks.

   a. M8739
   b. Formatter
   c. **TMSCP Adapter**
   d. LESI

Now continue the lesson.

THE UNIT

The rest of the TU81 subsystem is called the unit. Figure 14 is a functional block diagram of the TU81. The following paragraphs summarize each major component's function.

Formatter Modules

The formatter read and formatter write modules are functionally located between the TMSCP interface/controller and the read/write/servo control logic set. The formatter modules perform the following operations.

1. Translate I/O commands sent from the host system for the tape drive

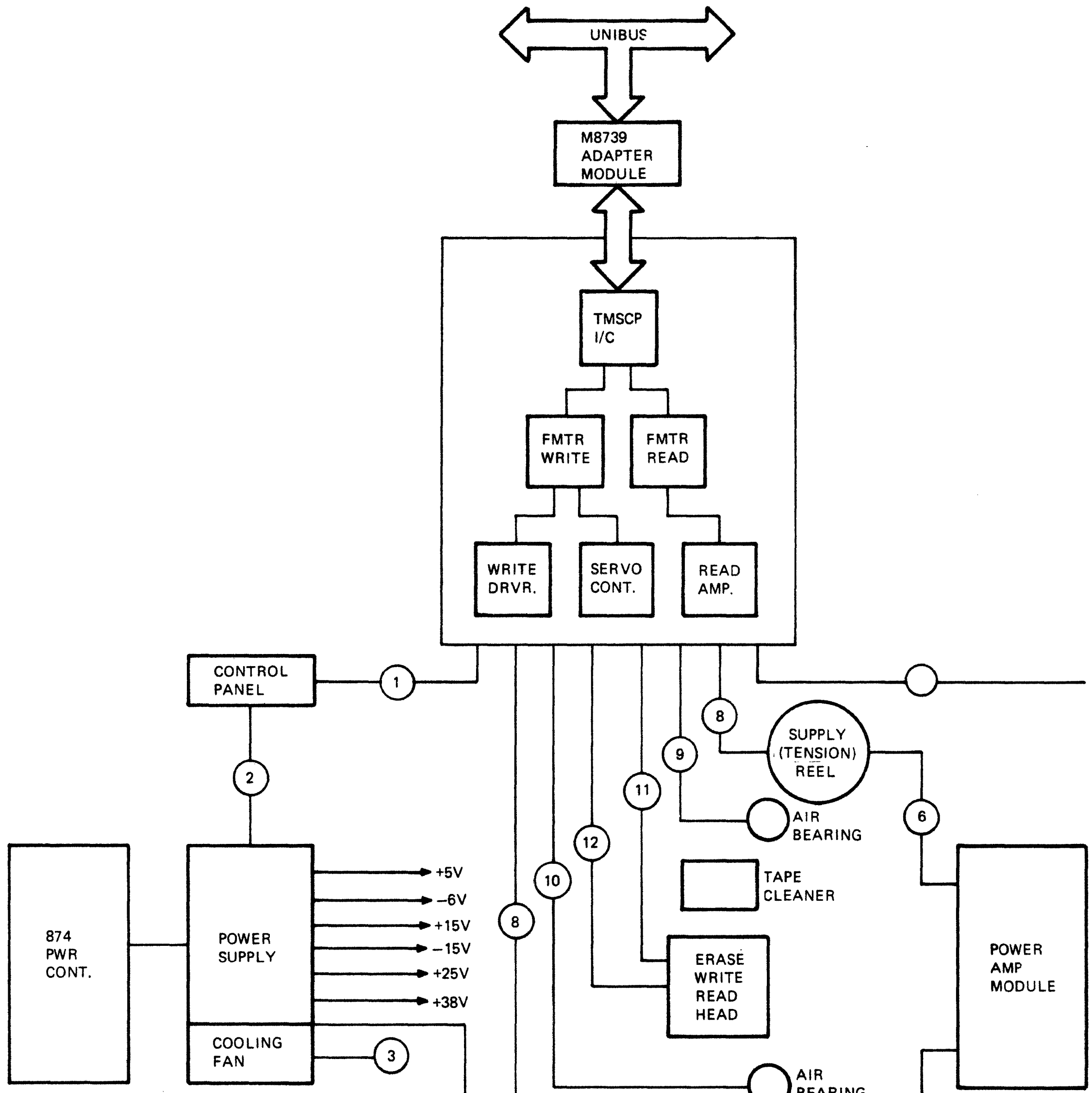
2. Encode and decode data to and from PE format or GCR format

3. In write operations, generate tape control and identification marks; in read operations, delete tape control and identification marks

4. Generate and monitor data error detection codes and perform error correction on-the-fly

5. Monitor and report hard error (HER) conditions

6. Control reinstruct times during streaming operation.



1 OPERATOR/DIAGNOSTIC COMMANDS

2 ON/OFF SWITCHES AND PANEL INDICATOR VOLTAGES

3 COOLING AIR TO 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 POWER TO PUMP MOTOR

Figure 14 TU81 Functional Block Diagram

The formatter write module receives commands from the TMSCP interface/controller (I/C) and translates the commands into tape motion and data transfer instructions for the tape drive (Figure 15). This module also encodes the data received from the TMSCP I/C into PE or GCR format, and generates the tape control and identifier marks, and error checking and correction codes in write operations.

The formatter read module decodes the data from PE or GCR format and strips off the tape control and identifier marks during the read operation. Errors that are detected are corrected if possible, or the error condition is reported to the TMSCP I/C.

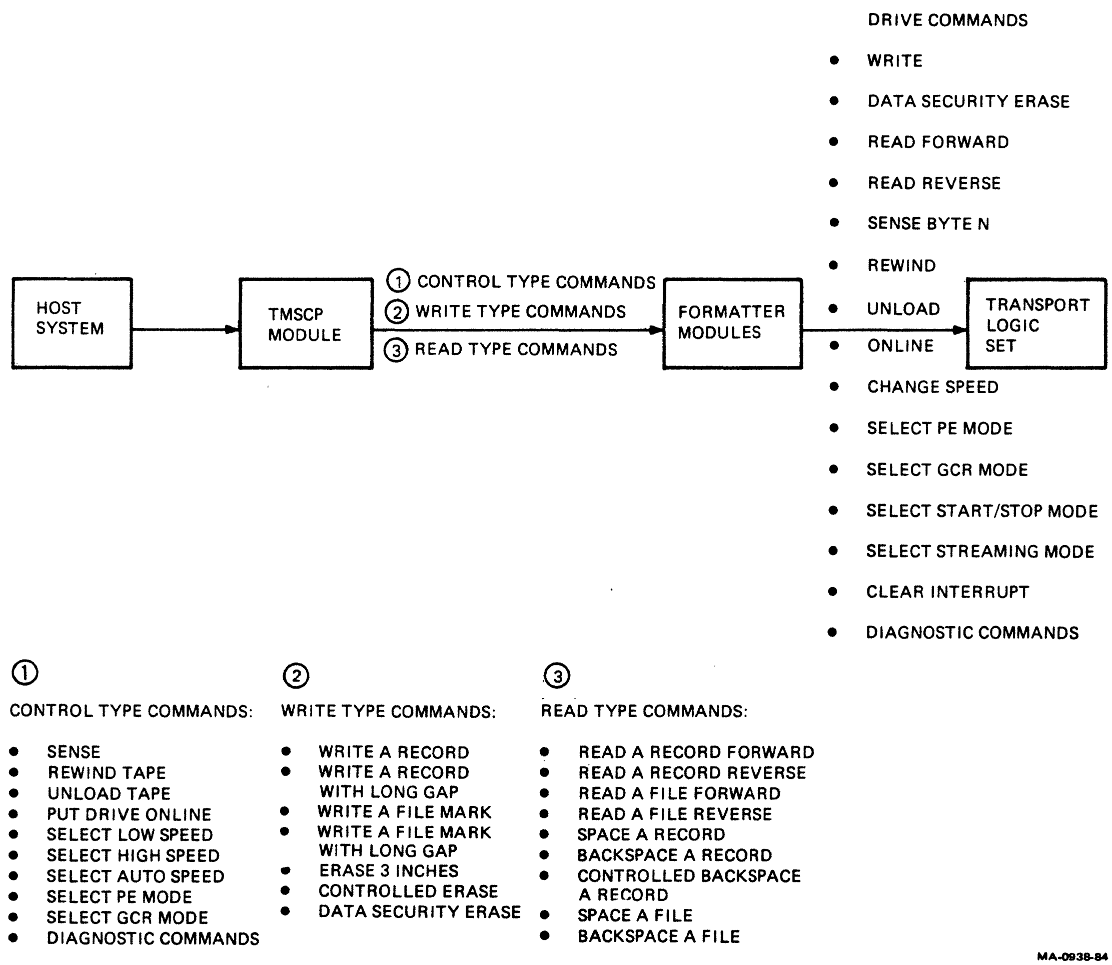


Figure 15 I/O Command Translation

Servo/Control Module

The servo/control module is responsible for:

1. Formatter commands and responses
2. Transport control and monitoring
3. Control panel command execution
4. Tape motion and servo control

The servo/control module microprocessor and the formatter write module microprocessor control communication between the transport and the formatter. The servo/control module receives, validates, and executes commands sent from the write formatter. It also determines the correct sequence of execution and monitors the necessary tape motion to complete these commands.

The servo/control module responds to the various sensors throughout the drive, such as, BOT/EOT, file protect, etc. It also responds to manually initiated commands from the control panel, such as load and unload tape or execute diagnostics.

The servo/control logic regulates tape motion by monitoring tape speed and providing compensation to ensure constant speed during all tape motion operations.

Servo Circuits

A servo, or servomechanism, is a group of components that monitor an operation and makes necessary adjustments to control the operation. The TU81 has two servo assemblies: the velocity servo and the tension servo. The electronics for both servos are located on the servo/control module. The mechanics and sensors for both servos are on the tape deck.

The TU81 servo functions are performed differently from most tape recording devices. When you read the Velocity Servo and Tension Servo sections, keep the following two things in mind to avoid confusion.

First, the take-up reel motor works in conjunction with the servo/control microprocessor, both tachometers, and the velocity servo circuitry to maintain constant tape speed across the head. This is why the TU81 does not need a capstan.

Second, the supply reel motor works in conjunction with both pressure sensors in the air bearings, and the tension servo circuitry to maintain a constant tape tension of 8 ounces. This is why the TU81 does not need tension arms or vacuum columns.

__Velocity Servo (Speed Control)__ - The velocity servo circuitry maintains constant tape velocity until an operation is done.

The take-up reel turns to maintain tape velocity. The radius of the tape on the take-up reel is used to determine how much the reel needs to turn to maintain velocity.

You might ask how can this radius be measured since it changes the entire time tape is moving?

That's true, but when tape is loaded to BOT, the take-up reel radius is assumed to be 2.56 inches. The servo/control microprocessor recalculates the radius every 8 revolutions of the supply reel. The 1-line supply tachometer counts the supply reel revolutions. In this way, the radius is always known. The counter increments when tape moves forward, and decrements when tape moves in reverse.

Even if you start the function in the middle of a reel of tape, the counter will be correct. The count can only be lost if the transport is powered down, since all functions first search for BOT after power-up.

To compensate for the radius changes, the turning distance must change to keep tape moving at the same speed across the head. The turning distance changes by varying the amperage applied to the take-up reel motor.

Refer to Figure 16 while you read the following description of how the correct amperage is determined.

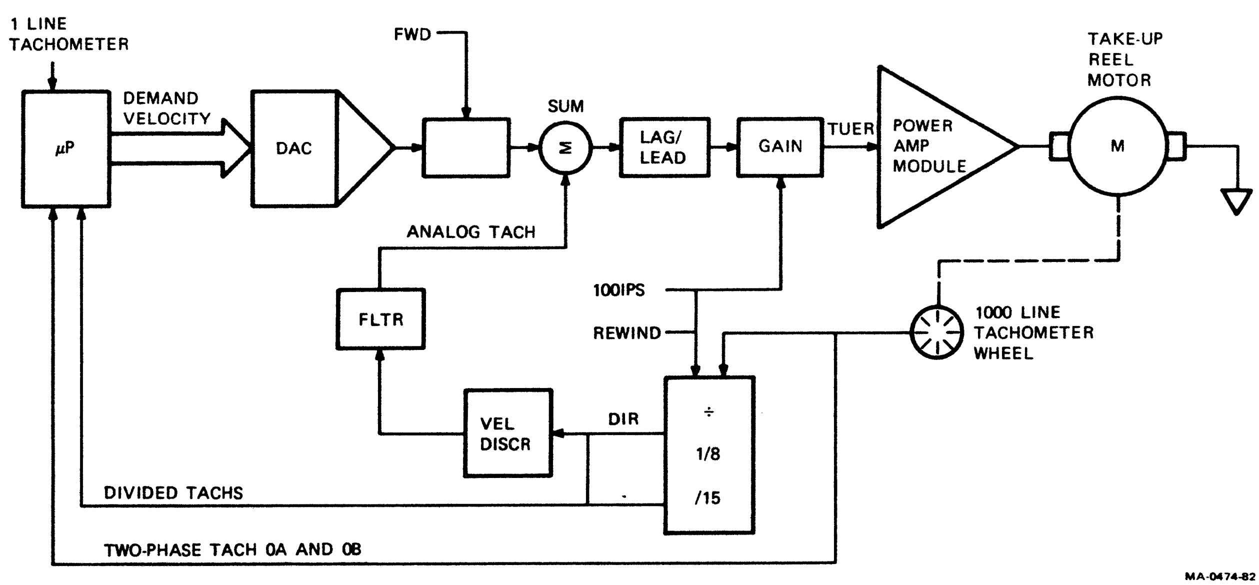


Figure 16 Velocity Servo

The 1000-line take-up tachometer signal is in two phases, ØA and ØB. The phase signals are decoded into direction and divided according to the current operating velocity. The leading phase determines the direction of reel movement.

NOTE

The FWD (forward) signal determines in which direction to begin tape movement. Tachometer phasing determines the direction in which to continue tape movement.

Then the directional and divided phase signals are NANDed together and sent through descriminating and filtering logic to create the ANALOG TACH signal.

Meanwhile, the servo/controller microprocessor uses the radius, direction, and divided phase to determine a demand velocity, which is sent to a digital-to-analog convertor (DAC).

The analog demand velocity is summed with the ANALOG TACH signal to create an error signal. A lag-lead filter smoothes out the voltage reversals in the error signal to avoid jerky reel motor motion. The error signal is amplified according to the operating speed to create a velocity error signal (TUER). TUER is sent to the power amplifier, which turns the reel motor the desired amount.

This process repeats continually as long as tape movement is desired.

Tension Servo - The tension servo circuitry (Figure 17) maintains constant tape tension as long as a tape is loaded.

Several inputs to this circuitry must be explained before we examine how the circuit works.

Zero Tension Offsets (TEN OFF)
During the lifetime of a device there will be small deviations in power supply voltages, component characteristics, and the external environment. Usually preventive maintenance is scheduled to make adjustments that compensate for these deviations. To eliminate TU81 adjustments, offsets are introduced into the circuitry and tied together with sensing units via differential amplifiers. The offsets are automatically optimized periodically.

On the TU81, the air bearing pressure transducers are tied together with the tension offsets calculated during each load sequence.

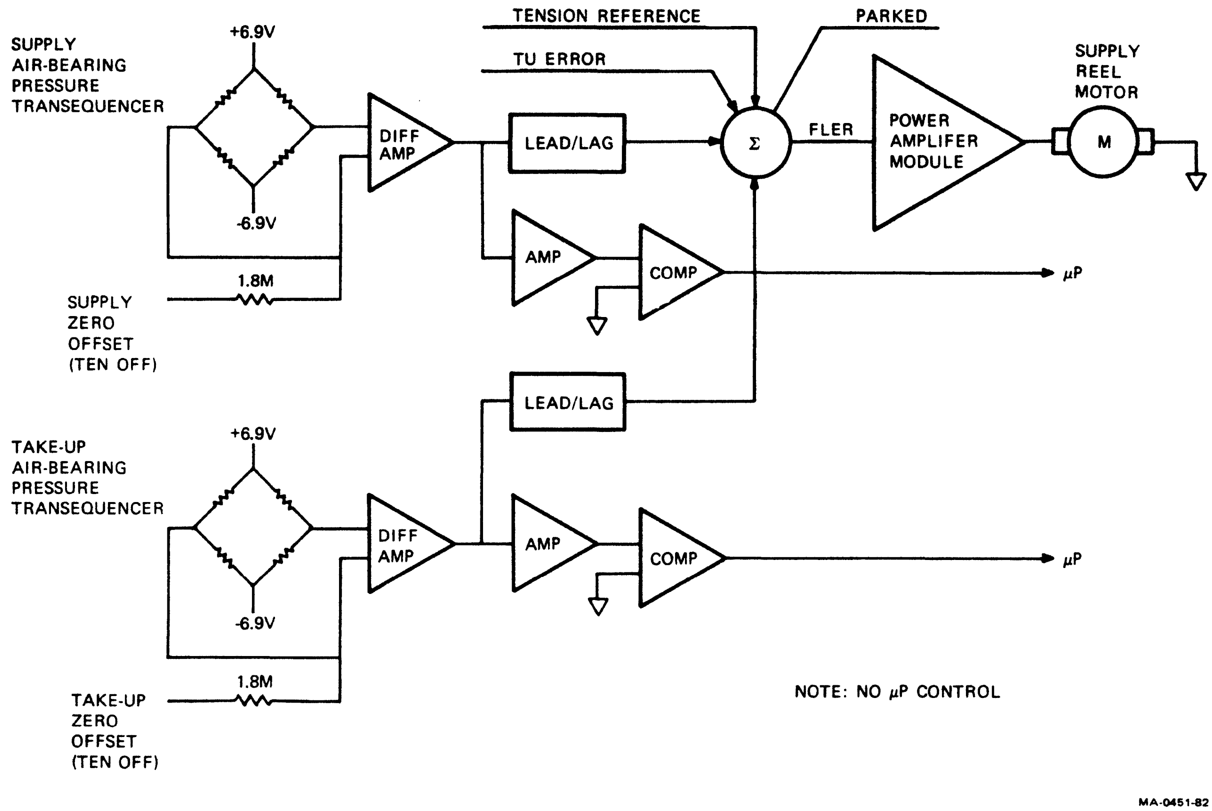


Figure 17 Tension Servo

During each load sequence, the microprocessor sweeps both offset signals from maximum to minimum voltage. At the point where the offset signals zero their respective operational amplifiers, the sweep stops and the offset sets at that voltage level until the next load sequence. In this way the offset is always optimized.

Tension Reference (REF)
This reference is equivalent to 16 ounces of tape tension. It is used to bias the circuit so that 8 ounces of tension is developed.

Take-Up Error (TUER)
This signal is summed with the tension reference and transducer inputs so the take-up reel movement is factored in when determining supply reel movement. The movement of the two reels are coordinated with this signal.

Parked (PRKD)
This signal is used when there is no tape movement. PRKD is amplified and causes the reel motor to maintain tension.

Tension Protection
These comparator signals sent to the microprocessor cause it to shut down the tension servo if too high or too low tension levels are sensed.

Now that we have reviewed inputs to the tension servo circuitry, we can examine the circuitry itself. The supply and take-up pressure transducers within the air bearings sense the air pressure reflecting off the tape. Both transducer signals, the take-up reel error signals, and the tension reference signal are summed together. The resulting signal (FLER) is amplified on the power amplifier module and the supply reel motor turns to maintain a correct tape tension of 8 ounces on each air bearing.

WRITE DRIVER MODULE

The write driver module converts digital data received from the write formatter to analog write current in order to record on tape.

Write Control

The write control circuits (Figure 18) are enabled by the absence of REWIND and FILE PROTECT. The +25 volt supply generates a voltage greater than +22 volts when FILE PROTECT and REWIND are not true. This voltage generates the write current and enables the ac bias generator. The erase circuit is also enabled when the ERASE signal is true.

Tape is erased before it crosses the write head during a write command. The erase head is a single full-tape-width element, which uses dc saturation to erase. The erase head operates in forward only.

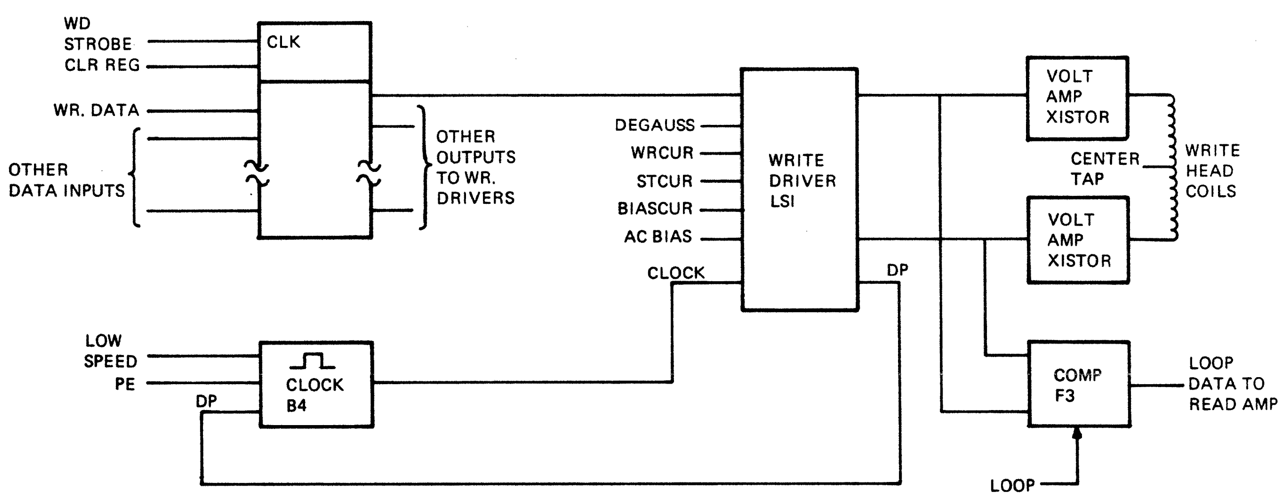


Figure 18 Write Control Block Diagram

Write Driver LSI

The write driver circuit is an LSI circuit (Figure 19). The LSI drive output is the sum of the ac bias current, step current, and write current. The LSI data pulse output triggers a timing circuit. Depending on the speed of the tape and the recording method, the output pulse of timer B4 determines the write compensation times for the write driver.

Degauss

Residual magnetism builds up on the heads during a write operation. If this magnetism is allowed to continue to build up, partial erasure could occur on the tape. To prevent this, the TU81 degausses the head at the end of every write function to neutralize the residual magnetism.

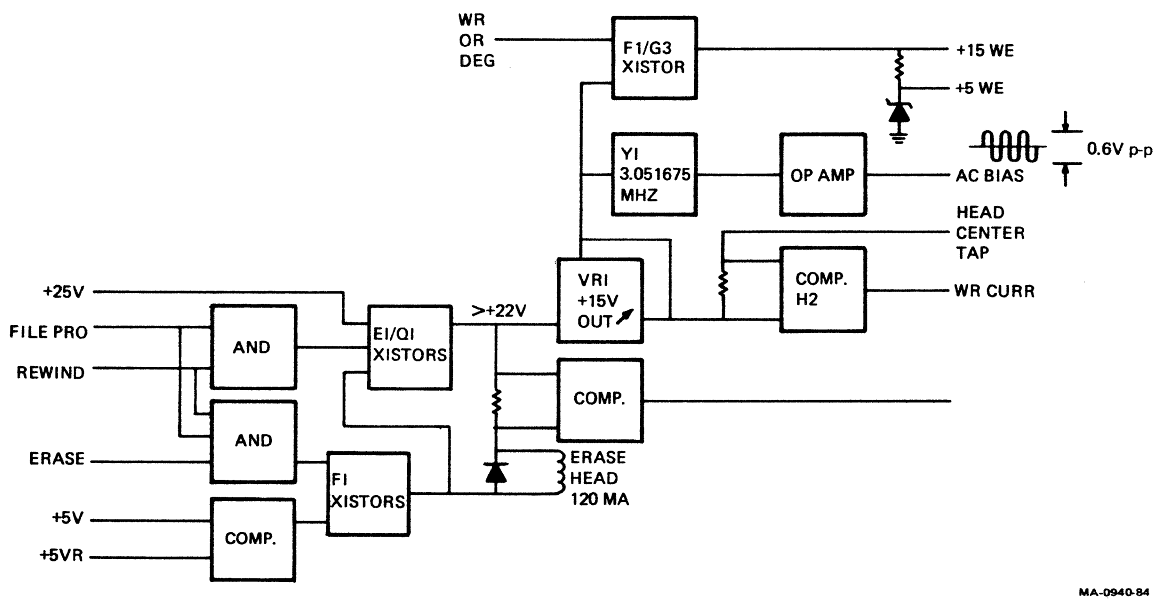


Figure 19 Write Driver Block Diagram

READ AMPLIFIER MODULE

The read amplifier module amplifies the data signals detected by the read head, and converts these analog signals to digital logic levels usable by the read formatter and TMSCP interface controller logic.

The analog READ DATA signal (Figure 20) is taken off the tape by the read head, amplified and filtered several times. Amplification factors are determined by programmable gain control circuits, which are selected by the microprocessor and dependant on the speed and recording mode. The output of these circuits goes to a zero crossing comparator and a clip level comparator. The zero crossing detector converts the data signal to a digital pulse. The clip level detector outputs a digital pulse only when the processed read signal overcomes the microprocessor controlled clip levels. The output of the envelope detection/clip circuits is ANDed with the output of the zero crossing detector to enable the transfer of read data to the read formatter module.

The TU81 uses automatic gain control (AGC) to replace the gain adjust potentiometers usually found in tape transports. In normal use the AGC lines are constant. They are set to provide a first stage amplification output of 2 volts. However, this output may vary due to component wear or replacement. In PE mode, if symptoms occur that indicate a possible read gain problem, you can invoke an internal diagnostic to reset the AGC level for each track. You should run this diagnostic whenever you replace the head or module. In GCR mode, the circuit is activated every time tape is read from the BOT marker. When the formatter recognizes the GCR ID burst, the AGC circuit is enabled so that the first stage amplifier gains are set during the ARA burst.

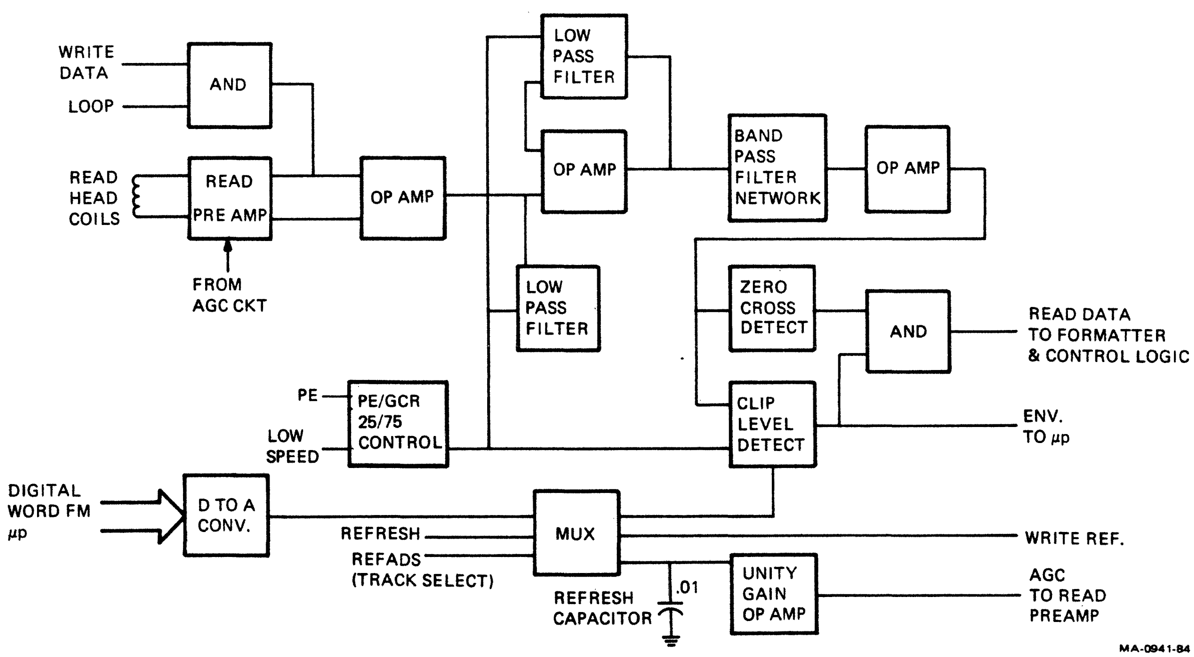


Figure 20 Read Amplifier Block Diagram

VACUUM AND PRESSURE PUMP SYSTEM

The vacuum and pressure pump system is a pneumatic system. A pneumatic system is a system that is operated by a gas. In this case the gas used is air.

This pump system generates and distributes the air pressure and vacuum required by the transport. This system functions by doing the following three steps (Figure 21).

1. Air is pulled in through the tape cleaner port by the vacuum side of the compressor in order to draw unwanted particles away from the tape path.

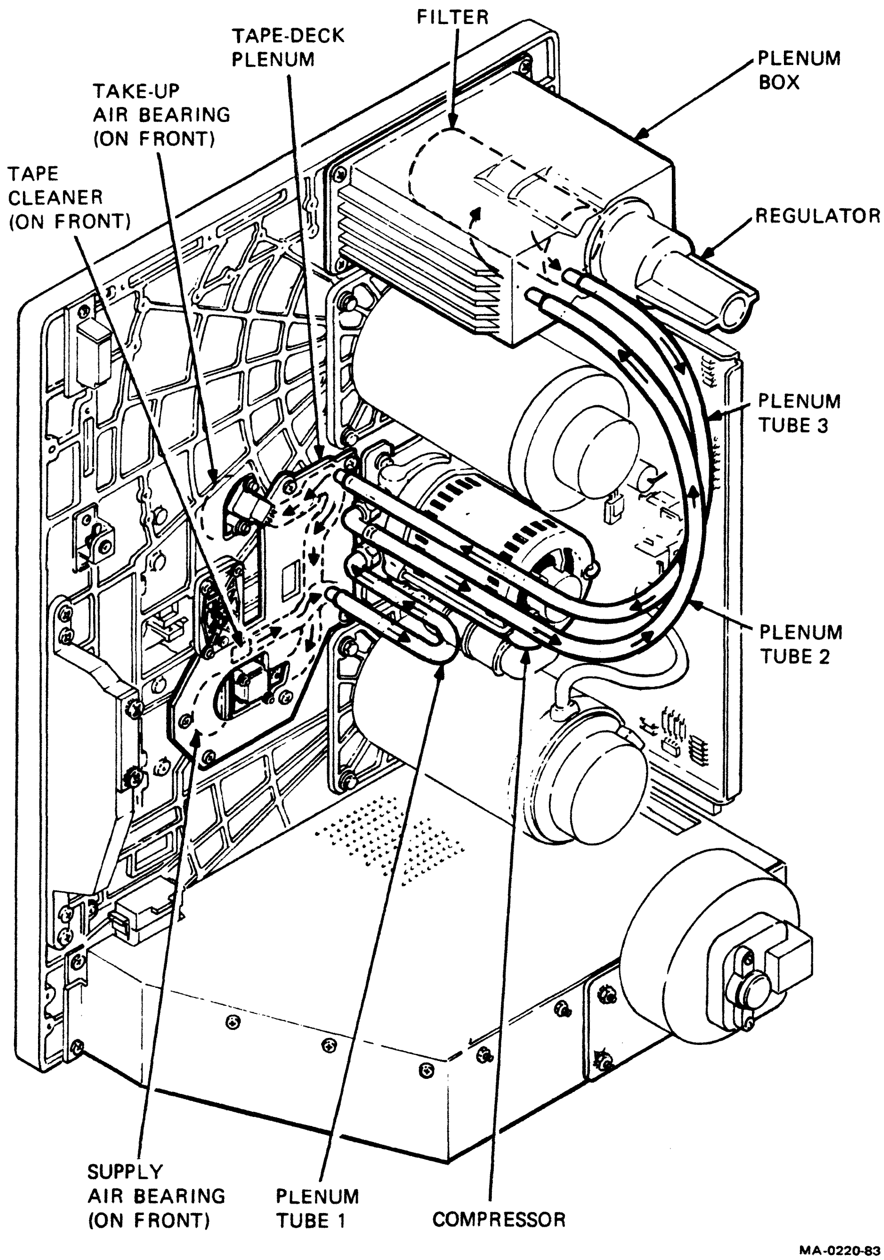


Figure 21 Vacuum and Pressure Distribution

2. The air is filtered and regulated.

3. The air is pushed out through the many air bearing ports by the pressure side of the compressor to help maintain smooth tape movement and proper tape tension.

The compressor is an ac inductor motor with a four-blade, carbon vane pump.

The servo/control microprocessor enables the compressor during the load sequence. The air intake side of the compressor has a small requlator hole (bleeder) in the intake line in addition to the tape cleaner port. The vacuum effect at the tape cleaner is about 8 inches water.

The plenum box on back of the tape deck routes the air through a high efficiency filter for cleaning. The filter is designed to last for the life of the TU81. However, in the case of a very dirty environment, you can change the filter by removing the plenum box.

The filtered air is regulated within the plenum box by the pressure regulator on one end of the box. The regulator, which is screwed onto the plenum box, maintains a pressure of 2 pounds per square inch (PSI) by bleeding off any excess pressure.

This clean, regulated air goes to the air bearings where it holds the tape off the bearing to enhance tape movement and reduce tape wear.

Once the air goes through the air bearing ports, some of the air reflects off the tape into a visibly larger hole in the center of the air bearing surface. A sensor within the air bearing case monitors pressure and sends back information to the servo/control microprocessor to help maintain tape tension.

POWER SUPPLY AND COOLING

The power supply provides ac power to the cooling fans and compressor, generates the dc voltages used throughout the transport, and provides shut-down capabilities in case of abnormal voltage conditions.

The power supply is a field replaceable unit (FRU). If the power supply is generating a faulty voltage, you should replace it. The only reason you ever remove the cover from the power supply in the field, is to convert between 115 Vac 60 Hz and 220 Vac 50 Hz. The Removal and Replacements lesson covers this conversion.

The following paragraphs provide a short physical and functional description of the power supply.

The power supply consists of the following components (Figure 22).

AC input receptacle
Line filter (FL1)
Circuit breaker (CB1)
Voltage select module
Power supply module
Power supply control module

The ac input receptacle connects the power supply to outside ac voltage via the switched receptacles on a Digital power controller.

The line filter suppresses noise on the input line.

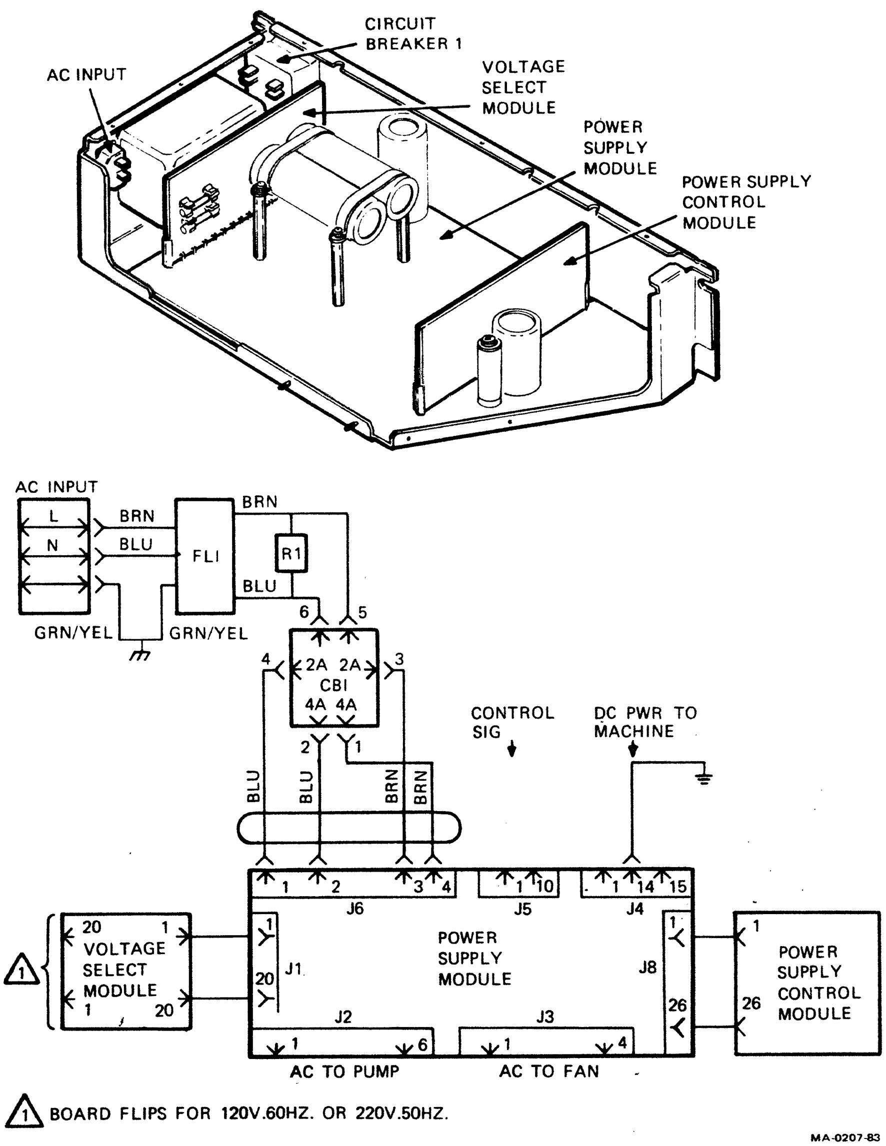


Figure 22 Major Power Supply Components

The circuit breaker is the off/on (0/1) switch in the corner of the transport nearest the supply hub. The circuit breaker turns the power supply on and off. The power supply provides ac voltage to the cooling fan motor whenever the circuit breaker is on.

The power supply control module is vertically inserted into connector J8 on the power supply module. This board contains the following circuits.

- Low voltage and over-voltage detect circuits
- LOGIC ON and LOGIC OFF switch receivers and indicator circuits
- Master clear circuits
- Power-on latching circuit

The voltage select module is vertically inserted in connector J1 on the power supply module. You can insert the voltage select module two ways (Figure 23). Connector J1A is for 120 Vac 60 Hz; Connector J1B is for 220 Vac 50 Hz. Figure 23 shows the difference between the two circuits. Notice that fuse F2 is used only in the 120 Vac configuration. Fuse F3 is used in both configurations.

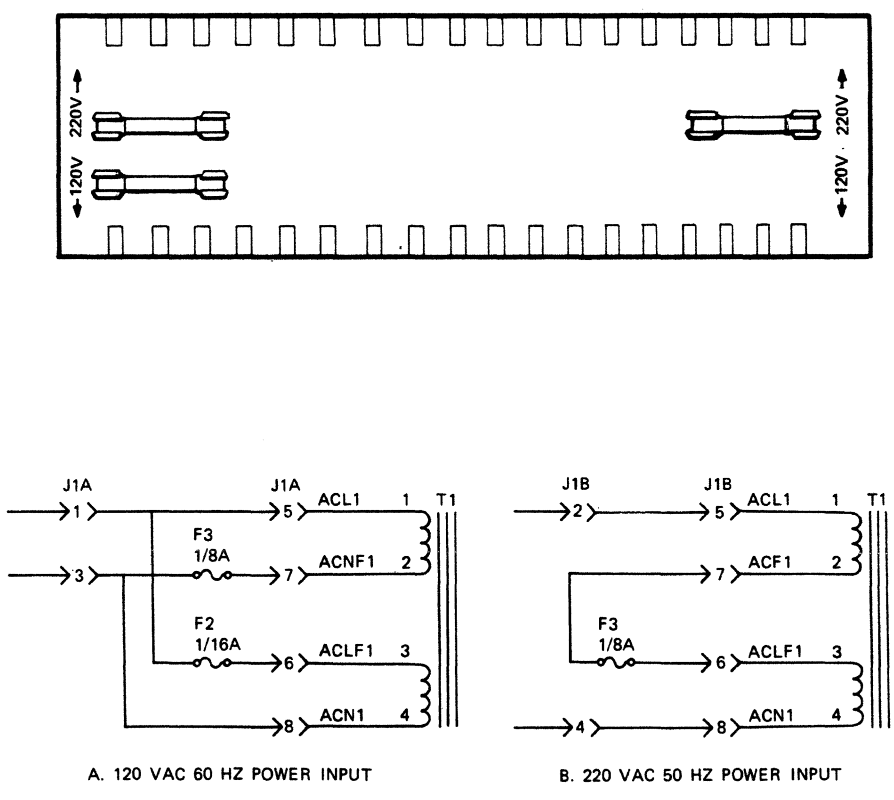


Figure 23 Voltage Select Module

The detection circuits initiate a power shutdown if any voltage exceeds the limits shown in Table 2.

The power supply module generates the dc voltages for all TU81 functions. The voltages generated are +5, -6, ±15, +25, and +38. Table 3 shows how these voltages are used.

Standby voltages of +20, +15, and +5 are generated on the power supply printed circuit board for control circuits within the power supply. These voltages are not used outside of the power supply.

Cooling fans cool all components within the TU81 cabinet.

Complete Exercise 2 before you continue this lesson.

Table 2 Shutdown Voltages

Nominal Voltage	LOW Voltage Threshold	Over Voltage Detection
+5	+4.53	+6.0
-6	-5.0	-6.96
+15	+12.58	+17.25
-15	-12.58	-17.25
+25	+21.25	+28.13
+38	+25.25	+50.3

Table 3 TU81 DC Voltage Use

Voltage	Used On
+5	All modules as a supply voltage for TTL circuits
-6	Read amplifier circuits
+15	Servos, power amplifier and read recovery VFO
-15	Servos and power amplifier
+25	Write driver circuits
+38	Power amplifier

EXERCISE 2

Fill in the blanks with the letter for the correct answer.

1. Abnormal voltages in the TU81 are usually caused by the ______.

   a. Compressor
   b. Heads
   c. Power supply
   d. M8739 UNIBUS adapter module

2. To convert the TU81 between 5Ø Hz and 6Ø Hz voltages, you should ______.

   a. Insert the voltage select module differently in the power supply.

   b. Change the voltage select switch on back of the power supply.

   c. Change the wire connections on the voltage select module.

   d. Change switch settings on the LESI board.

3. The ______ cleans the air, and the ______ provides vacuum and pressure in the pump system.

   a. Air bearings
   b. Compressor
   c. Filter
   d. Tape cleaner port
   e. Carbon vanes

4. The ______ reel motor turns to maintain tape velocity. The ______ reel motor turns to maintain tape tension.

   a. Bottom
   b. Take-up
   c. Top
   d. Supply
   e. Fishing

5. If the 1-line tachometer failed during operation, _____.

   a. Tape direction would be lost.
   b. Incorrect air pressure would exit the air bearings.
   c. Tape velocity would be incorrect.
   d. The 1ØØØ-line tachometer would go out of phase.

6. The read amplifier module's read circuitry _____.

   a. Amplifies and digitizes analog data from the tape.
   b. Sends data directly to the host memory.
   c. Buffers data until errors are located.
   d. Formats data from the tape.

This completes Exercise 2. Now check your answers on the next page.

EXERCISE 2 ANSWERS

Fill in the blanks with the correct letter.

1. Abnormal voltages in the TU81 are usually caused by the __c__.

   a. Compressor
   b. Heads
   c. **Power supply**
   d. M8739 UNIBUS adapter module

2. To convert the TU81 between 5Ø Hz and 6Ø Hz voltages, you should __a__.

   a. **Insert the voltage select module differently in the power supply.**

   b. Change the voltage select switch on back of the power supply.

   c. Change the wire connections on the voltage select module.

   d. Change the switch settings on the LESI board.

3. The __c__ cleans the air, and the __b__ provides vacuum and pressure in the pump system.

   a. Air bearings
   b. **Compressor**
   c. **Filter**
   d. Tape cleaner port
   e. Carbon vanes

4. The __b__ reel motor turns to maintain tape velocity. The __d__ reel motor turns to maintain tape tension.

   a. Bottom
   b. **Take-up**
   c. Top
   d. **Supply**
   e. Fishing

5. If the 1-line tachometer failed during operation, __c__.

   a. Tape direction would be lost.
   b. Incorrect air pressure would exit the air bearings.
   c. **Tape velocity would be incorrect.**
   d. the 1ØØØ-line tachometer would go out of phase.

6. The read amplifier module's read circuitry __a__.

a. **Amplifies and digitizes analog data from the tape.**
b. Sends data directly to the host memory.
c. Buffers data until errors are located.
d. Formats data from the tape.

Now continue the lesson.

SUMMARY

The TU81 uses both phase encoded (PE) and group coded recording (GCR). PE has a write current reversal for every recorded bit. GCR is a type of NRZI recording with a coding scheme.

The TU81 uses both start/stop (25 ips) and streaming (25 or 75 ips) modes. The TU81 automatically selects the fastest mode.

Track four is the parity track. In PE, the TU81 performs single-track error detection and correction by using the parity bit. In GCR, the TU81 performs single- and dual-track error detection and correction performed by using cyclic codes.

The TU81 subsystem transfers command, data and status information to and from the host system by using TMSCP. The host and the TMSCP interface/controller exchange commands and responses by using messages structured in a general format. The TU81 performs data I/O over the UNIBUS and low end storage interconnect (LESI), which is made up of a set of I/O cables and the LESI-UNIBUS adapter (M8739). The TMSCP interface/controller module contains intelligence under microprocessor control to convert these messages to TU81 device specific commands and responses.

The TU81 can be broken into the following functional components.

1. Power supply and cooling

   Power supply
   Centrifugal fan on the power supply
   Axial fan on the cabinet frame

2. Vacuum and pressure pump system

   Compressor
   Air bearings (two)
   Tape cleaner intake
   Plenum components

3. TMSCP interface/controller

   LESI interface
   Microprocessor controller
   PE/GCR formatter interface

4. Formatter subsytem

   Formatter write module
   Formatter read module

5. Servo and control

   Servo/control module
   Air bearing sensors
   Power amplifier module
   1-line tachometer on the supply reel motor
   1000-line tachometer on the take-up reel motor
   Control panel

6. Read/write/erase

   Write driver module
   Read amplifier module
   Read head
   Write head
   Erase head
   BOT/EOT sensors

7. Host interface

   M8739

This completes the Theory of Operation lesson for the TU81. The rest of this lesson covers how the TU80 differs with the TU81.

TU80 DIFFERENCES

The TU80 is functionally similar to the TU81 (Figure 24). The power supply, power amplifier, servo system, read/write circuitry, and vacuum/pressure system function as they did in the TU81. However, the TU80 has only two logic modules in the card cage: the formatter/control module and the read/write/servo module. This is due in part to the fact that the TU80 is a PE only device. Also, the TU80 is not a TMSCP device. Therefore, the formatter/control module connects directly to the UNIBUS adapter module (M7454), which is microprocessor controlled. The following paragraphs describe each module's function.

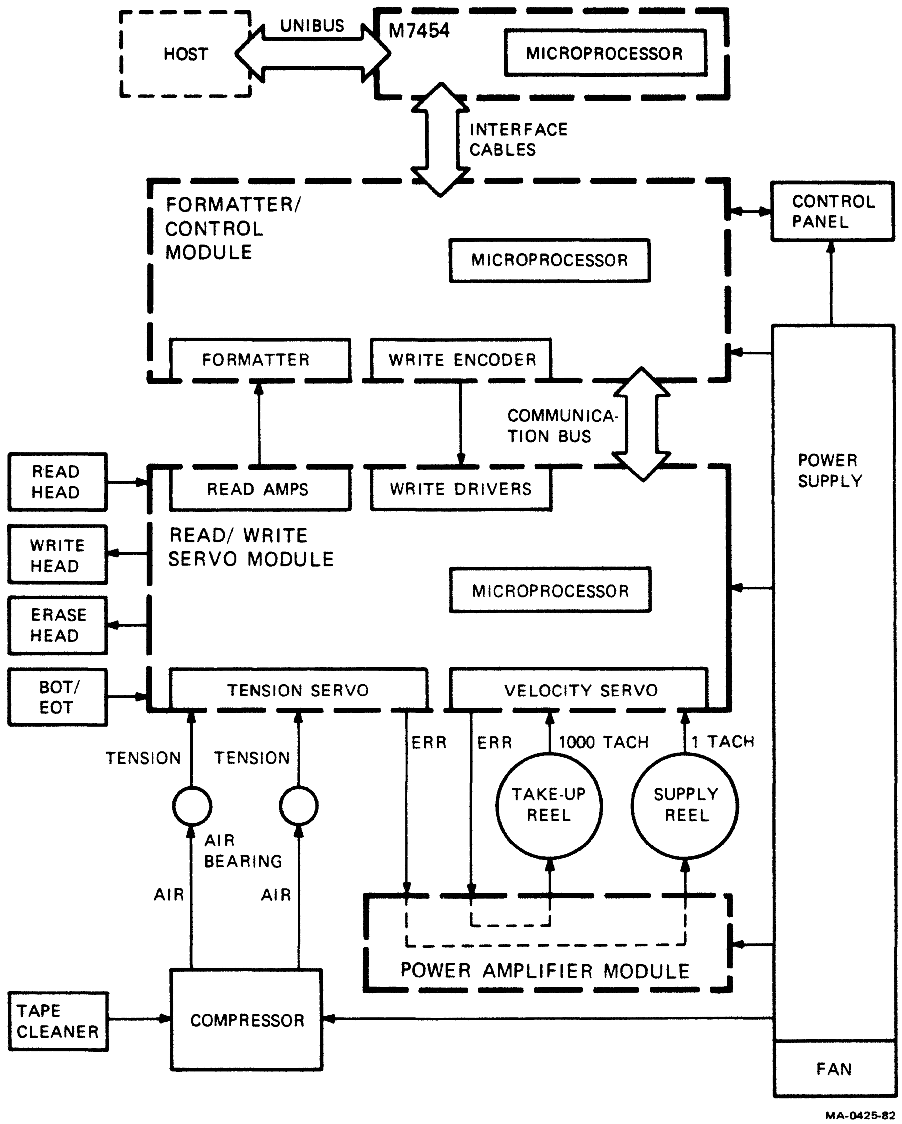


Figure 24 TU80 Functional Block Diagram

M7454 (UNIBUS Adapter Module)

The M7454 connects the TU80 with a VAX or PDP-11 host system. This module has self-diagnostics, which run automatically at power-up or any other initialization time. An LED comes on to indicate that the TU80 successfully completed the self-diagnostics.

The M7454 has its own microprocessor, ROM, sequencer, data paths, and 1K byte buffer. The microprocessor is the timing and control center of the M7454. The microprogram contained on programmable ROM puts M7454 operations in sequence and operates the self-diagnostics. A buffer helps eliminate data lates and overruns, which significantly slow data transfer.

The M7454 communicates with the host processor by using packet protocol. The host puts the command information and data location information for the TU80 into its memory, where the M7454 accesses the information. This information is called a command packet, and is located in the host memory's command buffer.

The M7454 puts TU80 extended status information in the host memory, where the host can access it when needed. This information is called a message packet, and is located in the message buffer in host memory.

NOTE

The programming chapter in the TU80 User Guide has more information on the functionality and use of packet protocol.

Also, the TS11 uses packet protocol and the TS11 Technical Manual has a lot of useful packet protocol information.

The TU80 does not communicate with packet protocol. The M7454 and TU80 communicate only with command and status lines, and pass parallel data back and forth. The M7454 also communicates with the host, identifies the command, and sends a command (not the packet) to the TU80 formatter/controller microprocessor.

Formatter/Control Module

The formatter/control module formats and controls TU80 events. This module communicates with all other parts of the TU80 and the adapter card.

The formatter/control microprocessor controls TU80 events. Five peripheral interface adapters (PIA) connect the formatter/control module to the following TU80 functional units (Figure 25).

Read/write/servo module (PIA 0)
M7454 (UNIBUS Adapter module) (PIA 2)
Operator panel (PIA 1)
TU80 write circuits (PIA 4)
TU80 read circuits (PIA 3)

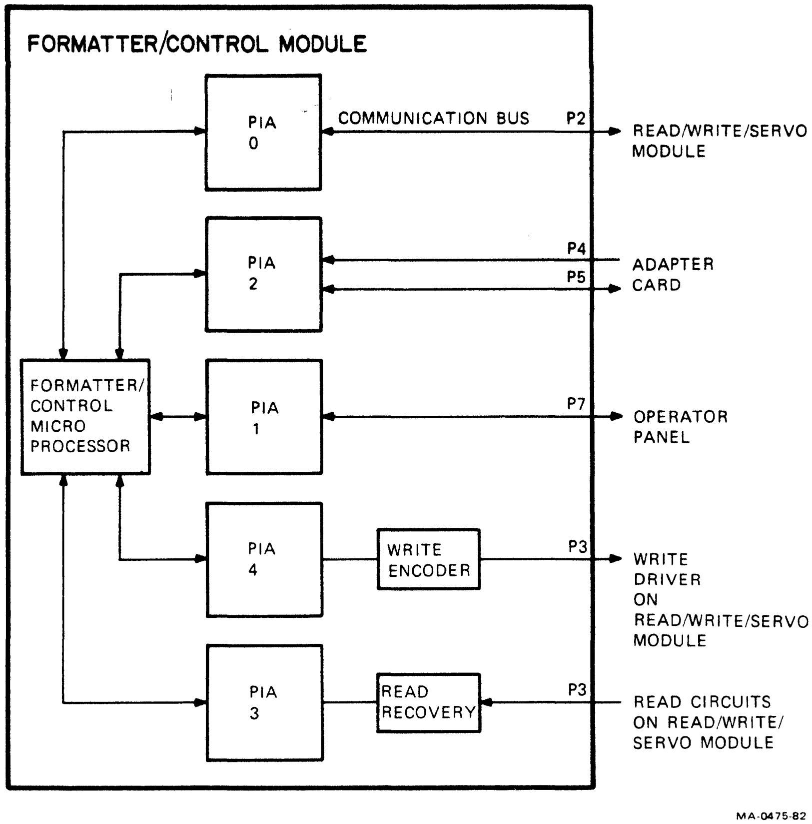


Figure 25 DIA Interfacing (Formatter/Control Module)

The formatter/control microprocessor treats each functional unit like a peripheral.

NOTE

The read/write/servo microprocessor controls tape manipulation. However, the formatter/control microprocessor initiates the actions of the read/write/servo microprocessor. The formatter/control module ultimately controls TU80 events.

Each PIA has bidirectional data buffers, internal registers, and both internal and external interupt/control lines. The formatter/control microprocessor programs the direction of the data lines and the interrupt/control lines during system initialization.

The formatter/control microprocessor controls the write encoder circuitry via PIA 4. A 32 X 8 bit PROM controls formatting. Formatted write data is sent from this circuitry to the write driver on the read/write/servo module.

The formatter/control microprocessor controls the read recovery circuitry via PIA 3. Formatted read data and envelope data enter this circuitry from the read amplifier area of the read/write/servo module. The read recovery circuits include the variable frequency oscillator, the deskew buffer for each track, and the read data error correction circuitry.

Read/Write/Servo Module

The velocity and tension servo circuitry and the read/write circuitry is on the read/write/servo module. The read/write/servo microprocessor controls each of these circuits. The microprocessor initiates activity within the circuits and coordinates activity between the circuits.

One PIA communicates with the formatter/control module via the communication bus. The functional and diagnostic program for the microprocessor resides on ROM chips. Transport status is stored in RAM.

An electrically erasable programmable ROM stores the read amplifier's gain values and velocity servo offset values.

This completes the Theory of Operation lesson.

TEST P275.

Now you should take Test 1. You may use any documentation necessary to complete the test.

When you are finished, give the test to the Course Administrator to be graded.

You must answer 80 percent of the questions correctly before you go to the next lesson.

INTRODUCTION

This lesson describes how to use all the TU81 diagnostic tests. TU81 diagnostic tests fall into the following four categories.

1. Power-on health check
2. Field Service diagnostic tests
3. Host-based diagnostic tests
4. ASCII port test panel diagnostic tests

The power-on health check program is located on internal ROMs and runs automatically every time you turn on the transport by using the power switch.

The Field Service diagnostic tests are located on ROM chips internal to the TU81. There are many of these tests for various purposes. The operator test (Ø1) you ran in the Operation lesson is included in the Field Service tests.

You can run TU81 Field Service diagnostic tests without taking the customer's system off-line.

Host-based diagnostic tests are loaded by the host from external storage media and run from the host (VAX) console terminal.

The ASCII port test panel lets you use any RS232C compatible terminal to troubleshoot and test the TU81.

OBJECTIVES

1. Identify the four categories of diagnostic tests.

2. Identify the pre-site procedures.

3. Identify the on-site procedures.

4. Use the TU81 Pathfinder to interpret errors.

5. Run any Field Service diagnostic test.

6. Interpret any error code.

7. Identify the purpose of any Field Service diagnostic test.

8. Run the VAX-based diagnostic tests.

9. Interpret test errors.

10. Interpret error log messages.

11. Use the ASCII port test panel.

POWER-ON HEALTH CHECK

The power-on health check (Figure 1) initializes and tests various portions of TU81 logic. It does not check any logic or components directly related to tape motion.

Several fault codes may be displayed. You can clear many of these fault codes by pressing the RESET switch. If the fault code clears, you should run the test again.

Tell your customers that they can clear some fault codes by pressing the RESET switch. But, even if a fault code clears, your customers should write down the code and give it to the Field Service representative on the next service call. This information can help a Field Service representative fix a TU81 faster.

FIELD SERVICE DIAGNOSTIC TEST

Field Service representatives run and interpret the Field Service diagnostic tests by using the TU81 Pathfinder document. The TU81 Pathfinder has the following two sections.

> **Fault Code Troubleshooting Procedures** help you find a problem step by step. The troubleshooting procedures may ask about current TU81 status, designate points where you must run certain diagnostic tests, and point out probable solutions to the problem.
> The TU81 sub-fault codes used with the troubleshooting procedures, help you more clearly define a problem.
>
> **Field Service Test Descriptions** describe what each test does, the sequence it runs through, and possible termination (error) codes.

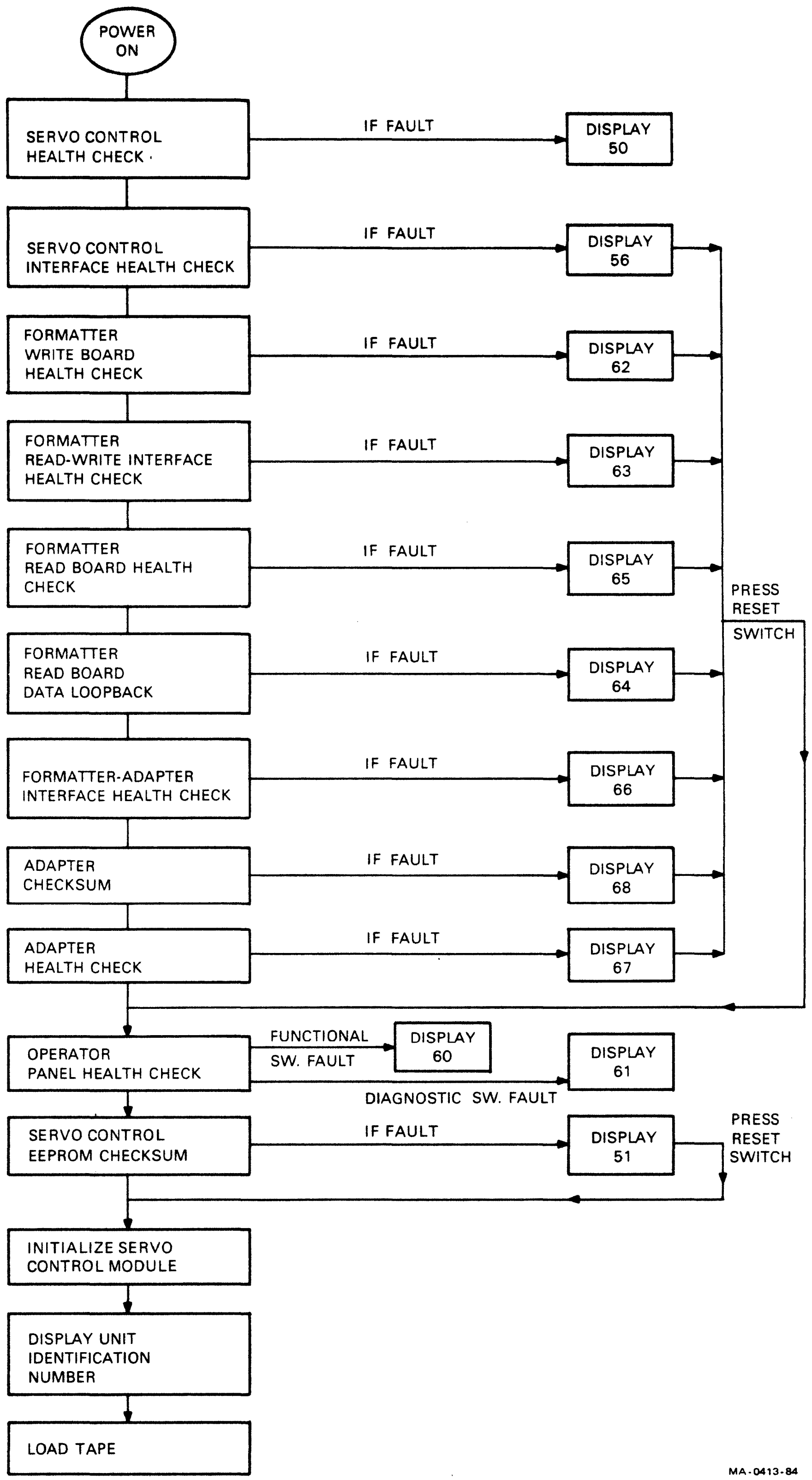


Figure 1 Power-On Health Check Flowchart

____ Turn to the TU81 Pathfinder and find these two sections.

NOTE

The TU81 documentation uses three terms which can be misinterpreted. These terms are error code, fault code, and termination code.

Error code and fault code are the same thing and are used interchangeably.

Termination code is the code received at the end (termination) of a Field Service test. It may be a fault code, or a ØØ that indicates the test was successful.

You will use the TU81 Pathfinder during most of this lesson. It is important that you understand how to use the Pathfinder, because it is the reference you use in the field.

NOTE

The Pathfinder is part of the CD kit and must always remain with the kit.

You cannot service the TU81 without using the Pathfinder explanations, error symptoms, and tests.

The Pathfinder is based on the fault codes that appear in the control panel display.

Fault Codes

A fault code can occur during power up, on-line use, or diagnostic testing. (Fault codes always appear in the digital display indicator on the control panel.)

NOTE

All fault codes, no matter when they appear, are handled as described in the following Pre-site and On-site sections.

You ran the operator test in the Operation lesson. Remember that the operator has a short table of actions to take if a fault code appears. If none of these actions clear the fault, the operator must call Field Service.

Pre-site

This section explains what to do when you receive a call from the operator or customer.

1. First you should ask the customer if a fault code appeared, or if the problem exists without a fault code.

   NOTE

   This lesson often refers you to the Pathfinder, which is part of the TU81 course resources. Referring to the Pathfinder will help you become familiar with how to use it.

   Do not write in the Pathfinder, other students will use it.

2. If there has not been a fault code, you should refer to Malfunction Matrix Table 1-1 in the TU81 Pathfinder.

____ Find Table 1-1 in the Pathfinder.

The top half of this table lists possible malfunctions. The middle three lines list the action that you must suggest the operator take while you wait on the phone. If an A appears below the malfunction, you must ask the customer to perform the corrective action indicated.

The bottom part of the table lists the most probable failing components when particular malfunctions occur. The most probable failing component has a 1 next to it, the second most probable failing component has a 2, and so on. Make sure you have all the FRUs you may need to replace probable failing components when you go to the customer site.

NOTE

No matter what the failure is, you should have the customer make sure the supply hub is latched correctly (periphery ring pushed in).

The inner diameter of the plastic supply reels varies significantly. Many false error indications can result from varying degrees of reel slippage if the hub is not latched.

Also, the hub rollers wear excessively if reel slippage occurs.

3. If a fault code appeared, refer to Fault Code Matrix Table 1-2 in the Pathfinder.

____ Find Table 1-2 in the Pathfinder.

This table is based on Operator Test Ø1 faults. The top line of the table on both pages lists fault codes. Find, in this table, the fault code that the customer has reported. The table lists what the customer should do next.

An X in any column means that action is the last thing the customer must do in that column. An A, B, or C means the customer should check each of those items to try to solve the problem. After any action, the customer should run Test Ø1 again to see if the fault has cleared.

NOTE

Remember, the customer does not have these tables. You must tell the customer to do these actions.

The bottom part of the table is for your use only. It lists the most probable failing components for a given fault code. The most probable failing component has a 1 next to it, the second most probable failed component has a 2, and so on.

On-Site

Once you arrive at the scene of the fault, use the Pathfinder to lead you to the specific failing component.

The Pathfinder identifies most TU81 problems. The Pathfinder is the first mode of diagnosis to use after you complete the standard troubleshooting procedures upon your arrival at the customer site. The Troubleshooting lesson describes standard troubleshooting procedures.

For certain Test Ø1 faults, Table 1-2 in the Pathfinder asks you to run Test Ø2 or Ø3. If the TU81 displays a fault code with either of these tests, refer to Termination Code Tables 1-3 through 1-14 in the Pathfinder.

____ Find Tables 1-3 through 1-14 in the Pathfinder.

These tables are based on specific fault codes that appear during Test Ø1.

For example, Table 1-3 is used only when fault code 22 appears during Test Ø1. Then run Test Ø2 and match the fault code to the numbers in the first line of Table 1-3 (71-ØØ). Then, follow through the table vertically as you did with Table 1-1 and Table 1-2.

Do the following steps to run Test Ø2.

_____ 1. Thread but do not load tape.

_____ 2. Press the RESET switch to clear the display.

_____ 3. Press the TEST switch to put the TU81 in diagnostic mode. Test 1 is indicated on the display.

_____ 4. Press the STEP switch. The display increments to Ø2.

_____ 5. Press the EXECUTE switch. The test runs in less than a minute and displays ØØ when successfully completed. A termination code appears if the test is unsuccessful.

Do the following steps to run Test Ø3.

_____ 1. Clear the tape path of tape. Do not thread or load tape.

_____ 2. Clear the display by pressing the RESET switch, then load Test 1 by pressing the TEST switch.

_____ 3. Press the STEP switch twice. The display now shows that the TU81 is ready to run Test Ø3.

_____ 4. Press the EXECUTE switch. Test Ø3 is very short and displays ØØ when successfully completed. A termination code is displayed if the test is unsuccessful.

Fault Code Troubleshooting Procedures

Figure 2 points out each part of a typical fault code troubleshooting procedure in the Pathfinder.

_____ Refer to Figure 2 as you read the following paragraphs.

These procedures are organized according to fault code numbers. The fault code is listed at the top of each procedure.

The assumption is under the fault code. The assumption explains the meaning and cause of the fault code.

NOTE

Never overlook the assumption. It often gives the first step or clue in solving a problem.

The rest of the table is the step-by-step procedure to follow in order to identify the failing component. Always start with the first line of the procedure (Ø1Ø).

The step reference numbers are for your convenience. You can use them to reference your question when talking with support personnel over the phone.

The maintenance symptom is either a question, an action item, or both.

For every question there is a yes/no (Y/N) column to the left on the same line. If you answer the question yes, follow the Y column downward. If the answer is no, follow the N column down.

If you come to a Y when following the N column, you must answer another question at that point. Answer the question on that line and repeat the process.

In every case, when you reach numbers in the vertical column, do the action next to the 1 first, then do the action next to the 2 second, and so on.

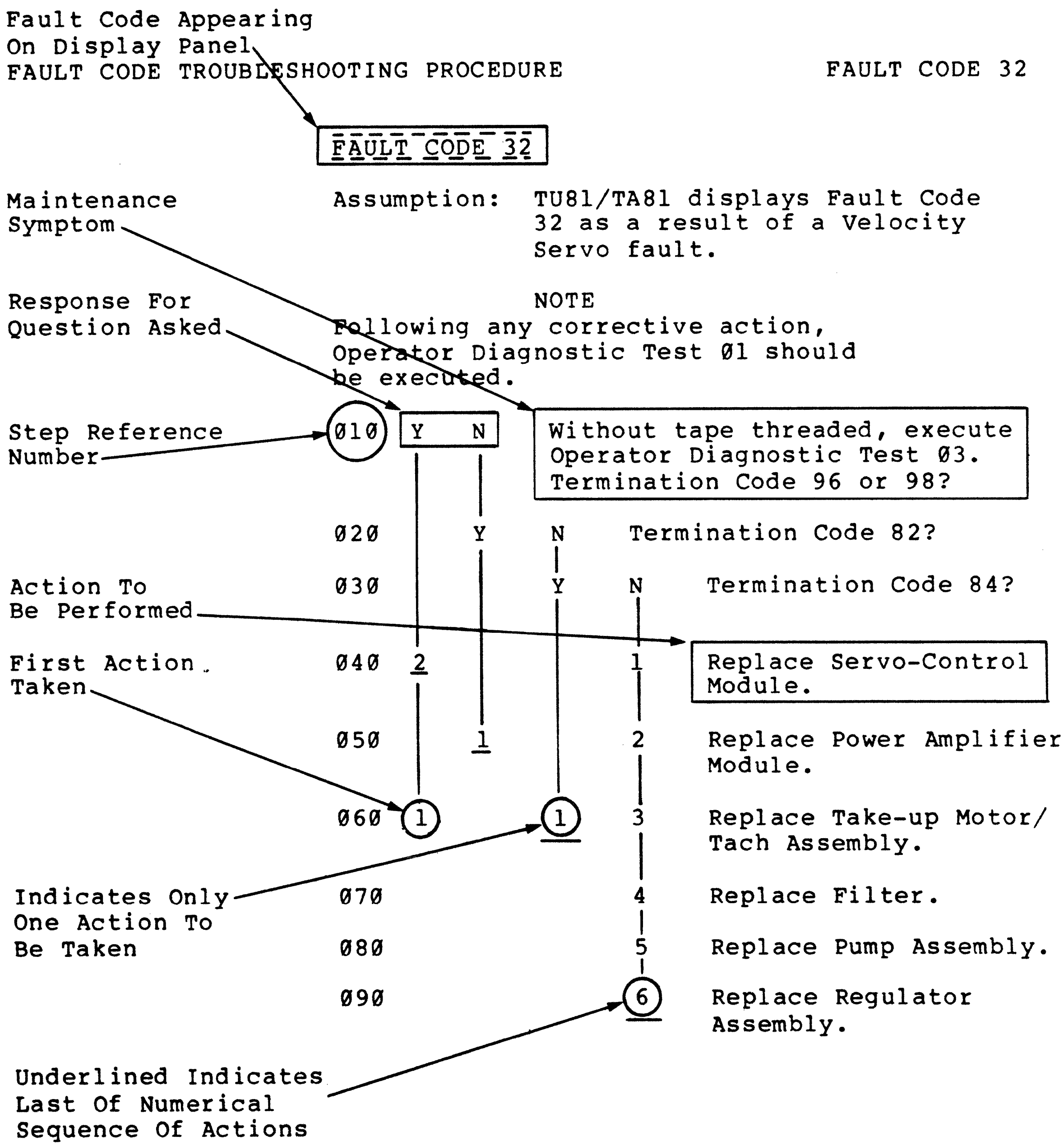


Figure 2 Pathfinder Fault Code Troubleshooting Procedure

The following examples describe how to troubleshoot fault codes by using the troubleshooting procedure listed in the TU81 Pathfinder.

Example 1

To learn how to use the troubleshooting procedures, start with fault code 29. The flowchart (Figure 3) is very simple. If fault code 29 appears, first (line Ø1Ø) disconnect a cable, close the door, and press the LOAD switch.

Next, you answer the question in line Ø1Ø (Fault Code 11?). If fault code 11 appeared, answer yes and follow the Y column down until you find the 1 (line Ø3Ø). Then, replace the BOT/EOT assembly.

Run Test Ø1 (refer to the note in Figure 3) after every corrective action to see if the problem was solved.

If Test Ø1 now ends with fault code ØØ, you have corrected the problem and the BOT/EOT assembly was bad.

If Test Ø1 still ends with fault code 29, the BOT/EOT assembly was good. So, reinstall the original assembly, and go to action number 2 in the table's Y column.

Number 2 (line Ø2Ø) tells you to replace the servo control module. Replace that module, then check the repair by running Test Ø1.

Notice that number 2 on line Ø2Ø is underlined. The underlined number in any column means it is the last action to take in that column.

FAULT CODE TROUBLESHOOTING PROCEDURE FAULT CODE 29

FAULT CODE 29

Assumption: TU81/TA81 displays Fault Code 29 as a result of detecting absence of tape. This fault can be caused by the use of a damaged tape that has oxide missing, such that the BOT and EOT sensors detect light passing through the tape.

Unloading of tape with a short leader may also result in Fault Code 29.

NOTE
Following any corrective action, Operator Diagnostic Test Ø1 should be executed.

```
Ø1Ø  Y   N   Disconnect cable from the EOT/BOT Sensor Assembly.
     |   |   Remove the reel of tape, close operator top cover,
     |   |   and press the LOAD switch. Fault Code 11?
     |   |
Ø2Ø  2   1   Replace Servo-Control Module Assembly.
     T   
Ø3Ø  1   Replace BOT/EOT Sensor Assembly.
```

Figure 3 Pathfinder Example 1

What happens if the problem is still not solved after you replace the servo/control module? Well, the procedure is very thorough. The odds are very low that the same fault code (29) will appear after you try every suggested action.

Another fault code can appear, although the odds of this happening are low except with a multi-component problem. If another fault code appears follow the troubleshooting procedure for that code. The procedure might lead to a different failing component.

If the original fault code persists, you must rely on your own troubleshooting experience and proceed accordingly. After all, nothing is foolproof.

Example 2

Figure 4 outlines a more difficult example of using troubleshooting procedures. Fault Code 32 appeared. By answering the questions starting at line Ø1Ø and performing the actions called for, the Field Service representative knew that the take-up motor/tach assembly (line Ø6Ø) had to be replaced.

FAULT CODE TROUBLESHOOTING PROCEDURE — FAULT CODE 32

FAULT CODE 32

Assumption: TU81/TA81 displays Fault Code 32 as a result of a Velocity Servo fault.

NOTE

Following any corrective action, Operator Diagnostic Test Ø1 should be executed.

Ø1Ø	Y	N			Without tape threaded, execute Operator Diagnostic Test Ø3. Termination Code 96 or 98? No (Assume you got 84)
Ø2Ø		Y	N		Termination Code 82? No
Ø3Ø			Y	N	Termination Code 84? Yes
Ø4Ø	2			1	Replace Servo-Control Module.
Ø5Ø		1		2	Replace Power Amplifier Module.
Ø6Ø	1		1	3	**Replace Take-up Motor/Tach Assembly.**
Ø7Ø				4	Replace Filter.
Ø8Ø				5	Replace Pump Assembly.
Ø9Ø				6	Replace Regulator Assembly.

Can you see the flow of the logic in arriving at line Ø6Ø?

If not, reread the paragraphs that preceded example 1 and try again.

Functional Troubleshooting Procedures

The first three functional troubleshooting procedures are numbered 1ØØ1 (Power On 1), 1ØØ2 (Power On 2), and 1ØØ3 (Power On 3). These procedures are not based on fault codes.

These three procedures are used to detect faults that cannot be detected by running diagnostic tests. Faults of this nature could cause a failure before a test could be run.

Also, some functional operations and sensors cannot be tested by the transport microprocessor without manual operation and visual feedback. There are steps within these three procedures to check the functional operations and sensors.

A brief description of each procedure follows.

> **Power On Checkout 1ØØ1** -- You can use this procedure to find ac power problems. It directs you to power supply and cooling fan problems.
>
> **Power On Checkout 1ØØ2** -- You can use this procedure to find dc power problems. An incorrect dc voltage to any part of the TU81 could prevent tests from running.
>
> **Power On Checkout 1ØØ3** -- You can use this procedure to help identify errors that cause the control panel to give false indications, or not work correctly. It may direct you to replace a module, the control panel, a switch, or another component.

____ 1. Look up these procedures in your TU81 Pathfinder. They are the first three troubleshooting procedures listed.

Notice that Power On 1ØØ1 assumes only that the ac circuit breaker is off, and the TU81 is plugged into a live ac outlet that supplies the correct voltage. Line Ø1Ø starts when you turn on the circuit breaker (on/off switch). You can start troubleshooting at this point anytime you have nothing else to go on.

Also, you may have to start with procedure 1ØØ1 and go through 1ØØ3. All three procedures are connected.

____ 2. Go to the TU81 and perform procedures 1ØØ1 through 1ØØ3 listed in your Pathfinder.

The following example describes how to use the functional troubleshooting procedures listed in the TU81 Pathfinder.

Example 3

A customer cannot load tape, but no fault code appeared.

You have suggested, over the phone, that the customer check power connections, press RESET, and run operator tests. The customer does these things, but there is still no fault code or tape movement.

You arrive at the site and determine that the customer was right. Nothing works and no fault code appears.

At this point you can eliminate doing the fault code troubleshooting procedures, but not procedures 1001 through 1003.

____ Go to procedure 1002 in the Pathfinder.

Let's say the formatter read module is causing dc voltage errors in the control panel. The following paragraphs describe how to identify that problem.

Line 120 in procedure 1002 tells you to replace the formatter read module. If you examine the lines that lead up to line 120, you find that this problem was identified by connecting or disconnecting specific cables and modules related with dc voltage.

If you used this procedure, you would get to line 120 and replace the module.

Although you might not use these three procedures very often, you should keep them in mind. They can save you several hours when power problems occur.

FIELD SERVICE DIAGNOSTIC TEST DESCRIPTIONS

P2-1 ____ Go to the Diagnostic Tests Table near the beginning of Section 2 in your Pathfinder.

This table lists all Field Service diagnostic tests for the TU81.

Currently there is only one operator test (01). Tests 02 and 03 should be run by Field Service only, when directed to do so by the results of Test 01. Numbers 05 through 09 are reserved for future tests, if needed.

Test 04 is the routine for entering the three digit unit number. The Installation Lesson describes how to enter the unit number.

Numbers 10 through 97 are reserved for Field Service tests. Many of these numbers are also reserved for future tests. Any future tests would need ROM changes, and would be announced in Tech Tips at that time.

Of the existing tests, only eight (18, 31, 37, 43, 44, 49, 62, and 64) are used in normal TU81 service. You may use the others at your discretion during troubleshooting.

You should run Field Service tests as instructed by the Pathfinder and removal/replacement procedures.

The rest of Section 2 in the Pathfinder describes all the Field Service diagnostic tests. Figure 5 is a sample test description.

____ Find the Test 21 description in the Pathfinder.

Notice that each description gives the following information.

Test requirements	Test sequence
Short test description	Possible termination codes

TEST 21: 25 IPS STREAMING WRITE TO EOT IN PE MODE — TEST 21

TEST REQUIREMENT: A write enabled scratch tape should be loaded.

TEST DESCRIPTION: Test 21 rewinds the tape and writes 2K byte records, incrementing data pattern to EOT at 25 ips streaming mode. On detection of EOT, it rewinds and positions at BOT. If a write error occurs, the unit performs Backspace, Erase, and attempts to write again. If more than five consecutive erases are required, the test terminates with a write fault. If 32 erases are required in one complete pass, the test terminates with a write fault. All functional checks are active throughout the test.

TEST SEQUENCE:

a. Rewind to BOT (this function is not performed if 02 option is selected).

b. Write 2K byte records at 25 ips streaming to EOT.

c. Rewind to BOT.

POSSIBLE TERMINATION CODES:

00 - Test is successful
03 - ID Check
04 - Low Speed Write Error
09 - Hardware Failure
08 - Noise Detected While Erasing
10 to 69 - Refer to Fault Code Troubleshooting Procedure
70 - Invalid Operator Sequence (Tape Not Loaded Fault)

Figure 5 Pathfinder Test Description

These descriptions are important. They list valuable information about every Field Service diagnostic test.

NOTE

The list of possible termination codes has some codes that are not in any other TU81 document. Do not forget these codes.

If you like to use your own specialized troubleshooting methods, you will find these descriptions to be invaluable.

The following example describes how to use the Field Service diagnostic test descriptions.

Example 4

Figure 6 is an example from the fault code troubleshooting procedures.

FAULT CODE TROUBLESHOOTING PROCEDURE　　　　FAULT CODE 13

FAULT CODE 13

Assumption: TU81/TA81 displays Fault Code 13 during a load operation as a result of not establishing tension within 1Ø seconds.

The most probable cause of this fault is that tape has been threaded with a long loop, or tape has not been tightly wrapped on take-up hub.

NOTE

Following any corrective action, a tape load operation should be performed.

```
Ø1Ø  Y     N    Execute Field Service Test 43. Does pump fail to
     |     |    start?
     |     |
Ø2Ø  |     Y    N    Does air pressure lift tape off air bearings?
     |     |    |
Ø3Ø  |     |    1    Replace Filter.
     |     |    |
Ø4Ø  1     |    2    Replace Pump Assembly.
     |     |    |
Ø5Ø  |     |    3    Replace Regulator Assembly.
     |     |
Ø6Ø  2     1    Replace Servo-Control Module.
     |
Ø7Ø  3    Replace Power Supply Assembly.
```

Figure 6 Pathfinder Example 4

In this example, line Ø1Ø tells you to run Test 43, and then asks a question based on that test.

To follow this instruction, you would go to the Field Service test description for Test 43, check the test requirement, and run the test. Then, you would continue following the troubleshooting procedure as you did in earlier examples.

FIELD SERVICE DIAGNOSTIC TEST ACCESS

You can gain access to the Field Service diagnostic tests from the control panel. The four keys to the right of the display let you load and run a specific test.

Do the following steps.

____ 1. Load and run Operator Test Ø1. Review the Operation lesson if you have trouble.

____ 2. Open the Pathfinder, turn to the test descriptions, and find the description of Operator Test Ø1. Its title is Functional Fault Detection Test.

Scan through the test sequence. Notice that this test is very elaborate and performs nearly all TU81 functions. For this reason you use Test Ø1 very often. The need for other tests is minimal.

____ 3. Stop the test after a few minutes by pressing the RESET switch.

NOTE

The Pathfinder has test access procedures in Paragraphs 1.3.2 and 1.3.4.

To load the Field Service Diagnostic Tests do the following steps.

____ 1. Press and hold the CE switch.

____ 2. Press the TEST switch. The digits ØØ should appear in the display.

If you are not holding down the CE switch when you press the TEST switch, a Ø1 appears in the display.

A Ø1 indicates the operator tests have been loaded. A ØØ indicates the Field Service tests have been loaded.

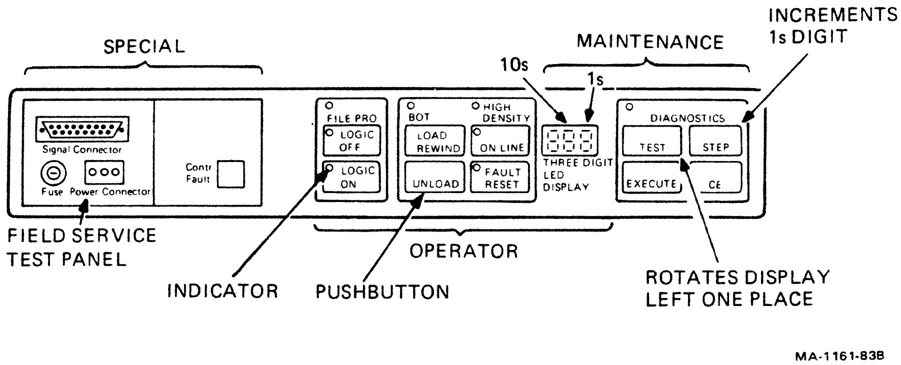


Figure 7   Control Panel With Field Service Tests Loaded

Now you must load a specific Field Service test. Consider the left digits in the display (Figure 7) as the 1Øs digits (1Ø, 2Ø, 3Ø, etc.) and the right digit as the 1s digit (1, 2, 3 . . .).

When you press the STEP switch, the 1s digit increments by 1. When you press the TEST switch, the current 1s digit shifts to the 1Øs position. The 1s digit now becomes Ø. In other words, the 1s digit moves left one place.

To demonstrate this, do the following steps to load Field Service Test 65.

____ 1. With Field Service tests loaded (ØØ appears after you press CE and TEST), press the STEP switch 6 times.

Each time you press the switch the 1s digit increments by 1. A 6 should now be in the 1s digit.

____ 2. Press the TEST switch once. The 6 shifts left and 6Ø appears in the display.

____ 3. Press the STEP switch 5 times. 65 appears in the display.

Field Service Test 65 is now loaded. Do the following steps to load Field Service Test 46.

____ 1. Press the STEP switch several times until the 1s digit is a 4.

____ 2. Press TEST once. 4Ø appears in the display.

____ 3. Press STEP 6 times.

Field Service Test 46 is now loaded.

____ Load several other tests until you are comfortable with the procedure. You can now load any TU81 test.

Like Operator Test Ø1, each Field Service test has certain requirements under which it must be run. For example, Test 91 tests similiar functions to Test Ø1, but allows tape to be loaded.

NOTE

You should run Field Service Tests only if directed to do so by the Pathfinder document; otherwise, results will be unpredictable.

To run a test, go the the test description in the Pathfinder and set up the TU81 to meet the requirements. Then, load the number into the display and press the EXECUTE switch. A successful pass always displays a ØØ termination code.

____ 1. Load Test 18 with tape unloaded.

____ 2. Run the test by pressing the EXECUTE switch. Fault code 7Ø will appear.

If you look up fault code 7Ø up in the Pathfinder's Fault Code Troubleshooting Procedures, you will not find it. However, if you look up the test description for the test you just ran (18), you will find fault code 7Ø in the under Possible Termination Codes list.

____ 1. Determine what caused fault code 7Ø, solve the problem, and run the test. If you have any problems read the previous paragraphs again.

NOTE

You can halt all tests by pressing the RESET switch.

____ 2. Load and run several tests until you are comfortable with the procedure.

Use the Diagnostic Test listing in the Pathfinder to get test numbers and names. Use the test descriptions in the Pathfinder to find test requirements and possible termination codes.

OPTION KEY

____ Go to the Diagnostic Test listing.

The Option Key is described at the end of the Diagnostic Test listing. You can make certain tests bypass error halts or do continuous test loops by using this key. The Option Key is valuable when you are looking for intermittent problems or looking at signals with an oscilloscope.

Notice the right column of the Diagnostic Test listing is called Option Code. The letter in the Option column, used with the Option Key, identifies which option is possible with the test listed on the same line.

Do the following steps to run a test with an option.

____ 1. Load a test that has a B in the Option column.

____ 2. Press the CE switch and EXECUTE switch at the same time. Option default code 00 will appear in the display in place of the test number you loaded.

____ 3. Press the STEP switch to choose the option you desire.

Now the test is loaded and the desired option selected.

____ 4. Run the test by pressing the EXECUTE switch. The test will run according to the option you selected.

You will not use the options very often, but remember they are available if you need them.

SUB-FAULT CODES

Most fault codes have sub-fault codes. The sub-fault code descriptions follow the Fault Code Troubleshooting Procedures. The sub-fault codes give more information about the fault. The Fault Code Troubleshooting Procedures might tell you to examine a sub-fault code and answer a related question.

The following example describes how to use sub-fault codes.

EXAMPLE 5

The troubleshooting procedure in Figure 8 asks in three places if certain sub-fault codes are displayed. When you arrive at any of these points, you would look for the sub-fault code, answer the question, and proceed as in the other examples.

Do the following steps to cause an error and find the sub-fault code.

____ 1. Load and run Operator Test Ø1.

____ 2. Open the door while the test is running.

A fault code of 1Ø is displayed.

FAULT CODE TROUBLESHOOTING PROCEDURE FAULT CODE 21

FAULT CODE 21

Assumption: TU81/TA81 displays Fault Code 21 as a result of a Take-Up Tension fault.

NOTE

Following any corrective action, a tape load operation or Operator Diagnostic Test Ø1 should be executed.

Ø1Ø	1				Ensure that cable between Take-Up Air Bearing Assembly and Servo-Control Module is correctly connected.
Ø2Ø	Y	N			Sub-Fault Code Ø5?
Ø3Ø		Y	N		Sub-Fault Code Ø2 or Ø3 or Ø4?
Ø4Ø			Y	N	Disconnect cable between Take-Up Air Bearing Assembly and Servo-Control Module at Servo Control Module Assembly. Try to load a tape. Fault Code 21, Sub-Fault Code Ø5?
Ø5Ø	1		1		Replace Take-Up Air Bearing Assembly. Reconnect cable.
Ø6Ø	2	1	2	1	Replace Servo-Control Module. Reconnect cable.

Figure 8 Pathfinder Example 5

You can check for a sub-fault code by pressing the CE switch when a fault code is displayed.

____ 3. Press the CE switch.

The 1Ø changes to a number between Ø1 and Ø7. These are sub-fault codes.

____ 4. Look up fault code 1Ø in the Pathfinder.

After you perform the fault code 1Ø troubleshooting procedure, you find the 7 sub-fault code for this fault code. The sub-fault code that appeared depends on what part of the test was running when you opened the door.

In some cases, a sub-fault code appears that is actually two or more sub-fault codes added together. The following example describes this condition.

Example 6

____ Go to the Pathfinder and find the sub-fault code description for fault code 25.

The sub-faults are divided into six groups. In some cases a sub-fault code may be the sum of one number from each group.

If a sub-fault code of 24 appears on fault code 25, it is a sum of ØØ from group 1, 2Ø from group 2, Ø4 from group 3, ØØ from group 4, ØØ from group 5, and ØØ from group 6. Remember, only one number is added from any box. The combination just listed is the only possible combination that gives 24.

The Troubleshooting procedures do not refer to the sub-fault codes very often. However, like the unused Field Service tests, the sub-fault codes are one more tool that you can choose to use during troubleshooting.

So far, this lesson has covered the following Pathfinder diagnostic tools.

1. Field Service diagnostic tests
2. Fault codes
3. Fault code troubleshooting procedures
4. Field Service diagnostic test descriptions
5. Sub-fault codes

Complete Exercise 1, which covers using the Pathfinder, before you continue this lesson.

EXERCISE 1

This exercise will help you become more familiar with how to use the Pathfinder. It is easy to confuse different parts of the Pathfinder and how they fit together. Take your time and be careful. Remember, when used correctly, the Pathfinder will help you find 98 percent of TU81 transport problems.

1. What error has sub-fault code 37 on fault code Ø6?

   a. Fault occured on down ramp
   b. Unable to establish tension during test load
   c. File mark detection error
   d. Short IBG detected

2. If the customer calls with fault code Ø6, what should you do first while in the office?

   a. Tell the customer you will arrive at his site as soon as possible.

   b. Tell the customer to run Test 36.

   c. Tell the customer to run Test Ø3.

   d. Tell the customer to clean the tape path components.

3. At the customer site with fault code Ø6 displayed, what are the first two actions you should perform on the TU81?

   a. Clean the tape path components and run Test Ø1.

   b. Clean the tape path components and change the media.

   c. Power down the TU81 and disconnect the interface cables.

   d. Run Test Ø1 and Test Ø3.

4. While following the troubleshooting procedure for fault code Ø6, you are directed to run Test Ø3. You run Test Ø3 and get termination code 82. What are the first two things you should do?

   a. Replace the servo/control module and the take-up motor assembly.

   b. Replace the servo/control module and run Test Ø1.

   c. Replace the take-up motor assembly and run Test Ø1.

   d. Replace the power amplifier module and run Test Ø1.

This completes Exercise 1. Now check your answers on the next page.

EXERCISE 1 ANSWERS

1. What error has sub-fault code 37 on fault code Ø6?

   a. Fault occured on down ramp

   b. Unable to establish tension during test load

   c. **File mark detection error (The answer is found under the fault code Ø6 sub-fault code descriptions).**

   d. Short IBG detected

2. If the customer calls with fault code Ø6, what should you do first while in the office?

   a. Tell the customer you will arrive at his site as soon as possible. (No, you have not performed the pre-site actions.)

   b. Tell the customer to run Test 36. (No, the customer never runs any test other than Ø1, Ø2, and Ø3.)

   c. Tell the customer to run Test Ø3. (No, there is no logical reason to request this as a first action.)

   d. **Tell the customer to clean the tape path components. (Yes, the first thing to do on even call is consult the pre-site matrix tables in the Pathfinder. In Pathfinder Table 2-3, under fault code Ø6, the first action labeled A, is to clean the head/tape path.)**

3. At the customer site with fault code Ø6 displayed, what are the first two actions you should perform on the TU81?

   a. **Clean the tape path components and run Test Ø1. (Yes, line Ø1Ø of the Pathfinder's troubleshooting procedure for fault code Ø6 tells you to clean the tape path components. The note in the procedure tells you to run Test Ø1 after every action.)**

   b. Clean the tape path components and change the media. (No, these are the actions described in the top two lines of the troubleshooting procedure, but you have not run Test Ø1 to check your first action.)

   c. Power down the TU8Ø and disconnect the interface cables. (No, you can perform Field Service diagnostic tests on the TU81 while it is connected to the host.)

   d. Run Test Ø1 and Test Ø3. (No, both tests may be necessary to correct fault code Ø6, but not at this time.)

4. While following the troubleshooting procedure for fault code Ø6, you are directed to run Test Ø3. You run Test Ø3 and get termination code 82. What are the first two things you should do?

   a. Replace the servo/control module and the take-up motor assembly. (No, this is the replacement for termination code 98, and you did not run Test Ø1.)

   b. Replace the servo/control module and run Test Ø1. (No, This would be correct for termination code 98.)

   c. Replace the take-up motor assembly and run Test Ø1. (No, this would be correct for fault code 84.)

   d. Replace the power amplifier module and run Test Ø1. (Yes, a yes answer to termination code 82 sends you down to line 19Ø, which tells you to replace the power amplifier module.)

If you had trouble with this exercise, reread this lesson up to this point. Using the Pathfinder to follow fault codes is the most important part of this course.

When you are ready, continue this lesson.

HOST-BASED DIAGNOSTIC TESTS

Host-based diagnostic tests check the complete TU81 subsystem's performance.

As you have already seen, the TU81 transport has elaborate internal Field Service tests. Therefore, you will not have to depend on the host-based diagnostic tests as much as with many other Digital products.

However, the internal Field Service tests do not check the M8739 or interface cables. To diagnose any problem in these two parts of the subsystem, you must use host-based diagnostic tests.

Also, you can often find intermittent subsystem problems only by host-based diagnosis.

This course does not explain how to start the system or load the host-based diagnostic tests. That information is part of the course prerequisites.

NOTE

The TU81 Magnetic Tape Subsystem Pocket Service Guide (EK-ØTU81-PS) and TU81/TA81 Subsystem User Guide (EK-TUA81-UG) provide complete procedures for running the diagnostic tests for VAX systems.

This course introduces the host-based tests. You can run all the tests until you are confident with the procedure. For more information, refer to the diagnostic listings on microfiche.

NOTE

Do not overlook the diagnostic listings during this course. This may be the only time you have a chance to study these listings in depth. They are valuable in identifying intermittent and other errors.

M8739 Status Checking

Before you run the VAX diagnostics, check the TU81 and I/O connection status by using the Show Device command. Then the system checks the M8739 module in any of the following conditions.

New System Configuration -- If the M8739 fails during new system installation and configuration, the host does recognize the TU81, and configures around it.

TU81 Add-On Configuration -- Upon system power-up, the host automatically configures the tape unit into the system. If the M8739 fails at that time, the host cannot communicate with the TU81.

On-Line Operation Failure -- If the M8739 fails during normal on-line operation, the host cannot continue to communicate with the TU81. An error message is entered in the system error log.

VAX-Based Diagnostic Tests

The TU81 has the following two VAX-based diagnostic tests.

EVMBB
EVMBA

EVMBB -- is the front-end diagnostic test. This diagnostic checks the subsystem in all basic operating modes, and tests the TU81 logic, interface bus, and I/O silo. You can run this test with the host in standalone mode only.

This front-end diagnostic has three test sections: default, manual, and fault, which consist of 13 tests. For acceptance testing purposes, you should use only the default and manual sections when you must check the TU81 at system initialization, transport add-on, or after repairs. You also use the fault sections along with default and manual for routine testing. Each section has several tests, which check various TU81 subsystem modules and functions.

Default Section Tests

Default section tests do not require the operator to mount and remove magnetic tape. You can run this section of the EVMBB test by entering the following commands.

NOTE

Throughout the rest of this lesson, the DS> is the diagnostic superviser prompt, and the commands appear in bold print.

DS> **RUN EVMBB**
or
DS> **LOAD EVMBB**
DS> **START**

The default section contains the following nine tests.

1. Register Existence Test
   This test checks if the TU81 IP and SA registers can be accessed on the UNIBUS through the UNIBUS adapter. No error looping is allowed. All errors abort the test or program.

2. Power-Up Initialization Test
   This test does a TU81 controller hard initialize to cause the TU81 ROM resident power-up diagnostics to run.

3. Steps 1 through 3 Initialization Test
   This test does a TU81 hard controller initialize, then does initialization steps 1 through 3.

4. Diagnostic SA Wrap Test
   This test initializes the TU81 in diagnostic wrap mode, then floats a 1 bit through the SA register to check if it echoes properly. The test repeats this process and floats a 0 bit through the SA register.

5. Vector and BR Level Test
   This test initializes the TU81 with interrupt enable set to check if the TU81 interrupts to the correct vector and BR level. This test only runs on the first pass. Possible reasons for an incorrect interrupt vector include:

   Incorrect hardware configuration
   The Attach command specified the wrong vector
   Bad LESI adapter
   Bad TU81 controller.

6. Purge and Poll Test
   This test performs steps 1 through 3 of the initialize sequence, then sets the purge and poll bit in step 3. The purge and poll sequence then does the following steps.

   a. Writes Øs to the SA register to simulate UNIBUS adapter purge complete

   b. Reads and disregards the IP register to start polling

   c. Waits for the controller to go into step 4.

7. Small Ring Buffer Initialization Test
   This test does steps 1 through 4 of the TU81 initialization, with the smallest ring buffer size and interrupts disabled. The test checks if the controller clears the ring descriptor field in the host communication area. This is the first time the initialize sequence is carried out to the point where the controller NPRs to memory are verified.

8. Large Ring Buffer Initialization Test
   This test does steps 1 through 4 of the TU81 initialization, with the largest number of ring descriptors allowed and interrupts disabled. The test checks if the controller clears the ring descriptor field in the host communications area. This test also checks if the controller can gain access to the complete host communications area in VAX memory.

9. Get Diagnostic Utility Status Test (DUST)
   This test requests the DUST status and checks if the response packet is received as expected. It also checks if invalid command status is returned when illegal modifiers are specified in the command packet. The Get DUST command does not allow command modifiers. This is the first time a command packet is actually sent to the controller and a response packet received by the host.

To start an individual test in this section, enter the following command.

DS> **Start/Test:n**

where n is the test number from 1 to 9

The diagnostic starts at the specified test, and continues until the end of the default section.

Figure 9 is an example of the EVMBB dialogue for a default run.

```
DIAGNOSTIC SUPERVISOR, ZZ-ECSAA-6.10-322  7-JUN-1983 12:27:17.21

DS> LOAD EVMBB
DS> ATTACH DW750 HUB DW0 3 4
DS> ATTACH TU81 DW0 MUA0 774500 260 5
DS> SELECT MUA0
DS> START

 ..Program: EVMBB TU81 Front-End/Host Diagnostic, Rev. 1.0
   9 Tests at 12:27:38.15
Testing __MUA0

Test 1: Register Existence Test
Test 2: Power Up Initialization Test
Test 3: Step 1-3 Initialization Test
Test 4: Diagnostic SA Wrap Test
Test 5: Vector and BR Level Test
Test 6: Purge and Poll Test
Test 7: Small Ring Buffer Initialization Test
Test 8: Large Ring Buffer Initialization Test
Test 9: Get DUST Status Test

 ..End of Run, 0 Errors detected, Pass count is 1,
   Time is 7-JUN-1983  12:29:48.53
```

Figure 9   EVMBB Dialogue - Default Section

Manual Section Test

The manual section test requires the operator to mount and remove magnetic tape when requested through the console terminal by the diagnostic. This section runs preselected Transport Controller Microdiagnostic Test 1.

You can run this section of the EVMBB test by entering the following commands.

```
DS> RUN EVMBB/SEC:MANUAL
or
DS> LOAD EVMBB
DS> START/SEC:MANUAL
```

The manual section contains the following test.

10. Functional Fault Detection Test
    This manual intervention test executes internal Transport Controller Microdiagnostic 1. The failing FRU is the LESI adapter for initialize errors, or the TU81 controller/server for all other errors.

Figure 10 is an example of the EVMBB dialogue for a manual run.

```
DIAGNOSTIC SUPERVISOR,  ZZ-ECSAA-6.10-322  7-JUN-1983 21:10:17.21

DS> LOAD EVMBB
DS> ATTACH DW750 HUB DW0 3 4
DS> ATTACH TU81 DW0 MUA0 774500 260 5
DS> SELECT MUA0
DS> START/SEC:MANUAL

 ..Program: EVMBB TU81 Front-End/Host Diagnostic, Rev 1.0
   3 Tests 21:16:09.00
Testing __MUA0


Test 10: Functional Fault Detection Test (Drive Resident Test #1)

"Mount a scratch tape UNTENSIONED BUT THREADED"
"Is the tape ready?" YES


 ..End of run, 0 errors detected, Pass count is 1,
   Time is  7-JUN-1983  21:18:00.0
```

Figure 10   EVMBB Dialogue - Manual Section

Fault Section Tests

Fault section tests require the operator to mount and remove magnetic tape when requested by the diagnostic through the console terminal. You can run this section of the EVMBB test by entering the following commands.

```
DS> RUN EVMBB/SEC:FAULT
or
DS> LOAD EVMBB
DS> START/SEC:FAULT
```

The fault section contains the following three tests.

11. Tension Fault Isolation Test
    This manual intervention test executes TU81 internal microdiagnostic Test 2. Internal Test 2 isolates servo faults by checking different transport assemblies.

12. Velocity Fault Isolation Test
    This manual intervention test executes internal microdiagnostic Test 3. Test 3 isolates servo faults by checking the take-up motor tach assembly and the velocity servo loop.

13. Select a Drive Resident Test
    This test asks the operator to select a drive resident test. Any test described in the Pathfinder can be executed with this test.

To start an individual test in this section, enter the following command.

```
DS> START/SEC:FAULT/TEST=13
```

Figure 11 is an example of the EVMBB dialogue for a fault run.

```
DIAGNOSTIC SUPERVISOR, ZZ-ECSAA-6.10-322  19-OCT-1983 15:10:17.21

DS> LOAD EVMBB
DS> ATTACH DW750
DS> ATTACH TU81 DW0 MUA0 774500 260 5
DS> SELECT MUA0
DS> START/SEC:FAULT/TEST=13

 ..Program: EVMBB TU81 Front-End/Host Diagnostic. Rev. 1.0
   1 Test at 15:11:19.09
Testing __MUA0

Test 13: Select a Drive Resident Test

Enter TU81 drive unit number: [(0), 0-3(D)] 0
Enter Drive resident test number<1-99>:     91

Setup the tape drive per the maintenance
manual for this drive resident test.
READY? YES

 ..End of Run, 0 errors detected, pass count is 1,
   Time is 19-OCT-1983  15:12:00.0
```

Figure 11   EVMBB Dialogue - Fault Section

Now let's look at EVMBA, the second VAX based diagnostic test.

EVMBA -- is the data reliability exerciser. This diagnostic checks out the complete tape subsystem. It lets you test the TU81 while it is on-line without bringing the system down. EVMBA has the following three test sections.

- Default (tests 1, 2, and 3)
- Media (test 4)
- Conversation (test 5)

Default Section Tests

Default section tests verify that the TU81 can be initialized and can communicate with the VAX over the UNIBUS. You can run this section of the EVMBA test by entering the following commands.

```
DS> RUN EVMBA
or
DS> LOAD EVMBA
DS> START
```

The default section contains the following three tests.

1. Acceptance Test
   This test performs basic acceptance testing on all selected units. The sequence repeats twice; once in GCR, once in PE.

2. Qualification Test
   This test exercises each selected unit from BOT to EOT, once in GCR, once in PE. It uses fixed byte counts and number of records per file to optimize streaming operations.

3. Multi-Drive Test
   This test runs all selected units under test simultaneously. It uses random byte counts and number of records per file. It makes two complete passes from BOT to EOT on each unit in GCR, and then in PE.

Figure 12 is an example of the EVMBA dialogue for a default run.

```
DIAGNOSTIC SUPERVISOR, ZZ-ECSAA-6.1-322 7-JUN-1983 12:27:17.21
DS> LOAD EVMBA
DS> ATTACH DW750 HUB DW0 3 4
DS> ATTACH TU81 DW0 MUA0 774500 260 5
DS> SELECT MUA0
DS> START

.. Program: EVMBA TU81 DATA RELIABILITY EXERCISER, REV 1.0
   3 Tests at 12:27:38.15
Testing_MUA0:

Test 1: Acceptance Test
Test 2: Qualification Test
Test 3: Multi Drive Test

...End of Run, 0 Errors detected, Pass count is 1,
   Time is 7-JUN-1983  12:29:48.53
```

Figure 12   EVMBA Dialogue - Default Section

Media Section Test

The media section test performs read operations from BOT to EOT (or logical EOT) if a tape containing valid data is mounted on the TU81. You can run this section of the EVMBA test by entering the following commands.

```
DS> RUN EVMBA/SEC:MEDIA
or
DS> LOAD EVMBA
DS> START/SEC:MEDIA
```

The media section contains the following test.

4. Read Unknown Tape
   This test rewinds a prerecorded tape and begins a series of read operations. It terminates the read sequence at EOT, logical EOT, (LEOT), or a device fatal error. The user may request a dump of each record, or may just collect information about the data on the tape (for example, the number of records per file and byte count per record).

Figure 13 is an example of the EVMBA dialogue for a media run.

```
DIAGNOSTIC SUPERVISOR, ZZ-ECSAA-6.10-322 7-JUN-1983 21:10:17.21

DS> LOAD EVMBA
DS> ATTACH DW750 HUB DW0 3 4
DS> ATTACH TU81 MUA0 774500 260 5
DS> SELECT MUA0
DS> START/SEC:MEDIA

..Program: EVMBA TU81 DATA RELIABILITY EXERCISER, Rev 1.0
  1 Test at 21:16:09.00
Testing MUA0:

Test 4: Read Unknown Tape
..End of /Run, 0 Errors detected, Pass count is 1,
  Time is 7-jun-1983  21:18:00.0
```

Figure 13 EVMBA Dialogue - Media Section

Conversation Section Test

The conversation section test runs operator specified sequences as input to the program. You can run this section of the EVMBA test by entering the following commands.

```
DS> RUN EVMBA/SEC:CONVERSATION
or
DS> LOAD EVMBA
DS> START/SEC:CONVERSATION
```

The conversation section contains the following tests.

5. Operator Specified Sequence
   This test lets the user specify sequences of operations to input to the program. The program then tries to execute the specified sequence on each selected unit.

Figure 14 is an example of the EVMBA dialogue for a conversation run.

```
DIAGNOSTIC SUPERVISOR, ZZ-ECSAA-6.10-322 19-OCT-1983 15:10:17.21
DS> LOAD EVMBA
DS> ATTACH DW750 HUB DW0
DS> ATTACH TU81 DW0 MUA0 774500 260 5
DS> SELECT MUA0
DS> START/SEC:CONVERSATION

..Program:  EVMBA TU81 DATA RELIABILITY EXERCISER, revision   1.7,
5 tests, at 14:28:04.01
Testing: _MUA0

PLEASE ANSWER THE FOLLOWING QUESTIONS FOR ALL SELECTED DRIVES
NEW PARAMETERS WANTED ? [(YES), Y, NO, N, SHOW, S, HELP, H]
DENSITY = GCR [(Yes), No]
RANDOM BYTE COUNT ? [(YES), NO]
SELECT DATA PATERN: [(0), 0 - 17(D)]
TYPE FUNCTIONS WANTED - TERMINATE WITH AN "END"
FUNC>HFGL
NO SUCH FUNCTION DO YOU WANT HELP [(NO), YES] Y
TYPE ONE FUNCTION PER LINE
ANY FUNCTION FOLLOWED BY A "!" WILL BE EXECUTED ONLY ONCE
EXAMPLE REWIND: FUNCTION>REWIND!
FUNCTION CODES ARE LISTED BELOW:
REW (REWIND), WTM (WRITE TAPE MARK), ERA (ERASE)
RPR (REPOSITION RECORD), RPF (REPOSTION FILE) WRT (WRITE)
CHD (COMPARE HOST DATA), RED (READ)
SUC (SET UNIT CHARACTERISTICS), RDR (READ-REVERSE)
RDC (READ COMPARE), WCK (WRITE CHECK)
DSE (DATA SECURITY ERASE), END
A DELAY MAY BE SPECIFIED FOR EACH FUNCTION
BY TYPING 'DEL' AT THE NEXT FUNCTION> PROMPT
YOU WILL BE PROMPTED FOR THE DELAY LENGTH
FUNCTION>REW!
ITERATION> [(1), -32768-32767(D)] 1
FUNCTION>WRT
ITERATION> [(1), -32768-32767(D)] 400
FUNCTION>RPR
ITERATION> [(1), -32768-32767(D)] -400
FUNCTION>RED
ITERATION> [(1), -32768-32767(D)] 400
FUNCTION>END
```

Figure 14   EVMBA Dialogue - Conversation Section

____ Run the host-based diagnostics until you feel comfortable with how to use them.

Use your TU81 Magnetic Tape Subsystems Pocket Service Guide and diagnostic listings on microfiche to answer any questions.

ASCII PORT DIAGNOSTICS

The ASCII port, when connected to any RS232C compatible terminal, serves as an input/output device that performs the following tasks.

- Runs the transport resident diagnostics
- Runs Special Test 27 (Conversation Mode Test using selective parameters)
- Prints out error log information (sense bytes)

The ASCII port is on the left side of the TU81 control panel (under the cover). To use the port, open the cover and plug a RS232 compatible terminal into the EIA 25-position signal connector (Figure 15).

NOTE
The ASCII port accepts and generates the full ASCII character set. Certain characters are ignored or have a special meaning as defined in Table 3-3 in the TU81 Magnetic Tape Subsystem Pocket Service Guide.

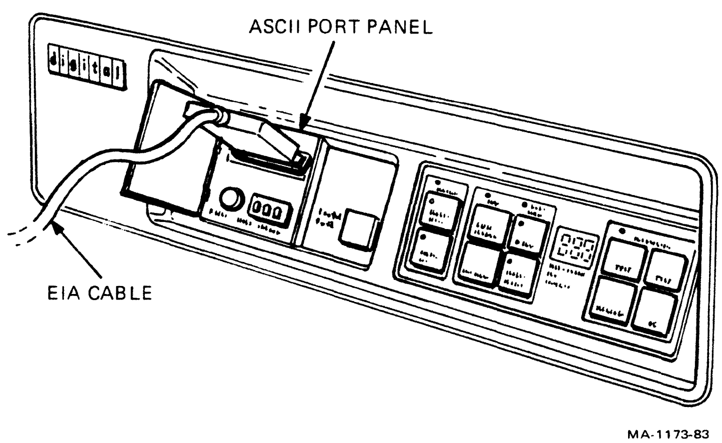


Figure 15 ASCII Port and EIA Cable

To communicate with the ASCII port, do the following steps.

____ 1. Plug in the RS232 compatible terminal.

____ 2. Place the TU81 off-line from the host system.

____ 3. Type in **CONTROL C** or **CONTROL Y** (any characters typed before this are ignored).

The ASCII port's control program responds with the following command level prompt, which indicates it is ready for you to enter a diagnostic command.

TU81>

Diagnostic commands are used to check TU81 status and set up and control the diagnostic execution. To set a diagnostic control parameter, enter the correct set command before you start the test. Once specified, the parameter remains in effect until you change it with another command or exit terminal mode. If you do not specify set parameters, the ASCII control program automatically sets the default parameters, which remain active until you use a set command.

Each input line, together with the command prompt, should not exceed 64 characters. Characters beyond the 64th are ignored.

____ 4. Find Table 3-4 in the TU81 Magnetic Tape Subsystem Pocket Service Guide, then enter a command from this table. To run the transport diagnostics, enter RUN DIAGNOSTICS/TEST=XX to execute a particular test (from the Pathfinder).

If the test succeeds, the terminal responds with the TU81> prompt.

If the test fails, the terminal displays a diagnostic message that specifies the fault condition. This diagnostic message is in the following format.

TEST:xx FAULT CODE:xx FAULT SUBCODE:xx

where

TEST:xx = diagnostic test number (in decimal)
FAULT CODE:xx = code indicating primary FRU
FAULT SUBCODE:xx = Code indicating hardware element that failed

Special Diagnostic Test 27

Test 27 is not a resident microdiagnostic permanently stored in TU81 memory. You can only run this diagnostic via a terminal since it requires you to manually enter data.

This test writes, backspaces, then reads a specified number of blocks according to operator selected input parameters. You must enter input parameters in the following order.

1. Speed and density select:
   1 = 25 ips PE
   2 = 75 ips PE
   3 = 25 ips GCR
   4 = 75 ips GCR

2. Pattern identifier:
   1 = All ones
   2 = All zeros
   3 = Alternating bytes of 1s and Øs
   4 = Worst case PE pattern:
      Byte 1
         3 - 1s
         2 - Øs
         3 - 1s
      Byte 2
         3 - Øs
         2 - 1s
         3 - Øs

3. Bytes/block:
   1 = 512 bytes
   2 = 2Ø48 bytes

4. Write block count:
   XXX = Ø to 255

5. Backspace block count:
   XXX = Ø to 255

6. Read block count:
   XXX = Ø to 255

To cause 16 blocks of 2048 bytes of 1s to be written at 25 ips PE, backspace 16 blocks, then read the 16 blocks, you should enter the following commands at the prompt.

____ 1. TU81> **RUN DIAGNOSTICS/TEST = 27**

____ 2. TU81> **1**

____ 3. TU81> **1**

____ 4. TU81> **2**

____ 5. TU81> **16**

____ 6. TU81> **16**

____ 7. TU81> **16**

If you enter zero in a block count field, the corresponding command is not executed. Enter all parameters as decimal numbers.

After it receives input parameters, the TU81 rewinds to BOT. (A density change can only be made at BOT.)

If you type Control Z after you enter:

RUN DIAGNOSTICS/TEST = 27

input parameters revert to the following default values.

Speed and density select	=	1 (25 ips PE)
Pattern identifier	=	3 (alternating ones and zeros)
Bytes/block	=	1 (512 bytes)
Write block count	=	10
Backspace block count	=	10
Read block count	=	10

If you enter Control Z during parameter selection, default parameters are assumed for the remaining parameters.

Sense Bytes

You can also use the ASCII port to obtain sense byte error information. When the port is enabled, sense bytes are sent to the RS232 device whenever an error occurs. You can enable the port by running internal test 7Ø with option Ø1. To disable the port, run test 7Ø with option ØØ.

Figure 16 is a typical example of an ASCII port error printout obtained while running EVMBA. In Figure 16, each sense byte is represented by a pair of hexidecimal digits. The ASCII address of the first byte is in the left column. For instance, the sense byte at address 426Ø is Ø3. The address increments by one for each byte of two hexidecimal digits. Therefore, the next sense byte at address 4261 is 22.

Table 1 is the chart used to interpret the ASCII port error printout. Starting at address 4257 through address 4271, each group of two hexidecimal digits in the error printout represents one 8-bit sense byte at the same address on the chart. The ASCII address for each byte is in the right column on the chart. For example, the sense byte at address 4259 in the error printout is ØB. When you look up address 4259 in Table 1, you find that the three bits set are data check, unit check, and unit exception.

When an error occurs 16 sense bytes are sent to the system. These sense bytes are numbered on the chart under the column heading "System Sense Bytes." Table 1 defines pertinent system sense byte bits.

```
ASCII
Address                    Sense Bytes

42FA    ØØ   68                                4257
                                              /
425Ø    98   Ø9  CØ  ØØ  ØØ  Ø3  A2  ØØ  ØØ  ØB  ØØ  ØØ  21  98  A2  Ø2

426Ø    Ø3   22  ØØ  Ø1  ØØ  Ø2  CØ  Ø1  CØ  58  ØØ  ØØ  ØØ  ØØ  ØØ  ØØ

427Ø    ØØ   ØØ
             \
             4271

423Ø    ØØ   ØØ  ØØ  ØØ  A6  FA  ØØ  ØØ  ØØ  ØØ
```

Figure 16 ASCII Port Error Printout

Table 1 Sense Bytes

7	6	5	4	3	2	1	Ø	System Sense Bytes	ASCII Address
Compare Error	Read Parity Error	RAM/FIFO Overflow/ Overrun		Buffer Parity Error	MSCP I/F Parity Error	RAM Parity Error	ROM Parity Error		4257
Non-Existent Memory	LESI I/F Parity Error	Host I/F Parity Error							4258
Command Reject	Inter-vention Required		Equipment Check	Data Check		Unit Check	Unit Exception	Ø	4259
Illegal Channel Command	Device Command Check		File Protected	Reset Key		Device Not Ready	Device Off-line	1	425A
Channel Parity Error	Channel Response Check	Read Hardware Check	Write Hardware Check	Device Response Check	Device Hardware Check	Velocity Check	Device Interrupt Check	2	425B
AGC Fault	PE CRC Check	Read Data Check	ID Fault		E R R O R R E C O V E R Y C O D E Unrecov-erable	BOT	Tape Moved	3	425C
Diagnostic Fault Code									425F
Diagnostic Fault Sub Code									426Ø
Write Error Symptom Code									4261
Write Transfer Check	Residual Byte Count Check	Write CRC Parity Error	45 Parity Error		Write AUX CRC Parity Error			6	4262
Residual Check	Read CRC Check	Read Auxiliary CRC Check	Resync Check	ECC3 Check	Uncorrectable Data	No Track Pointer	Excessive Pointers	7	4263

Table 1 Sense Bytes (Cont)

7	6	5	4	3	2	1	0	System Sense Bytes	ASCII Address
Noise Check	Postamble Error	Skew Error	Read Time Out	Write Tape Mark Check	ID Check	ARA Burst Check	ARA ID Check	8	4264
EC Hardware Check	Read Buffer In Parity Error	Read Transfer Check	Read Data Parity Error	End Mark Check	Dual-Track Correction	Single-Track Correction	TIE P	9	4265
TIE 7	TIE 6	TIE 5	TIE 3	TIE 9	TIE 1	TIE 8	TIE 2	10	4266
Read Error Symptom Code									4267
Ready	On-line	Rewind	File Protected	Gap Control	High Speed	BOT	EOT	11	4268
Reverse	Write	DSE	GCR	Long Gap	Start/Stop			12	4269
Remote Diag-nostics Inhibit	Remote Diag-nostics	LWR I/F	LWR PE	LWR GCR		Local Density Select	GCR Default Density		426A
CMD Reject	Inter-vention Required	Diagnostic Request	Density Change	AGC Check	Reset Key	Reverse in BOT	Air Flow/ Temperature Check	13	426B
Command Code								14	326C
Marginal Condition Code								15	426D
Fault/Test Completion Code									426E
Sub-Fault/Sub-Test Completion Code									426F
Unit Number									4270
Microcode Revision Level									4271
16 Sense Bytes to System									

Table 2 System Sense Byte Definitions

System Sense Byte Ø

Bit	Name	Definition
7	Command reject	Invalid command was received from host adapter. Detailed information is available from bits 4 through 7 of sense byte 1.
6	Intervention required	Condition exists that operator or host must correct before normal operations can resume. Detailed information is available from bits Ø through 3 of sense byte 1.
5	Not used	
4	Equipment check	Hardware has malfunctioned in formatter or drive. Detailed information is available from remaining sense bytes.
3	Data check	Uncorrectable data error has occurred. Detailed information is available from remaining sense bytes.
2	Not used	
1	Unit check	Hard error condition that indicates at least one of following flags is also set: Data check Equipment check Intervention required Command reject
Ø	Unit exception	Marginal acceleration, or error correction, was performed on read.
System Sense Byte 1		
7	Illegal channel command	Illegal opcode from host (implies hardware malfunction).

Table 2 System Sense Byte Definitions (Cont)

Bit	Name	Definition
6	Device command check	Read reverse or backspace command was issued at BOT, or the device rejected formatter command.
5	Not used	
4	File protected	Write command was issued to a device with no write ring.
3	Reset key	RESET switch on front panel has been activated.
2	Not used	
1	Device not ready	Device command was received and the drive was not ready.
Ø	Device off-line	Device command was received and the drive was off-line.
System Sense Byte 2		
7	Channel parity error	Formatter detects either command or data parity error from adapter.
6	Channel response check	Adapter does not respond to formatter during diagnostic protocol.
5	Read hardware check	Hardware malfunction occurred in formatter read circuitry. Detailed information is available from sense byte 9.
4	Write hardware check	Hardware malfunction occurred in formatter write circuitry.
3	Device response check	Device presented incorrect status to formatter.
2	Device hardware check	Hardware malfunction occurred in drive.
1	Velocity check	Drive did not come up to speed in required time.
Ø	Device interrupt	Device interrupt occurred during operation.

Table 2 System Sense Byte Definitions (Cont)

Bit	Name	Definition
System Sense Byte 3		
7	AGC fault	Gain could not be set correctly in GCR during ARA burst.
6	PE CRC check	
5	Read data check	Formatter read logic detected error.
4	ID fault	Formatter detected a bad ID field on tape.
3	Not used	
2 -- Ø	Error recovery code	Bit 2 is an unrecoverable error. Bit 1 is an error at BOT and requires a rewind. Bit Ø indicates tape moved.

System Sense Byte 4

Formatter command code sense byte 4 is the code in binary of the command that was executed.

System Sense Byte 5

Bit	Name	Definition
7	GCR mode	Formatter in GCR mode during the last operation.
6	High-speed mode	Formatter in high-speed mode during last operation.
5	Auto-speed mode	Speed is automatically selected by formatter to provide optimum throughput.
4	File mark detected	File mark was detected during last operation.
3	Diagnostic mode	Only set while executing diagnostic test.
2	Start/stop mode	Formatter was in start/stop mode during last operation.

Table 2 System Sense Byte Definitions (Cont)

Bit	Name	Definition
1	Variable long gap mode	Formatter was in variable long gap mode during last operation.
Ø	Variable short gap mode	Formatter was in variable gap mode during last operation.

System Sense Byte 6

System Sense Byte 6 is a further breakdown of the write hardware check bit in sense byte 2.

Bit	Name	Definition
7	Write transfer check	Indicates malfunction in write strobe generator.
6	Residual byte count check	Indicates malfunction in formatter latency buffer, resulting in wrong number of residual bytes at end of an operation.
5	Write CRC parity error	Indicates malfunction in write CRC generator.
4	45 parity error	Indicates malfunction in write 4-to-5 conversion logic.
3	Not used	
2	Write AUX CRC parity error	Indicates malfunction in write AUX CRC generator.
1	Not used	
Ø	Not used	

System Sense Byte 7

Bit	Name	Definition
7	Residual Character Check	GCR residual character is in error.
6	Read CRC check	GCR CRC character is in error.
5	Read AUX CRC check	GCR auxiliary character is in error.

Table 2 System Sense Byte Definitions (Cont)

Bit	Name	Definition
4	Resync check	Error was detected in GCR resync group.
3	ECC3 check	Error was detected on corrected data. This bit sets uncorrectable data bit.
2	Uncorrectable data	Uncorrectable error was encountered in data.
1	No track pointer	Error was detected in PE mode and no track pointer was specified. This bit sets uncorrectable data bit.
Ø	Excessive pointers	Error was detected in GCR mode and more than two pointers were specified. This bit sets uncorrectable data bit.
System Sense Byte 8		
7	Noise check	Indicates incomplete or marginal erase operation.
6	Postamble error	Error was detected in postamble.
5	Skew error	Excessive skew was detected.
4	Read timeout	Long gap was detected during read operation or read-after-write data was not detected within predetermined window.
3	Write tape mark check	Read-after-write error was detected while writing tape mark.
2	ID check	Error was detected in ID burst in PE or GCR mode.
1	ARA burst check	Error was detected during ARA burst in GCR mode.
Ø	ARA ID check	Error was detected in ARA ID in GCR mode.

Table 2 System Sense Byte Definitions (Cont)

Bit	Name	Definition
System Sense Byte 9		
Sense byte 9, bits 7 through 5, is a further breakdown of read hardware check in sense byte 2.		
7	EC hardware check	Malfunction occurred in error correction hardware.
6	Read buffer in parity error	Parity error occurred on read data into latency buffer.
5	Read transfer check	Malfunction occurred in read strobe generator.
4	Read data parity error	Parity error was detected by read circuitry while passing data to read output buffer during diagnostics.
3	End mark check	Missing end mark in GCR mode.
2	Dual-track correction	Dual-track correction occurred in GCR mode.
1	Single-track correction	Single-track correction occurred in PE or GCR mode.
0	TIE P	Parity track (track 4) was in error.
System Sense Byte 10		
Sense byte 10 is a further breakdown of data check in sense byte 0. Sense byte 10 designates the track in error (TIE) excluding the parity track, which is in byte 9.		
System Sense Byte 11		
Sense byte 11 is the device status byte.		

Table 2 System Sense Byte Definitions (Cont)

Bit	Name	Definition
System Sense Byte 12		
Sense byte 12 represents drive status for the last command issued.		
Bit	**Name**	**Definition**
7	Reverse	When set, indicates reverse tape motion; when reset, indicates forward tape motion.
6	Write	When set, indicates write operation; when reset, indicates read operation.
5	Data security erase (DSE)	Indicates data security erase.
4	GCR	When set, indicates GCR mode; when reset, indicates PE mode.
3	Variable long gap	When set, indicates variable long gap; when reset, indicates normal gap.
2	Start/stop mode	When set, indicates start/stop mode; when reset, indicates streaming mode.
1	Not used	
Ø	Not used	
System Sense Byte 13		
Sense byte 13 represents drive status associated with a device interrupt.		
Bit	**Name**	**Definition**
7	Command reject	Invalid command was received from the STU adapter. Detailed information is available from sense byte 4.
6	Intervention required	Condition must be corrected by operator or host system before normal operation can resume.

Table 2 System Sense Byte Definitions (Cont)

Bit	Name	Definition
5	Diagnostic request	Drive notified formatter that local diagnostic is to be executed.
4	Density change	
3	AGC check	Drive could not set up AGC correctly in GCR mode.
2	Reset key	RESET switch on drive panel was activated.
1	Reverse in BOT	BOT was encountered while drive was going in reverse.
Ø	Air flow/temperature check	

ERROR LOG

The system error log keeps an ongoing list of errors seen by the system software. These errors are printed in the system error report. You can request this report from the console terminal at any time.

For a typical error logged when VMS is running, the device and CPU are identified near the top of the report.

All other information is broken into three columns. Column one identifies the type of information. Column two is the value for that information. Column three is a comments area, which often elaborates on the value in column two.

The information in the error log usually includes all subsystem registers, software registers, and error statistics. Error logs vary from one type of software to another, but in general they provide similar information.

The error log is useful as a general subsystem check during any service call. It also is the only place where recoverable errors are identified.

If a customer complains that the TU81 is slow, multiple recoverable errors may by the cause. You can define the problem area by examining the error log and interpreting the error bits.

FINAL ON-SITE TESTING

After any repair, you must complete final testing by doing the following steps.

1. Turn the transport off and back on to allow the health check to run.

2. Then, run Test Ø1 to completion. This takes about 1Ø minutes.

3. When the host system is available, run the appropriate VAX diagnostics.

NOTE
You can run EVMBA with the VAX on-line.

SUMMARY

This lesson provided all the diagnostic test information you need to troubleshoot the TU81.

The power-on health check runs when you apply power to the transport by pressing the Power On switch.

Internal diagnostic tests are used by the customer (Operator Test Ø1) and Field Service representatives (Tests Ø1 through Ø3 plus Field Service Tests 1Ø through 99).

Fault codes are displayed for all internal diagnostic test errors.

The Pathfinder documentation stocked in the CD (controlled distribution) kit can direct you to 98 percent of the TU81 problems, when properly used.

The Pathfinder has the following parts.

Pre-site procedures
On-site procedures
Fault code troubleshooting procedures
Functional troubleshooting procedures
Field Service diagnostic test descriptions
Sub-fault code descriptions

VAX systems have the following two host-based diagnostic tests.

EVMBB
EVMBA

You should run Operator/Field Service Test Ø1 for all TU81 repairs, and as a confidence test.

You should run host-based diagnostic tests whenever the system is available. You can run EVMBA with the VAX on-line.

NOTE

If you have questions on any of these diagnostic tools, return to the lesson and find the answers now. You will not have time to find the answers when you are on a call.

This completes the diagnostic lesson for the TU81. The rest of this lesson describes the differences between the TU81 and TU8Ø diagnostics.

TU8Ø DIFFERENCES

The following paragraphs describe how the TU8Ø diagnostics differ from the TU81 diagnostics.

M7454 Self-Diagnostic

The M7454 self-diagnostic resides on ROMs on the M7454, and runs whenever that module is powered up (usually when the host is turned on).

The M7454 self-diagnostic checks the M7454 module only and does not involve tape motion or interface signal testing. This diagnostic checks the M7454 microprocesssor, sequencer, data paths, and buffer area.

This self-diagnostic runs at power-up and the green indicator on the module comes on to indicate that the test completed successfully.

There are two possible indications that the self-diagnostic has failed. First, the green indicator on the M7454 will be off. Second, the host system cannot access the TU8Ø. In most cases, the host configures the system around the TU8Ø when the system is booted.

M7454 failure while the host operating system is running results in error messages on the system error log, and/or console terminal error messages. In this case, the green indicator may stay on since the diagnostic has not been rerun. You should turn the host off and back on to rerun the self-diagnostic. If the M7454 is bad, the green indicator will stay off.

Host-Based Diagnostic Tests (PDP-11 and VAX)

Whether the TU8Ø is connected to a PDP-11 CPU or VAX CPU, there are host-based diagnostic tests that check the complete TU8Ø subsystem performance.

The TU8Ø transport also has elaborate internal Field Service tests. Therefore, you do not have to depend upon the host-based diagnostic tests as much as with other Digital products.

However, internal Field Service tests do not check the M7454 or interface cables. To diagnose any problem in these two parts of the subsystem, you must use host-based diagnostic tests.

NOTE

Procedures for running diagnostic tests for both PDP-11 and VAX systems are in the TU8Ø Pocket Service Guide and the TU8Ø User Guide.

PDP-11-Based Diagnostic Tests

The TU8Ø has five PDP-11-based diagnostic tests.

CAUTION

After you start any PDP-11 test the question "Change HW(L)?" is asked. You must answer this question with a Y, or the test will not run.

CZTUV -- This is the data reliability or exerciser test (Figure 17). This diagnostic test causes data wraparounds through the TU8Ø, interface cables, I/O silo, and formatter. Data transfers to and from tape.

CZTUV consists of the following six tests. The execution times, listed in parentheses, are for testing one TU8Ø.

1. Basic Functions (3Ø seconds per pass) performs all TU8Ø functions.

2. Data Reliability (45 minutes per pass) performs random commands and patterns for the full tape length.

3. Write/Read Streaming (8 minutes per pass) writes at 1ØØ ips and reads in forward and reverse at 25 ips in streaming mode. This is the only part of CZTUV that causes streaming.

4. Write Compatibility (2Ø minutes per pass) writes random length records and data from BOT to EOT.

5. Read Compatibility (2Ø minutes per pass) reads the entire tape forward and reverse.

```
.R CZTUVA
DRS LOADED
DIAG. RUN-TIME SERVICES REV. D APR-79
CZTUV-A-Ø
DATA RELIABILITY TEST
UNIT IS TU8Ø
DR>STA/FLA:PNT

CHANGE HW (L) ? Y
# UNITS (D)  ?  1
UNIT Ø
TSSR ADDRESS (O)  172522 ?
VECTOR (o) 224 ?

CHANGE SW (L) ? N

TAPE LENGTH MUST BE 24ØØ FT. TO CORRECTLY RUN THIS TEST!!

TST:  ØØ1 Basic Functions
TST:  ØØ2 Data Reliability
TST:  ØØ3 Write/Read Streaming
TST:  ØØ4 Write Compatibility
TST:  ØØ5 Read Compatibility
TST:  ØØ6 Operator Selected Not Executed Test
CZTUV EOP  1

    Ø CUMULATIVE ERRORS
```

Figure 17   CZTUV, Data Reliability Dialogue

6. Operator Selected Sequence (variable time) performs a default sequence of "rewind/write/read, reverse/read, forward/rewind" of the entire tape by using random patterns and a 2Ø48 byte record length.

The CZTUV output calls out a failing module when an error occurs.

To run CZTUV, tape must be loaded and on-line. CZTUV is usually the final test run. This test takes approximately 1-1/2 hours per pass. However, a 2Ø minute runtime is long enough when you use this test as a data confidence test.

> **CAUTION**
> **You can run the CZTUV Data Reliability Test, with a 24ØØ-foot tape only. Other tapes will cause the test to fail.**

The diagnostic listing on microfiche contains more information. Section 3, error reporting, and section 6, device information tables, are important.

The next four tests, CZTUW, CZTUX, CZTUY, and CZTUZ are the front-end, or functional, diagnostic tests. You usually run these tests in the sequence listed to progressively check more and more of the subsystem.

All of these tests, except CZTUW, require that the TU80 has tape loaded and is on-line. The status of the TU80 does not affect the CZTUW test.

CZTUW (Functional 1) -- This tests some M7454 circuitry, the self-diagnostic, and communication between the host and host memory. Any failure during this test means that you should replace the M7454.

CZTUW consists of 11 tests. The total runtime is 12 minutes. A quick verify pass (without iterations) takes 1 minute and 57 seconds. The sample printout (Figure 18) lists the 11 tests.

```
R CZTUWC

DRS LOADED
DIAG. RUN-TIME SERVICES REV. D APR-79

CZTUW-A-0
**** TU80 LOGIC DIAGNOSTIC - REPLACE M7454 IF ERROR ****

UNIT IS TU80
DR>STA/FLA:PNT

CHANGE HW (L)  ? Y

# UNITS (D)  ? 1

UNIT 0

DEVICE ADDRESS (TSBA/TSUB)  (U)  I/2522 ?
INTERRUPT VECTOR  (0)  224?

INTERRUPT PRIORITY  (0)  5 ?

CHANGE SW  (L)  ? Y

INHIBIT ITERATIONS  (L) N ? N

TST:  001 Initialization Test
TST:  002 Ram Test

TST:  003 Command Reject Test
TST:  004 Write Characteristics Test

TST:  005 Volume Check Test
TST:  006 Completion Interrupt Test

TST:  007 Basic Packet Protocol Test
TST:  008 Non-Tape Motion Commands Test

TST:  009 DMA Memory Addressing Test
TST:  010 Initialization After WRITE CHARACTERISTICS Test

TST:  011 Basic WRITE SUBSYSTEM MEMORY Command Test
CZTUW EOP  1

    0 CUMULATIVE ERRORS
```

Figure 18   CZTUW Functional 1 Dialogue

Individual test and sub-test descriptions are in the diagnostic listing on microfiche.

CZTUX (Functional 2) -- This consists of 8 tests. Total runtime is 11 minutes and 35 seconds. A quick verify pass takes 2 minutes and 19 seconds. The sample printout Figure 19 lists the 8 tests.

The first five tests check the M7454 circuitry used for the FIFO buffering logic, TSSR, basic tape motion commands, and read/write commands.

Errors on CZTUX Tests 1 and 2 are caused by the M7454.

```
.R CZTUXC
DRS LOADED

DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUX-A-Ø

****  TU8Ø  LOGIC  DIAGNOSTIC  - CHECK M7454, CABLES AND TRANSPORT IF ERROR
****
UNIT IS TU8Ø

DR>STA/FLA:PNT

CHANGE HW (L)  ?  Y

# UNITS (D)  ?  1

UNIT Ø
DEVICE ADDRESS (TSBA/TSDB)  (Ø)  172522  ?

INTERRUPT VECTOR  (Ø)  224 ?
INTERRUPT PRIORITY  (Ø)  5  ?

CHANGE SW  (L)  ?

NO DEFAULT

CHANGE SW  (L)  ?  N

TST:  ØØ1 FIFO Exerciser Test
TST:  ØØ2 Initialization #2 Test
TST:  ØØ3 Off-Line And Reject Rewind Test
TST:  ØØ4 Basic Write Test

TST:  ØØ5 Basic Read Data (Forward and Reverse) Test
TST:  ØØ6 Stand-alone Manual Intervention Not Executed Test

TST:  ØØ7 Stand-alone Configuration Typeout Not Executed Test
TST:  ØØ8 Stand-alone Scope Loops Not Executed Test

CZTUX EOP  1
    Ø CUMULATIVE ERRORS
```

Figure 19   CZTUX Functional 2 Dialogue

Errors on CZTUX Tests 3 through 5 can be caused by any subsystem component involved with the function in error. However, if Operator Test Ø1 has run successfully on the transport, the M7454 and interface cabling are the most probable failing components.

CZTUX Tests 6 through 8 are standalone tests. They are not executed unless specified at the start command.

Test 6 is a manual intervention test. It lets the Field Service representative check out various elements and functions of the subsystem that cannot be manipulated by the program alone.

Test 7 is the TU8Ø subsystem configuration typeout. The Field Service representative checks the typeout against the actual subsystem configuration.

Test 8 is used to set up scope loops. There are 8 selectable loops to check various register access problems.

Each of the 8 tests are described in detail in the diagnostic listing on microfiche.

CZTUY (Functional 3) -- This consists of 4 tests with a total runtime of 31 minutes. A quick verify pass takes 7 minutes. The sample printout (Figure 2Ø) lists the 4 tests.

CZTUY checks the space records, reread, write data retry, and write tape mark commands.

Errors can be caused by the interface cabling or the transport.

Each test and all sub-tests are described in detail in the diagnostic listing on microfiche.

CZTUZ (Functional 4) -- This consists of 6 tests with a total runtime of 16 seconds. The quick verify pass takes 15 seconds. The sample printout (Figure 21) lists the 6 tests.

Tests 1 through 4 check the write tape mark retry, skip tape marks, no-op, initialize, and erase commands. Test 5 checks the EOT status handling.

Test 6 checks that records and gaps are the correct length in both low- and high-speed modes. You can only run this test if a real-time clock is available on the system.

The transport is the most probable cause of CZTUZ errors.

CZTUZ is described in detail in the diagnostic listing on microfiche.

```
.R CZTUYC
DRS LOADED

DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUY-A-Ø

****  TU8Ø LOGIC DIAGNOSTIC - CHK CABLES-TRANSPORT IF ERR ****
UNIT IS TU8Ø

DR>STA/FLA:PNT

CHANGE HW  (L)  ?  Y

# UNITS (D)  ?  1

UNIT Ø
DEVICE ADDRESS (TSBA/TSDB)  (Ø)  172522  ?

INTERRUPT VECTOR  (Ø)  224  ?
INTERRUPT PRIORITY  (Ø)  5  ?

CHANGE SW  (L)  ?

NO DEFAULT

CHANGE SW  (L)  ?  N

TST:  ØØ1 Space Records Test
TST:  ØØ2 Rereads Test

TST:  ØØ3 Write Data Retry Test
TST:  ØØ4 Write/Read Tape Mark Test

CZTUY EOP  1
    Ø CUMULATIVE ERRORS
```

Figure 2Ø CZTUY Functional 3 Dialogue

```
.R CZTUZC
DRS LOADED

DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUZ-A-Ø

**** TU8Ø LOGIC DIAGNOSTIC - CHECK TRANSPORT IF ERROR ****
UNIT IS TU8Ø

DR>STA/FLA:PNT

CHANGE HW  (L)  ?  Y

# UNITS  (D)  ?

NO DEFAULT
# UNITS  (D)  ?  1

UNIT Ø

DEVICE ADDRESS (TSBA/TSDB)  (Ø)  172522  ?

INTERRUPT VECTOR  (Ø)  224 ?

INTERRUPT PRIORITY  (Ø)  5  ?

CHANGE SW  (L)  ?  Y/N

TST:  ØØ1 Write Tape Mark Retry Test
TST:  ØØ2 Skip Tape Marks Test

TST:  ØØ3 NO-OP  ("Clean Tape") And INITIALIZE Test
TST:  ØØ4 Erase And Operation Incomplete Test
TST:  ØØ5 Operations At EOT Test
TST:  ØØ6 Function Timing Test

CZTUZ EDP  1
    Ø CUMULATIVE ERRORS
```

Figure 21   CZTUZ Functional 4 Dialogue

VAX-Based Diagnostic Tests

The TU8Ø has the following two VAX-based diagnostic tests.

EVMBD and EVMBE -- EVMBD (Figure 22) and EVMBE (Figure 23) are the front-end diagnostic tests. These tests check the subsystem in all all basic operating modes.

You can run these tests with the host off-line only.

```
$DIAGNOSTIC SUPERVISOR, ZZ-ECSAA-6.7-252  30-AUG-1982  19:08:41
DS> LOAD EVMBD.EXE
DS> ATTACH DWXXX HUB DW0
DS> ATTACH TU80 DW0 TU0 772520 224  5
DS> SET TRACE
DS> SEL ALL
DS> START
        PROGRAM EVMBD TU80 DIAGNOSTIC, REVISION 1.0, 16 TESTS
                AT 19:09:42.09


TEST 1: INITIALIZATION TEST
TEST 2: RAM VERIFICATION TEST
TEST 3: COMMAND REJECT TEST
TEST 4: WRITE CHARACTERISTICS TEST
TEST 5: VOLUME CHECK TEST
TEST 6: COMPLETION INTERRUPT TEST
TEST 7: BASIC PACKET PROTOCOL TEST
TEST 8: NON-TAPE-MOTION COMMANDS TEST
TEST 9: DMA MEMORY ADDRESSING TEST
TEST 10: INITIALIZATION AFTER WRITE CHARACTERISTICS TEST
TEST 11: BASIC WRITE SUBSYSTEM MEMORY COMMAND
TEST 12: FIFO EXERCISER TEST
TEST 13: INITIALIZE 2 TEST
TEST 14: MANUAL INTERVENTION TEST
TEST 15: CONFIGURATION TYPEOUT TEST
TEST 16: SCOPE LOOPS TEST

         END OF RUN, 0 ERRORS DETECTED, PASS COUNT IS 1,
                TIME IS 30-AUG-1982 19:09:49.30
```

Figure 22   EVMBD Dialogue

```
$DIAGNOSTIC SUPERVISOR, ZZ-ECSAA-6.7-252  30-AUG-1982  19:08:41
DS> LOAD EVMBE.EXE
DS> ATTACH DWXXX HUB DW0
DS> ATTACH TU80 DW0 TU0 772520 224 5
DS> SET TRACE
DS> SEL ALL
DS> START
        PROGRAM EVMBE TU80 DIAGNOSTIC, REVISION 1.0, 12 TESTS
                AT 19:09:42.09

TEST 1: BASIC WRITE DATA TEST
TEST 2: BASIC READ DATA (FORWARD AND REVERSE) TEST
TEST 3: SPACE RECORDS TEST
TEST 4: REREADS TEST
TEST 5: WRITE DATA RETRY TEST
TEST 6: WRITE TAPE MARK TEST
TEST 7: WRITE TAPE MARK RETRY TEST
TEST 8: SKIP TAPE MARKS TEST
TEST 9: NO-OP AND INITIALIZE TEST
TEST 10: ERASE AND OPERATION INCOMPLETE TEST
TEST 11: TEST OF OPERATIONS AT EOT TEST
TEST 12: FUNCTION TIMING TEST

         END OF RUN, 0 ERRORS DETECTED, PASS COUNT IS 1,
                TIME IS 30-AUG-1982  19:09:49.30
```

Figure 23   EVMBE Dialogue

EVMAA -- This is the data reliability test. This test thoroughly checks out the entire subsystem in both start/stop and streaming modes.

EVMAA lets you test the TU80 while it is on-line.

> **NOTE**
>
> **EVMAA (Version 12 and higher) has a new test section for the TU80. This section tests the TU80 in streaming mode. You can designate this section by entering RUN EVMAA/SEC:TU80 at the DS> prompt.**

EVMAA consists of the following six tests. Only tests 2 through 6 apply to the TU80.

1. Qualification Test (SEC:QUALIFICATION) is not used on the TU80.

> NOTE
>
> The correct qualification test is defaulted to according to the type of transport being tested.

2. Qualification Test (SEC:QUALIFICATION) performs basic subsystem functions.

3. Data Reliability Test (SEC:MEDIA) writes and reads several data patterns.

4. Multi Drive Test (SEC:MULTI) provides maximum interaction on a system with more than one transport. It checks compatibility between transports on one system.

5. Conversation Mode Test (SEC:CONVERSATION) lets you specify the function sequence of the test. Remember, you can cause error by asking for an inoperable sequence.

6. TU80 Streaming Read/Write Test (SEC:TU80) causes high-speed (100 ips) read and write streaming. This is the only test that causes the TU80 to stream. If the host system does not have too much other activity, the transport should ramp up to 100 ips and go to EOT. If the host system is loaded down, the transport can switch between streaming and start/stop modes. The test is still considered successful as long as there is no error message.

Final On-Site Testing

After any repair you must complete final testing by doing the following steps.

1. Turn the transport off and back on to allow the health check to run.

2. Then, run Test Ø1 to completion. This takes about 1Ø minutes.

3. When the host system is available, run the appropriate PDP-11 or VAX diagnostics.

   NOTE
   You can run EVMAA with the VAX on-line.

4. When the M7454 has been replaced or is suspect, turn the UNIBUS box off and back on to let the M7454 self-diagnostic run.

5. By using DECX11, you can exercise the complete PDP-11 system including the TU8Ø subsystem.

This completes the Diagnostic lesson.

Now start Section 2 of the video tape to review the procedures you will perform in the Removal and Replacement lesson.

INTRODUCTION

This lesson describes how to remove and replace TU81 field replaceable units (FRUs) and perform the appropriate verification checks after each replacement.

These procedures are taken from the TU81 Magnetic Tape Subsystem Pocket Service Guide and changed to fit into the course format. The TU81/TA81 Technical Manual also contains similar procedures.

Most of the verification checks are pathfinder tests. These tests are explained in detail in the Pathfinder test descriptions. (Refer to the Diagnostics lesson.)

OBJECTIVES

1. Remove and replace TU81 FRUs.
2. Run verification tests for replaced FRUs.

TAPE DECK COMPONENTS

The three FRUs you remove in the following paragraphs are on top of the tape deck. You can gain access to them by opening the top cover.

BOT/EOT/AOT Assembly

The following paragraphs describe how to remove, replace, and check the BOT/EOT/AOT assembly.

Removal -- Do the following steps to remove the BOT/EOT/AOT assembly.

____ 1. Remove the head assembly dust covers by pulling them straight out.

____ 2. Disconnect the W3P1 plug from the BOT/EOT/AOT assembly (Figure 1). The mounting screw is under the cable.

NOTE

Do not loosen the screw on top of the assembly. This can cause sensor misalignment.

If you loosen it by mistake, tighten it and do the verification checks found later in this procedure. If a sensor does not work, replace the assembly.

____ 3. Remove the mounting screw from the assembly base mount, and lift the assembly off the tape deck.

Replacement -- Do the following steps to replace the BOT/EOT/AOT assembly.

____ 1. Position the assembly in its place on the tape deck, then install and slightly tighten the mounting screw.

____ 2. Thread a tape onto the take-up reel and adjust the assembly so the sensors are aligned parallel to the tape path. Sensor positioning is not critical.

____ 3. Tighten the mounting screw.

NOTE

It is easy to misposition the W3P1 plug onto the wrong pins.

____ 4. Reattach the W3P1 plug to the sensor connector as shown in Figure 1. If excess cable exists, pull the excess under the tape deck.

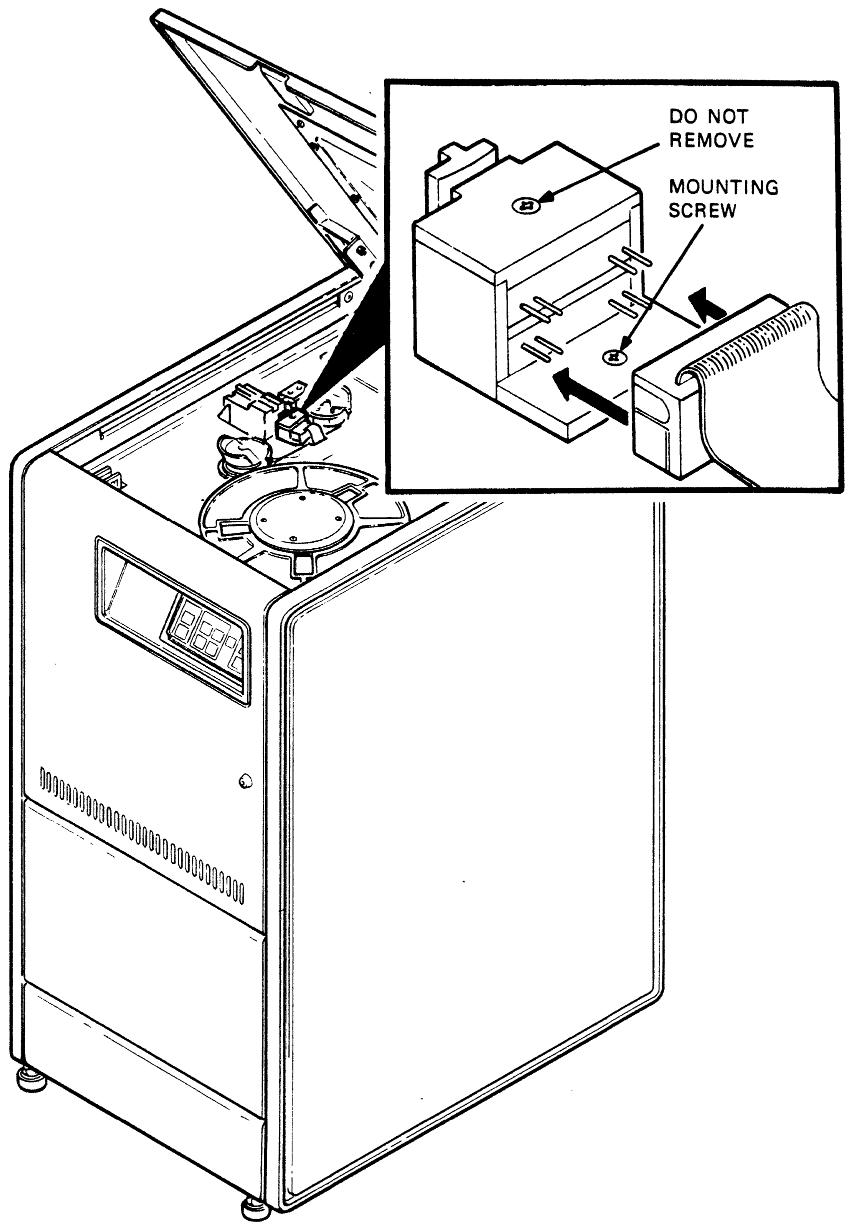


Figure 1   BOT/EOT/AOT Assembly Removal

Verification Check -- Do the following steps to perform the verification checks on the BOT/EOT/AOT assembly.

NOTE

If available, use a 600-foot reel of tape (PN 29-22020) with correctly installed EOT/BOT markers to reduce test time.

____ 1. Install a reel of tape onto the supply hub and thread the tape so the BOT marker is located before the EOT/BOT sensors.

NOTE

If steps 2 or 3 fail, reposition the assembly so the sensors are parallel with the tape, and attempt to perform the verification check again.

____ 2. Perform a load operation and check if the tape loads and positions itself at the BOT marker (BOT indicator comes on) to verify the BOT sensor.

____ 3. Run Test 44 to make sure the EOT sensor works.

Test 44 executes a fast forward to EOT.

____ 4. Unload the tape and power down the TU81.

Tape Cleaner

The following paragraphs describe how to remove and replace the tape cleaner.

Removal -- Do the following steps to remove the tape cleaner.

____ 1. Remove the head covers, the two mounting screws, and the tape cleaner (Figure 2) from the tape deck.

____ 2. Remove the mounting hardware and cover plate from the blade housing.

CAUTION

Make sure the filter screen is not lost or damaged when you do the following step.

____ 3. Slide the platform mount out of the housing.

NOTE

You must replace a defective tape cleaner as a complete assembly.

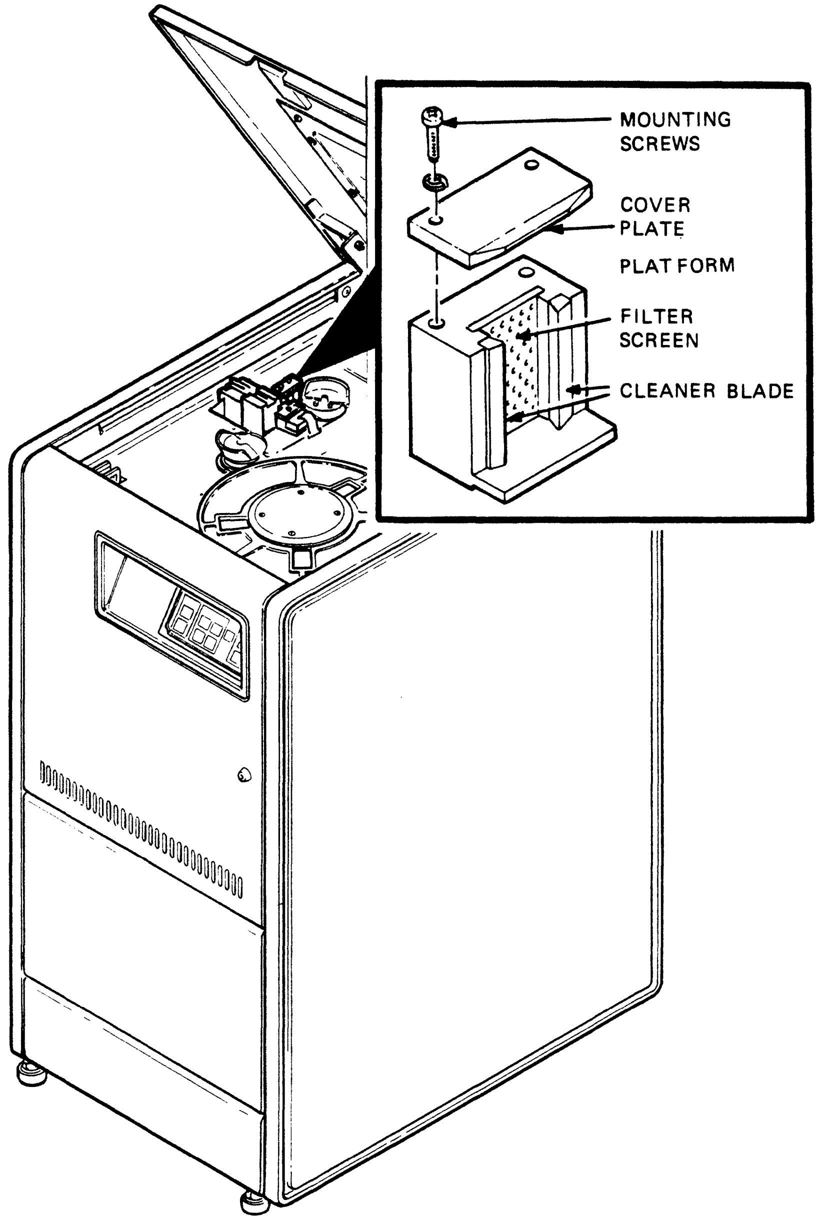


Figure 2   Tape Cleaner Removal

Replacement -- Do the following steps to replace the tape cleaner.

____ 1. Inspect the cleaner blades for damage. If blades are chipped or damaged, replace the entire assembly.

____ 2. If blades are not damaged, clean the platform and reinstall.

When you install the platform, make sure that the flanges are positioned so the platform fits firmly inside the housing.

____ 3. Install the cover plate and mounting hardware.

____ 4. Position the assembly onto the guide pins on the tape deck and tighten the screws.

Verification Check -- You do not have to perform any functional checks.

File Protect Sensor

The following paragraphs describe how to remove, replace, and check the file protect sensor.

Removal -- Do the following steps to remove the file protect sensor.

____ 1. Remove the tape reel from the supply hub.

____ 2. Remove the four short mounting screws and the file protect sensor cover plate (Figure 3) from the tape deck.

____ 3. Remove the mounting screw and washer that secure the file protect sensor to the tape deck.

NOTE
Mark connector W3P6 so you will not reverse it during replacement.

____ 4. Disconnect connector W3P6 from the sensor.

Replacement -- Do the following steps to replace the file protect sensor.

NOTE
File protect sensor positioning is not critical.

____ 1. Place the sensor on the tape deck as shown in Figure 3, and secure it with the mounting screw and washer.

____ 2. Attach cable W3P6 to the sensor pins.

NOTE
Do not overtighten the mounting screws on the sensor cover plate. The plate is so thin that the screw heads may pull through the plate and not secure it to the tape deck.

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

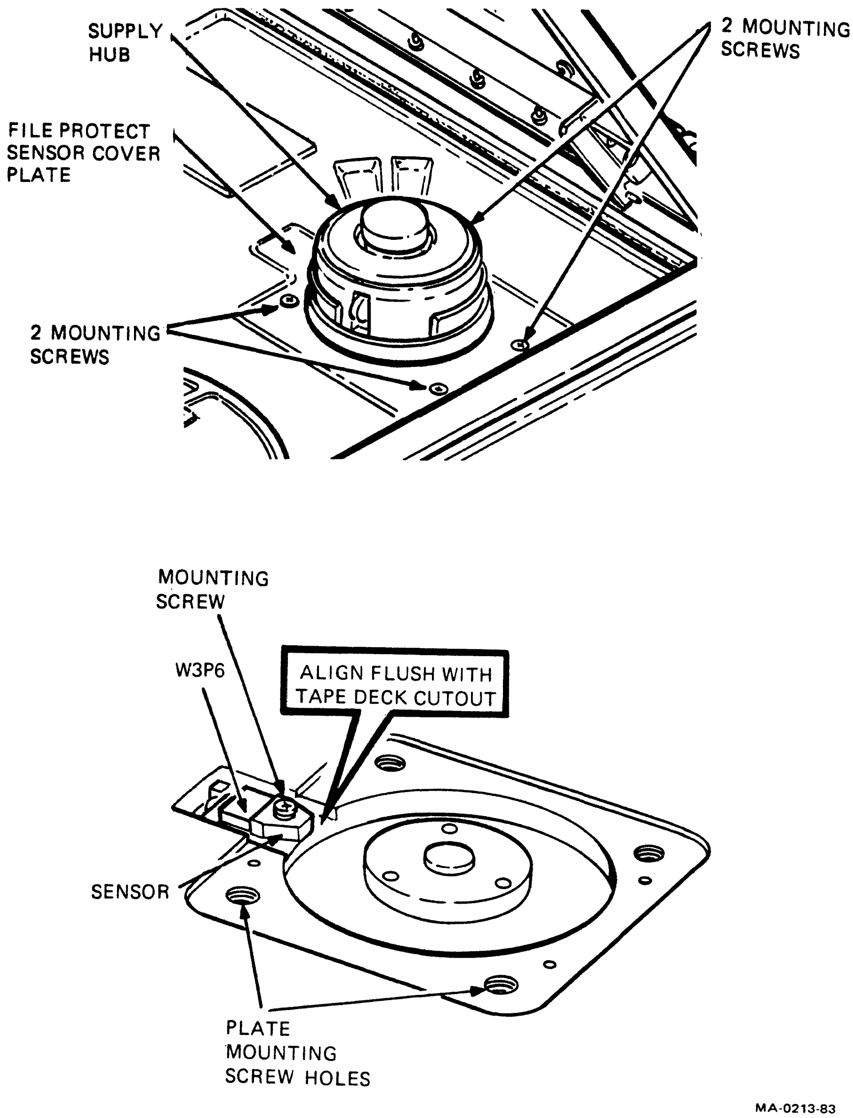


Figure 3 File Protect Sensor Removal

<u>Verification Check</u> -- Do the following steps to perform verification checks on the file protect sensor.

____ 1. Thread a write enabled tape and perform a load operation. Notice that the FILE PROT LED is not on.

____ 2. Unload tape and remove the write enable ring. Thread tape, perform a load operation, and notice that the FILE PROT LED is on.

INTERNAL COMPONENTS

You can gain access to the next several components you remove only by placing the TU81 in service position and removing the acoustic cover. However, for certain steps the operating position is better.

____ 1. Place the TU81 in service position. Make sure the tape deck locks into position.

____ 2. Remove the acoustic cover.

To avoid repetition and save time, this course combines the removal and replacement procedures for the write driver module, read amplifier module, servo/control module, head assembly, and air bearing assembly. Therefore, you only perform the module removals and replacements once. To service any of these modules, you must separate them from the logic cage (Figure 4) and move them to the service position (Figure 5). First, remove the mounting nut and holding bracket from the top of the logic cage.

CAUTION

All TU8Ø and TU81 modules are static sensitive. Follow proper handling procedures.

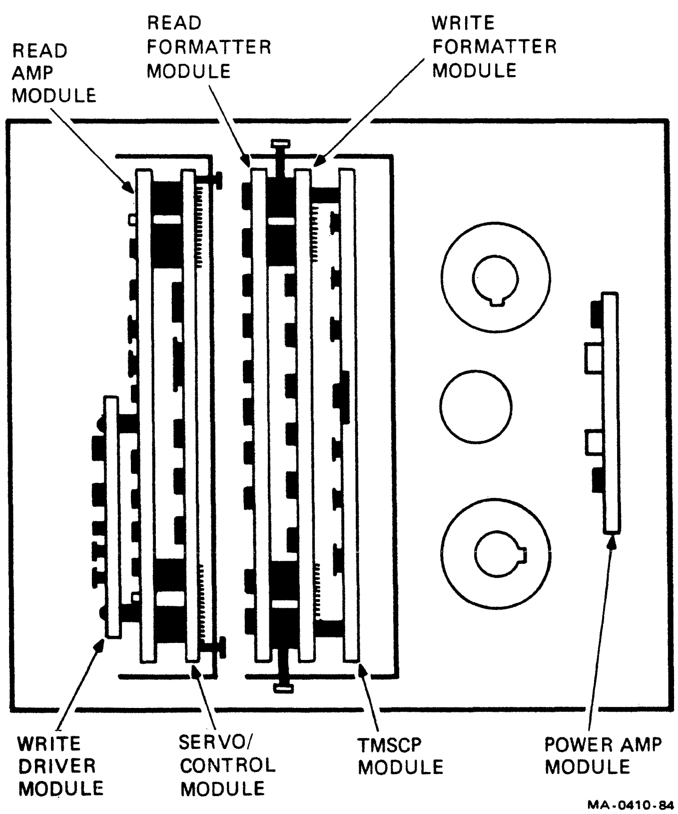


Figure 4 Logic Cage and Module Locations

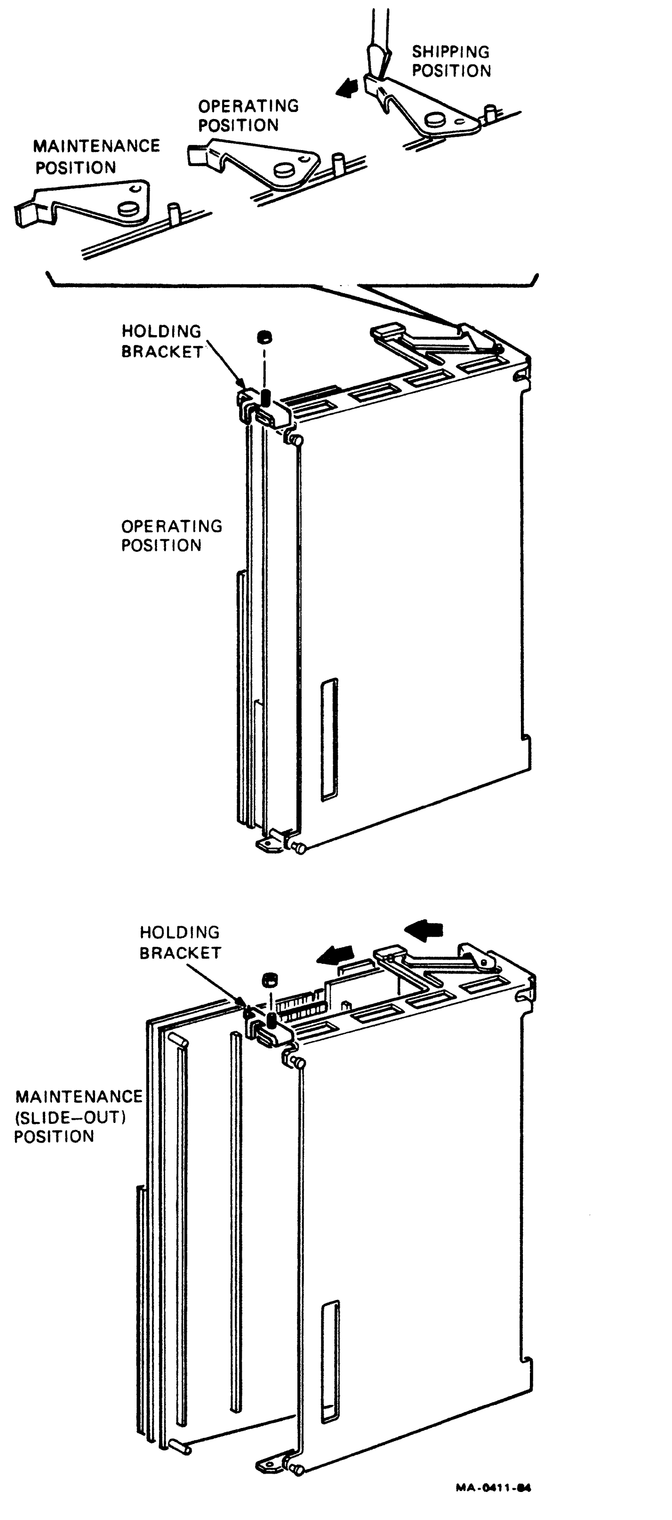


Figure 5 Card Cage Operating and Servicing Positions

Write Driver and Read Amplifier Modules

The following paragraphs describe how to remove and replace the write driver and read amplifier modules.

NOTE
You remove the write driver and read amplifier modules together, and then separate them (Figure 6). Future designs may let you remove the write driver separately.

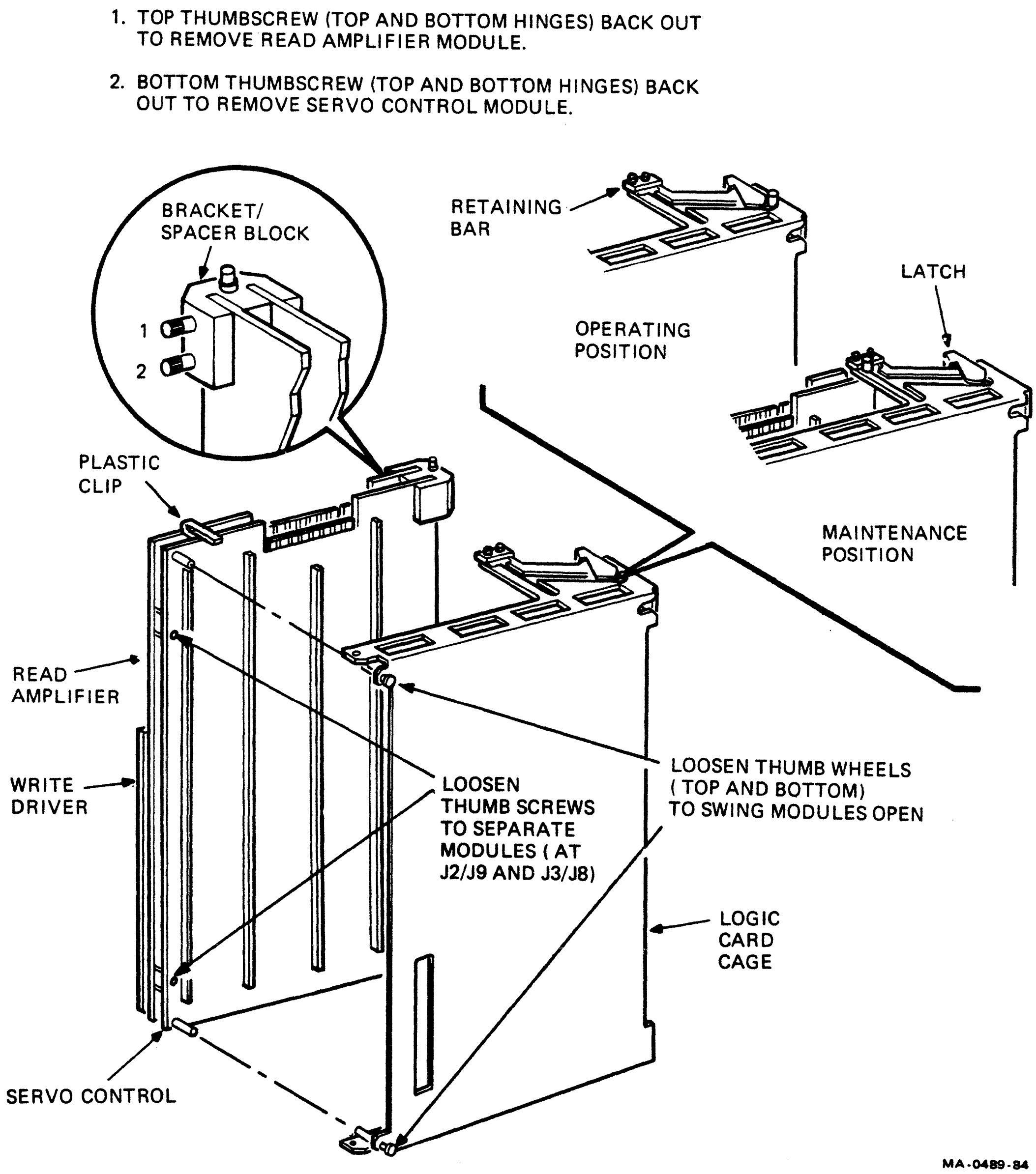


Figure 6 Write Driver/Read Amplifier/Servo Control Modules

CAUTION

Do not place unnecessary stress on the wires or modules when you remove the connectors.

Removal -- Do the following steps to remove the write driver and read amplifier modules.

____ 1. Remove connectors W5P2 and W7P6 (Figure 7) from the write driver module.

____ 2. Remove connector W6P2 from the read amplifier module (Figure 8).

____ 3. Loosen the top and bottom thumbscrews that hold the servo/control module to the logic cage.

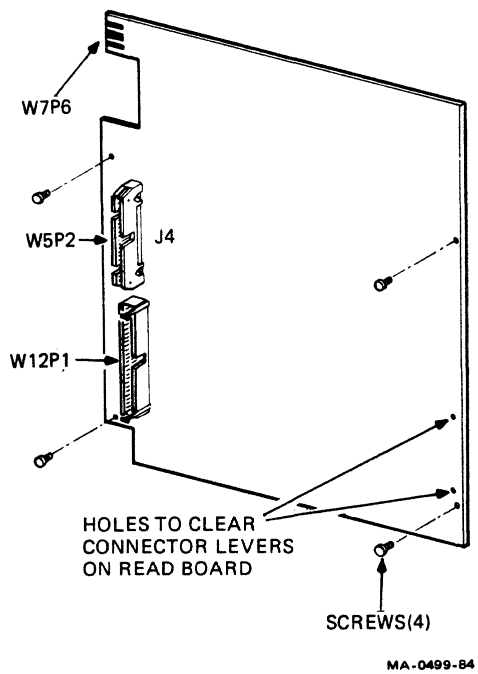


Figure 7 Write Driver Module Connectors

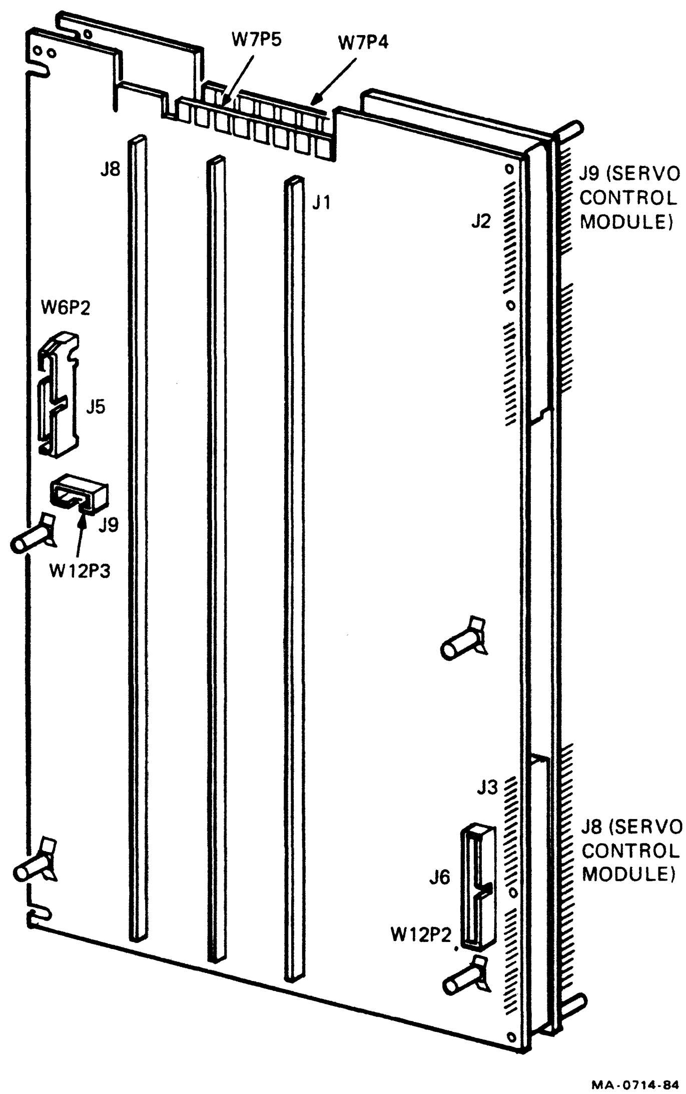


Figure 8 Read Amplifier Module Connectors

____ 4. Remove connectors W7P4 and W7P5 from the top of the read amplifier and servo/control modules (Figure 6). Release the retaining latch at the top of the card cage, and slide the modules to the service position (Figure 5).

____ 5. Back out the upper thumbscrews 6 to 8 turns at the top and bottom brackets (Figure 6).

____ 6. Remove the board clips at the top and bottom of the modules. Loosen the thumbscrews on read amplifier module at J2/J9 and J3/J8. Avoid unnecessary stress on modules by loosening thumbscrews alternately, and separating J2 from J9 and J3 from J8 as you loosen the screws.

____ 7. Slide the read amplifier module, with write driver module attached, out of the brackets and remove the modules from the cabinet.

____ 8. Use the quick disconnect tabs (Figure 9) to remove connector W12P1 from the write driver module (Figure 7).

____ 9. Separate the write driver module from read amplifier module by removing five screws from the standoffs.

NOTE

If you were replacing the read amplifier module, you would remove connectors W12P2 and W12P3 (Figure 8) and install them on the new module.

<u>Replacement</u> -- Do the following steps to replace the write driver and read amplifier modules.

____ 1. Mount the write driver module on standoffs and secure it with the five screws.

____ 2. Replace connector W12P1 on the write driver module.

____ 3. Slide the read amplifier module, with the write driver module, into the top and bottom brackets.

At this point, remove the servo/control module. The replacement is complete after you have removed and replaced the servo/control module, head assembly, and air bearing assembly.

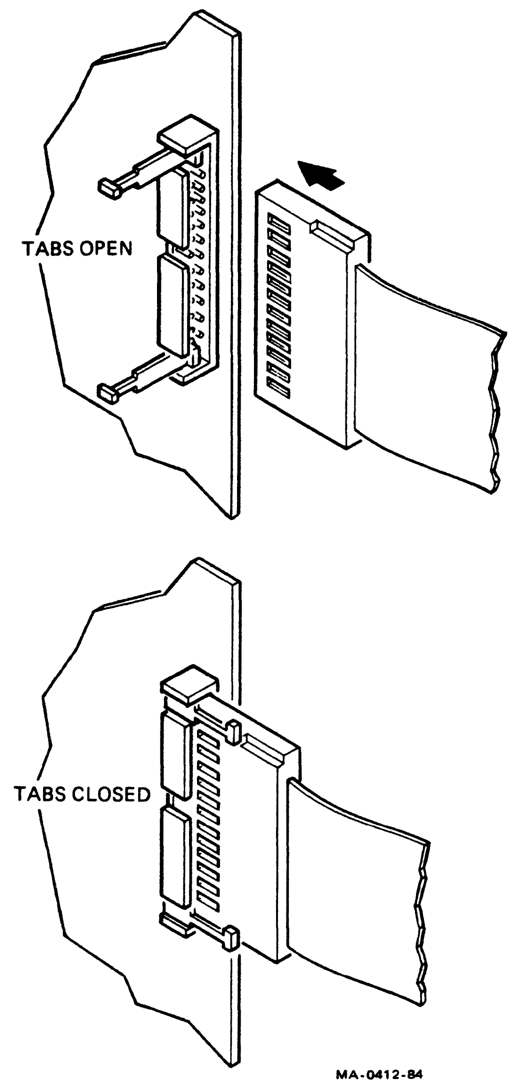


Figure 9 Quick Disconnect Tabs

Servo/Control Module

The following paragraphs describe how to remove and replace the servo/control module.

Removal -- Do the following steps to remove the servo/control module.

NOTE

Remove the write driver, read amplifier, and servo/control modules together. Then separate the servo/control from the other two.

CAUTION

Do not place too much stress on the wires or modules when you remove the connectors.

____ 1. Use the quick disconnect tabs to remove connectors W3P8, W1ØP1, W8P1, and W2P1 (Figure 1Ø) from the servo/control module. Label and remove connectors W9P2 and W1P2.

____ 2. Remove the upper retaining bar from the card cage, and remove the modules from the cabinet.

____ 3. At the top and bottom bracket, back out the lower thumbscrew 6 to 8 turns (Figure 6).

____ 4. Slide the servo/control module out of the top and bottom brackets.

Replacement -- Do the following steps to replace the servo/control module.

____ 1. Make sure jumper W1 is in the 2/3 position. Slide the servo/control module into the top and bottom brackets.

____ 2. Align connector J2 with J9, and J3 with J8 (Figure 8). Press the connectors together while you tighten the thumbscrews alternately. Make sure these connectors are completely pressed together. Replace the top and bottom board clips.

____ 3. Tighten the upper and lower thumbscrews at the top and bottom brackets.

At this point, set these three modules aside and remove and replace the magnetic head and air bearing assemblies.

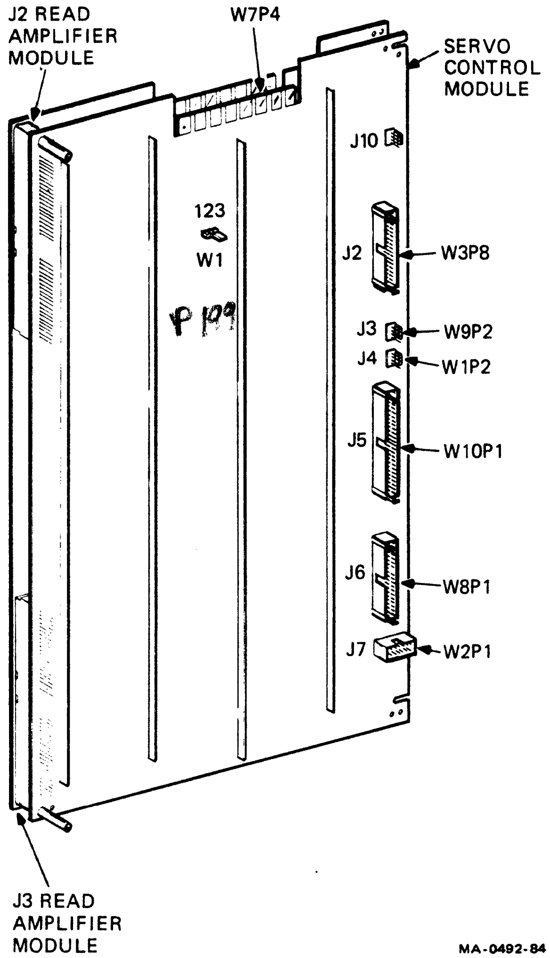


Figure 10   Servo/Control Module Connectors

Magnetic Head Assembly

The following paragraphs describe how to remove and replace the magnetic head assembly.

Removal -- Do the following steps to remove the magnetic head assembly.

____ 1. Place the tape deck in the operating position, then remove the head dust covers from the tape deck.

____ 2. Disconnect the read head connector W6P1 (Figure 11), the write head connector W5P1, and the erase head wires P3 and P4 from the magnetic head. Move the cables out of the way.

NOTE

Before you remove the head, tape a piece of soft, nonadhesive material across the recording surface for protection.

The head can easily hit the tape deck during removal.

CAUTION

Do not loosen the head alignment screws, otherwise, you must replace the entire head with a new assembly.

Never move the head. It is factory positioned on the base.

____ 3. Loosen the four head mounting screws. Hold the head assembly against the tape deck while you remove the mounting hardware.

____ 4. Carefully remove the head from the tape deck.

Replacement -- Do the following steps to replace the magnetic head assembly.

NOTE

Before you install a magnetic head, make sure that the recording surface is protected with soft, nonadhesive material.

____ 1. Put the magnetic head through the hole in the tape deck and position the head onto the guide pins.

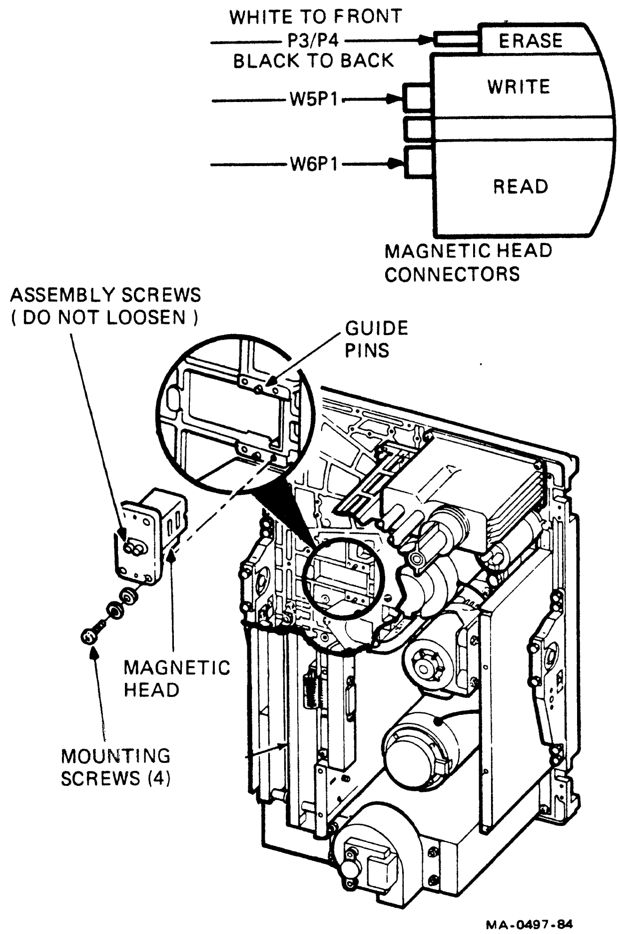


Figure 11   Magnetic Head Removal

____ 2. While you hold the head in place, insert the mounting hardware and tighten the screws.

NOTE
You do not have to align the head. Make sure the erase cables are attached as shown at the top of Figure 11.

____ 3. Guide the read and write/erase cables through the tape deck. Attach the cables to the correct head as shown in Figure 11.

____ 4. Remove the covering you added to protect the recording surface.

____ 5. Clean the magnetic head recording surface with a soft lint-free cloth moistened with Digital cleaning fluid. Wipe the recording surface in the same direction as tape motion, and then wipe 90 degrees to tape motion.

<u>Verification Checks</u> -- You perform the verification checks after you replace the modules.

Air Bearing Assembly

NOTE

Replacement parts for the air bearing assembly are in a kit (PN 29-24359). This kit contains two spring guides (one upper and one lower), a transducer, a small O-ring, and a large O-ring.

You should completely refurbish the air bearing assembly whenever you replace a transducer. This means you should use all parts of the refurbish kit, and order a new kit.

When you replace the spring guides only, you do not need to remove the air bearing assembly from the tape deck. Refer to the TU81 Magnetic Tape Subsystem Pocket Service Guide for details.

You can remove both air bearings by using the same procedure. In this lesson you will remove only one air bearing (your choice).

Removal -- Do the following steps to remove the air bearing assembly.

CAUTION

For this course, make sure you do not damage any air bearing parts during the removal procedure. You must use all the original parts during the replacement procedure.

Be very careful with the transducer pins when you detach the cable. They break very easily when bent.

NOTE

Check (and mark if necessary) the pins on the transducer and the cable plug so you can reconnect them correctly. Incorrect connection may cause inaccurate fault symptoms.

____ 1. From the bottom of the tape deck, disconnect the cable connector from the transducer pins (Figure 12).

____ 2. To gain access to the screws that hold the air bearing, remove the screws that hold the logic cage and move the cage enough to gain access to the air bearing mounting screws. Do not remove the tie wraps that hold the cables to the cage.

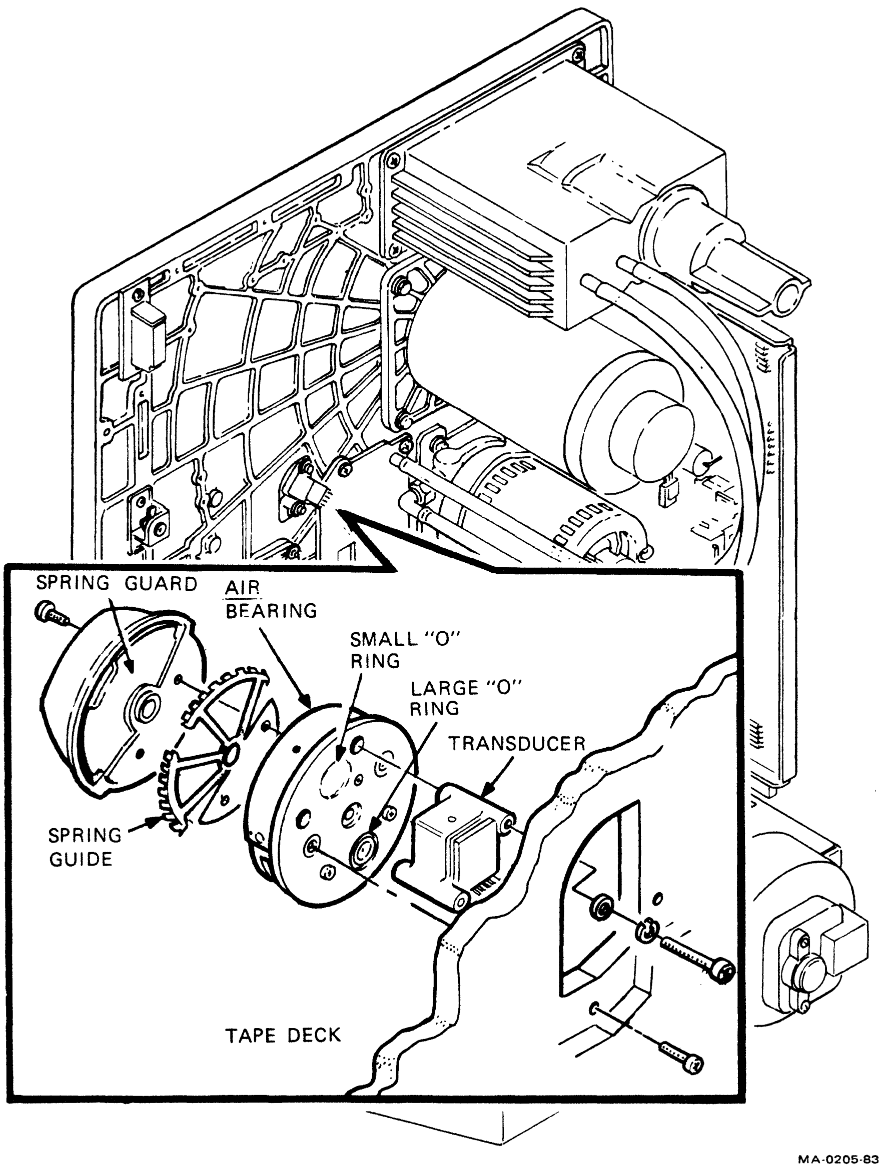


Figure 12   Air Bearing Assembly Removal

____ 3. Remove the two mounting screws that hold the air bearing assembly to the bottom of the tape deck. (The tape path cover on the top of the tape deck will hold the air bearings in place at this time.) Do not remove the screws that hold the sensor to the air bearing at this time.

> **CAUTION**
> Do not snag or chafe the control panel cable or any other cable when you position the tape deck.

____ 4. Place the tape deck in the operating position.

____ 5. Remove the tape path cover, then remove the complete air bearing assembly from the top of the tape deck. Make sure the large O-ring does not fall out of the air bearing.

____ 6. Place the assembly on a flat surface, then remove the two mounting screws that hold the sensor to the air bearing.

A small O-ring is under the transducer. It can fall out of position, so be careful not to lose it.

____ 7. Remove the two screws from the front of the air bearing. You can now remove the spring guide.

Replacement -- Do the following steps to replace the air bearing assembly. Use the original parts during this procedure.

____ 1. Secure the spring guide and spring guide guard to the air bearing with the two mounting screws.

____ 2. With the small O-ring seated properly, position the transducer on the air bearing. Then, install and tighten the two mounting screws to secure the transducer.

____ 3. With the large O-ring seated properly, position the air bearing onto the tape deck. Then, install the tape path cover to hold the air bearing in position.

____ 4. Place the tape deck in the maintenance position. Secure the air bearing with the mounting screws and washers.

____ 5. Replace the screws that hold the logic cage.

____ 6. Reconnect the connector to the transducer pins.

Verification Check -- You perform the verfication check after you replace the modules.

Servo/Control, Write Driver and Read Amplifier

The following paragraphs describe how to finish replacing, then check, the servo/control, write driver, and read amplifier modules.

Replacement -- Do the following steps to replace the modules.

____ 1. Place the modules in the cabinet in the service position. Then, replace the top retaining bar.

____ 2. Replace connectors W2P1, W8P1, W10P1, W1P2, W9P2, and W3P8 on the servo/control module.

____ 3. Replace connectors W7P4 and W7P5 on top of the servo/control and read amplifier modules.

____ 4. Swing the modules to the right against the logic cage and close the retaining latch. Then tighten the thumbscrews on the servo/control module.

____ 5. Replace connector W6P2 on the read amplifier module.

____ 6. Replace connectors W5P2 and W7P6 on the write driver module.

<u>Verification Checks</u> -- Do the following steps to perform verification checks on the modules.

____ 1. Move jumper W1 at location D23 on the servo/control module to the 1/2 position.

____ 2. Place the tape deck in the operating position.

____ 3. With tape not threaded, run Field Service Test 37.

Test 37 sets up the velocity correction multiplier for the velocity DAC. You must run this test whenever you replace the servo/control module.

____ 4. Run Field Service Test 49.

Test 49 enables autoload on power-up, displays the unit identifier, and sets up the power-down timer for one minute if no tape motion has occurred. Test 37 disables everything this test enables.

____ 5. Load a known good write-enabled scratch tape.

____ 6. Run Field Service Test 64.

Test 64 loads the write current values. You must run this test whenever you replace a head assembly, write driver, or servo/control module.

____ 7. Run Field Service Test 31.

Test 31 sets up and checks the read amplitudes for each track at 25 and 75 ips. You must run this test whenever you replace a head assembly, write driver, servo/control, or read amplifier module.

____ 8. After the test is complete (display ØØ), return jumper W1 at location D23 from the 1/2 position to the 2/3 position before you powered down the unit.

____ 9. Install and tighten the top and bottom thumbscrews to secure the modules to the card cage.

____ 1Ø. Replace the holding bracket.

Test Ø1 is the final verification test. It verifies many of the replacements you do in this lesson. To save time, run Test Ø1 only once at the end of this lesson.

This course combines the removal and replacement procedures for the read formatter, write formatter, and TMSCP interface modules.

<u>Read Formatter Module</u> -- The following paragraphs describe how to remove and replace the read formatter module.

<u>Removal</u> -- Do the following steps to remove the read formatter module.

____ 1. Loosen the logic cage lock screws and slide the cage out until the top and bottom detents engage (Figure 13).

____ 2. Loosen the two thumb screws and separate the formatter read module from the write formatter module. Avoid unnecessary stress on the modules by loosening the thumbscrews alternately and separating the modules as the screws are loosened.

____ 3. Loosen and back out the hinge's upper screws 6 to 8 turns. Loosen the lower screws 2 turns (do not remove). Hold the module in place while you loosen the screws.

____ 4. Remove the read formatter module from the logic cage.

<u>Replacement</u> -- Do the following steps to replace the read formatter module.

____ 1. Insert the module into the cage's top and bottom hinge slots. Make sure the module is fully inserted into the hinge slot and W7P8 connector.

____ 2. Tighten each hinge's upper screws 4 to 6 turns.

Now remove the write formatter module.

Verification Checks -- The verification check for the read formatter is Operator Test Ø1, which you run at the end of this lesson.

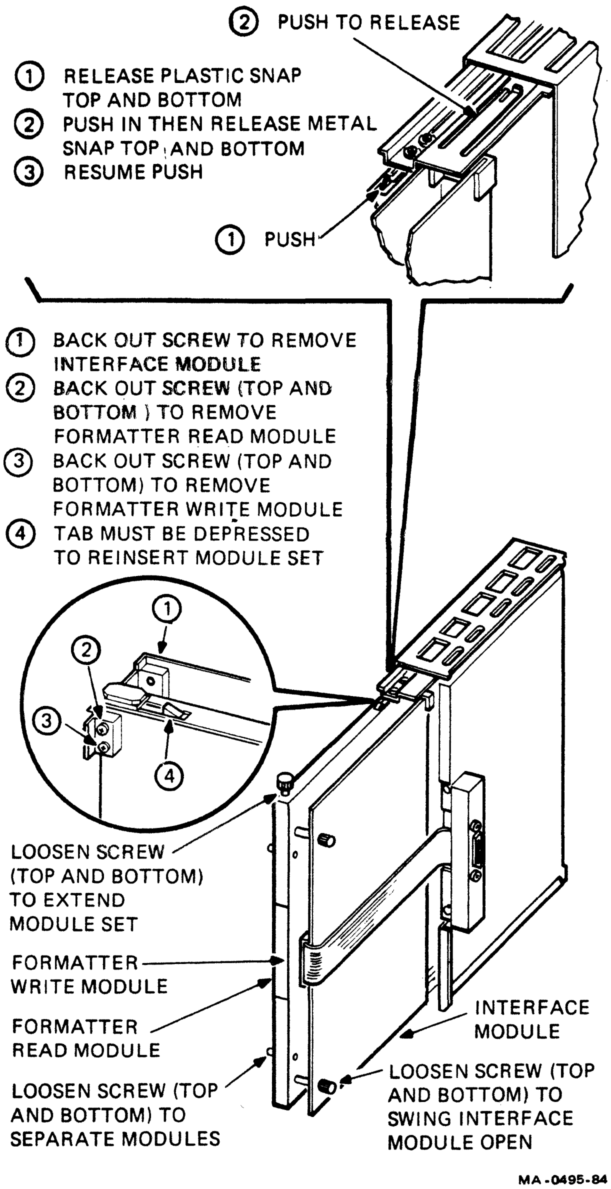


Figure 13 Formatter Read/Write Interface Module

Write Formatter Module

The following paragraphs describe how to remove and replace the write formatter module.

Removal -- Do the following steps to remove the write formatter module.

____ 1. Loosen the thumbscrews and fold out TMSCP module to gain access to the cables (Figure 13).

____ 2. Use the quick disconnect tabs to remove connectors W1ØP2 and W11P from the module (Figure 14).

____ 3. Loosen and back out each hinge's lower screws 4 to 6 turns. Hold the module in place while you loosen the screws.

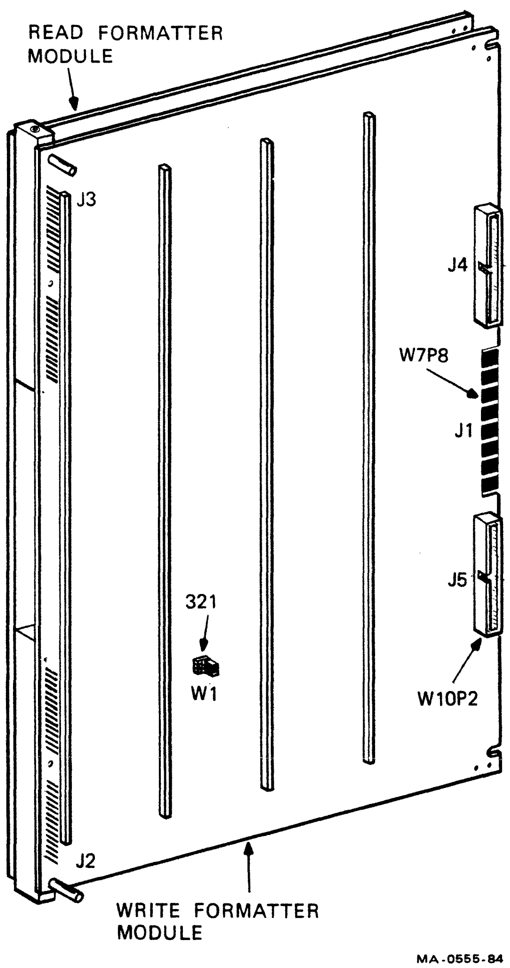


Figure 14 Write Formatter Module

____ 4. Remove the write formatter module from the cage.

Replacement -- Do the following steps to replace the write formatter module.

NOTE

Before you install a new module, make sure the jumper blocks (W1 and W2) are in the same position as on the old module. Refer to Table 1 for the standard setting.

____ 1. Insert the module into the cage's top and bottom hinge slots. Make sure the module is fully inserted into the hinge slot and W7P8 rear connector.

____ 2. Attach the edge pin connectors of both modules, and secure them with the two thumbscrews. Make sure these connectors are completely pressed together.

____ 3. Tighten the top and bottom hinges' lower screw to lock the module into position. Make sure all four hinge screws are tight.

____ 4. Attach connectors W10P2 to J5 and W11P to J4 on the module.

Now remove the TMSCP interface.

Table 1 TU81 Interblock Gap Setting

Function	Formatter Write Module Jumper/Switch
Variable long gap (0.6" to 1.2")	W1 at positions 1 and 2

Verification Checks -- The verification check for the write formatter is Operator Test Ø1, which you run at the end of this lesson.

TMSCP Interface Module

The following paragraphs describe how to remove, replace, and check the TMSCP interface module.

Removal -- Do the following steps to remove the TMSCP interface module.

____ 1. Use quick disconnect tabs to remove connectors W17P1, W15P1, W11P, and W18 (I/O cable) from the interface module (Figure 15).

____ 2. Unscrew the top and bottom screws from the brackets (Figure 13), then remove the module from rear connector W7P9.

Replacement -- Do the following steps to replace the TMSCP interface module.

NOTE
Before you install a new interface module, make sure the jumpers are in the same position as those on the replaced module.

____ 1. Insert the module in the upper and lower brackets, then secure it with the upper and lower screws.

____ 2. Install the cable connectors as follows.

W7P9 to J1
W18 to J2
W11P to A1
W17P1 to J4
W15P1 to J5

____ 3. Tighten the upper and lower thumbscrews to secure the interface module to the write formatter module.

____ 4. Release the upper and lower detents and slide the cage into the frame. Tighten the cage lock screw.

Verification Checks -- Do the following steps to perform the verification checks on the TMSCP interface.

____ 1. Apply dc power to the drive to run the interface health check. If the check is successful, the unit identifier appears on the operator panel.

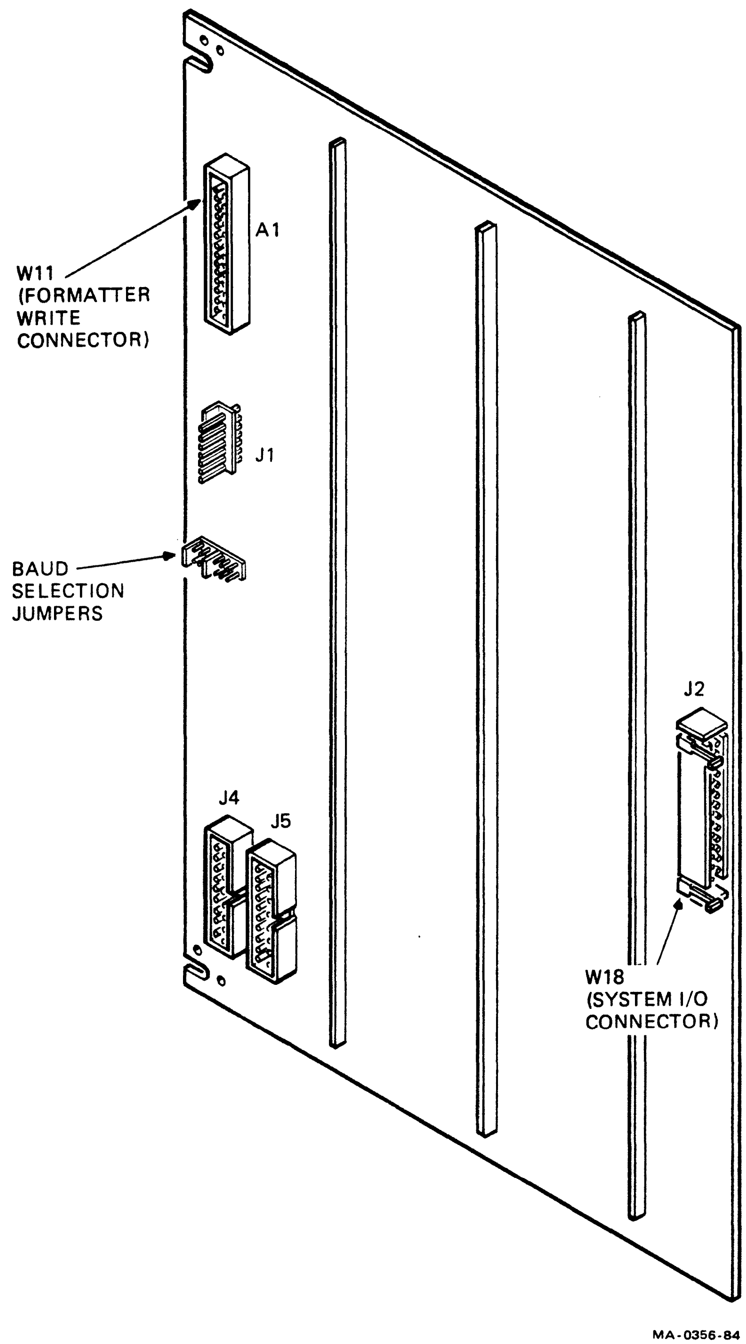


Figure 15   TMSCP Interface Module

Supply Reel Hub Assembly

The following paragraphs describe how to remove and replace the supply reel hub assembly.

Removal -- Do the following steps to remove the supply reel hub assembly.

____ 1. Press the center button on the hub to unlatch it.

____ 2. Find the slotted opening (Figure 16, slot A) on the periphery of the reel cover. Insert a small blade screwdriver into slot A and twist to unsnap the hub cover from the hub assembly.

____ 3. Place the hub assembly in the latched position by pressing the cam carrier. Pushed down

CAUTION

Make sure the hub is latched before you go to the next step. Otherwise, the assembly may disassemble. The assembly is difficult to reassemble.

____ 4. Remove the three large mounting screws from the cam carrier. You can then remove the hub assembly from the tape deck.

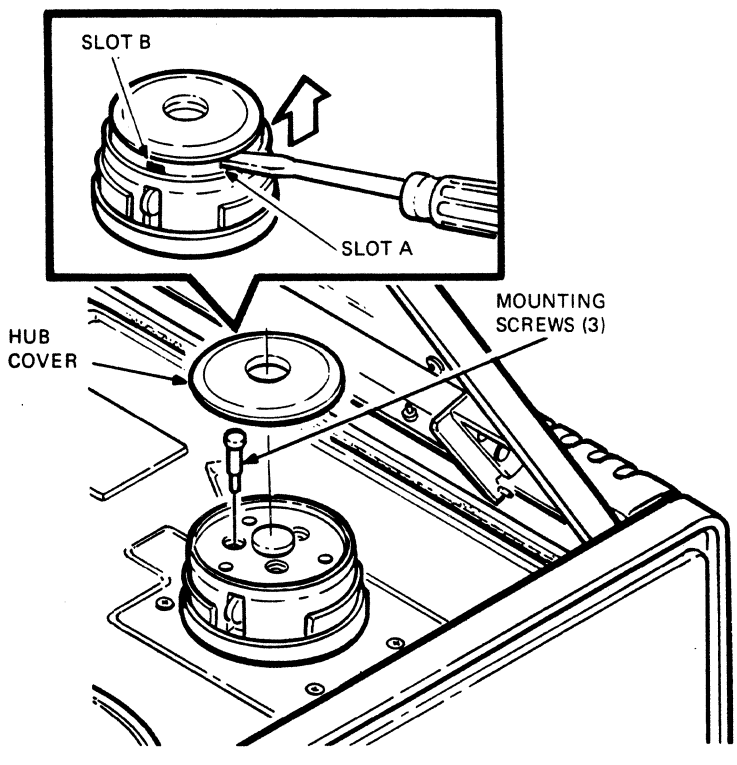


Figure 16 Supply Hub Assembly Removal

Replacement -- You replace the supply reel hub assembly after you remove and replace the reel motor. The procedures to replace the supply reel hub assembly are part of the supply reel motor replacement procedures.

Supply Reel Motor

The following paragraphs describe how to remove and replace the supply reel motor.

Removal -- Do the following steps to remove the supply reel motor.

NOTE
This procedure is easier if you remove connector P1 to the power supply in order to get it out of the way.

____ 1. Remove the B1P1 connector from the J3 plug on the power amplifier module (Figure 17).

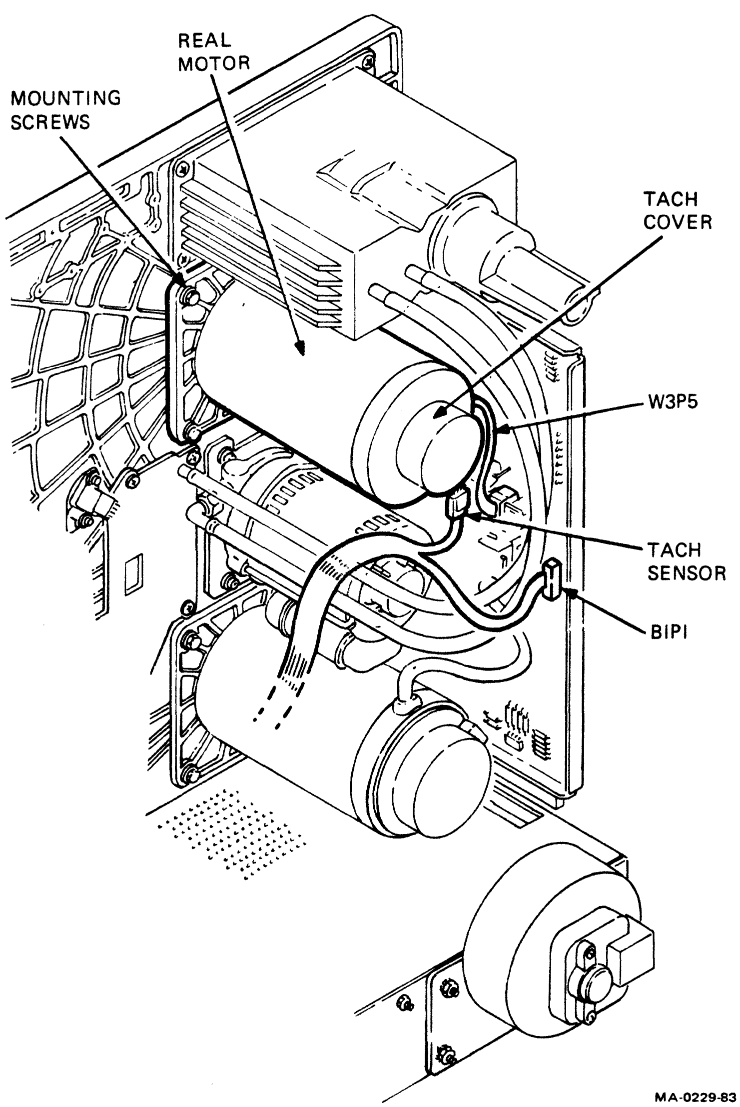


Figure 17 Supply Reel Motor Removal

____ 2. Remove the four mounting screws and the tach cover from the motor.

____ 3. Remove the W3P5 connector from the tach sensor on the motor.

This connector is not keyed. Make sure it is marked so you will not replace it in the reverse position.

NOTE

You need a 9/16 inch socket, 6-inch extender, and 3/8 inch drive rachet to do the following step. These items are part of a socket set (PN 29-22445-ØØ).

____ 4. Remove the four mounting screws that hold the motor to the back of the tape deck.

____ 5. Carefully remove the motor from the transport.

Replacement -- Whenever you order a reel motor, it comes with the 1ØØØ-line tachometer attached. If you are replacing the supply reel motor, you have to install the 1-line tachometer on the old reel motor in place of the 1ØØØ-line tachometer. The TU81 Magnetic Tape Subsystem Pocket Service Guide has the procedure for tach installation. Do the following steps to replace the supply reel motor.

NOTE

Both TU81 reel motors have the same part number.

CAUTION

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

____ 1. Position the motor on back of the tape deck so the sensor extends to the right of the motor assembly. Secure the motor to the deck with four mounting screws.

NOTE

If you are installing a new motor assembly, remove the four mounting screws and the tach cover from the motor before installation. Then, install the 1-line tachometer from the original supply reel motor.

____ 2. Connect the B1P1 cable to J3 on the power amplifier module.

____ 3. Connect the W3P5 cable to the tach assembly on the motor.

____ 4. Position the tach cover on the motor and secure it with four mounting screws.

Do the rest of these steps to replace the hub you removed earlier.

____ 5. Position the hub assembly on to the motor shaft assembly and secure it with the three large shoulder screws.

____ 6. Install the reel cover on the face of the hub assembly.

<u>Verification Check</u> -- Do the following steps to perform the verification check on the supply reel motor.

____ 1. Mount the tape reel on to the hub assembly. The reel should mount easily on to the hub and against the bottom flange.

____ 2. Latch the reel on to the hub. Make sure that the reel is securely fastened.

____ 3. Load a known good quality tape and watch the reel during tape motion. Tape should not touch the top reel flange.

Operator Test Ø1 is the final verification check for both the reel motor and the hub. You run Operator Test Ø1 at the end of this lesson.

<u>Pressure Regulator</u>

The following paragraphs describe how to remove and replace the pressure regulator.

CAUTION

Do not turn the large allen screw at one end of the regulator (Figure 18). This screw is factory set. You must replace the regulator if you turn this screw and break the seal.

Removal -- Do the following step to remove the pressure regulator.

____ 1. Remove the pressure regulator by unscrewing it (counterclockwise) from the plenum box by hand (Figure 18).

Replacement -- Do the following step to replace the pressure regulator.

____ Screw the pressure regulator clockwise on to the shaft that protrudes from the plenum box, until it sits firmly against the plenum box.

Make sure an O-ring is in place on the filter base to maintain a seal between the base and the plenum box.

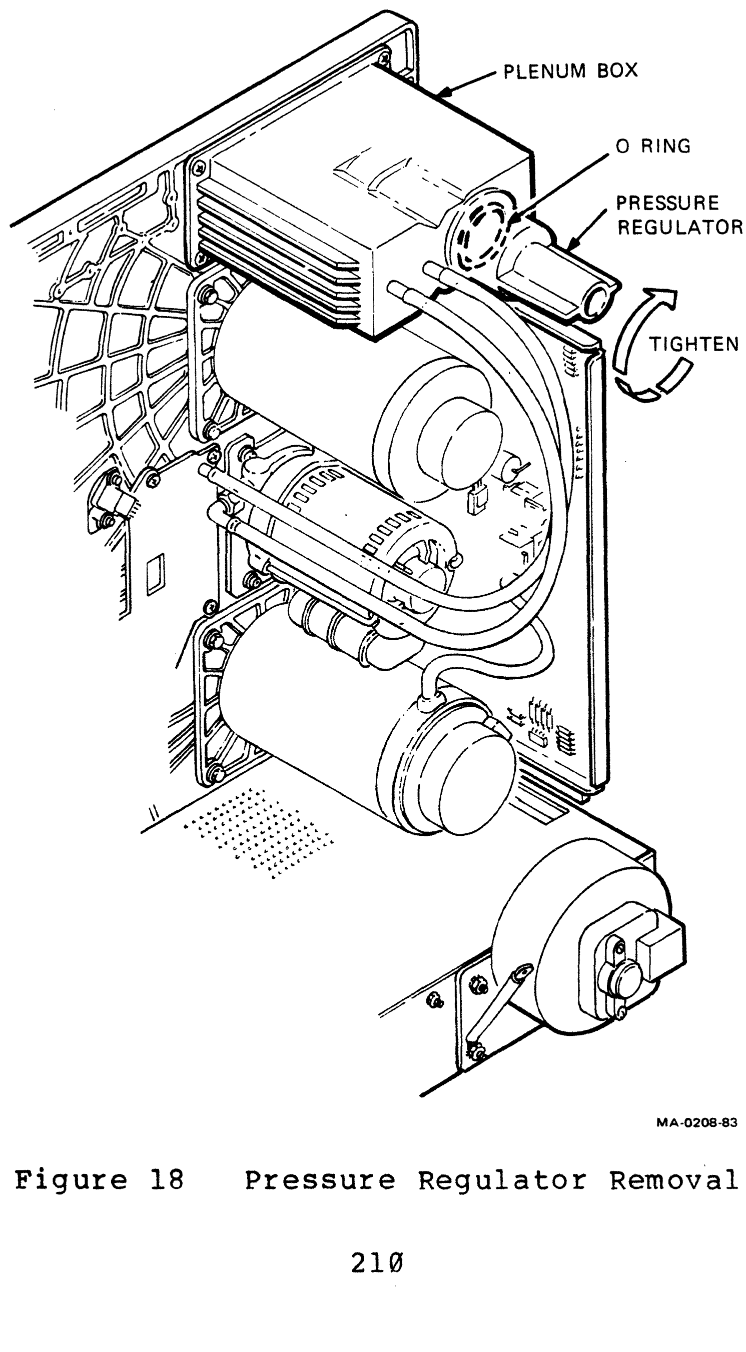


Figure 18 Pressure Regulator Removal

Verification Checks -- The verification checks for the pressure regulator are Tests Ø2 and Ø1, which you run at the end of this lesson.

Plenum Box and Air Filter

The following paragraphs describe how to remove and replace the plenum box and air filter.

Removal -- Do the following steps to remove the plenum box and air filter.

___ 1. Remove the two plenum tubes (Figure 19) from the plenum box.

You must never mix up these tubes. Make sure they are marked so you can replace them correctly.

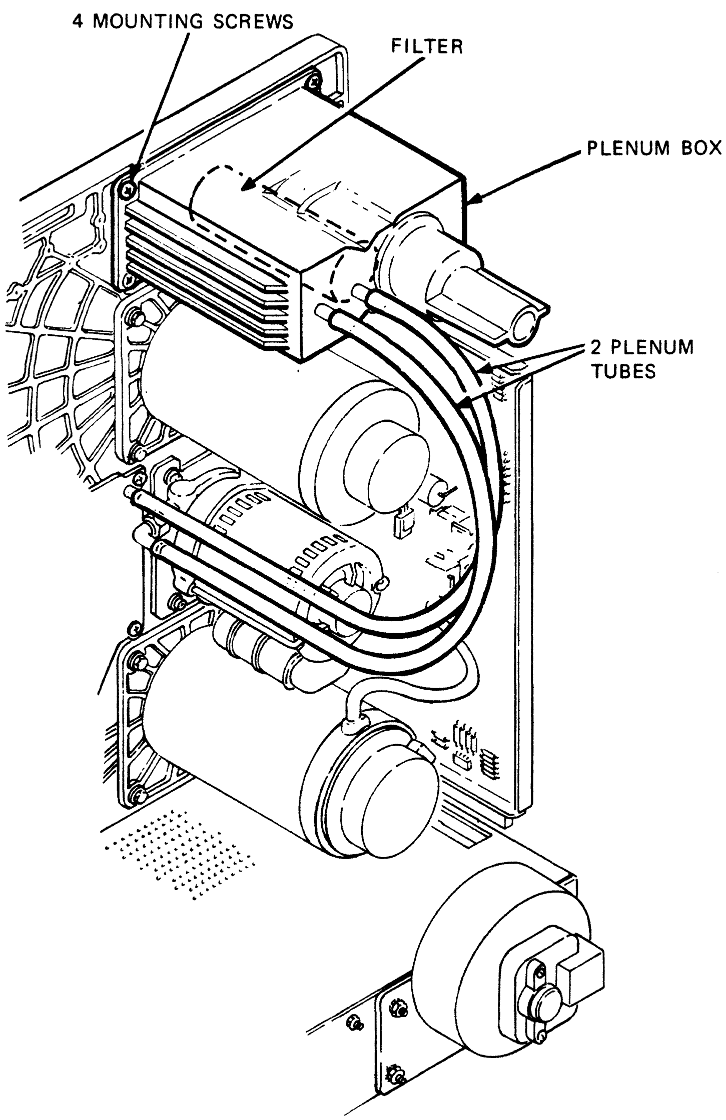


Figure 19 Plenum Box and Air Filter Removal

____ 2. Remove the plenum box by removing the four mounting screws.

Make sure the screws do not fall into the cabinet. The screw in the lower left corner is the hardest to remove without letting it fall into the cabinet.

____ 3. Remove the air filter by pulling it straight out from inside the plenum box.

Replacement -- Do the following steps to replace the plenum box and air filter.

NOTE

There is no recommended replacement time for the filter. The time varies widely according to the cleanliness of the customer environment.

Errors associated with a dirty filter are defined when you use the Pathfinder as shown in the Diagnostic lesson.

____ 1. Position the filter on to the filter base inside the plenum box.

____ 2. Position the plenum box on the tape deck and secure it with the four mounting screws.

____ 3. Install the two plenum tubes. Make sure they are not mixed up.

Verification Checks -- The verification checks for the plenum box and air filter are Tests Ø2 and Ø1, which you run at the end of this lesson.

Power Amplifier Module

The following paragraphs describe how to remove and replace the power amplifier module.

Removal -- Do the following steps to remove the power amplifier module.

____ 1. Remove the following connectors from the power amplifier module (Figure 2Ø).

B3P1 from J1
W3P7 from J2
B1P1 from J3
W7P7 from J4
C1P1 from J5

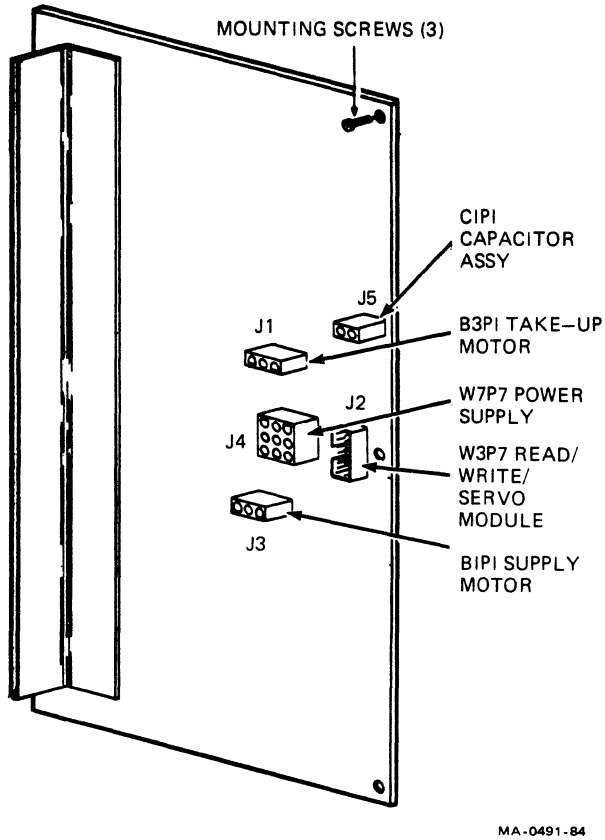


Figure 20 Power Amplifier Module

____ 2. Release the three quick disconnect tabs along the outside edge of the module to let you remove the module from the mounting assembly.

____ 3. Remove the module.

<u>Replacement</u> -- Do the following steps to replace the power amplifier module.

____ 1. Insert the module into the mounting assembly. Inside, the mounting assembly has metal slots to receive the module.

____ 2. Secure the module by pressing it on to the tabs.

____ 3. Install the connectors as follows.

B3P1 from J1
W3P7 from J2
B1P1 from J3
W7P7 from J4
C1P1 from J5

Verification Check -- The verification check is Operator Test Ø1, which you run at the end of this lesson.

Power Supply and Cooling Fan

The following paragraphs describe how to remove, replace, and check the power supply and cooling fan.

Removal -- Do the following steps to remove the power supply and cooling fan.

____ 1. Open the rear door, then remove the frame stabilizing bar (Figure 21).

____ 2. Unplug the power cord.

____ 3. Remove the four mounting nuts from the cooling fan.

____ 4. Disconnect the cooling fan connector and put the fan aside.

____ 5. Disconnect the power cable from the power supply and put the cable aside.

____ 6. Detach all connectors from the power supply.

NOTE

The power supply weighs approximately 9 lbs (4.1 kg). Be very careful.

____ 7. Return the tape deck to its operating position.

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

____ 8. Loosen but do not remove the two mounting screws on the left side of the power supply (Figure 21).

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

____ 1Ø. Slide the power supply out of the slots on the left, then carefully remove the power supply from the cabinet.

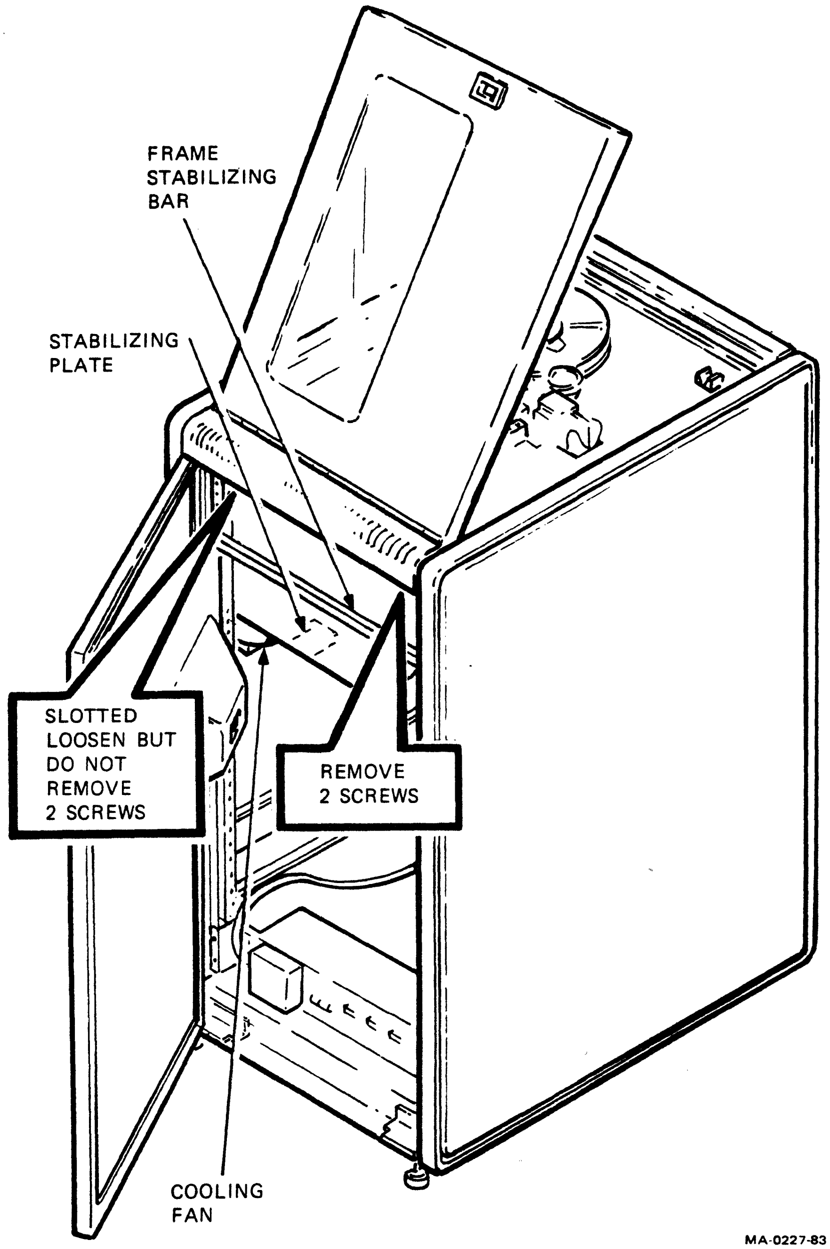


Figure 21 Power Supply Removal

<u>Replacement</u> -- Do the following steps to replace the power supply and cooling fan.

> **CAUTION**
>
> If you are installing a new power supply, remove the top cover and look at the position of the voltage select module. The position of this module must correspond to the input voltage defined on the Equipment Identification Plate. The ends of the cord are labeled with 120 V and 220 V and indicating arrows. Make sure the module is connected to match the input voltage.
>
> You can disconnect the module, turn it upside down, and reconnect it to the main power supply module if necessary.

____ 1. Remove the top cover of the power supply.

____ 2. Make sure the voltage select module (Figure 22) is installed in the correct position.

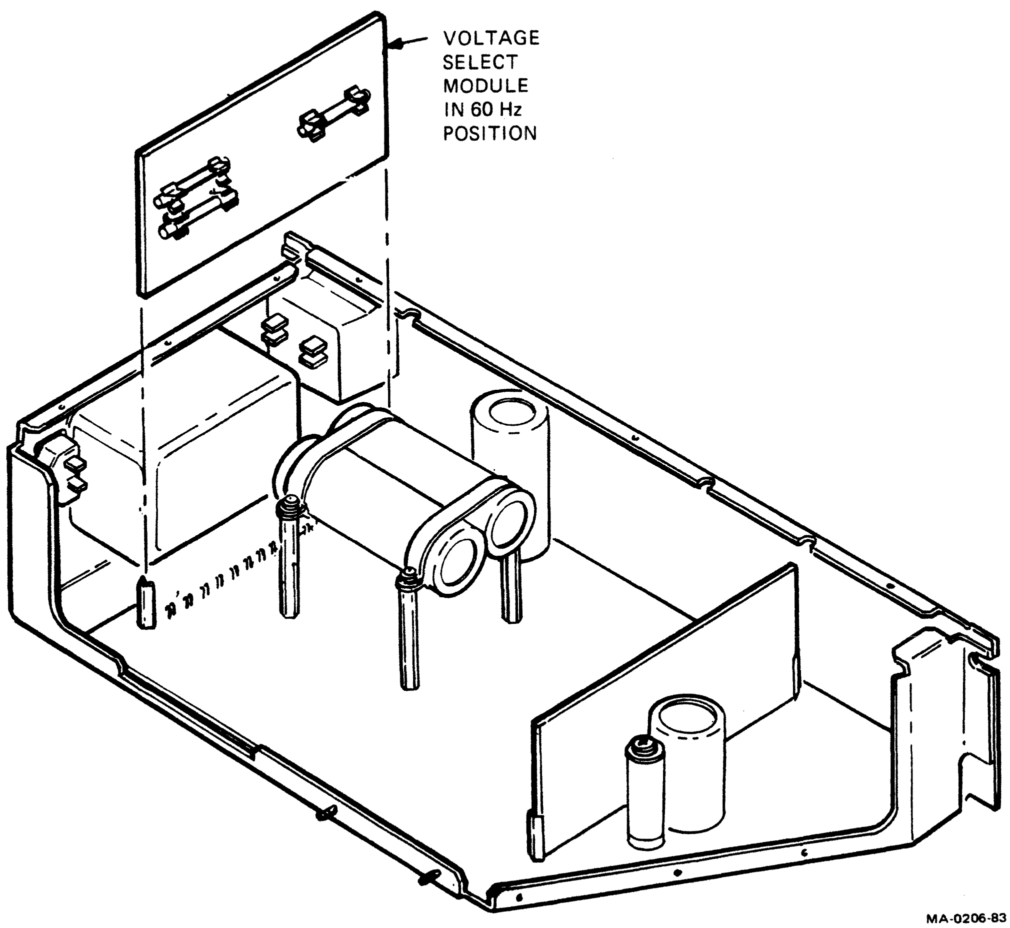


Figure 22 Power Supply Removal (Continued)

____ 3. Replace the cover.

____ 4. From rear of the transport, slide the power supply under the two installed mounting screws.

____ 5. Insert and tighten the other two mounting screws.

____ 6. Tighten the two mounting screws on the left.

____ 7. Install the frame stabilizing bar.

____ 8. Turn the tape deck into the service position.

____ 9. Attach the connectors to the power supply as follows.

Power Supply	Cable
J2	W4P4 pneumatic pump
J3	P1 cooling fan
J4	W7P1 TB1 terminal block
J5	W2P1 servo control module
J1Ø	TB1 terminal block

____ 1Ø. Install the cooling fan connector and slide the cooling fan into position.

____ 11. Install and tighten the four mounting nuts.

____ 12. Connect the power cable to the power supply, then plug the power cord into the power outlet.

<u>Verification Check</u> -- Do the following steps to perform verification checks on the power supply and cooling fan.

____ 1. Make sure air is flowing from the cooling fan exhaust.

____ 2. Use a digital voltmeter (DVM) to check all dc voltages. First, connect the voltmeter's ground lead to pin 5 on power terminal strip TB-1 (Figure 23). Connect the other volt meter lead to the points shown in Figure 23 to test all dc voltages. Refer to Table 2 for tolerences.

You have performed 16 of the 25 removal and replacements shown in Table 3. The final verification check, is to run Operator Test Ø1. Remember, this is the final verification check on many of the FRUs you replaced. If you get an error, follow the procedures in the Pathfinder document. A failure is not necessarily in the modules you replaced.

____ 3. With tape threaded, but not loaded, run Operator Test Ø1.

This test takes more than 1Ø minutes to run. Read the rest of this lesson while you wait.

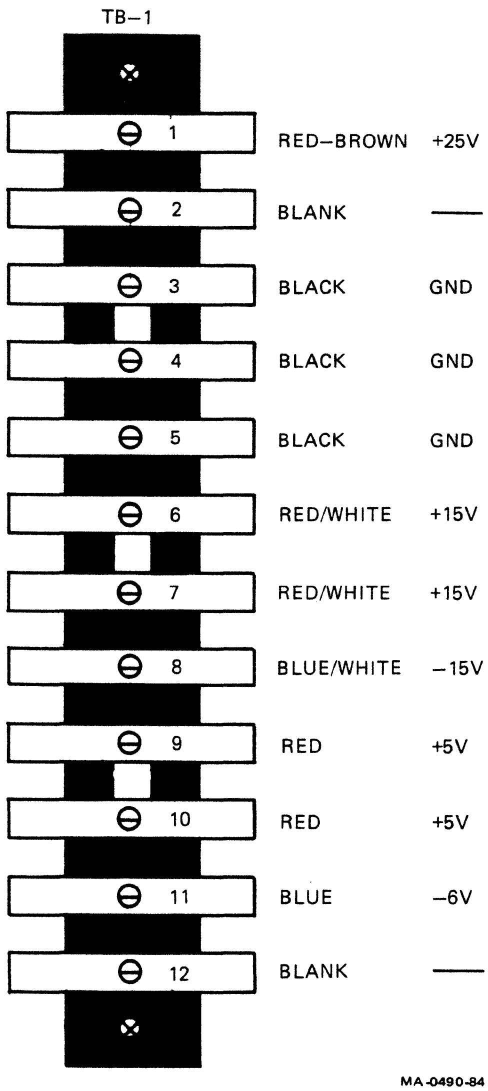


Figure 23 DC Voltage Checks - TB1

Table 2 DC Voltages and Tolerances

Location	Voltage	Tolerance
TB1-9/10	+ 5	± 2% (+4.9 to +5.1)
TB1-8	- 15	± 10% (-13.5 to -16.5)
TB1-6/7	+ 15	± 10% (+13.5 to +16.5)
TB1-1	+ 25	± 10% (+22.5 to +27.5)
TB1-11	- 6	± 10% (-5.4 to -6.6)

Table 3 TU81 FRU Replacement/Verification

FRU Replaced	Verification Check
1. BOT/EOT/AOT Assembly	Run Test 44.
2. Tape Cleaner	None
3. File protect sensor	Load tape with and without write-enable ring. Observe FILE PROT LED.
4. Magnetic head assembly	Clean, then run Test 54, Test 31, and Test Ø1.
5. Air bearing assembly	Run Test Ø1.
6. Supply reel hub assembly	Smooth reel movement and run Test Ø1.
7. Supply reel motor	Run Test Ø1.
8. Pressure regulator	Run Test Ø1.
9. Plenum box and air filter	Run Test Ø1.
1Ø. Power supply	Check voltages at TB-1.
11. Cooling fan	Check air flow from fan.
12. Write driver/read amplifier	Run Test 31 and Test Ø1.
13. Servo/control	Run Test 37, Test 54, Test 31, and Test Ø1.
14. Formatter read	Run Test Ø1.
15. Formatter write	Run Test Ø1.
16. TMSCP interface	Turn power on (Interface Health Check).

NOTE

You did not replace and verify the following FRUs in this course. The procedures are in the TU81 Magnetic Tape Subsystem Pocket Service Guide.

FRU Replaced	Verification Check
17. Door interlock switch	Run Test Ø1.
18. Take-up reel	Make sure reel does not rub on tape deck or tape.

Table 3 TU81 FRU Replacement/Verification (Cont)

FRU Replaced	Verification Check
19. Take-up reel motor	Run Test 37, Test 48, and Test Ø1.
2Ø. Air bearing spring guides	Run Test Ø1 and check for tape damage.
21. Compressor	Run Test Ø1.
22. Control panel	Run Test Ø1.
23. Power amplifier module	Run Test Ø1 and Pathfinder 1ØØ1 through 1ØØ3.
24. Capacitor	Run Test Ø1 and Test Ø2.
25. Supply tach/sensor	Run Test Ø1.

The next lesson covers how to identify and fix TU81malfunctions inserted by the Course Administrator. To expedite this process, you can leave the acoustic cover off at this time.

If you want to perform other removal procedures (17 through 25 in Table 3) do so only with the Course Administrator's authorization. Also, use the procedures in the TU81 Pocket Service Guide.

This completes the Removal and Replacements lesson. Now go to the Troubleshooting lesson.

GENERAL

This lesson outlines general troubleshooting procedures and lists troubleshooting aids that are specific to the TU81. In this lesson you will troubleshoot at least three TU81 problems installed by the Course Administrator.

OBJECTIVE

Use all available TU81 resources to identify and repair faults in the TU81.

MAINTENANCE

Keep the following points in mind when you maintain the TU81.

1. The TU81 has no scheduled preventive maintenance (PM).

2. You do not have to make any manual adjustments. However, if read/write errors or incompatibility with other transports exist, and the tape path is clean, you should activate the EGC circuit with Test 31. This test sets the read gains.

   You do not need a standard output tape when running Test 31. However, with customers who use a wide variety of tapes, you should use the best tape possible when running Test 31.

3. The customer should periodically clean the tape path.

4. The customer should run Operator Test Ø1 whenever any problems are suspected. Periodically running Test Ø1 is not required, but serves as a convenient confidence test for the customer.

NOTE

You are responsible for teaching the customer how to correctly take care of the TU81.

The customer should record all fault codes, whether or not Field Service is called.

5. The power-up health check runs when you power on the transport. A fault code may result. If so, pressing the RESET switch may clear the fault. The customer may report errors found by this check to Field Service.

6. The Pathfinder documentation, if used correctly, will help you find 98 percent of TU81 problems. However, the Pathfinder does not help you diagnose problems in the M8739 or associated cables.

PRE-SITE TROUBLESHOOTING

Do the following steps when you first talk to the customer. You should do these steps before you go to the customer's site.

1. Find out exactly what type of TU81 problem has occurred.

   Loading or tape motion problems
   Cosmetic problems (cleaning, cables, etc.)
   Errors reported in system printouts or the error log
   Intermittent or solid problems
   TU81 fault code displayed
   Compatibility problems

Use the Malfunction Matrix Table in the Pathfinder to find possible solutions.

If the problem is intermittent, have the customer leave the TU81 in the failing state.

NOTE

If the hub is unlatched, random errors may occur because the inner diameter of the plastic supply reels can vary from reel to reel.

Always have the customer make sure the supply hub is latched no matter what problem is reported.

2. Ask if a fault code is displayed and what may have caused it (i.e. running on-line, power-up, Operator Test Ø1).

3. Have the customer run Operator Test Ø1 and tell you the results.

   Use these results along with the Fault Code Matrix Table in the Pathfinder to find possible solutions.

   Remember Tests Ø2 and Ø3 if they apply to the situation.

FIRST-PHASE ON-SITE TROUBLESHOOTING

Before you perform any maintenance on the TU81, do the following steps.

1. Have the customer reproduce the problem if possible.

2. Note the state of all TU81 indicators on the control panel.

3. Examine the TU81:

   Does anything smell wrong?

   Does anything sound wrong?

   What are the environmental conditions of the site?

   Do you see any problems? Open the access doors and look at everything: connectors, cables, modules, and mechanical assemblies. Check for breaks, loose connections, discoloration, etc.

   How does the tape look?

Often, Field Service representatives partially or totally overlook these basic troubleshooting steps. Do not overlook these steps. In the long run, these steps save a lot of time, money, and headaches.

If these steps help you find a probable cause of the problem, perform the appropriate testing and/or removal and replacement.

SECOND-PHASE ON-SITE TROUBLESHOOTING

If first-phase troubleshooting does not help you find any problems, do the following steps. Also refer to the flowchart (Figure 1).

1. Run Operator Test Ø1 using a known good tape. Look up any fault codes in the Pathfinder tables.

2. If you cannot run Operator Test Ø1 cannot be run, perform Pathfinder procedures 1ØØ1 through 1ØØ3.

3. Run the appropriate VAX diagnostic tests. These tests help you find intermittent problems because they have extended running times.

   At the same time, check the customer error log printout for errors and incorrectly set register bits. This information is useful when you troubleshoot intermittent problems.

4. Make sure the subsystem connections are correct. Check the overall installation.

5. If you have any idea what the problem might be, use the table at the start of the test descriptions in the Pathfinder to determine if any specific internal test could be useful.

   If you encounter a fault code, also check for sub-fault codes.

If neither the Pathfinder nor testing provides the solution, what do you do then?

First, check the Tech Tips, FCOs, ECOs, and option summary in the microfiche library. Often, Field Service representatives do not use these helpful resources, and many hours are wasted. Most devices have changes after they are introduced. You can find any combination of changes when you arrive at the site. You can identify the changes by using the microfiche.

> NOTE
>
> If you are not familiar with the microfiche library, now is a good time to look through the library and familiarize yourself with its contents. The Course Administrator can help you find all microfiche that applies to the TU81.

Remember, important hardware changes can happen anytime. You must keep up with these changes as you receive them on microfiche.

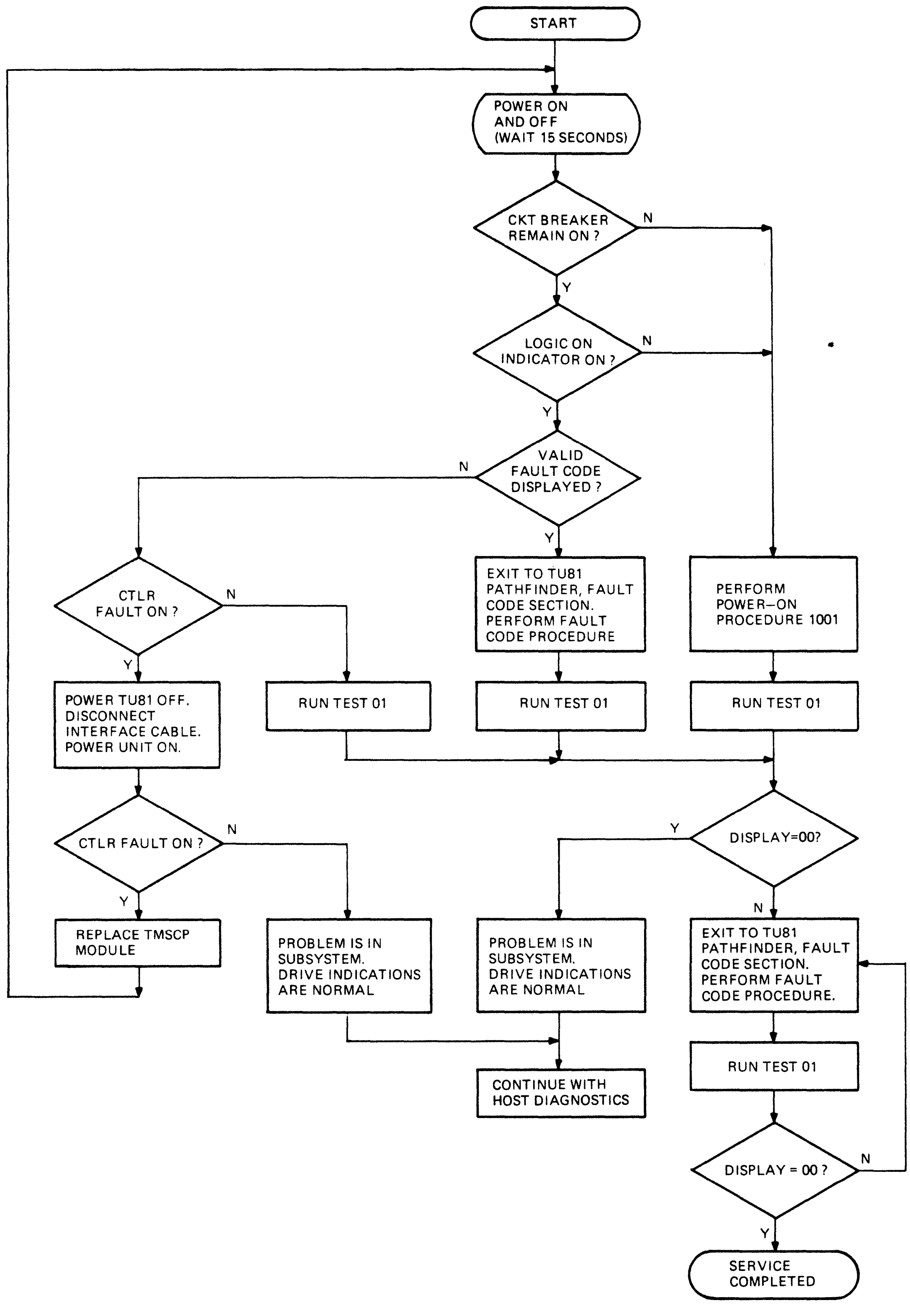


Figure 1 Troubleshooting Flowchart

Check the software. System software patches are always being written to solve problems. Has the customer installed all appropriate patches?

You can learn about software updates from Digital's monthly Software Dispatch and Small Buffer publications. Digital also provides a software hotline.

Use the TU81 Subsystem Technical Manual.

Make sure you thoroughly check the host system. If all tests run correctly on the TU81, the host may be at fault.

THIRD-PHASE ON-SITE TROUBLESHOOTING

After you find the probable cause of an error, replace the associated FRU.

If the first replacement does not solve the problem, replace the original FRU before you replace a second FRU. By working with more than one replacement, you may accidently introduce more problems and complicate the repair.

Always run Operator Test Ø1 to completion as a final check at the end of every repair call.

When possible, run the appropriate VAX diagnostic test to check the complete sub-system.

Also have the customer run the host software.

Finally, look over your work area. Is it clean? Are all doors closed and locked? Is the area ready to be used by the customer? Small things count. A few dirty fingerprints can negatively affect how the customer rates Digital Field Service.

Pathfinder Exercise

Perform this exercise to review how to use the Pathfinder when you troubleshoot the TU81 transport. You can find almost all the troubleshooting information you need in the Pathfinder, if you know where to look.

1. What causes fault code 21?

   a. Power-on health check fault
   b. Take-up tension fault
   c. Aborted unload operation
   d. Velocity correction calculation fault

2. What kind of error causes fault code 21 with sub-fault code Ø3?

   a. RESET pressed during an unload operation
   b. Tape slips while decelerating
   c. Speed fault
   d. 9 ounces detected with no tension

3. What failing component causes fault code 21 with sub-fault code Ø3?

   a. Servo/control module
   b. Supply air bearing assembly
   c. Take-up air bearing assembly
   d. Compressor

4. When Test Ø2 is running, what kind of error causes fault code 82?

   a. Take-up power amplifier fault
   b. Take-up comparator fault
   c. Tape loaded fault
   d. Compressor failure fault

5. When Test Ø2 is running, where in the test sequence does fault code 82 occur?

   a. When checking for quarter tachs
   b. When verifying that the tension comparators work
   c. When verifying that the take-up reel power amplifier works
   d. When checking the zero tension offsets

6. When Test Ø2 is running, what component probably causes fault code 82?

   a. Servo/control module
   b. Take-up motor/tachometer
   c. Power amplifier module
   d. Power supply

Pathfinder Exercise Answers

1. What causes fault code 21?

   b. Take-up tension fault (The assumption at the top of the FAULT CODE 21 page in the Pathfinder tables states, "TU81/TA81 displays Fault Code 21 as a result of a take-up tension fault.")

2. What kind of error causes fault code 21 with sub-fault code Ø3?

   d. 9 ounces detected with no tension (In the sub-fault code tables, this error is listed under fault code 21/sub-fault code Ø3.)

3. What failing component causes fault code 21 with sub-fault code Ø3?

   a. Servo/control module (In the Pathfinder troubleshooting procedure for FAULT CODE 21, if you answer yes on line Ø3Ø for sub-fault code Ø3, it leads down to line Ø6Ø. Line Ø6Ø suggests that you replace the servo/control module.

4. When Test Ø2 is running, what kind of error causes fault code 82?

   a. Take-up power amplifier fault (In the Operator Test Ø2 description, under POSSIBLE TERMINATION CODES, code 82 is listed as a "TU Power Amp Fault".)

5. When Test Ø2 is running, where in the test sequence does fault code 82 occur?

   c. When verifying that the take-up reel power amplifier works (In the Test Ø2 description under TEST SEQUENCE, step d verifies the take-up reel power amplifier and displays an 82 if an error occurs.)

6. When Test Ø2 is running, what component probably causes fault code 82?

   c. Power amplifier module (Since the power amplifiers to the reel motors are on the power amplifier module, it is the most probable cause.)

MALFUNCTIONS

Now you are ready to identify and repair some real malfunctions on the TU81. The Course Administrator will cause a malfunction (bug) in the TU81, and you will find and repair the malfunction.

You must identify and repair at least 3 malfunctions. You may identify and repair up to 10 if you have time.

The following list is a reminder of the resources available to you as you troubleshoot the TU81.

- Pathfinder
  - Fault code tables
  - Tables 1001 through 1003
  - Test descriptions
  - Sub-fault code descriptions

- TU81 Pocket Service Guide
- Internal and on-line diagnostic tests
- Your own physical senses
- TU81 Technical Manual
- TU81 Print set
- Microfiches
- Course documentation
- Customer's description of the problem

NOTE

Always use the Pathfinder tables. If you use them correctly, they will always point you near the problem. You can solve many problems in less than a minute by using the tables. No specialized troubleshooting or guesswork can match that.

Now complete the following procedure.

____ 1. Ask the Course Administrator to install the first TU81 malfunction.

____ 2. Identify the error and repair the problem.

____ 3. Ask the Course Administrator to check your work, then ask for another malfunction.

____ 4. Do steps 1 through 3 at least three times, or until you feel comfortable with the troubleshooting procedures.

This completes the Troubleshooting lesson. Now go to the Installation lesson.

GENERAL

This lesson covers how to install the UNIBUS-LESI adapter module and associated cabling, and then do a final on-line test to make sure the TU81 is error free.

Chapter 5 of the TU81/TA81 Magnetic Tape Subsystem User Guide covers site planning, unpacking, inspection, and cabinet installation. You may have previous training in these areas, so they are not discussed here.

OBJECTIVES

Install an M8739 and associated cabling.

M8739 UNIBUS ADAPTER MODULE

Do the following steps to remove the M8739.

____ 1. Power down the TU81 and the system to which it is attached.

The M8739 is installed in the UNIBUS backplane of the host. (Figure 1).

____ 2. Remove the cable from the M8739.

____ 3. Remove the M8739 from the backplane.

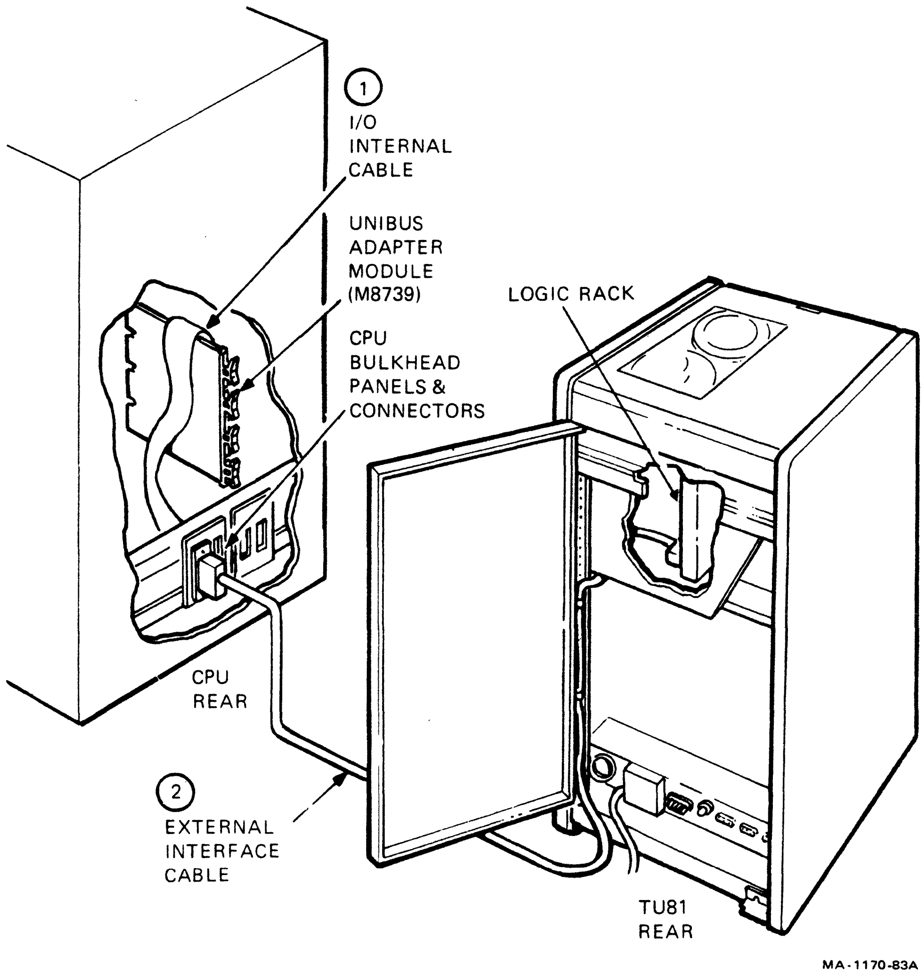


Figure 1 Interface Cabling

UNIBUS ADDRESS

You can select the UNIBUS address by using a single 10-position DIP switchpack and jumper W2 (Figure 2). Address bits 12 through 3 are specified via the DIP switch. Address bits 17 through 13 are hardwired to be 1s. Address bit 2 is set by the W2 jumper. Address bits 1 and 0 are ignored (Figures 3 and 4).

The M8739 module you just removed is probably set up as the first TU81 on the UNIBUS. This standard configuration is shown in Tables 1 and 2.

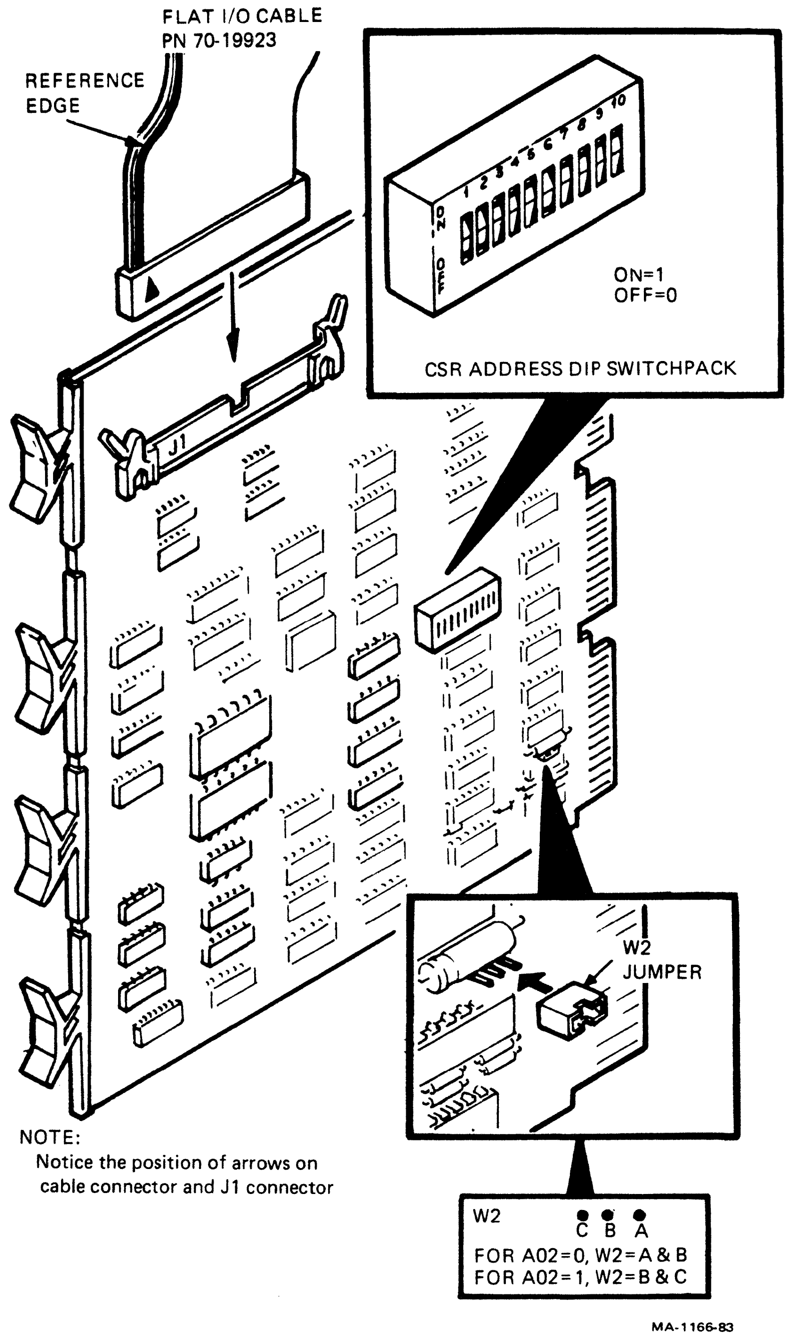


Figure 2 M8739 UNIBUS-LESI Adapter Module

For Base Address 7745ØØ

A18	A17	A16	A15	A14	A13	A12	A11	A1Ø	A9	A8	A7	A6	A5	A4	A3	A2	A1	AØ
1	1	1	1	1	1	1	1	Ø	Ø	1	Ø	1	Ø	Ø	Ø	Ø	Ø	Ø
X	X	X	X	X	X	S1	S2	S3	S4	S5	S6	S7	S8	S9	S1Ø	W2	X	X
		7			7			4			5			Ø			Ø	

Switch Positions

ON = S1, S2, S5, S7
OFF = S3, S4, S6, S8, S9, S1Ø
X = Unselectable (hardwired)

ON = 1
OFF = Ø

W2 jumper = Ø (see Figure 4)

Figure 3 Address Setting Diagram for Single Drive Configuration

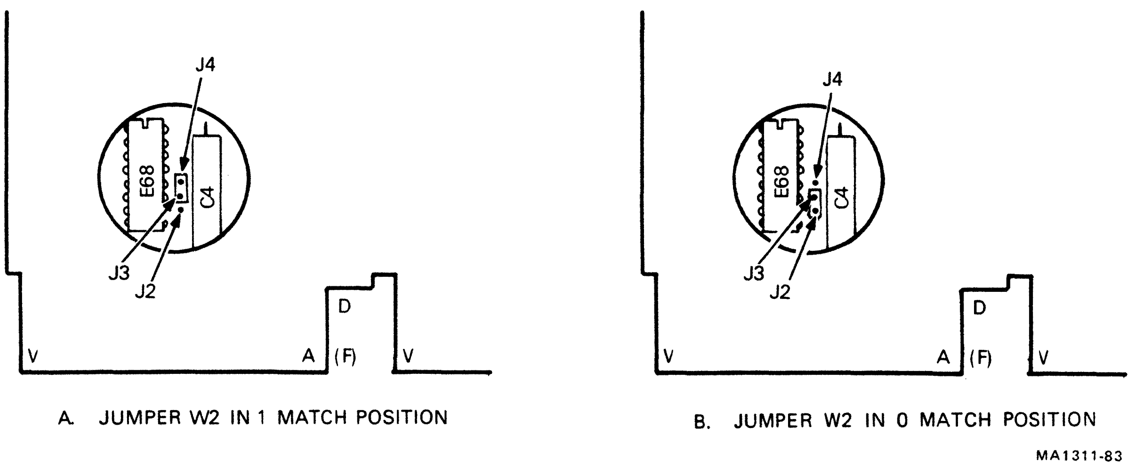


Figure 4 W2 Jumper Setting

Table 1 Single TU81 Address Configuration

Unit Number	Address	Vector
Ø	1745ØØ	26Ø

Table 2 Address Selection in Multi-TU81 Configuration

Transport	Unit Number	Address	Vector
1	0	174500	260
2	1	*	†
3	2	*	†
4	3	*	†

* Floating address -- 760000 to 777774

† Floating vector -- 300 to 700

NOTE
The system sets vector automatically at SYSGEN.

PRIORITY LEVEL

The TU81 subsystem has a suggested bus request priority level of 5 (BR5/BG5), although any priority level between 4 and 7 will work. If you need a priority level other than 5, obtain the appropriate priority level plug. You can change the priority level by changing the plug (Figure 2). However, you must change any Digital programs or other software that refers to the priority level if you change the priority plug.

Example

The following SYSGEN procedure finds the available CSR addresses and vectors. You set the CSR address with the UNIBUS DIP switchpack and jumper W2.

```
$ MCR SYSGEN
SYSGEN> CONFIG
DEVICE> RK611
DEVICE> DZ11
DEVICE> TU81,3
DEVICE> ^Z
Device: RK611   Name: DMA    CSR: 777440     Vector: 210
Device: TU81    Name: PTA    CSR: 774500     Vector: 260
Device: DZ11    Name: TTA    CSR: 760100*    Vector: 300*
Device: TU81    Name: PTB    CSR: 760444*    Vector: 310*
Device: TU81    Name: PTC    CSR: 760450*    Vector: 314*
SYSGEN>^Z
$
```

Now you are ready to install the M8739 in the host UNIBUS backplane. Some of these steps are already complete because the M8739 you are using has previously been installed.

____ 4. Remove the G727 bus grant continuity card from the SPC slot in the UNIBUS backplane where you will install the M8739 (Figure 5).

A bus grant continuity card must be in connector D of any unused SPC slot. If connector D is left open, bus grant continuity is lost.

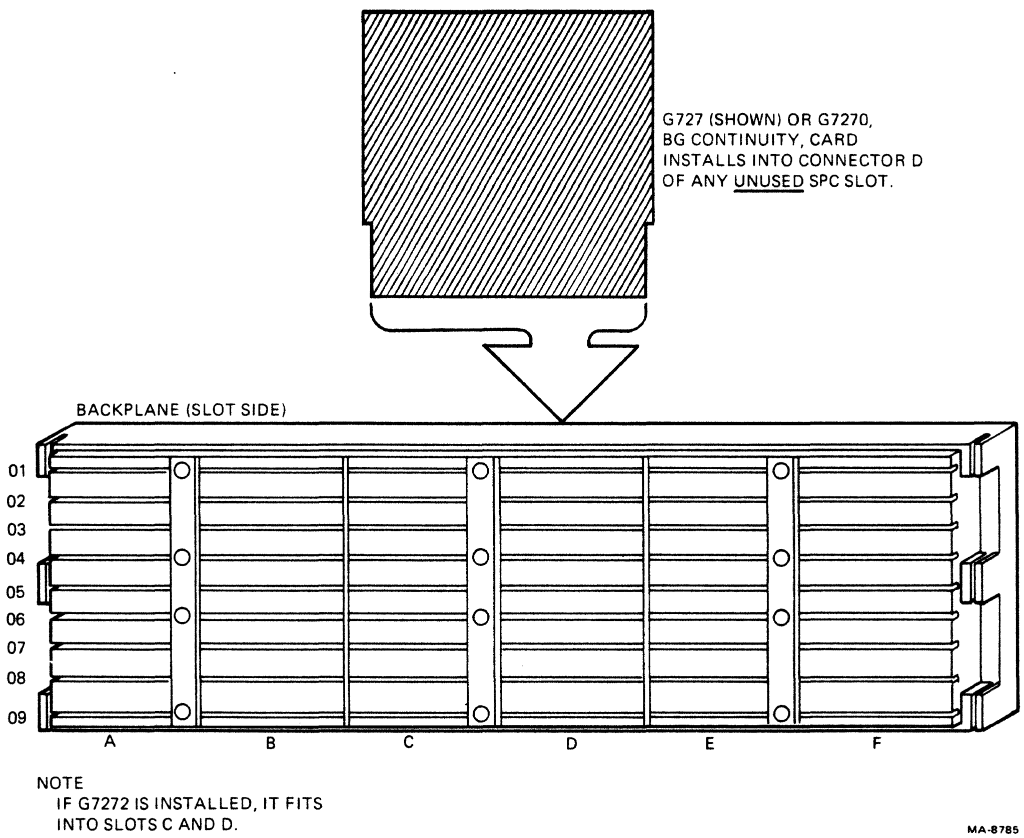


Figure 5 Bus Grant Continuity Card

____ 5. Also, in the same SPC slot, remove the nonprocessor grant (NPG) jumper, CA1 to CB1, on the pinside of the backplane (Figure 6).

____ 6. Install the ribbon cable into J1 on the M8739.

____ 7. Carefully insert the M8739 module into the SPC slot in the UNIBUS backplane.

____ 8. Make sure the cable does not snag other components or block mounting box movement.

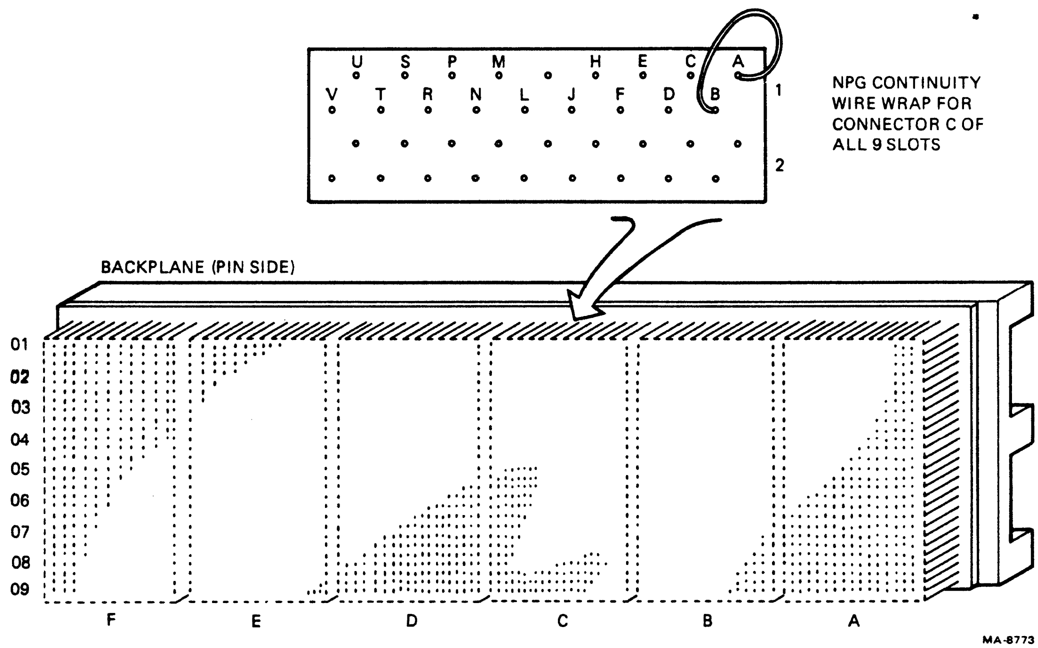


Figure 6 NPG Jumper

The cable goes from the M8739 to the bulkhead connector on the I/O panel in the back of the host cabinet. From there, the signals go across the round interface cable to the connector on the logic cage mounting plate in the TU81 cabinet. From this connector the signals go through the short cable to connect to the TMSCP interface controller module (Figures 1, 7, and 8).

____ 9. Take time now to follow the path of the bus signals from the M8739 to the interface controller module.

Notice the hardware involved in this path. It is simple to install, but you might have some questions when you first encounter this in the field. Find the answers to those questions now to save time when you are on the job.

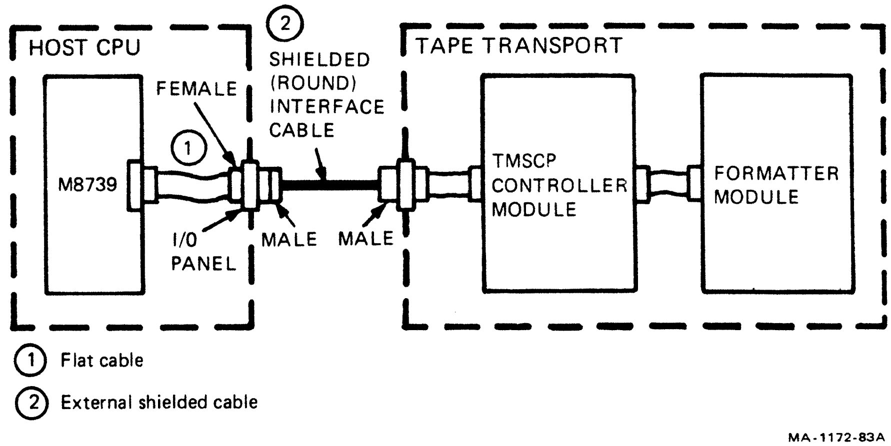


Figure 7 Plug-to-Plug I/O Cable Connections

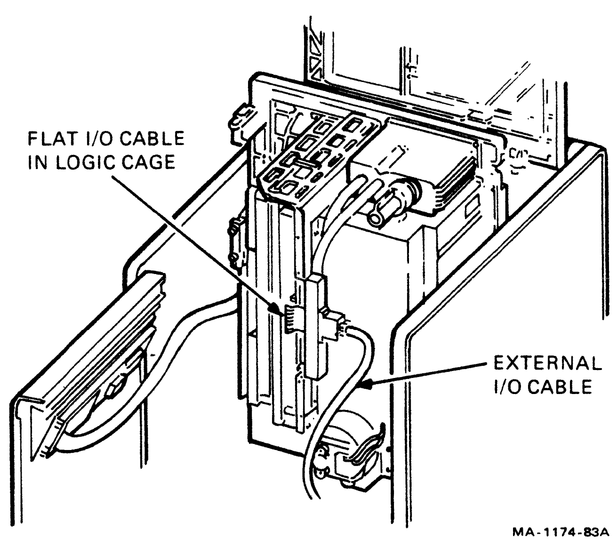


Figure 8 Internal I/O Cabling

____ 10. Make sure the voltage select module in the TU81 power supply is in the correct position for power requirements in your location.

____ 11. Make sure the jumpers on the write formatter module are in the correct position. Refer to Table 3 for the correct positions.

____ 12. Power up the host system.

____ 13. Make sure that a remote switching cable is installed between the host power controller and the TU81 power controller.

____ 14. Make sure the 3-position switch on both power controllers is in the REMOTE position. This allows you to power on peripherals in either cabinet by using the host on/off switch.

____ 15. Power up the TU81.

____ 16. Check all voltages.

Table 3 TU81 Interblock Gap Setting

Function	**Formatter Write Module Jumper/Switch**
Variable long gap (0.6" to 1.2")	W1 at positions 1 and 2

UNIT IDENTIFICATION (ID)

The unit identification (ID) is used as a unit address feature to give each tape transport a unique identification code to be recognized by the host. This ID is useful for the system error log, and in multidrive configurations.

The unit ID is a three-digit code that you manually enter from the transport control panel by using the following procedure (Test 04 in the Pathfinder). This ID code is stored in the transport's nonvolatile memory until you enter a new one. The ID code constantly appears in the digital display indicator when the drive is powered on and in the normal on-line, off-line, or tape-unloaded state. When there is a fault condition, or a test is run from the control panel, the unit ID is replaced by the fault code or test number indications.

Do the following steps to enter ID code 201.

____ 17. Run Test 49. Test 04. See Pocket Service Guide

____ 18. Press TEST.

____ 19. Press STEP three times.

____ 20. Press EXECUTE to initialize Procedure 04.

____ 21. Press STEP two times.

____ 22. Press TEST two times.

____ 23. Press STEP.

____ 24. Press EXECUTE.

____ 25. Press RESET. 201 should appear in the digital display indicator.

NOTE

For the rest of this procedure, tell the Course Administrator if an error occurs and the test does not pass.

Now, do the following steps to run the acceptance diagnostics.

____ 26. When you power up the transport, the power-up health check runs. A fault code appears if an error occurs. You may be able to clear the error by pressing the RESET switch.

A successful check is indicated if the LOGIC ON and FILE PROT indicators come on and if the unit number appears in the digital display indicator on the control panel (with all other indicators off).

____ 27. Thread a known good tape.

____ 28. Run Operator Test 01. It takes approximately 10 minutes for a 2400-foot tape. The test is successful if a 000 appears in the digital display indicator.

____ 29. Run the host-based diagnostic tests, EVMBB Tests 1 through 10 and EVMBA Tests 1 through 3 (default sections).

The data reliability test is the last test you should run. Let the test run about 15 minutes. During this time take a break or prepare for the final test.

____ 30. Stop the data reliability test after 15 minutes. In the field you would allow this test to run to the end.

____ 31. Unload the tape and power down the system.

____ 32. Put the system back in customer operating condition. Make sure all covers are secure and cables are intact.

As mentioned before, Chapter 5 in the TU81/TA81 Magnetic Tape Subsystem User Guide has detailed installation procedures. Also, Chapter 2 in the TU81 Magnetic Tape Subsystem Pocket Service Guide has a short version of the procedures.

This completes the Installation lesson.

FINAL TEST (TEST 2)

Next, complete the Final Test (Test 2). You may use any TU81 resources available.

Review the course materials to answer any remaining questions you have about the TU81.

Ask the Course Administrator for Test 2. When you have completed the test, return it for grading.

When you pass the test, fill in the lab performance certificate with the course administrator.

APPENDIX A
GROUP CODED RECORDING

INTRODUCTION

This appendix covers group coded recording encoding techniques.

For you to learn GCR recording techniques, you must understand both non return to zero inverted (NRZI) and phase encoded (PE) recording techniques. For this reason, the first portion of this module reviews some concepts used in both NRZI and PE techniques.

This module:

- Reviews non-return to zero inverted (NRZI) recording techniques
- Reviews phase encoded (PE) recording techniques
- Introduces group coded recording (GCR)
- Explains the function of the special groups, subgroups, and characters in GCR.

This module does not:

- Teach NRZI recording principles
- Teach PE recording principles
- Explain the algorithms used to derive or generate any of the special characters used in GCR
- Refer to the TU81 or any other tape drive subsystem that uses GCR.

OBJECTIVES

1. List the reasons for using the group coded recording (GCR) encoding method.

2. Describe the relationship between data bytes (characters) coming into the tape subsystem (GCR formatted), compared to how data is written on tape.

3. Supplied with a drawing representing GCR, identify each of the following items.

   a. ID burst
   b. ARA burst
   c. IRG
   d. Tape mark
   e. Data record

4. For each of the following items, list the active track(s),the data pattern, and the recording density.

   a. Subgroup
   b. Data group
   c. Storage group
   d. ID area
   e. IRG
   f. Data record
   g. Tape mark
   h. ID burst
   i. ARA burst
   j. ARA ID
   k. Preamble
   l. Mark 1
   m. Resync burst
   n. End mark
   o. Residual data group
   p. PAD characters
   q. ACRC character
   r. ECC character
   s. CRC character
   t. CRC data group
   u. Residual characters
   v. Mark 2
   w. Postamble

5. Describe each of the following item's function.

   a. Subgroup
   b. Data group
   c. Storage group
   d. ID area
   e. IRG
   f. Data record
   g. Tape mark
   h. ID burst
   i. ARA burst

j. ARA ID
k. Preamble
l. Mark 1
m. Resync burst
n. End mark
o. Residual data group
p. PAD characters
q. ACRC character
r. ECC character
s. CRC character
t. CRC data group
u. Residual characters
v. Mark 2
w. Postamble

RESOURCES

TU/TA81 Technical/Service Manual	EK-TUA81-TM
American National Standard recorded magnetic tape for information interchange (6250 char/in, group coded recording)	ANSI X3.54-1976
American National Standard recorded magnetic tape for information interchange (800 char/in, NRZI)	ANSI X3.22-1973
American National Standard recorded magnetic tape for information interchange (1600 char/in, PE)	ANSI X3.39-1973

PURPOSE OF GROUP CODED RECORDING

An inexpensive way to back up high-speed transfer and high-capacity disk storage is needed. The GCR encoding technique provides fast serial access of large quantities of data.

GCR, shown in Figure 1, has several advantages. One advantage is faster data transfer rates than PE or NRZI. Another advantage is more storage per tape reel. Finally, GCR can error correct for up to two bad tracks per data block (record). This error correction is done during tape reading; rereading is unnecessary.

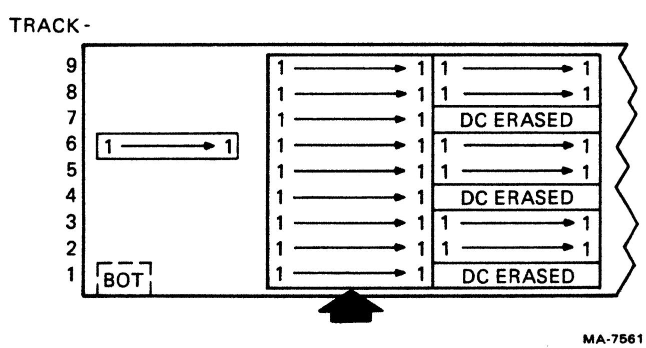


Figure 1 Group Coded Recording (GCR Tape)

TAPE FORMATS

Today there are three recording formats in use for 1/2-inch, 9-track tape. They are NRZI, PE, and GCR. Figure 2 shows the relationship between these formats.

The following text describes how each format is written on tape.

In NRZI mode, a 1 is represented by a flux change. This flux change can be either positive or negative. If a flux change does not occur, a Ø is written. Figure 2 shows this more clearly. To the right of the NRZI label, you can see how a data string is written on any data track in the NRZI format. Note that the data string is 1Ø1Ø1ØØØØ111. The NRZI format is normally written at either 2ØØ, 556, or 8ØØ bits per inch (bits/in).

In PE mode, a 1 is written by generating a negative transition in the center of data time. A Ø is written on tape by generating a positive transition in the center of data time. To the right of the PE label on Figure 2, you can see how the data pattern looks in PE mode.

Compare the NRZI and PE formats. Note that in NRZI you can have no more than 8ØØ flux changes per inch on tape. This is true if you write consecutive 1s and the density used is 8ØØ bits/in.

In PE mode, the tape is written at 16ØØ to 32ØØ flux changes per inch. Any time sequential 1s are written (11111), there are 32ØØ flux changes per inch. The same is also true when sequential Øs are written (ØØØØØ). If the data pattern written is alternate 1s and Øs (1Ø1Ø1Ø), the tape is written at 16ØØ flux changes per inch.

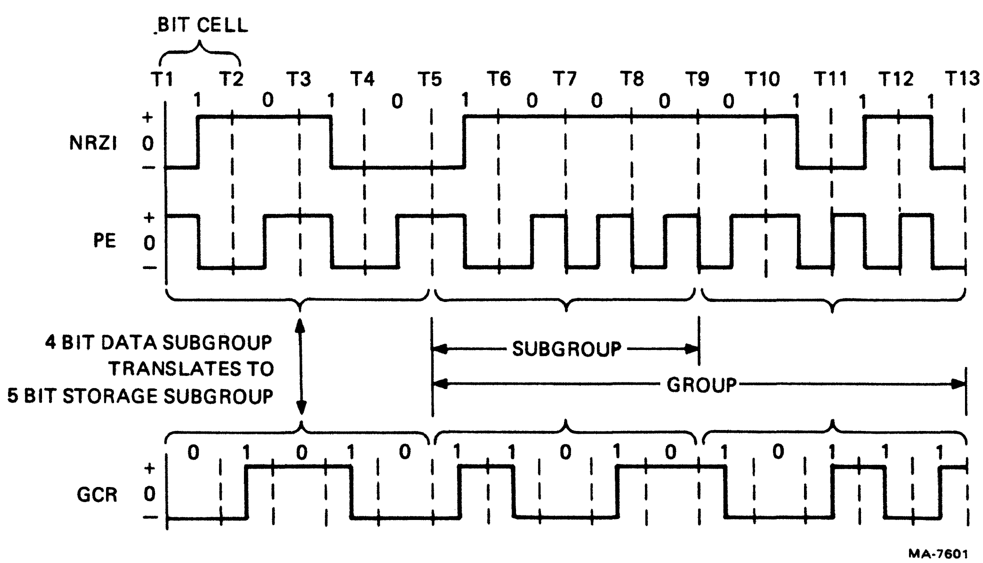


Figure 2 Tape Recording Formats

GCR is a type of NRZI recording. GCR has an effective transfer rate of 6250 bits/in. This is accomplished by writing at 9042 flux changes per inch. The reason for this discrepancy in bits per in and flux changes per inch follows.

4-bit to 5-bit translation occurs
Additional characters must be written in a GCR record.

Because these additional characters are not considered data, they are not counted when we describe the useful transfer rate.

Note that in Figure 2 the data to be written is 1010. In GCR format it becomes 01010, and is written using NRZI recording techniques. Do not worry about the addition of a fifth bit at this point (translation). Hardware in the machine performs the translation (this process is explained later in this module).

Note that every four bits of data are translated into five bits and written on the tape in NRZI mode for GCR. Every time a 1 is represented, a flux change occurs in the center of the bit cell. Every time a 0 is written, no flux change occurs during the bit cell.

As you can see, GCR is very similar to NRZI. However, two differences do exist. In GCR the recording density is 6250 bits/in as opposed to 800 bits/in in NRZI. In GCR every four bits are translated into five bits, then written on tape using NRZI recording techniques. In NRZI, the data is written on tape without undergoing any translation.

NRZI AND PE RECORDING

There are several similarities between NRZI, PE, and GCR recording techniques. Let's review NRZI and PE to help you learn GCR recording techniques.

This review covers the parts of NRZI records and PE records. It does not cover how each part is generated. You should already understand those aspects of NRZI and PE recording.

NRZI Recording

An NRZI tape consists of two types of information: data records and tape mark characters.

Figure 3 shows the typical components of an NRZI recorded tape. Starting at beginning of tape (BOT), tape is dc erased on all nine tracks. This gap is longer than the interrecord gap (IRG) between records. This longer IRG is called an initial interrecord gap (Initial IRG or IG).

After the IG, the first item written on tape is a record. A record consists of several characters grouped together.

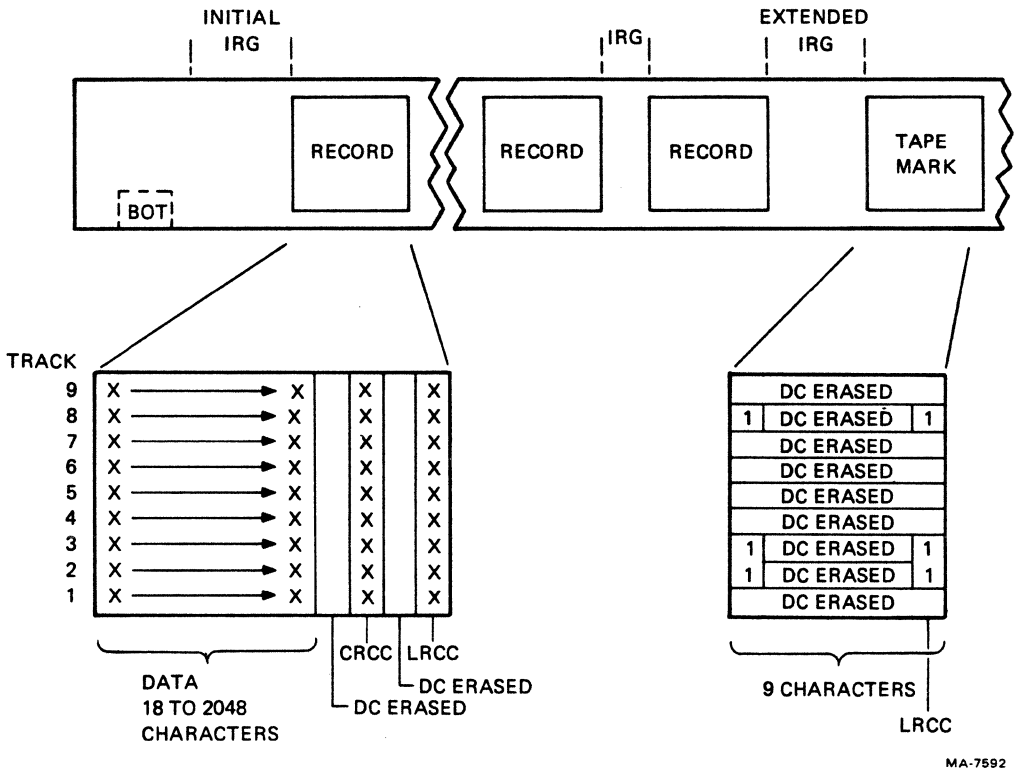


Figure 3 NRZI Recording

The NRZI record consists of a variable number of characters. The record ends with two special characters. They are the cyclic redundancy check character (CRCC) and the longitudinal parity check character (LRCC).

The CRCC is written four character spaces after the last data character. A LRCC is written four character spaces after the CRCC character. The areas between the end of data and both the CRCC and LRCC, are dc erased.

The CRCC is a check character used in NRZI records. It is derived by a complex mathematical formula applied to the characters written in the record. The result of this manipulation (the CRCC) can be used to recover a lost bit in a record read from tape.

The LRCC is the last character written in an NRZI record. It is written to generate even parity for each track.

A tape mark is written at the end of several records that constitute a file. A tape mark is also used to end a reel of tape.

In NRZI, a tape mark consists of a 1 bit written in tracks 2, 3, and 8. All other tracks are dc erased. All tracks are then dc erased for seven characters. The LRCC follows immediately (Figure 3).

PE Recording

In PE recording, we normally write one of three types of information. The three types of information are: an ID burst, a data record, and a tape mark.

NOTE

The Xs represent bits written on tape. They can be either data bits, CRCC bits, or LRCC bits. Each X represents a one or a zero.

Figure 4 represents a typical PE tape. The density identification area is the first thing written on tape. This area is called the identification burst (ID burst) on PE tapes.

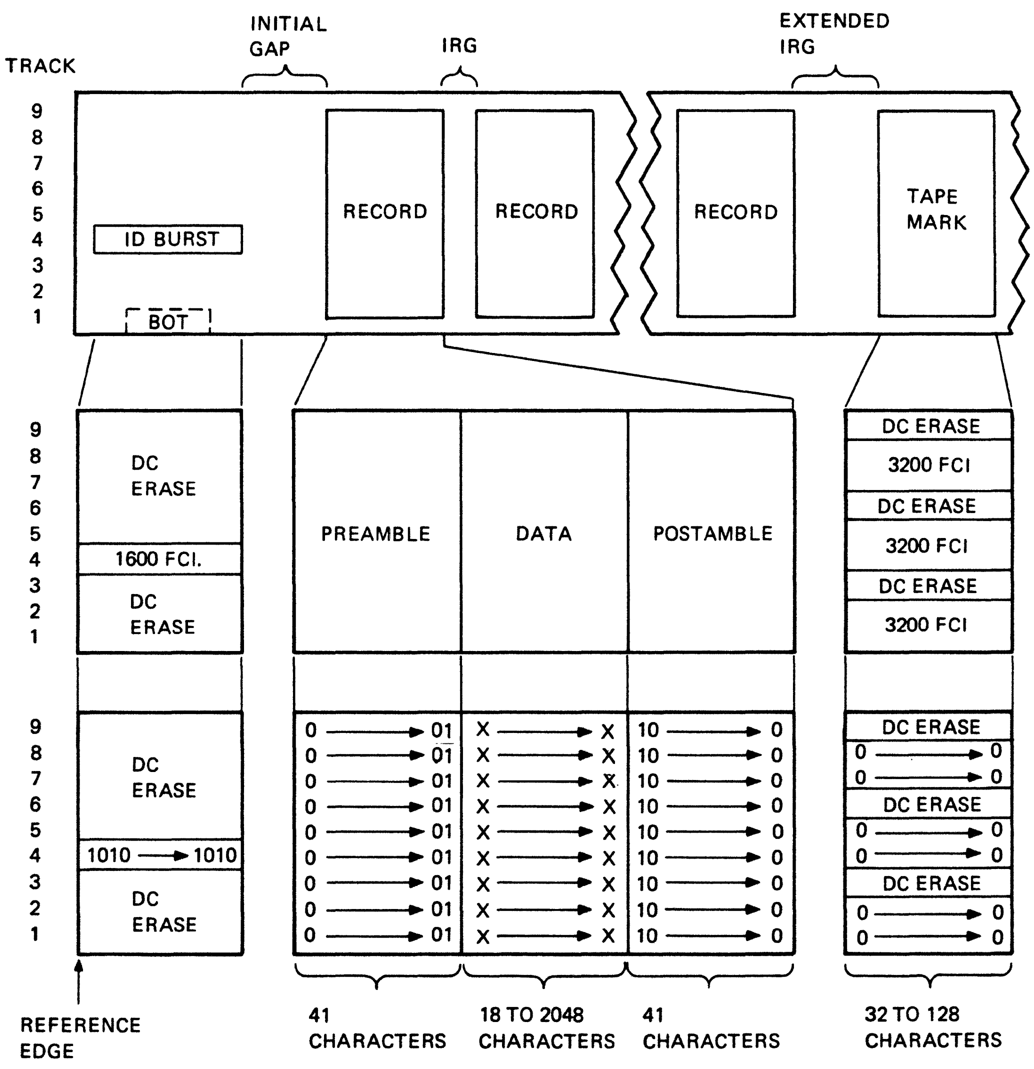


Figure 4 PE Recording

The ID burst is written to start before the BOT strip and extend past the end of the BOT strip. It is written at 1600 flux changes per inch on track 4 only. All the other tracks are dc erased.

Immediately after the ID burst, the initial gap (IG) is put on tape (Figure 4). This consists of erasing all nine tracks. The IG is between 3 inches and 25 feet long, from BOT.

The first record on tape is written starting at the end of the IG. In PE, a record consists of three parts: the preamble, data, and postamble.

The preamble consists of 41 characters. First, 40 sequential 0s are written on each track, including the parity track. Then, immediately after the 40th 0, there is a character that contains 1s on all nine tracks.

The data immediately follows the preamble. The data can consist of a minimum of 18 characters to a recommended maximum of 2048 characters (the ANSI specification). It is physically possible to write and read shorter or longer records.

The postamble immediately follows the data. The postamble consists of an all 1s character, followed by 40 all 0 characters. The postamble is identical to the preamble, but written in the reverse order.

The IRGs are written between records. They consist of dc erasing all nine tracks. An IRG is between 0.5 inches and 25 feet long (normally 0.6 inches).

The last type of information written is a tape mark. It is separated from other records by a longer IRG. This special IRG is called an extended interrecord gap (extended IRG).

A tape mark consists of 0s written in tracks 2, 5, 8, and possibly 1, 4, and 7 with tracks 3, 6, and 9 dc erased. A tape mark record is 32 to 128 characters long (Figure 4).

Tapes are always referenced to the reference edge. The reference edge is the side of tape closest to the operator when tape is correctly loaded.

GROUP CODED RECORDING (GCR)

GCR recording combines the best features of both PE and NRZI. Let's look at the way bits are written on tape in GCR (Figure 5).

Earlier in this module we found that NRZI recording techniques are used to place data on tape. Every time a 1 bit is to be written on tape, a flux change occurs. If a 0 is to be written, a flux change does not occur. The other thing we found was that every four bits of sequential data are grouped together. When the four bits for all nine tracks are grouped together, they form a data subgroup. Two data subgroups are referred to as a data group.

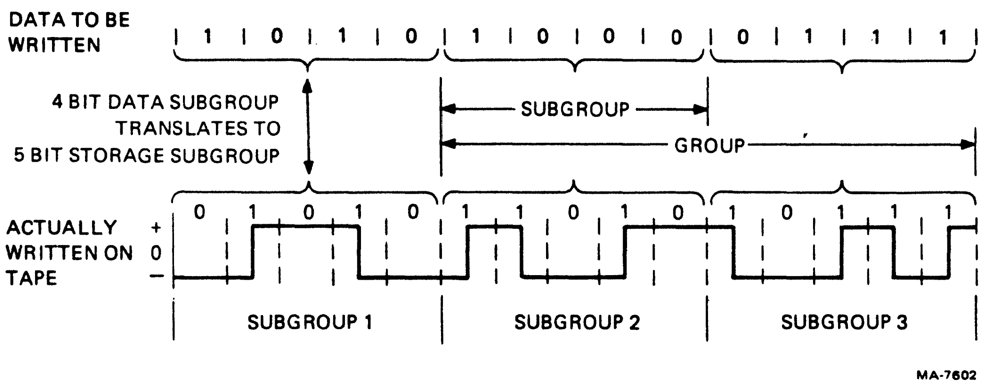


Figure 5 GCR Representation of Data Written on Tape

GCR 4-BIT TO 5-BIT TRANSLATION

We also know that data is translated and placed on tape. Every four data bits pass through a translator and become five bits. When the five bits for all nine tracks are grouped together, they form a storage subgroup. This new 5-bit storage subgroup is what is actually written on tape. Two storage subgroups are referred to as a storage group.

Why change a 4-bit code to a 5-bit code before placing it on tape? After all, it appears there is a greater chance of introducing errors. The following paragraphs try to answer this question.

In GCR no more than two Øs can be recorded in succession on a given track. This ensures synchronization.

GCR avoids recording more than two successive Øs by translating four bits into five. Four bits can be grouped in any of 16 combinations from ØØØØ to 1111. There are 32 possible combinations of five bits. Combinations that begin or end with more than one Ø, and those that contain more than two internally successive Øs, are not used to represent data.

After this elimination, 17 useful codes remain. The 11111 code is reserved for synchronization purposes. The remaining 16 combinations of five bits are correlated with the 16 combinations of four bits.

During GCR recording, each group of four bits in sequence is translated (encoded) to the corresponding 5-bit combination. This 5-bit combination is recorded by the transport in NRZI mode. During reading, the opposite occurs. The 5-bit combination is translated (decoded) into the original 4-bit code.

Table 1 shows the translation codes for the 4-bit to 5-bit translation, and vice versa. Look up the 5-bit code for 1Ø1Ø. Note that the 5-bit code for 1Ø1Ø is Ø1Ø1Ø. In Figure 5, this is the data on one track of the first data subgroup written on tape.

Table 1   Translation Record Codes

4-Bit Data Value (Data Subgroup)	5-Bit Recording Value (Storage Subgroup)
ØØØØ	11ØØ1
ØØØ1	11Ø11
ØØ1Ø	1ØØ1Ø
ØØ11	1ØØ11
Ø1ØØ	111Ø1
Ø1Ø1	1Ø1Ø1
Ø11Ø	1Ø11Ø
Ø111	1Ø111
1ØØØ	11Ø1Ø
1ØØ1	Ø1ØØ1
1Ø1Ø	Ø1Ø1Ø
1Ø11	Ø1Ø11
11ØØ	1111Ø
11Ø1	Ø11Ø1
111Ø	Ø111Ø
1111	Ø1111

Given a couple of 4-bit codes, use Table 1 to look up the 5-bit code for a data pattern of 1ØØØ. What is the 5-bit code? Check your answer with the second subgroup in Figure 5.

Look up the 5-bit code for a data pattern of Ø111. What is the 5-bit code? Check your answer with the third subgroup in Figure 5.

Now you should understand how information is written on tape in GCR mode. Information is written using NRZI recording principles. The information is translated from a 4-bit code to a 5-bit code. Each of these collections of four bits of data, when grouped together for all nine tracks, is called a data subgroup. The 5-bit coded information, when grouped together for all nine tracks, is called a storage subgroup. Two subgroups constitute a group. Two data subgroups constitute a data group. Two storage subgroups constitute a storage group.

Complete Exercise 1 before you continue this lesson.

EXERCISE 1

1. In GCR mode, every four data bytes (characters) translate into __________ bytes that are recorded on tape.

   a. 2
   b. 3
   c. 4
   d. 5
   e. 10

2. What is the advantage of using GCR?

   a. Simplicity of GCR formatting
   b. Increased size of the interrecord gap (IRG)
   c. More storage per tape reel
   d. Less storage per tape reel
   e. Ability to random access information

3. If the information to be written on track 5 of a GCR tape contains 1000, what is written on tape?

   a. 11010
   b. 11001
   c. 11111
   d. 0110
   e. 1001

4. If the information read from track 7 of a GCR tape contains 11101, what data pattern was originally written?

   a. 01110
   b. 11001
   c. 0100
   d. 1101
   e. 1010

5. One reason for using GCR mode is that it allows error correction for up to __________ track(s) simultaneously per block (each record) of data.

   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

This completes Exercise 1. Now check your answers on the next page.

EXERCISE 1 ANSWERS

1. d
2. c
3. a
4. c
5. b

If you answered all the questions correctly, continue this lesson. If you had any problems, review the material until you understand it, then continue.

TYPES OF GCR RECORDS

In GCR the following four types of information can be written on a GCR tape (Also refer to Figure 6).

Density identification (ID) area record
Automatic read amplification (ARA) burst record
Data record
Tape mark

The following paragraphs explain the function of each type of information, and the parts they contain.

The density ID area is the first information written on a GCR tape. There is only one of these areas on a GCR tape. The density ID area serves one function, it identifies that a tape is written in GCR.

An undefined gap is immediately after the density ID area record. This undefined gap separates the density ID area record from the automatic read amplification (ARA) burst record.

The ARA burst record is the second record written on a GCR tape. This is the only record of its type on a GCR tape. The ARA burst record serves two functions. It sets the gain on read amplifiers and verifies that the transport can write on all nine tracks.

An interrecord gap (IRG) is immediately after the ARA burst record. A normal IRG can be from 7.11 mm (0.28 in) to 4.57 m (15 ft). A 7.62 mm (0.3 in) IRG is normal.

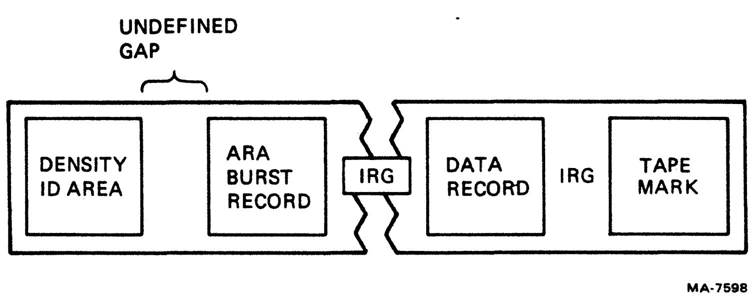


Figure 6 GCR Tape

After the IRG, the first data record is written. The ANSI specifications dictate that the record has a minimum of 18 characters and a maximum of 2048 characters. This is only a guideline, however, it is possible to write shorter or longer records.

Every record ends with an IRG. At the end of a file or tape, a tape mark is written. It serves the same function as it does on NRZI or PE tapes. Some manufacturers precede a tape mark with a longer IRG.

Now that we know the types of information that can be written on a GCR tape, let's look at the parts that make up each type of information. Also, let's look at each part's function.

Density ID Area Record and ARA Burst Record

The density ID area record has one part, an ID burst (Figure 7).

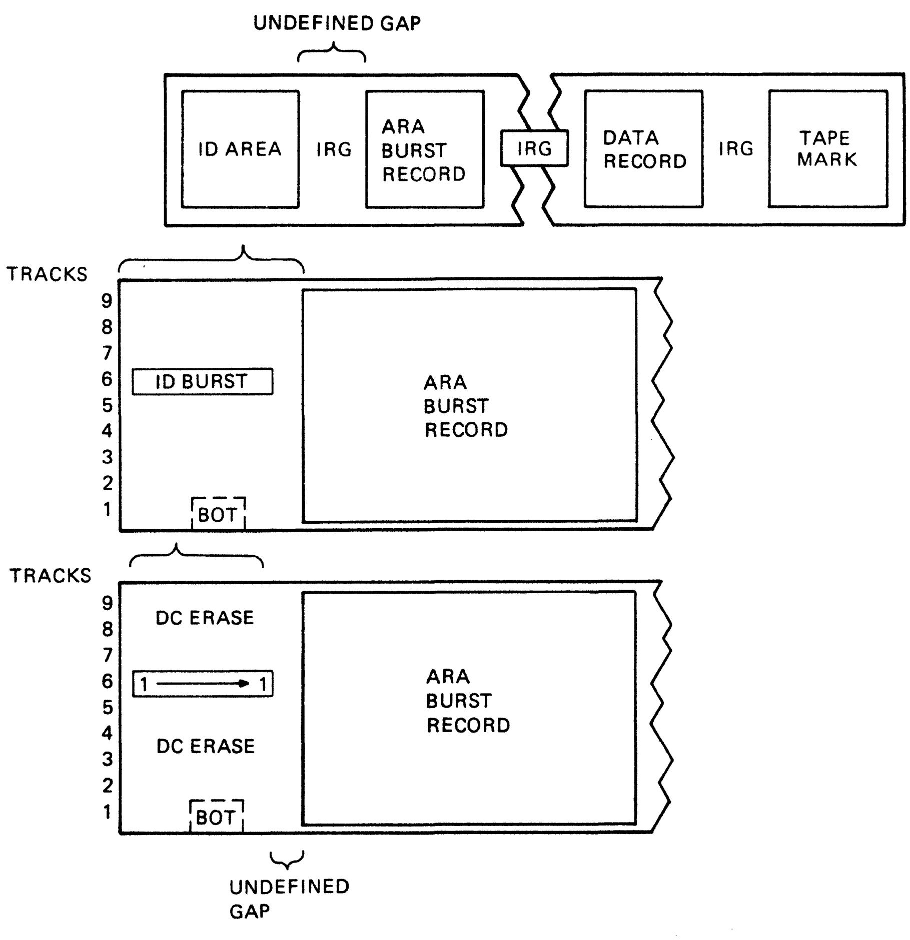


Figure 7   Density ID Area

The identification burst (ID burst) tells the tape transport controller that this tape was written in GCR. This burst is in the phase encoded frequency range. It consists of track 6 being written with all 1s or alternating 1s and Øs, and all other tracks erased. The burst begins at least 43.18 mm (1.7 in) before the trailing edge of the BOT marker, and continues past the trailing edge of the BOT markers.

An undefined gap (Figure 7) is immediately after the density ID burst. This undefined gap separates the ID burst from the ARA burst record. The ARA burst record is the second type of information written on a GCR tape. This is the only record of its type on a GCR tape.

The ARA burst record has two parts (Figure 8), the ARA burst and the ARA ID burst. Each of these parts has a recognizable pattern and serves a specific function.

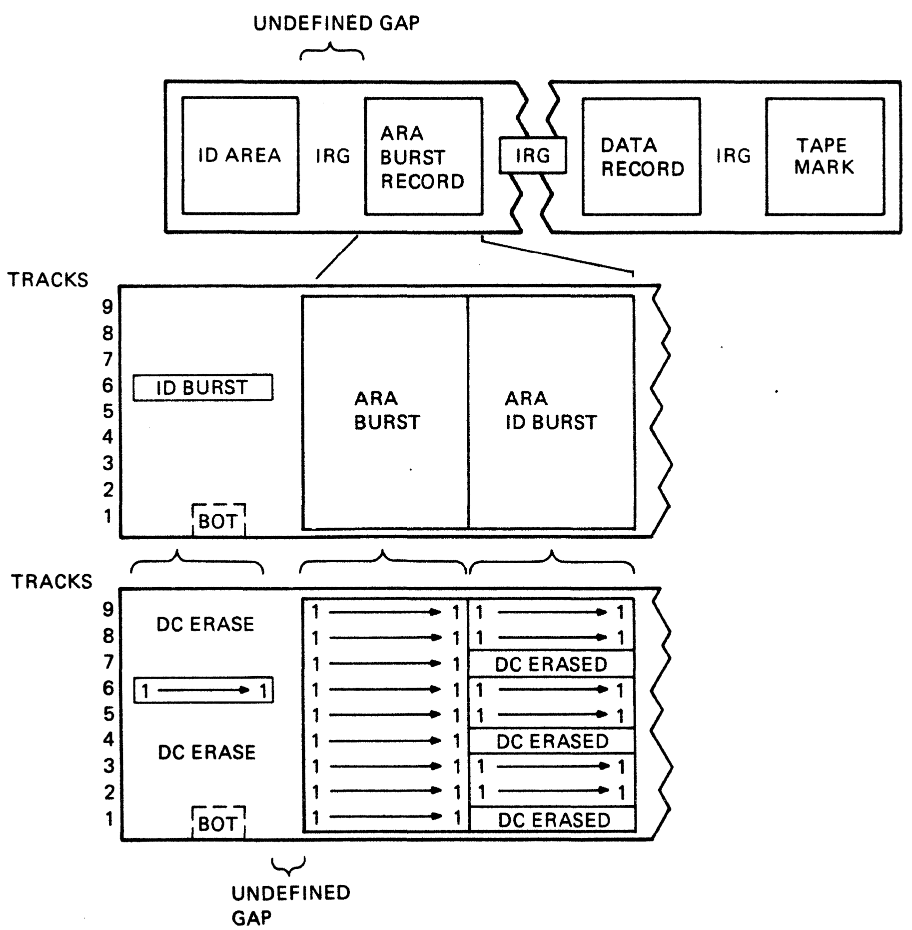


Figure 8 ARA Burst Record

The ARA burst is a burst of all 1s in all tracks. It has two functions. Its first function is to verify that the transport can write all tracks. Its second function is as a reference for the tape transport read amplifiers. This lets the read circuits set gains according to tape output.

The ARA burst begins no less than 38.1 mm (1.5 in) and no more than 10.92 cm (4.3 in) from the leading edge of the BOT marker. The ARA burst ends no less than 24.13 cm (9.5 in) and no more than 29.21 cm (11.5 in) from the leading edge of the BOT marker.

The ARA ID (Figure 8) is the second part of the ARA burst record. The ARA ID immediately follows the ARA burst (no gap exists). The second part's main function is to warn of the approaching load point during reverse tape operations.

The ARA ID has ones in tracks 2, 3, 5, 6, 8, and 9. Tracks 1, 4, and 7 are dc erased. This character is approximately 5.08 cm (2 in) long. At least one 0.63 cm (0.25 in) section of the overall 5.08 cm (2 in) recording burst must be error free in all tracks at the same time.

Complete Exercise 2 before you continue this lesson.

EXERCISE 2

1. Figure 9 shows a typical GCR tape. What is the arrow pointing to?

   a. ID burst
   b. ARA burst
   c. IRG
   d. ARA ID
   e. Data record

2. Figure 10 shows a typical GCR tape. What is the arrow pointing to?

   a. ID burst
   b. ARA burst
   c. IRG
   d. Tape mark
   e. Data record

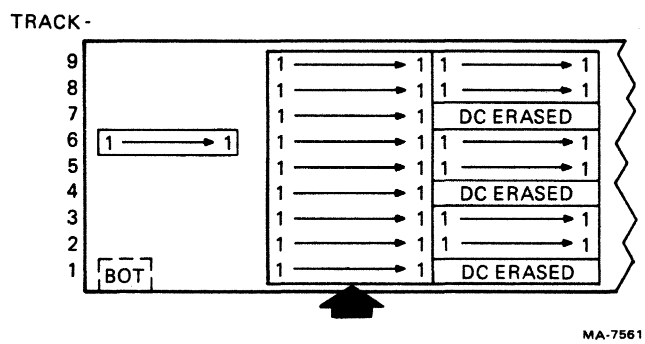


Figure 9 GCR Tape (Question 1)

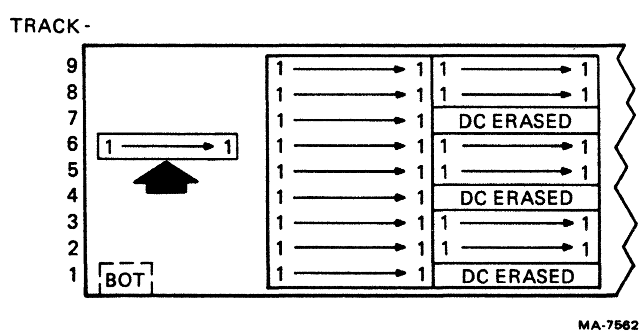


Figure 10 GCR Tape (Question 2)

3. What item has the following parameters?

   - The active track operates at either 1600 or 3200 flux changes per inch.

   - The active track is physical track 6, all other tracks are dc erased.

   - The data pattern is either all 1s, or alternate 1s and 0s (depending on the drive's manufacturer).

   a. ARA burst
   b. ARA ID
   c. IRG
   d. Mark 1
   e. ID burst

4. For a density ID area record in GCR, what is between the ID burst and the ARA burst?

   a. An ARA ID burst

   b. An undefined gap

   c. Tracks 2, 3, 5, 6, 8, and 9 recorded with 1s, and tracks 1, 4, and 7 dc erased.

   d. Tracks 1, 4, and 7 recorded with 1s, and all other tracks dc erased.

   e. Tracks 2, 3, and 8 recorded with 1s, and all other tracks dc erased.

5. What does a density ID area record in GCR consist of?

   a. Resync burst
   b. Mark 1 burst
   c. Mark 2 burst
   d. ID burst
   e. CRC burst

This completes Exercise 2. Now check your answers on the next page.

EXERCISE 2 ANSWERS

1. b
2. a
3. e
4. b
5. d

If you answered all the questions correctly continue this lesson. If you had any problems, review the material until you understand it, then continue.

Interrecord Gap

An interrecord gap (IRG) is written between the ARA burst record and the data record. An IRG can be from 7.11 mm (Ø.28 in) to 4.57 mm (15 ft). A 7.62 mm (Ø.3 in) IRG is normal.

Data Record

Next, we'll look at a data record (Figure 11). A data record is made up of eight different parts (refer to the numbering in Figure 11). Some of these parts are used more than once in the record. The eight parts that make up a GCR data are listed as follows.

1. Preamble
2. Mark 1 storage subgroup
3. Data (after translation)
4. Resync burst
5. End mark
6. RES/CRC data group
7. Mark 2 storage subgroup
8. Postamble.

Let's look at the parts of a GCR data record by examining the preamble (Figure 12). The preamble has three parts: a terminator control subgroup (TERM), a second control subgroup, and 141Ø sync subgroups. These three parts consist of 161Ø control subgroups. Each subgroup contains five characters. The preamble, therefore, contains 8Ø characters.

These 16 subgroups are used to initialize and synchronize the read circuitry. The first control subgroup is called TERM. It consists of five characters of 1Ø1Ø1 in each track. The TERM subgroup's function is to notify the formatter that you are leaving the data record in reverse.

The second control subgroup immediately follows. It consists of five characters of Ø1111 in each track. It has the same function as the TERM subgroup.

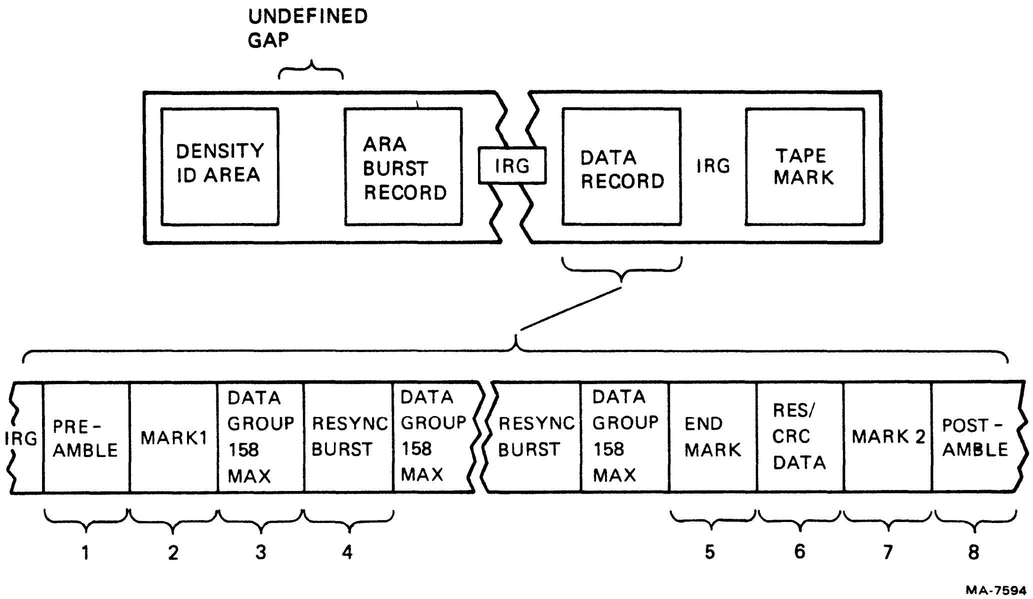


Figure 11   GCR Data Record

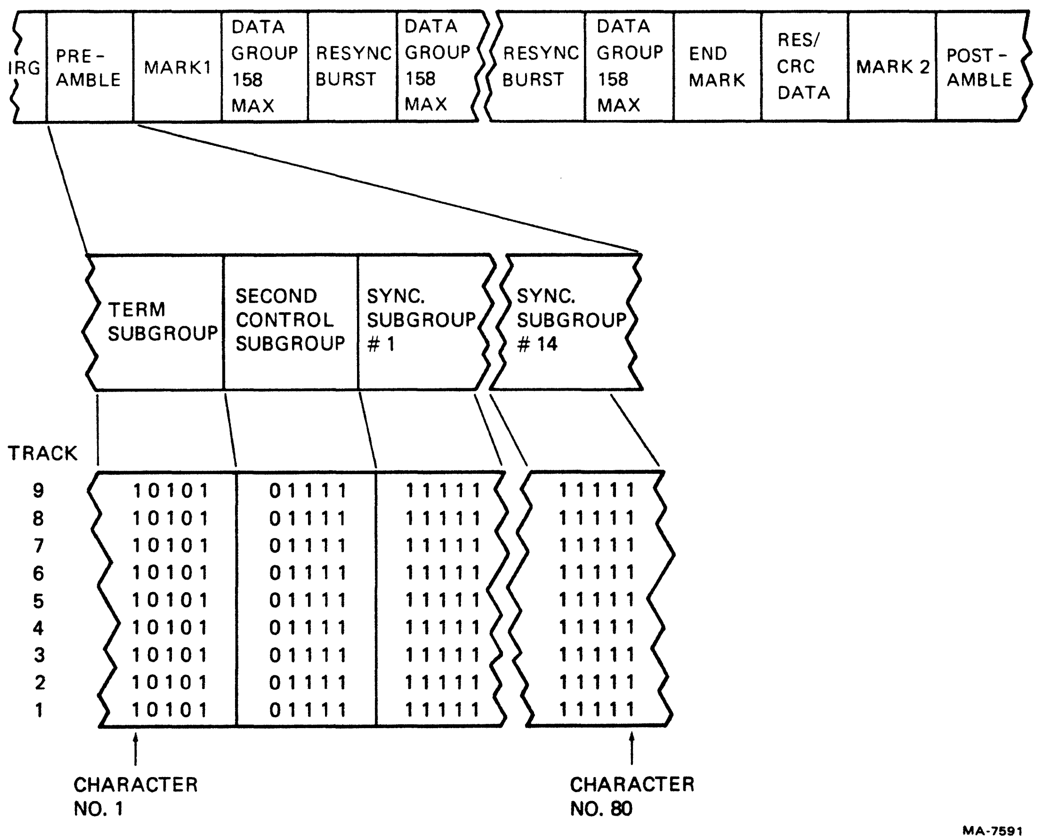


Figure 12   GCR Preamble

Fourteen sync control subgroups are immediately after the second control subgroup. Their primary function is to synchronize the read reference oscillator. Each sync control subgroup is five 1s (11111) in the respective tracks.

The mark 1 subgroup (Figure 13) is immediately after the preamble on a GCR data record. The mark 1 control subgroup is five characters of ØØ111 Ø in each track. It indicates that data arrives next.

Data is written on tape next. Refer to Figure 14 for an explanation of the changes that occur to data before it is written on tape.

The tape formatter reformats memory data into characters (Figure 14, Section A). Each character consists of eight bits plus a parity bit.

The parity bit is written on track 4 of the tape. This parity bit normally generates odd parity for each character before it is translated for placement on tape. Up to this point, data is handled the same as in PE or NRZI records.

The data is now formatted into data groups. Each data group consists of seven sequential data characters (bytes) followed by an ECC character (Figure 14, Section B). This new data group is divided into two data subgroups: A and B. These two data subgroups are translated into two storage groups (Figure 14, Section C).

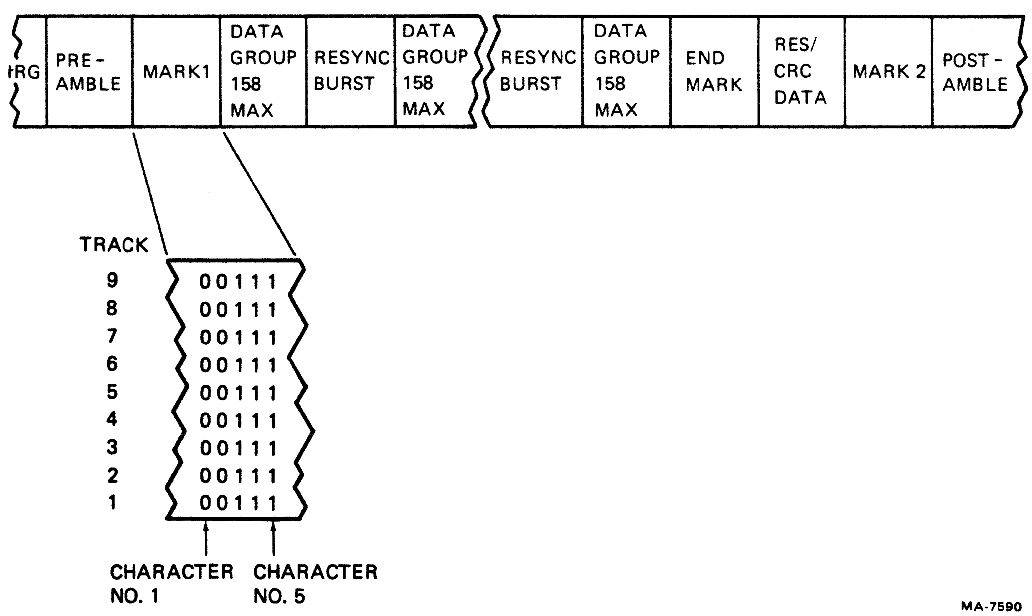


Figure 13 Mark 1

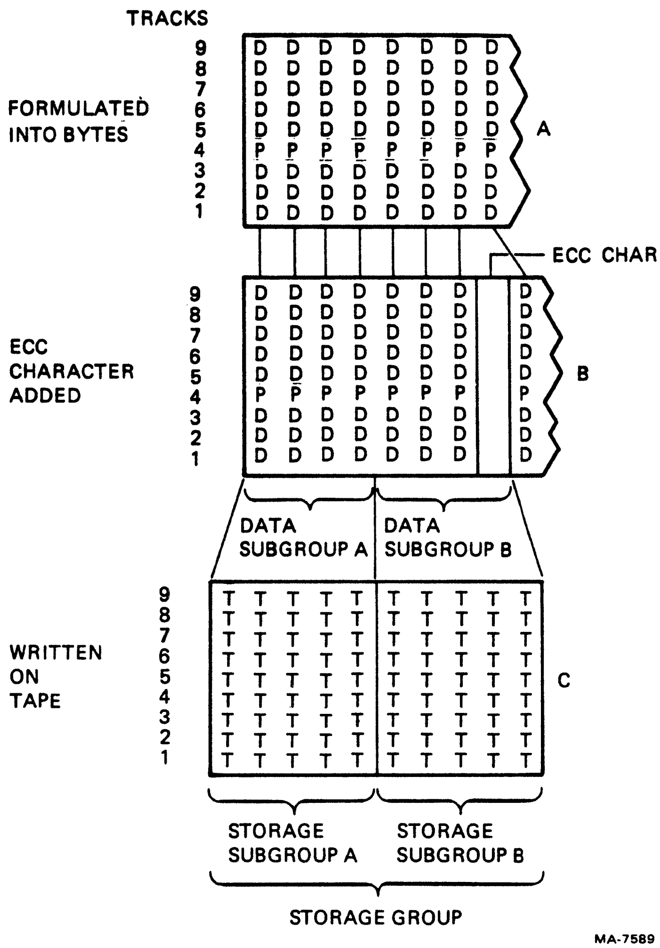


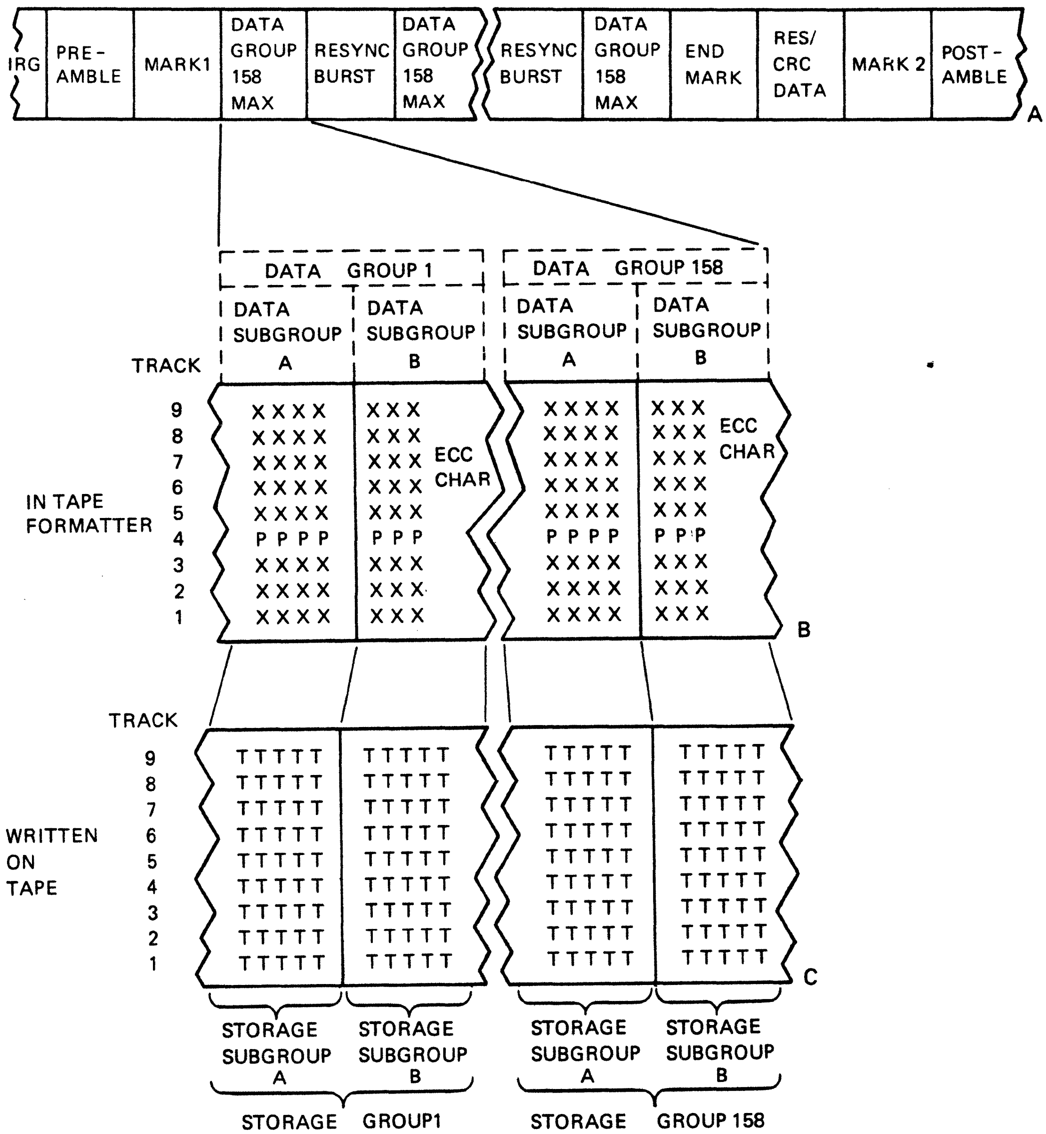
Figure 14 GCR Storage Group Generation

The 4-bit to 5-bit translator you studied earlier in this lesson (refer to Table 1 if necessary) translates data subgroups to storage subgroups.

The ECC character seems to have appeared from nowhere. The ECC character is an error correction code generated for each data group. It is used in an algorithm that helps the possible recovery of errors in that data group.

Now that you understand how a data group is generated, look at Figure 15. This figure should help you understand how the data shown in Figure 14 is written on tape.

Figure 15 shows where the data groups are written on tape. Note that Figure 15 (Section A) shows the data group's relative positions. Each data burst contains no more than 158 groups. However, there may be less than 158 groups.



NOTES:

ECC CHAR = ERROR CORRECTION CODE CHARACTER

P = PARITY BIT = 1 OR 0

T = DATA AFTER TRANSLATION = 1 OR 0

X = DATA = 1 OR 0

MA-7599

Figure 15 GCR Storage Groups

Each group (two subgroups) has seven data characters with an ECC character (Figure 15, Section B). This, however, is not what is written on tape. The tape controller takes each of the data subgroups and sends them through the 4-bit to 5-bit translator. This new 5-bit storage subgroup is what is actually written on tape (Figure 15, Section C).

This translation occurs for each data group to be written on tape. After 158 storage groups are written on tape, a resync burst is placed on tape before another 158 storage groups are written. The number of data bursts of 158 storage groups per data block is determined by the number of data characters to be written per block on the tape.

The resync burst (Figure 16) is the next item written on tape. A resync burst is written between every 158 storage groups written on tape. Its primary function is to resynchronize the read oscillators for any tracks that have a severe error.

The resync burst has four parts: a mark 2 subgroup, two sync subgroups, and a mark 1 subgroup.

The mark 2 subgroup is the first part of the resync burst. It has two functions. Its first function is to mark the end of data information and the beginning of nondata information in the forward direction. The second function, in read reverse, is to flag the end of nondata information and the beginning of data information. Refer to Figure 16 and compare the mark 1 and mark 2 characters. Notice they are the same, but the data direction is reversed.

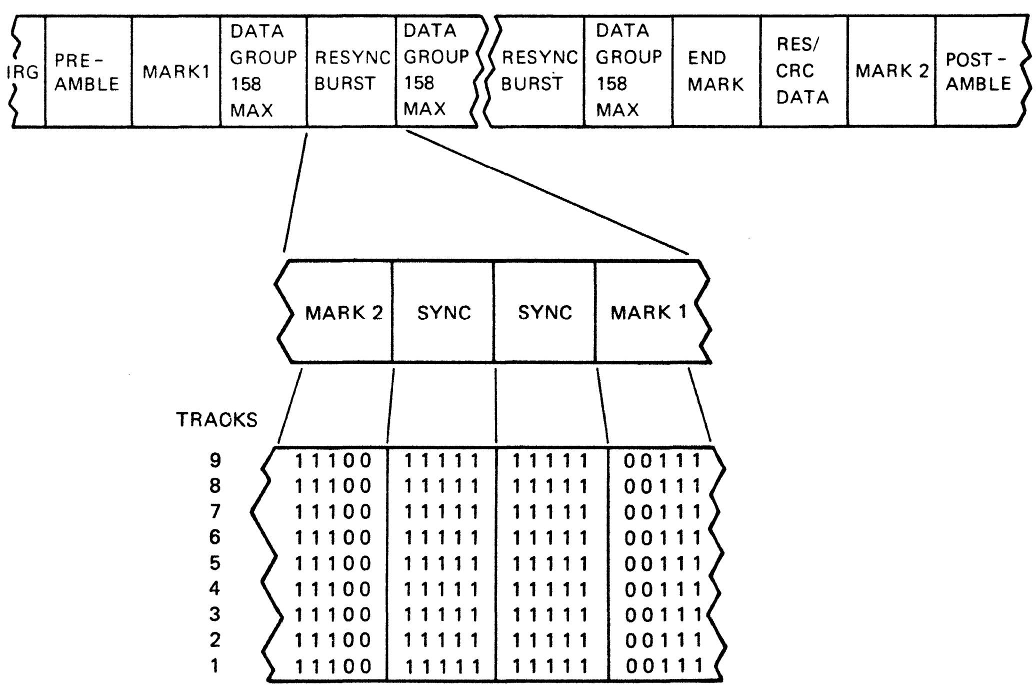


Figure 16 Resync Burst

The mark 2 subgroup is one set of nine parallel 5-bit serial values of 11100 in the respective tracks.

The two sync subgroups follow. The sync subgroups consist of 1s in all tracks. These bits resynchronize the read circuitry.

The mark 1 subgroup is immediately after the two resync subgroups. This subgroup indicates nondata information is ending and data information is arriving next in the forward direction. In the reverse direction, this subgroup indicates that data information is ending and nondata information is arriving.

The mark 1 character has nine parallel 5-bit serial values of 00111 in the respective tracks. Refer to Figure 16 and compare the mark 1 and mark 2 characters. Notice they are the same but the data direction is reversed.

The end mark control subgroup (Figure 17) is after the 158th data group on a GCR tape.

The end mark control subgroup has one set of 5-bit serial values of 11111 on all tracks. This end mark indicates the arrival of residual/cyclic redundancy check (RES/CRC) data.

RES/CRC data (Figure 18) is the next thing written on tape. The RES/CRC data has two groups: the residual data group and CRC data group.

The residual data group is written if there are six or less data characters to be written. This group has the following three parts.

1. Six characters (data and/or PAD characters)
2. An auxiliary CRC character
3. An ECC character

If less than six residual data characters remain, PAD characters are added to make sure a total of six characters are written. For example, if only two residual data characters are left to be written, four PAD characters are written. If a total of six residual data characters are written, no PAD characters are written. If no residual data characters are written, then six PAD characters are written.

Each PAD character consists of all 0s in all tracks with correct parity.

The seventh character written in the residual data group is an auxiliary CRC character. The auxiliary CRC character is a check character used for data validity.

The eighth character written in the residual data group is the ECC character. The ECC character used here is generated the same way it is for the other data groups.

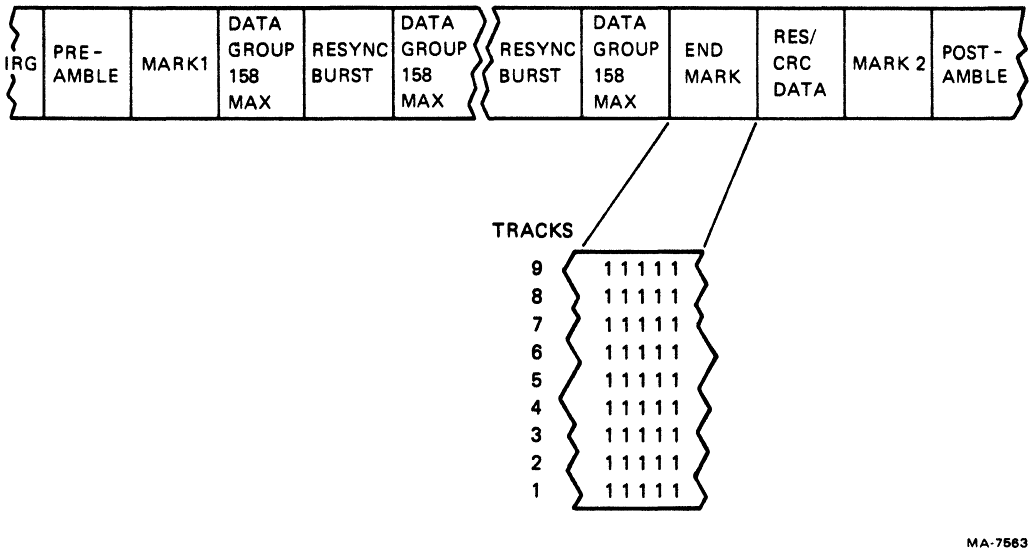


Figure 17 End Mark

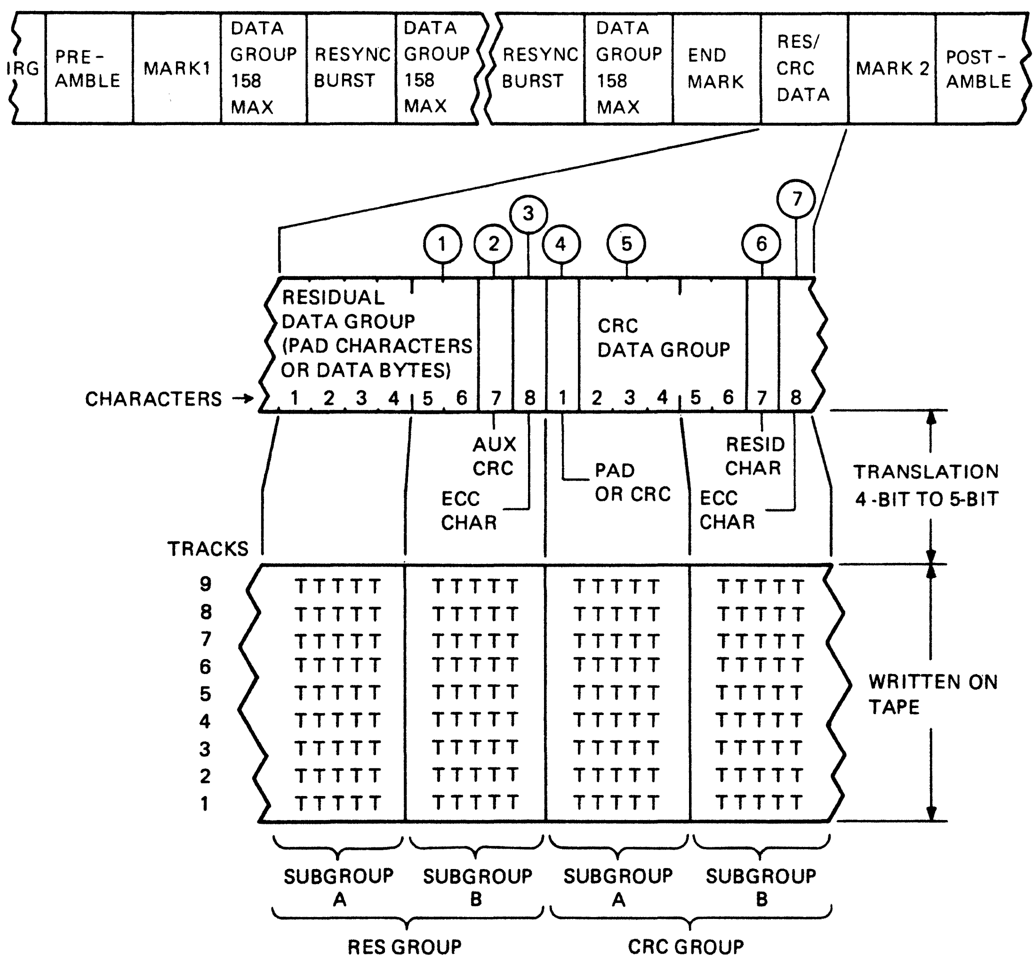


Figure 18 RES/CRC Data

The CRC data group is the next group written on tape. The CRC data group is made up of the following four parts (also shown in Figure 18).

1. PAD character or CRC character
2. CRC character repeated five times
3. Residual character
4. ECC character

The first character written in the CRC data group can either be a CRC character or a PAD character (Figure 18). The CRC character is derived from all data in the record. The GCR CRC character is derived with the same algorithm used to develop the NRZI CRC character.

If the CRC character has an odd number of bits set, it is the first character written. If the CRC character has an even number of bits set, a PAD character is written in order to generate odd parity. Character parity must always be odd in GCR.

To better understand this point, refer to Figure 19. This Figure shows the CRC characters for a record consisting of all 1s (1s in all nine tracks). The n signifies the number of all 1s characters written. If a 1 character is written, the CRC character is ØØØØØØ1Ø1 (starting at track one). Note that there are an even number of bits set (even parity). This would not be an acceptable CRC character. In this case, a PAD character (ØØØ1ØØØØØ) is written.

Refer to Figure 18. Notice that the CRC character is written next. If a CRC character was written in the last character position, that character is repeated five more times in this group's CRC data group position.

CRCC WRITTEN ON TAPE AFTER n-NUMBER OF BYTES
OF BYTES OF ALL ONES

TRACK	CHANNEL	n= 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
9	5	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1
8	7	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1
7	3	1	0	1	1	1	1	0	0	0	1	1	1	1	0	1	1	0	0	1	0	0	0	0	1	1	1	0	0	0	0	1	0	0	1
6	P	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1
5	2	0	0	0	1	1	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	1	1	0
4	1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1
3	0	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1
2	6	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1
1	4	0	1	1	0	1	1	1	0	1	1	0	0	1	1	1	1	0	0	1	1	0	1	1	1	0	1	1	0	0	1	1	1	1	0
		E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O

NOTE:
E = EVEN PARITY
O = ODD PARITY

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Figure 19 CRC Character

If the last character written was a PAD character, a new CRC character is generated. The new CRC character includes the PAD character in its algorithm. This new CRC character is repeated five times in this group's CRC data portion.

The seventh character written in the CRC data group is the residual character. The residual character consists of two parts. The first part is a Modulo-7 count. Bits 0 through 2 are used to indicate how many characters of data were written in the residual group.

NOTE

The last group contained the residual data characters. The Modulo-7 count tells you how many are actually data characters.

The second part of this character consists of a character count. The character count starts at the first data written in the first data group. This character count is a 5-bit field that can count up to a binary 32. Each character is counted while writing the record. At a 32 count, the counter goes back to 0 and starts over. The last value of the counter is what is stored at this location in the tape.

The final character stored in this CRC data group is the ECC character. Again, the ECC character is generated the same way as the other data groups. The residual and CRC data groups are translated and written onto tape the same way data groups are handled. The mark 2 subgroup (Figure 20) is the next thing stored on tape. This subgroup has two functions. In forward it marks the end of data information and the beginning of nondata information. In reverse it marks the end of nondata information and the beginning of data information.

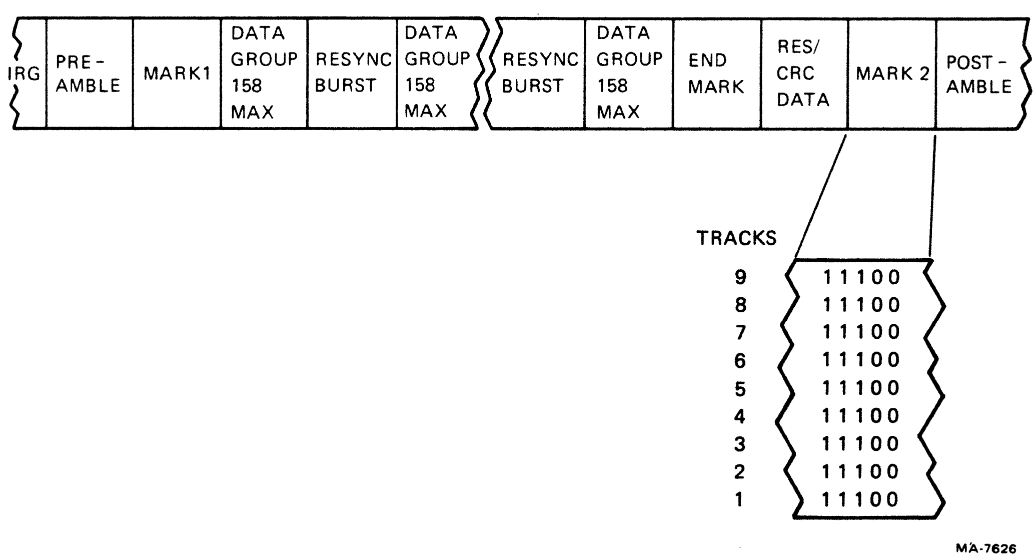

Figure 20 Mark 2 Subgroup

The postamble (Figure 21) is the last part of a data record. The postamble has three parts: 14 sync subgroups, a second control subgroup, and a TERM subgroup.

The first part has 14 sync subgroups (assuming forward tape motion). Each sync subgroup has nine parallel 5-bit values of 11111 in the respective tracks.

The second part of the postamble (second control subgroup) has one set of nine parallel 5-bit serial values of 1111Ø in each track. It initializes and synchronizes the read circuitry in the reverse direction.

The final part of the postamble (TERM subgroup) has nine parallel 5-bit serial values of 1Ø1ØL. L ensures that tape is magnetized in the correct direction for erasing tape. L can be either a 1 or Ø to put the write head in the proper polarity for erasing. This lets you write the interrecord gap. The interrecord gap is the next thing written on tape.

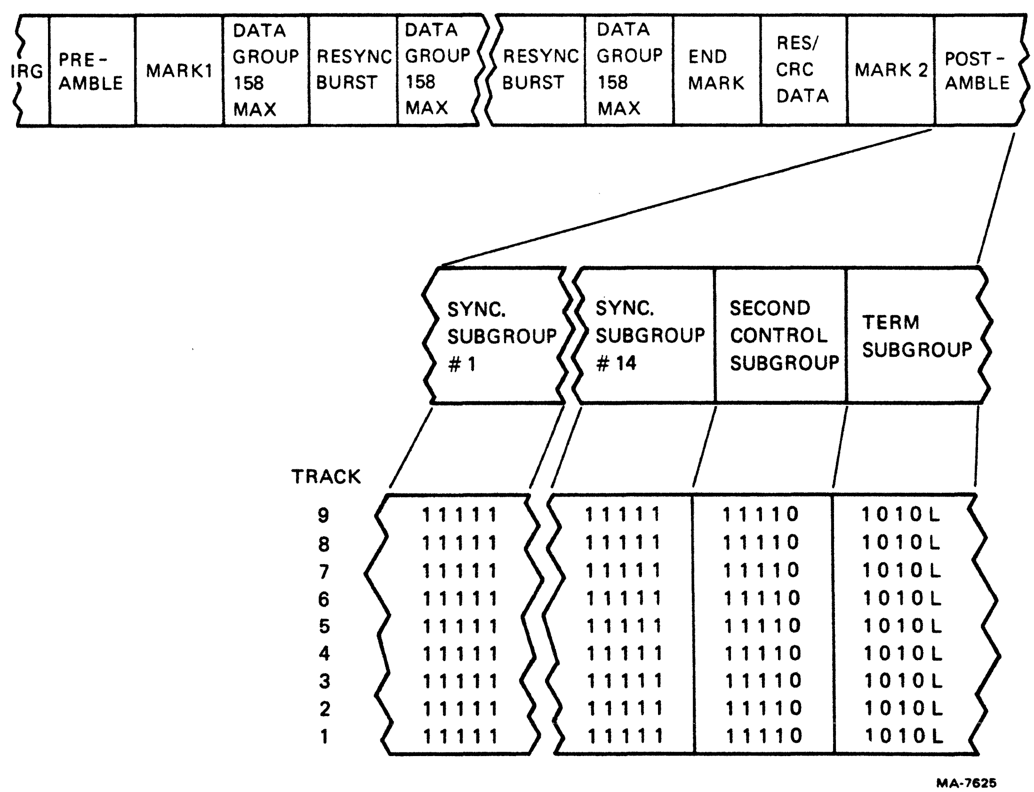

Figure 21 Postamble

Tape Mark Record

A tape mark record (Figure 22) is the third type of GCR record. A GCR tape mark is normally preceded by a longer interrecord gap.

A tape mark record is used to separate files on tape. It is also used to indicate the logical end of a tape.

The GCR tape mark consists of 250 to 400 flux changes at 9042 flux changes per inch. The 1s are written in tracks 2, 5, 8, 1, 4, and 7 with tracks 3, 6 and 9 dc erased.

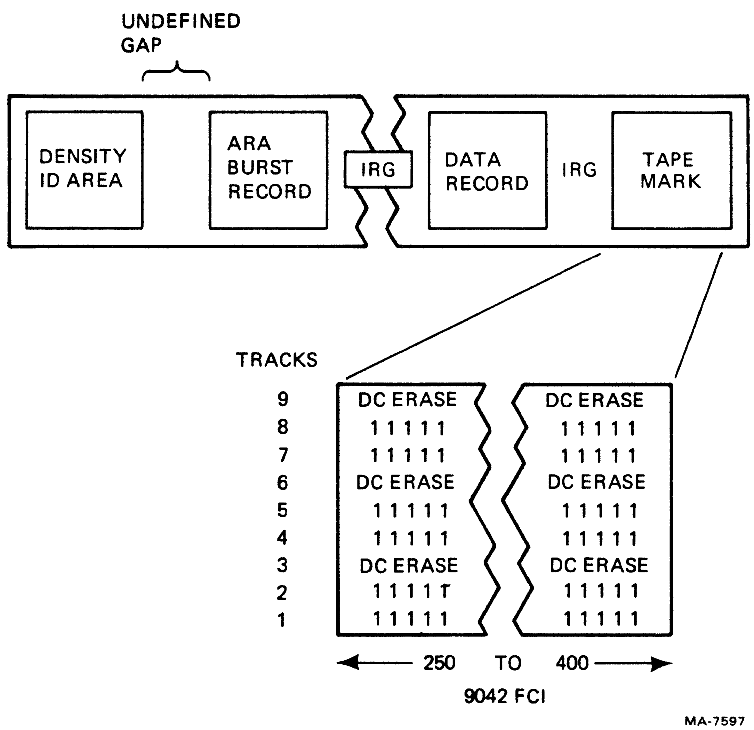

Figure 22 Tape Mark

SUMMARY

This module covered the following topics.

Purpose of group coded recording
Tape formats
A review of NRZI recording techniques
A review of PE recording techniques
GCR 4-bit to 5-bit translation
Types of GCR records
The ARA burst record, its parts, and their functions
The density ID area record, its parts, and their functions
The data record, its parts, and their functions
The tape mark record, its parts, and their functions

Complete exercise 3 before you continue.

EXERCISE 3

1. How many characters does a GCR data subgroup contain?

   a. 1
   b. 2
   c. 4
   d. 5
   e. 10

2. How many characters does a GCR storage group contain?

   a. 2
   b. 4
   c. 6
   d. 8
   e. 10

3. What is the data group formed when six or less data bytes are left to be written in a data record?

   a. Residual data group
   b. Data group
   c. Storage group
   d. CRC data group
   e. ECC group

4. A PAD character may be contained in a residual data group and a __________.

   a. resync group
   b. mark 2 group
   c. mark 1 group
   d. CRC data group
   e. preamble

5. An ECC character is written after every _________ data characters.

   a. 4
   b. 5
   c. 6
   d. 7
   e. 8

6. A GCR CRC character is derived the same way as an NRZI CRC character.

   a. True
   b. False

7. A GCR tape mark contains 150 flux changes at 9042 flux changes per inch with ones written in tracks 2, 5, 8, 1, 4, 7 and tracks 3, 6, and 9 dc erased.

   a. True
   b. False

8. A resync burst has a mark 2 subgroup, a sync group, and a ___________.

   a. mark 1 subgroup
   b. end mark subgroup
   c. residual data subgroup
   d. TERM subgroup
   e. second control subgroup

9. What is the data pattern for a PAD character?

   a. 111111111
   b. 000100000
   c. 010101010
   d. 101010101
   e. 111110000

10. What is a mark 1 character's pattern in each track (assuming forward tape motion)?

   a. 11100
   b. 11111
   c. 00011
   d. 11000
   e. 00111

This completes Exercise 3. Now check your answers on the next page.

EXERCISE 3 ANSWERS

1. c
2. e
3. a
4. d
5. d
6. a
7. b
8. a
9. b
10. e

If you did not answer all the questions correctly, review the material until you understand it.

TEST 1

1. Match each TU81 specification with the correct option.

Specification Type	Option
___ Capacity	a. 40 megabytes
	b. 8
___ Recording methods	c. Start/stop and Streaming
	d. 1
___ Number of drives per controller	e. 140 megabytes
	f. 7
___ Number of tracks	g. 9
	h. PE and GCR

2. Match the Roman Numerals in Figures 1 and 2 with the correct component names.

Roman Numeral	Component
___ I	a. Plenum box
	b. Take-up reel motor
___ II	c. Service release handle
	d. Compressor
___ III	e. Cover interlock switch
	f. Filter/regulator
___ IV	g. Tape cleaner
	h. 1-line tachometer
___ V	i. 1000-line tachometer
	j. Power amplifier module
___ VI	k. Servo/control module
	l. BOT/EOT sensor
___ VII	m. Magnetic head
	n. Air bearings
___ VIII	o. Read amplifier module

3. Match the component with the correct function.

Component	Function
___ Air bearings	a. Turns to maintain correct tape velocity
___ M8739	b. Guides the tape and maintains tape tension
___ Take-up reel motor	c. Helps handle data I/O
___ TMSCP controller module	d. Maintains pressure within the TU81
	e. Turns to maintain correct tape tension
	f. Controls the data interchange

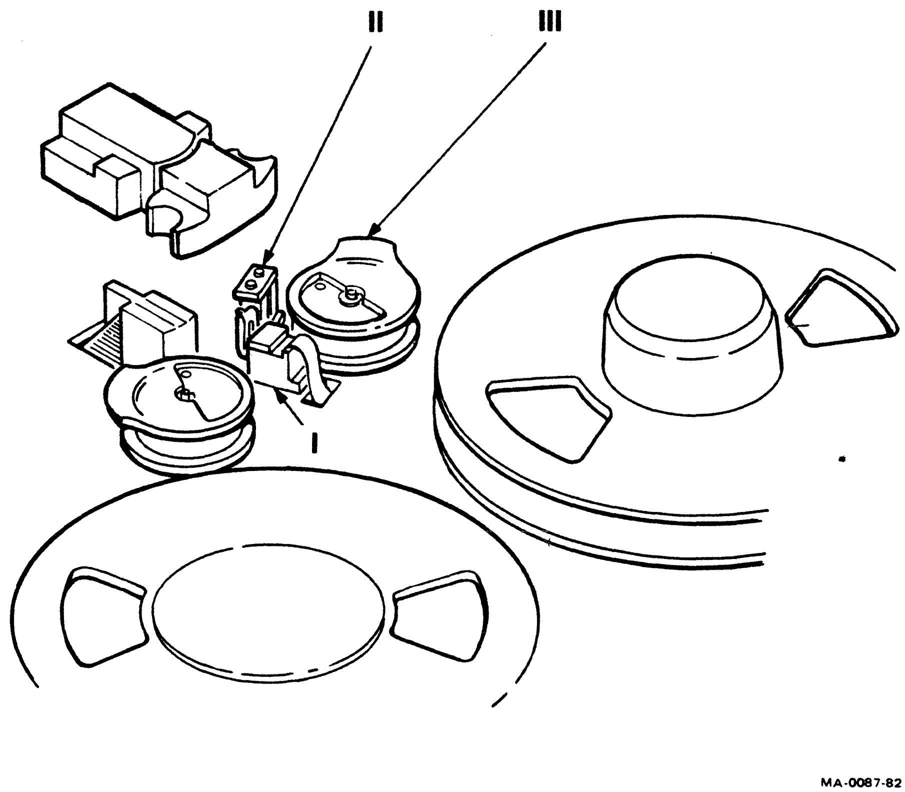

Figure 1   TU81 Tape Path Components

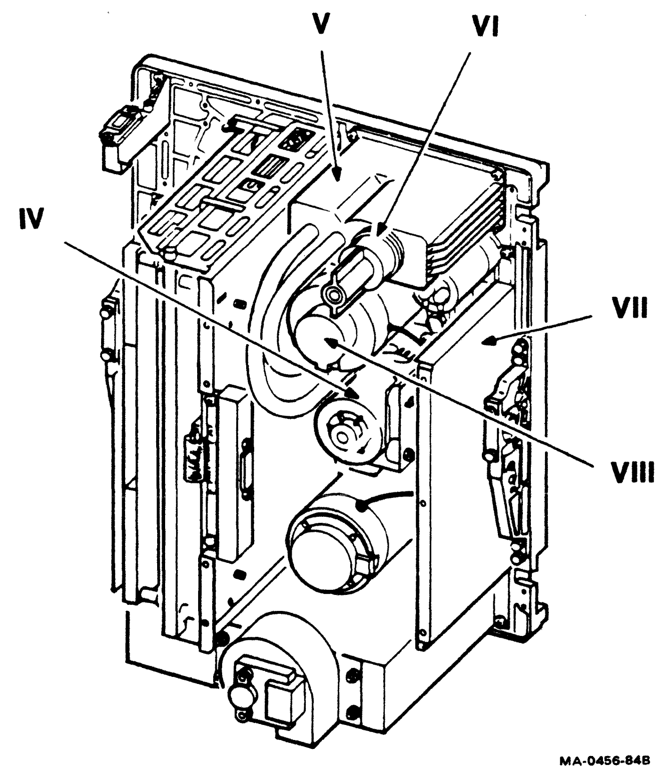

Figure 2   TU81 Components

4. Which of the following components do you clean when cleaning the tape path?

a. Tape cleaner blades
b. Air bearings
c. Take-up reel
d. Tape media
e. Control panel
f. Reflective strip
g. Erase head
h. Tape deck
i. Supply reel hub
j. Read/write head
k. Cover interlock switch
l. BOT/EOT sensor

5. Load and run Operator Test Ø1. Show the Course Administrator that Test Ø1 is running, then ask the Course Administrator to initial the following blank.

S.S. ________ Course Administrator's initials

6. Which PE data string is shown in Figure 3?

a. Ø 1 1 Ø Ø Ø
b. 1 1 1 Ø Ø 1
c. 1 Ø Ø 1 1 1
d. Ø Ø Ø 1 1 Ø

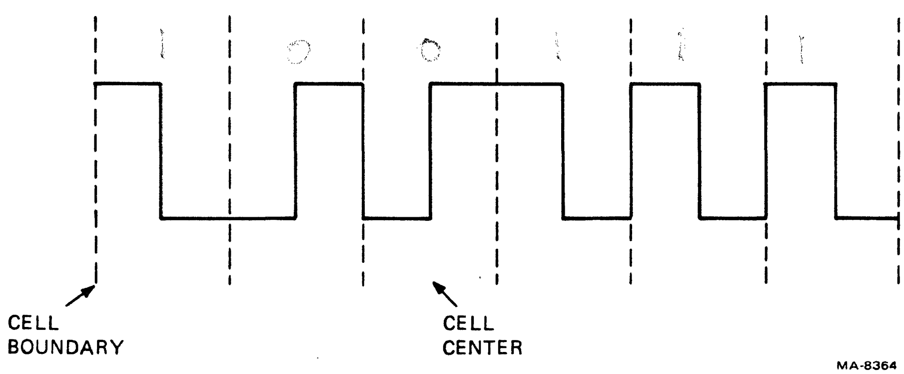

Figure 3 PE Data

7. Match the Roman Numerals in Figure 4 with the correct PE tape component.

Roman Numeral	PE Tape Component
D I	a. Data
E II	b. Preamble
b III	c. Leader
a IV	d. Identification burst (IDB)
g V	e. Record
	f. Initial gap
	g. Postamble
	h. Interrecord gap

8. Match the Roman Numerals in Figure 5 with the correct GCR tape component.

Roman Numeral	GCR Tape Component
d I	a. ARA burst record
b II	b. Tape mark
e III	c. IRG
b IV	d. Density ID area
	e. Data record
	f. Undefined gap

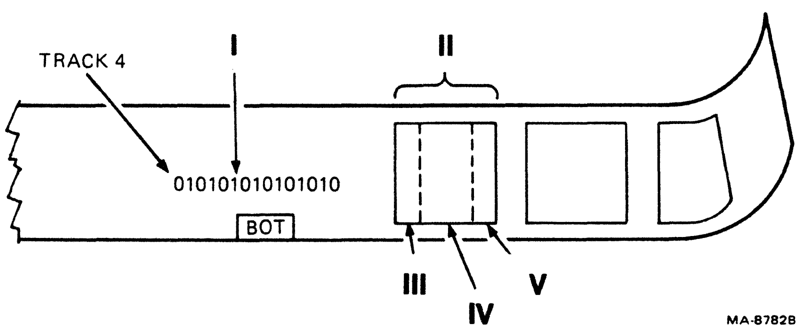

Figure 4 PE Tape Components

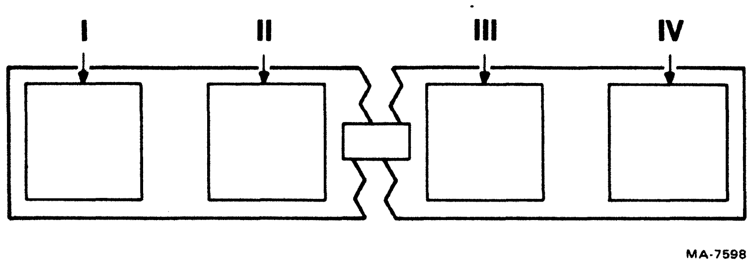

Figure 5 GCR Tape Components

9. Where is the TMSCP server firmware located?

a. On the M8739.
b. In host memory.
c. In the formatter subsystem.
d. On the TMSCP Controller module.

10. Place the letter for correct answer in the blank.

The ______ connects the UNIBUS to the ______ in the transport. The ______ fetches host-transmitted command messages and translates them to TU81 formatter commands. In the LESI interconnect, the ______ is always a slave to the ______.

The ______ module receives commands from the ______, and translates them into tape motion and data transfer instructions for the drive.

The ______ module responds to the various sensors throughout the drive and to commands initiated from the ______. This module also executes commands sent from the ______ module.

a. M8739 LESI adapter	f. Read amplifier
b. TMSCP controller	g. Write driver
c. Formatter write	h. Power amplifier
d. Formatter read	i. Power supply
e. Servo/control	j. Control panel

FINAL TEST (TEST 2)

1. Match each term to the correct description.

Term	Description
___ Internal diagnostic test	a. Used to obtain sense bytes
___ On-site procedures	b. Found in the Pathfinder and used when you are on the phone with the customer
___ Power-On health check	c. Runs using the TU81 control panel
___ ASCII port	d. Runs when the power switch turns on the transport
___ Pre-site procedures	e. Runs as a check on the TU81 subsystem
___ VAX diagnostic	f. Include(s) the Pathfinder tables and are used when you are working on the TU81

2. What can cause number 26 to appear in the display?

   a. Read fault
   b. Formatter write module
   c. Test Ø1 is loaded incorrectly
   d. Servo fault

3. Which is the correct switch sequence to load Test 19? (Assume tape is loaded.)

   a. Press CE and TEST at the same time, then press STEP nine times. Press TEST, STEP, and EXECUTE once each.

   b. Press CE and EXECUTE at the same time, then press STEP. Press TEST once, STEP nine times, and EXECUTE once.

   c. Press CE and EXECUTE at the same time, then press STEP nineteen times. Press EXECUTE.

   d. Press CE and TEST at the same time, then press STEP. Press TEST once, STEP nine times, and EXECUTE once.

4. What is one possible use of Test 18?

   a. Use when searching for intermittent servo errors at 75 ips, streaming mode.

   b. Use when checking for correct ramp times.

   c. Use when searching for random read errors at 75 ips, streaming mode.

   d. Use when searching for random write errors at 75 ips, streaming mode.

5. Which section of EVMBB does not require manual intervention?

   a. Manual
   b. Fault
   c. Default
   d. All of the above

6. Which diagnostic section allows you to run the drive resident tests?

   a. EVMBA/SEC:CONVERSATION
   b. EVMBB/SEC:FAULT
   c. EVMBA/SEC:MANUAL
   d. EVMBB/SEC:MEDIA

7. What is the best way to remove the air bearing transducer?

   a. From the bottom of the tape deck, remove the transducer from the back of the air bearing assembly.

   b. Remove the air bearing assembly from the tape deck. Then remove the transducer from the air bearing assembly.

   c. Remove the magnetic head assembly from the tape deck and then remove the transducer.

   d. Remove the spring guide to access the transducer. Then remove the transducer.

   e. Call support.

8. What are the verification tests after you replace the servo/control module?

   a. Tests 37, 49, 64, 31, and Ø1
   b. Test Ø1
   c. Tests 37, 49, and Ø1
   d. Power-On Tests 1ØØ1 through 1ØØ3

9. What should you always do as a final check at the end of every repair call?

   a. Run data reliability diagnostic EVMBA.
   b. Have the customer run the host software.
   c. Run drive resident Test Ø1.
   d. Run front-end diagnostic EVMBB.

1Ø. Have the Course Administrator put a test malfunction into the TU81 subsystem. Find the manfunction by using the Pathfinder documentation, then ask the Course Administrator to initial the following blank.

SS ______ Course Administrator's initials