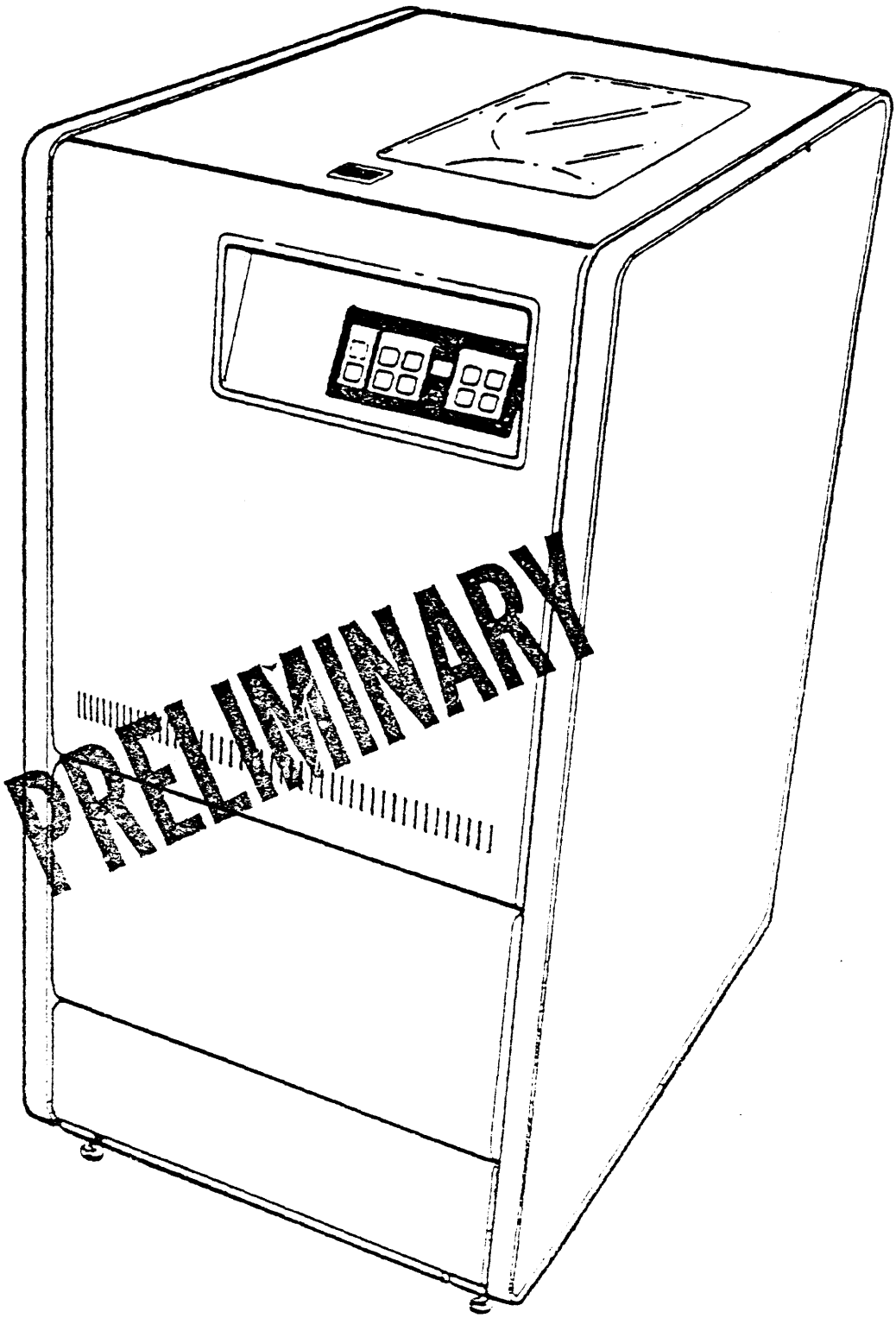
TU80 OPERATION
AND SERVICING COURSE



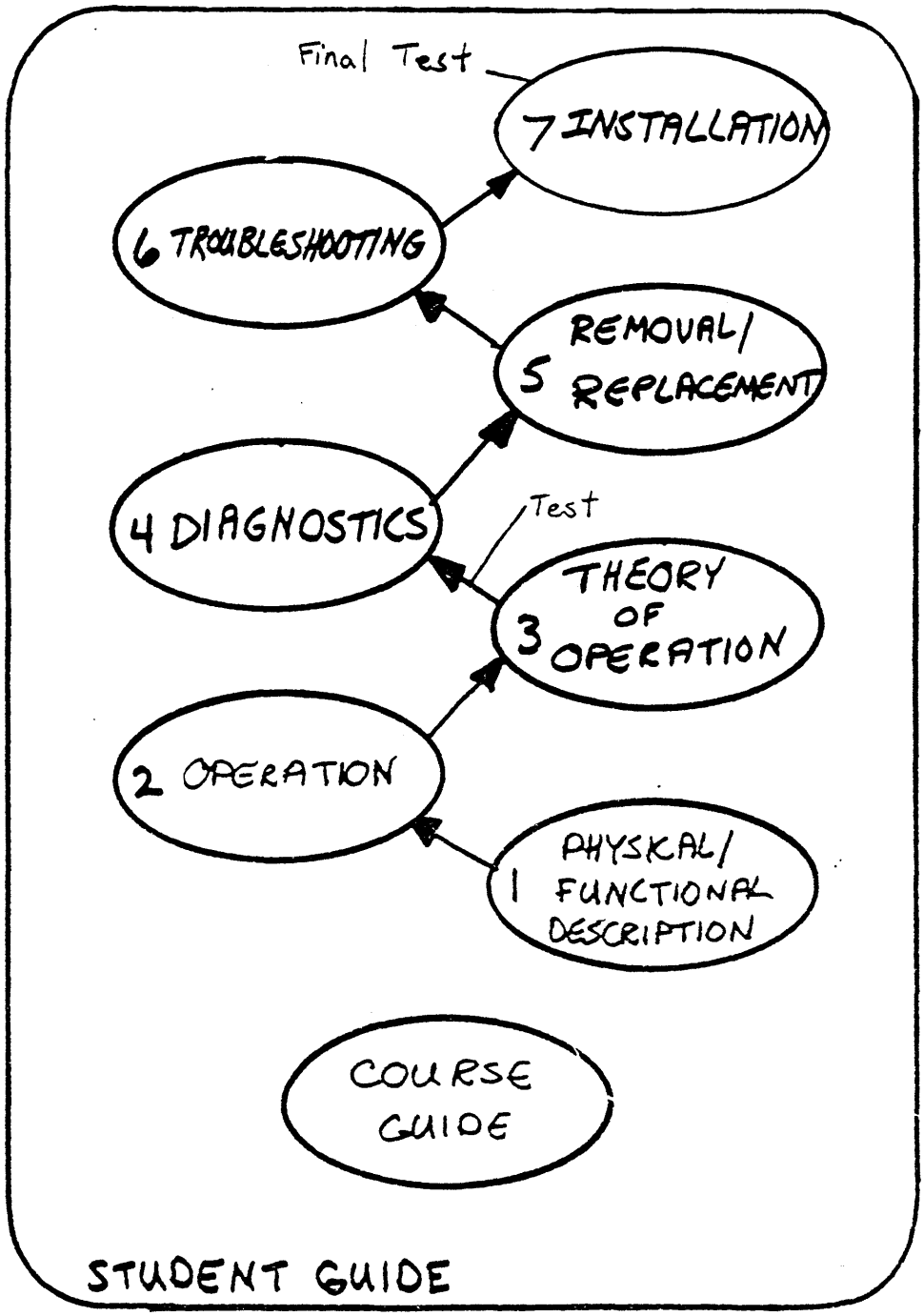


Figure 1 TU80 Course Map

TU80 COURSE GUIDE

INTRODUCTION

TU8Ø Operation and Servicing is a self-paced course. A self-paced course allows you to conduct the course in the way which fits your study habits best. Read "How to Take a Self-Paced Course" (EY-DXØ37-ID-ØØ1) if you have any questions about this type of course.

It should take you approximately two days to complete this course. The course map (Figure 1) outlines the sequence in which the lessons should be taken.

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 System Maintenance lesson.

The course administrator has provided you with all the documentation and equipment needed as resources to complete this course. Occasionally resources are shared between students. The course administrator will notify you if this is the case.

The most important thing to keep in mind while taking this course is this. DO NOT LEAVE ANY TU8Ø QUESTION UNANSWERED.

PREREQUISITES

You must satisfy the following requirements before taking this course.

1. Completion of the "Magnetic Recording" and "Tape Concepts" courses.

3. Experience in using XXDP+ and VAX diagnostics.

If you have not satisfied these requirements, notify the course administrator now.

COURSE GOAL AND LIMITATIONS

The goal of this course is to provide field service representatives with the knowledge and skills necessary to maintain and repair the TU8Ø subsystem.

To achieve this goal, the TU8Ø topics for this course include the following.

- operation
- diagnostic operation and interpretation

- o removal and replacement procedures
- o functional overview
- o troubleshooting to the field replaceable unit level.

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

COURSE ORGANIZATION

This course is divided into ~~six~~ seven lessons as shown in figure 1-1

Each lesson includes:

1. Lesson introduction
2. List of objectives
3. Reading material
4. Performed or written practice exercises
5. Additional resources and reference materials.

The table of contents at the start of this book contains a list of topics covered in each lesson.

Throughout this course there are sentences beginning with a blank space. For example,

____Press the UNLOAD switch to remove tape from the tape path and wind it on the supply reel.

This is an activity sentence. You are to perform the activity described in the sentence at that time. No other instructions are provided unless needed for a specific activity.

You may find it advantageous to place a check in the blank as you complete each activity.

DO NOT SKIM through an activity description. Read each carefully. Many small but very important bits of knowledge are overlooked by skimming in a course. This hurts your job performance.

POCKET SERVICE GUIDE

The pocket service guide (PSG) should be used while taking this course.

The PSG was NOT written as a learning tool. It was written for use in the field to complement the knowledge you gain in this course.

To enhance your performance in the field, add your own notes into the PSG. Everyone needs some reminders while in the field. The PSG is the perfect place to add notes since it will be the one document you always have in the field.

DOCUMENTATION

The introduction chapter of the PSG contains a complete list of TU80 documentation. Also found in the PSG are order numbers for each document. You will be referred to many of these documents during this course.

The course administrator has provided you with all the documents needed to complete this course.

PHYSICAL/FUNCTIONAL DESCRIPTION

INTRODUCTION

This lesson identifies the hardware components of the TU8Ø. A short description is included with each component.

A functional description overview is included at the end of the lesson to give you an understanding of how the components relate to each other.

You will not disassemble anything in this lesson. However, to access some components you must remove a cover or open a door. At the end of this lesson, you will know where every TU8Ø component is and what it looks like.

OBJECTIVES

- Use the TU8Ø specifications list to identify specified technical parameters.
- Locate and identify the TU8Ø physical components.
- Describe the function of any TU8Ø component.
- Give a general description of how the TU8Ø reads and writes.

TU8Ø

The TU8Ø is a magnetic tape transport for one-half inch tape used on PDP-11 and VAX computers. It is manufactured for DIGITAL by Computer Peripherals, Inc. (CPI) in Norristown, Pennsylvania. CPI is a subsidiary of Control Data Corporation (CDC). The host interface module is manufactured for DIGITAL by Distributed Logic Corp. (DILOG) in Garden Grove, California.

The TU8Ø operates in streaming or start/stop mode. Both modes are explained in the Theory of Operation lesson.

The mode used is determined and implemented within the TU8Ø depending on the data transfer rate. The mode used is transparent to the host and the operator.

The TU8Ø is designed primarily to be used as a data back-up device where large amounts of data are recorded or read in a continuous stream. The TU8Ø can read or write data at 1ØØ inches/second (ips) or 25 ips when in streaming mode . When in start/stop mode where small amounts of data are recorded or read at varying intervals of time, the TU8Ø operates at 25 ips only.

The TU8Ø has the following features.

- Microprocessor control

- o Complete internal microdiagnostics
- o No tension arms or vacuum columns
- o No capstan
- o No scheduled preventive maintenance
- o No adjustments

SPECIFICATIONS

Table 1 lists the most used specifications of the TU8Ø. Some of the specifications to note are the speed, the recording method, and the recording density.

Specifications tables provide answers for many of your questions, as well as, your customers questions. See the TU8Ø Technical Manual for a complete list of specifications.

MAJOR EXTERNAL COMPONENTS

You start working directly with the TU8Ø in the following paragraphs. You will NOT remove any components or power-up the TU8Ø in this lesson.

The TU8Ø is at your disposal for the rest of the course. You do not need the course administrator's permission to access it. If another student is taking the course, work out an accommodating schedule for both of you.

Refer to figure 1 throughout this section.

NOTE

In the next paragraph you will find a blank space just before the first word. The blank space signifies an activity paragraph. Whenever a blank space starts a paragraph, it means to complete that activity at that time without further directions. Place a check in the blank space when you have completed the activity. Throughout this course you will find these blank spaces before activity paragraphs.

____Open the top cover of the TU8Ø by pushing back on the latch (Figure 1).

Underneath the top cover is the streaming tape unit (STU). Often in TU8Ø documentation, the terms STU and TU8Ø are used interchangeably and it does not really matter. However, the following definitions follow the designed usage of the terms.

- o Streaming Tape Unit (STU)- The STU includes all the components attached to either side of the tape deck and the control panel.

Recording density	1600 bits/in. (bpi)
Recording method	Phase encoded (PE)
Rewind speed	200 in./sec. (ips)
Tape	
Width	one-half inch
Length	2400 ft. maximum
Tracks	9
Capacity	30 megabytes
Tape speed	
Start/stop	25 in./sec. (ips)
Streaming	100 in./sec. (ips)
Data transfer rate	
Start/stop	20 kilobytes/sec.
Streaming	160 kilobytes/sec.
Weight	280 pounds (drive and cabinet)
Dimensions	
Height	41.6 inches
Width	21.5 inches
Depth	30.0 inches
Operating Temperature	50°F to 104°F

Table 1 TU80 Specifications

preliminary
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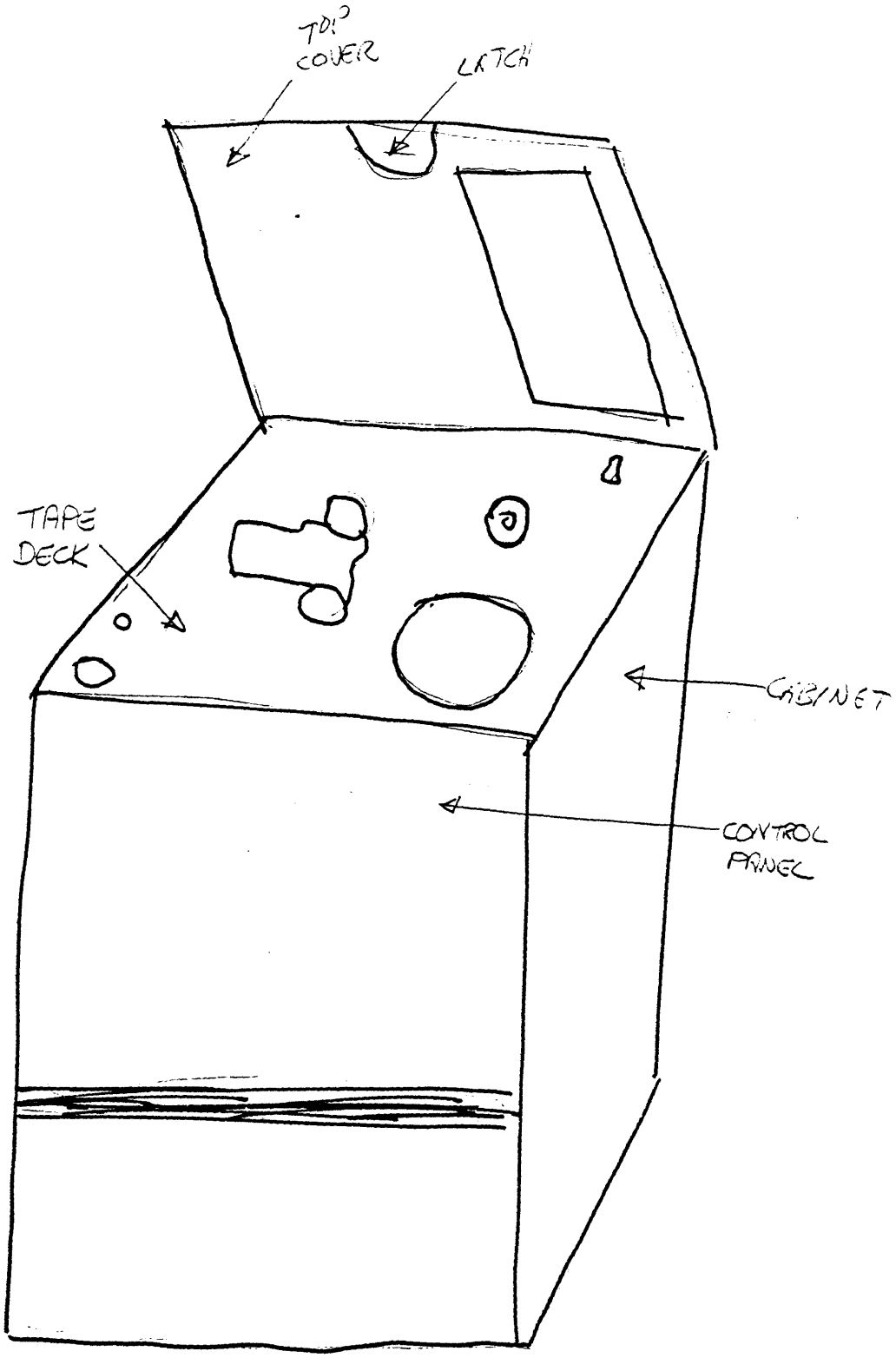

Figure 1 TU80 Major Assemblies

- o TU8Ø - STU, power controller, and the cabinet.
- o TU8Ø subsystem - TU8Ø, the interface cables, and the UNIBUS adapter card.

Find the following components on the TU8Ø.

____Cabinet
The cabinet is a modified DIGITAL H9643 cabinet.

____Streaming Tape Unit (STU)
The STU is made up of the deck plate and all attached components.

____Tape Deck
The tape deck is cast and is the base for mounting the STU components.

____Control Panel
The control panel has switches and indicators for all customer AND field service operations of the TU8Ø.

____Open the rear door of the TU8Ø (Figure 2). You may need a corporate cab key if this door is locked.

Find the following component on the TU8Ø.

____Power Controller
The power controller is a standard DIGITAL 874 controller with 8 AC output plugs.

STU COMPONENTS (TOP)
Identify the following STU components on the top of the tape deck. Refer to figure 3.

____TU8Ø On/Off Switch
The on/off switch powers up the TU8Ø power supply. This switch is usually left on by a customer so TU8Ø power is controlled by the host on/off switch.

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

____Take-up Hub and Reel
The take-up reel is a 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 in order to operate the TU8Ø. The operator must close and latch the top cover to enable this switch. You, as a field service reprsentative, can override

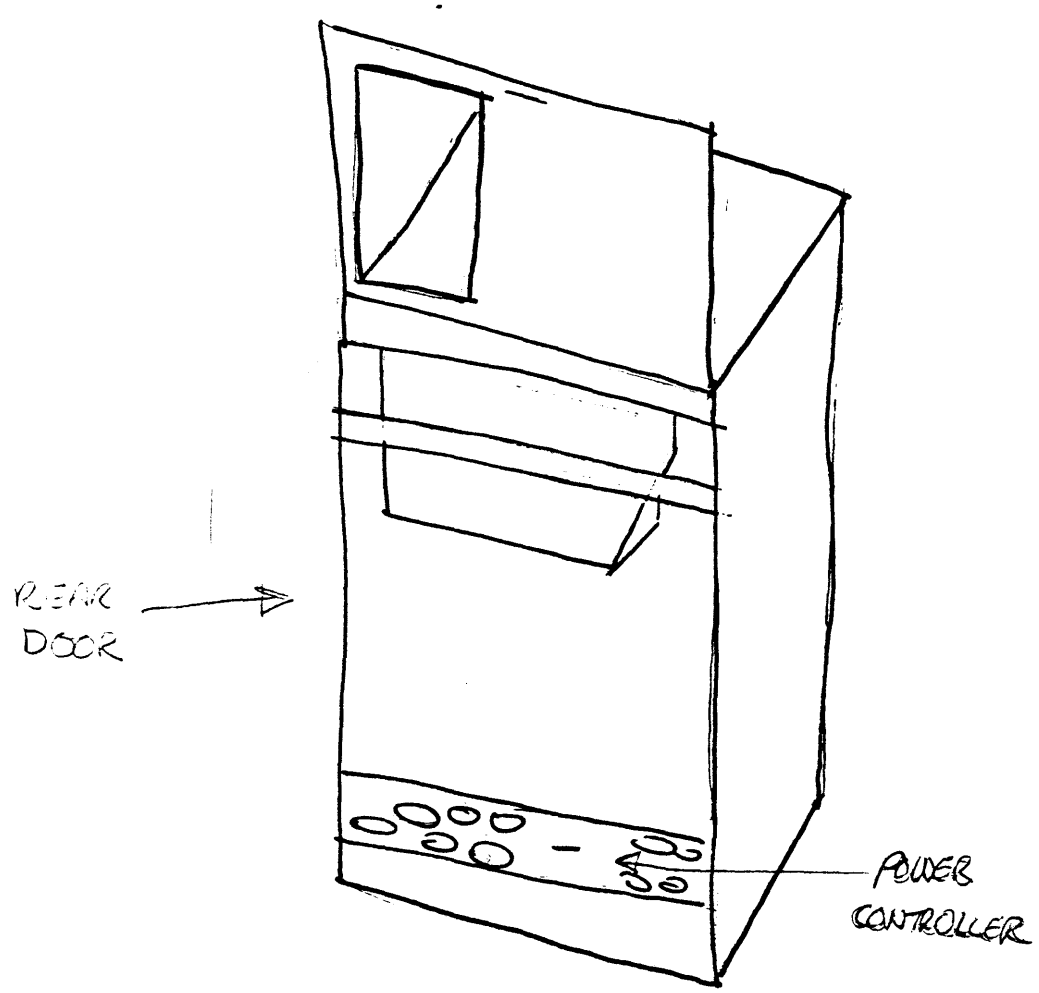

Figure 2 TU80 Major Assemblies (Rear)

angle this figure and make it 3D

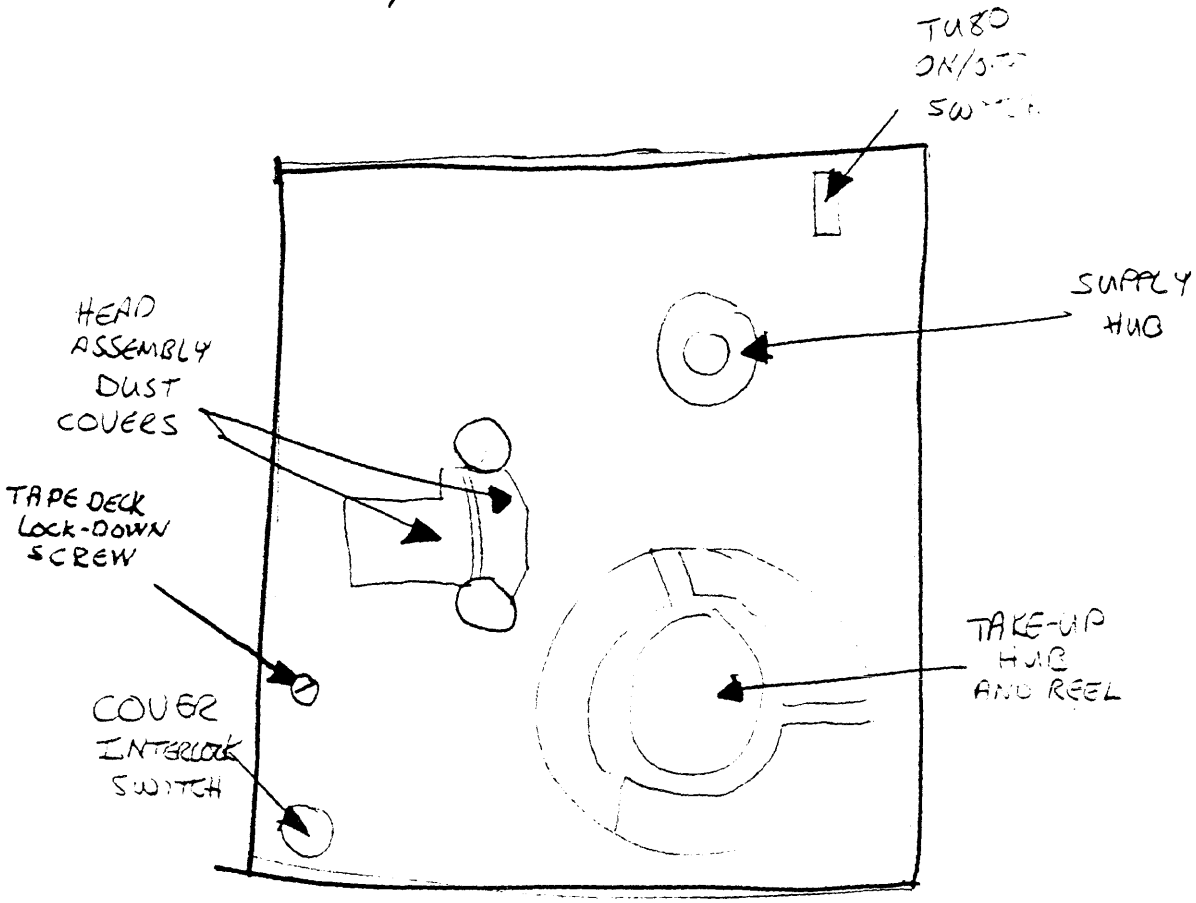

Figure 3 STU Components (Top)

this switch with an appropriate tool.

____Tape Deck Lock-down Screw
This screw holds the tape deck secure when the TU8Ø is being operated. If this screw is not tight, the tape deck can vibrate causing errors and operator annoyance.

____2 Head Assembly Dust Covers
These covers keep the head assembly components clean.

TAPE PATH COMPONENTS
The head assembly components, the air bearings, and the reels are included in the tape path components.

____Remove the 2 head assembly dust covers by pulling straight out on them. This reveals the head assembly components.

Identify the following components (Figure 4).

____Tape Cleaner
The tape cleaner pulls unwanted particles off the tape passing over it. There are 2 blades on the tape cleaner; one blade for each direction of tape movement. Air is pulled through the port between the two blades by an pump within the TU8Ø. This air suction pulls the unwanted particles collected by the blades into a filter.

____BOT/EOT Sensor Assembly
The BOT/EOT sensor assembly senses the beginning-of-tape (BOT) and end-of-tape (EOT) markers on the tape. These markers are used by the TU8Ø to identify tape position. This assembly also contains a reflective strip opposite the sensors which, when sensed, causes a signal to be generated which notifies the TU8Ø that there is no tape in the tape path.

____Erase Head
The erase 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
The read/write head is a dual-gap head. This means a single assembly contains 18 coils. 9 coils are for writing, and 9 coils are for reading.

____Supply Air Bearing and Take-up Air Bearing
The air bearings guide the tape across the heads and help to maintain correct tape tension. Figure 5 is a close-up of an air bearing.

Air is blown out of the small holes in the bearing surface. The air provides a cushion for the tape to travel on reducing the frictional coefficient. The guide spring limits

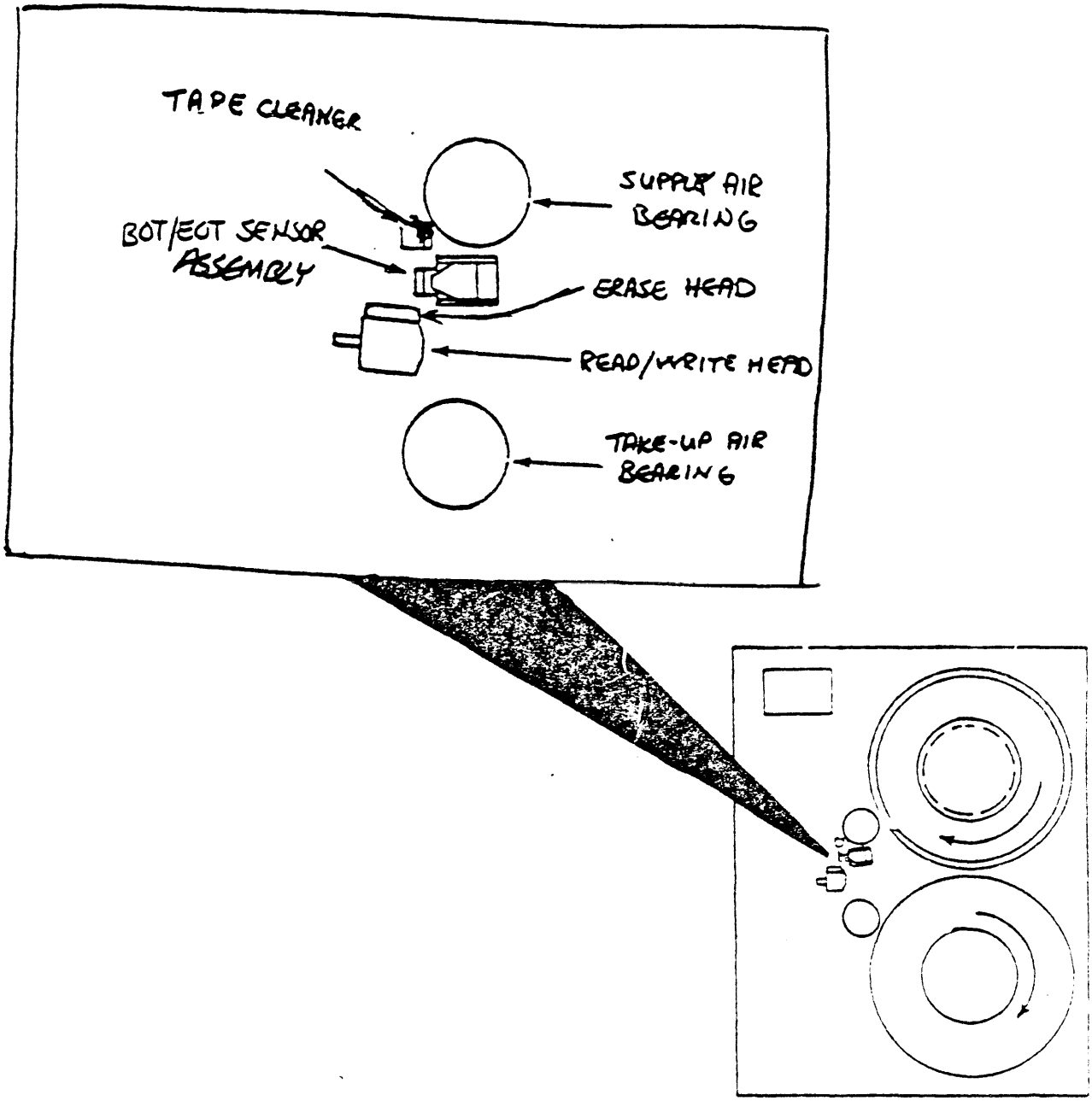

Figure 4 TU80 Tape Path Components

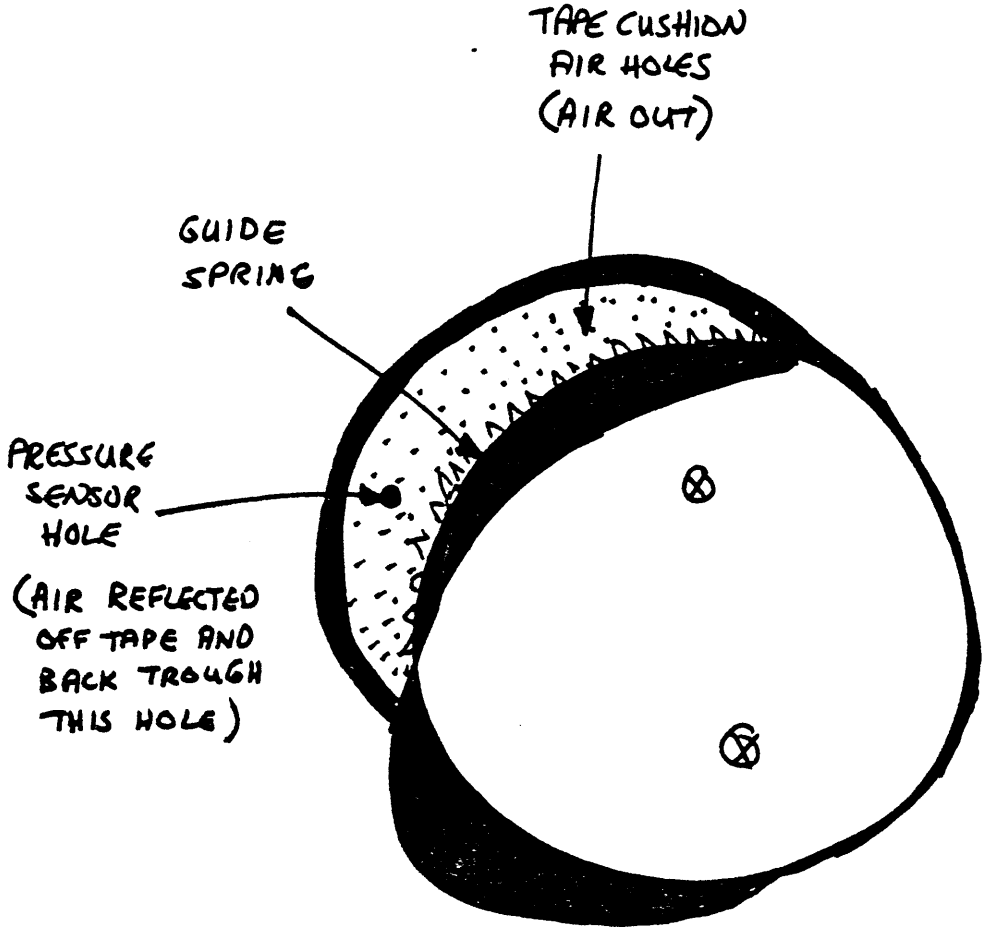

Figure 5 Air Bearing

side-to-side tape movement. Also, a sensor within each air bearing monitors the air pressure through the large hole on the surface of the air bearing. A signal based on the amount of pressure is sent to the control logic. This signal is used with other signals to turn the supply reel the correct amount to maintain correct tape tension. This is the tension servo function and eliminates the need for tension arms or vacuum columns.

STU COMPONENTS (BOTTOM)

This section describes how you access the STU components on the bottom of the deck plate, and then identifies them.

____Open the front door of the cabinet (Figure 6).

The STU pivots 90° for servicing. This allows easy access for the field service representative when components need to be removed or cleaned.

____Service Release Handle

The service release handle (Figure 6 inset) allows field service access to the components on the back of the deck plate.

____Disengage the service release handle from the operating lock hole. Reach through the front of the TU80, around the control panel cable, and pull out on the service release handle.

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

____Grasp the front edge of the casting and tilt it upward (Figure 7). Be careful not to snag the operator panel cable.

____Make sure that the casting is tilted a full 90° and has snapped into the service lock (Figure 6).

The service lock works the same as the operating lock. To put the tape deck in operating position, pull out on the handle and rotate the tape deck. Leave the tape deck in the service position at this time.

The TU80 is now in service position.

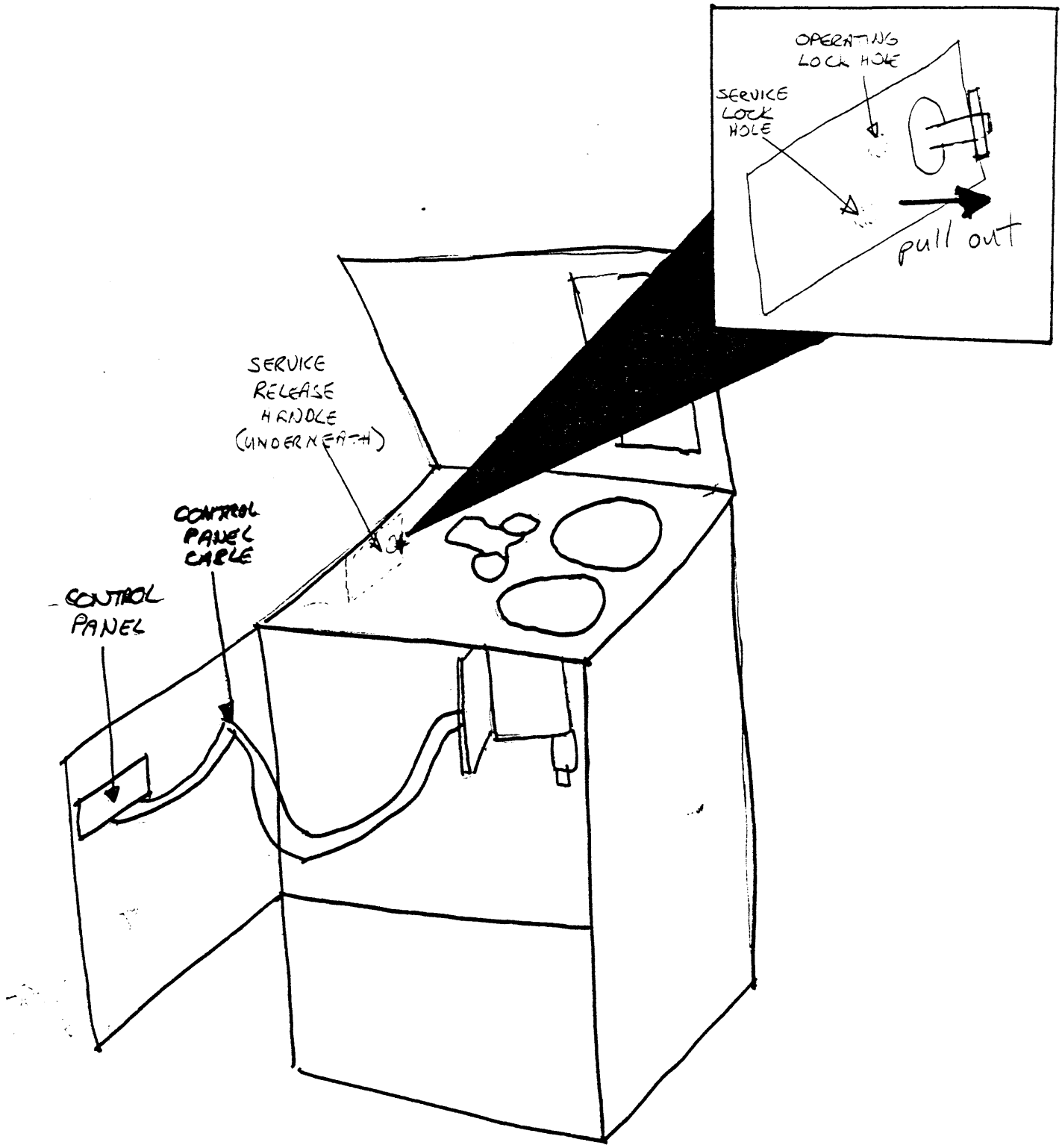

Figure 6 Service Release Handle Access

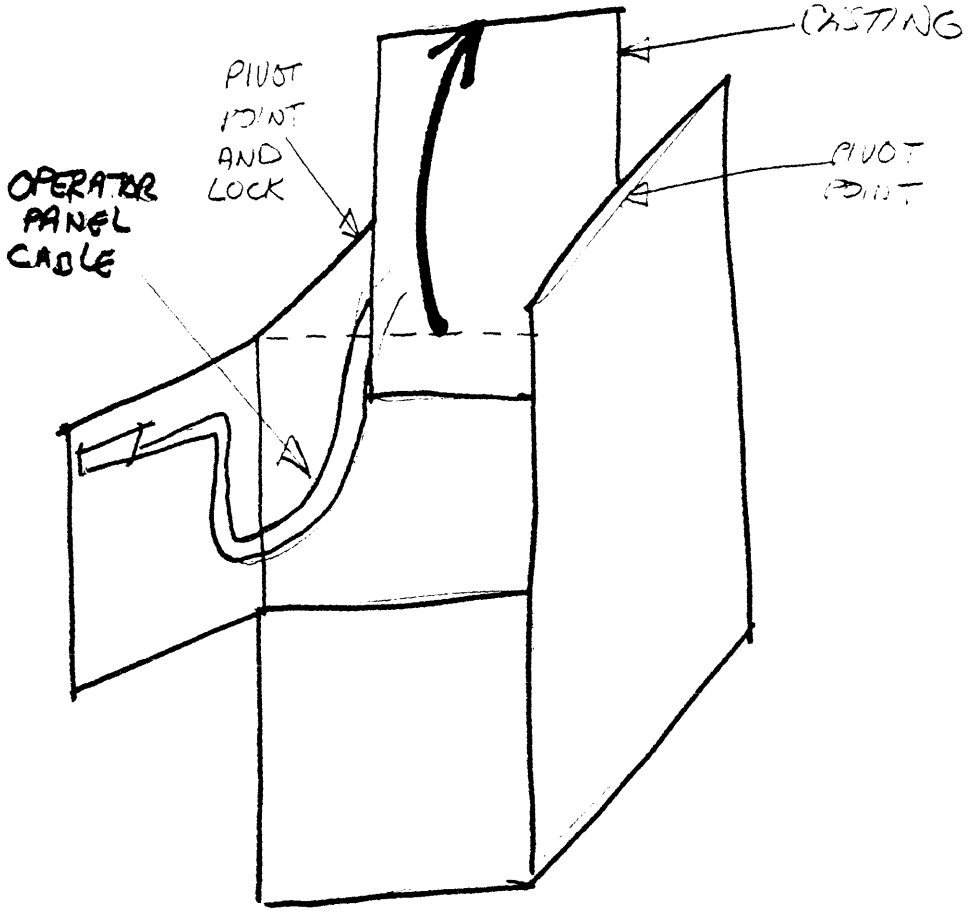

Figure 7 Rotating the STU

Identify the following STU components located on the rear of the tape deck (Figure 8).

____Power Supply
The power supply accepts input AC voltage and converts it to DC voltages of +5, -6, +15, -15, +25.5, +38 for the STU. The on/off switch on the top of the deck plate is the circuit breaker for the power supply.

When the on/off switch is on and the LOGIC ON indicator is off, only the power supply and part of the control panel has power. When the on/off switch is on and the LOGIC ON indicator is on, the rest of the STU has power from the power supply.

____Cooling Fan
The cooling fan is the only means for cooling in the entire TU8Ø. It cools everything within the cabinet.

____Acoustic Cover
The acoustic cover suppresses noise. It covers the reel motors, the tachometers, and the compressor.

The acoustic cover must be removed to access the reel motors and the compressor.The cooling fan must be removed before the acoustic cover.

____Remove the cooling fan by removing the 4 mounting nuts and washers (Figure 9). Separate the connector and lay the fan aside.

WARNING

Some of the components under the acoustic cover can cause severe shock if touched when powered up.

Make sure power is off BEFORE the cover is removed.

____Remove the mounting hardware from the acoustic cover and remove the cover.

You may have to remove the tubes from the plenum box. Notice that they are color coded.

____Remove the parallel bus cables from the logic cage connector.

____Logic Card Cage
The logic card cage is inside the FCC shield. The cage contains two modules, the formatter/ control module (nearest the acoustic cover) and the read/write/servo module.

____Follow each cable from the read/write/servo (R/W/S) module (Figure 1Ø) to determine what it connects to at the other end. This familiarization is important in understanding TU8Ø

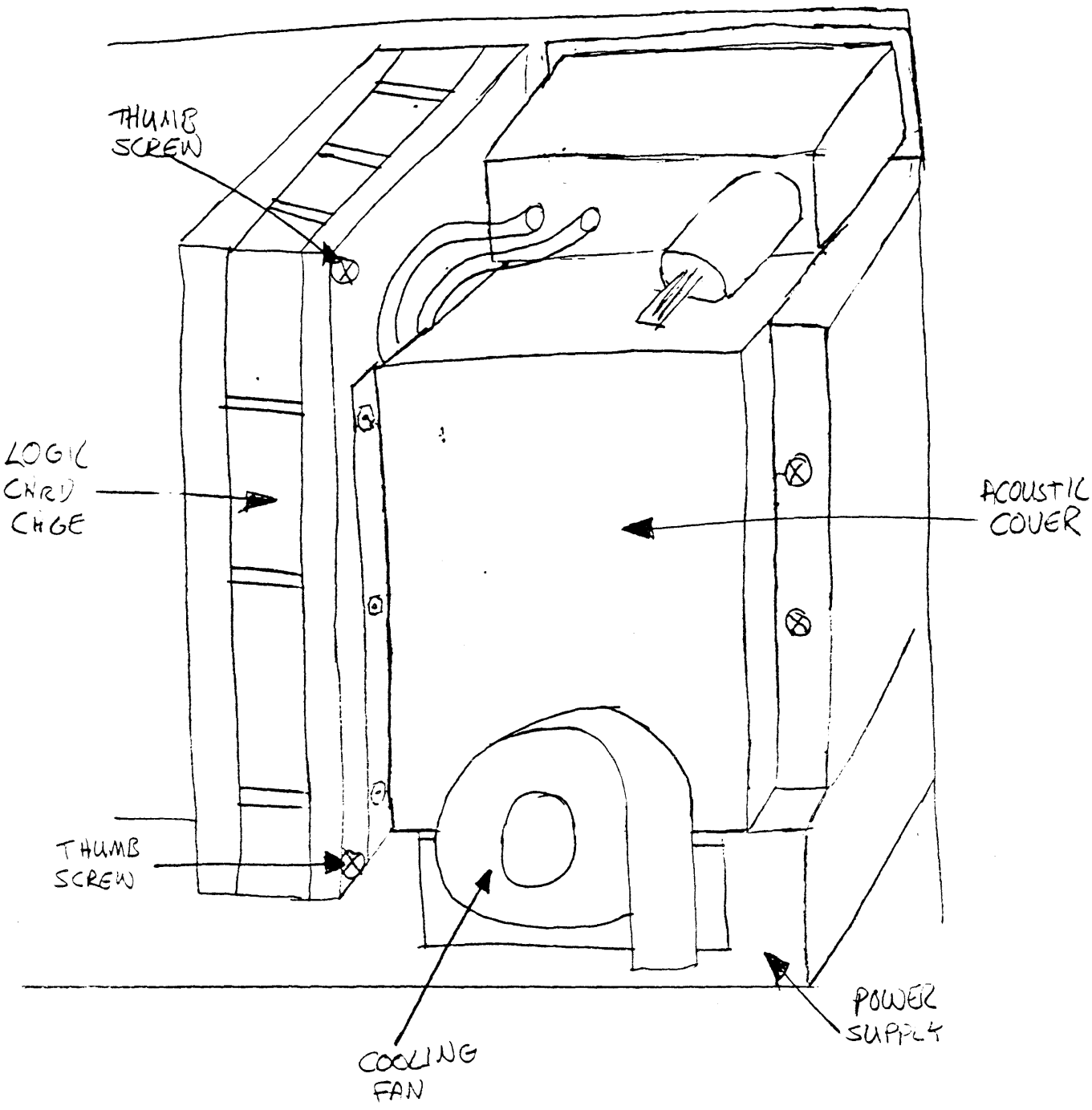

Figure 8 STU Components (Bottom)

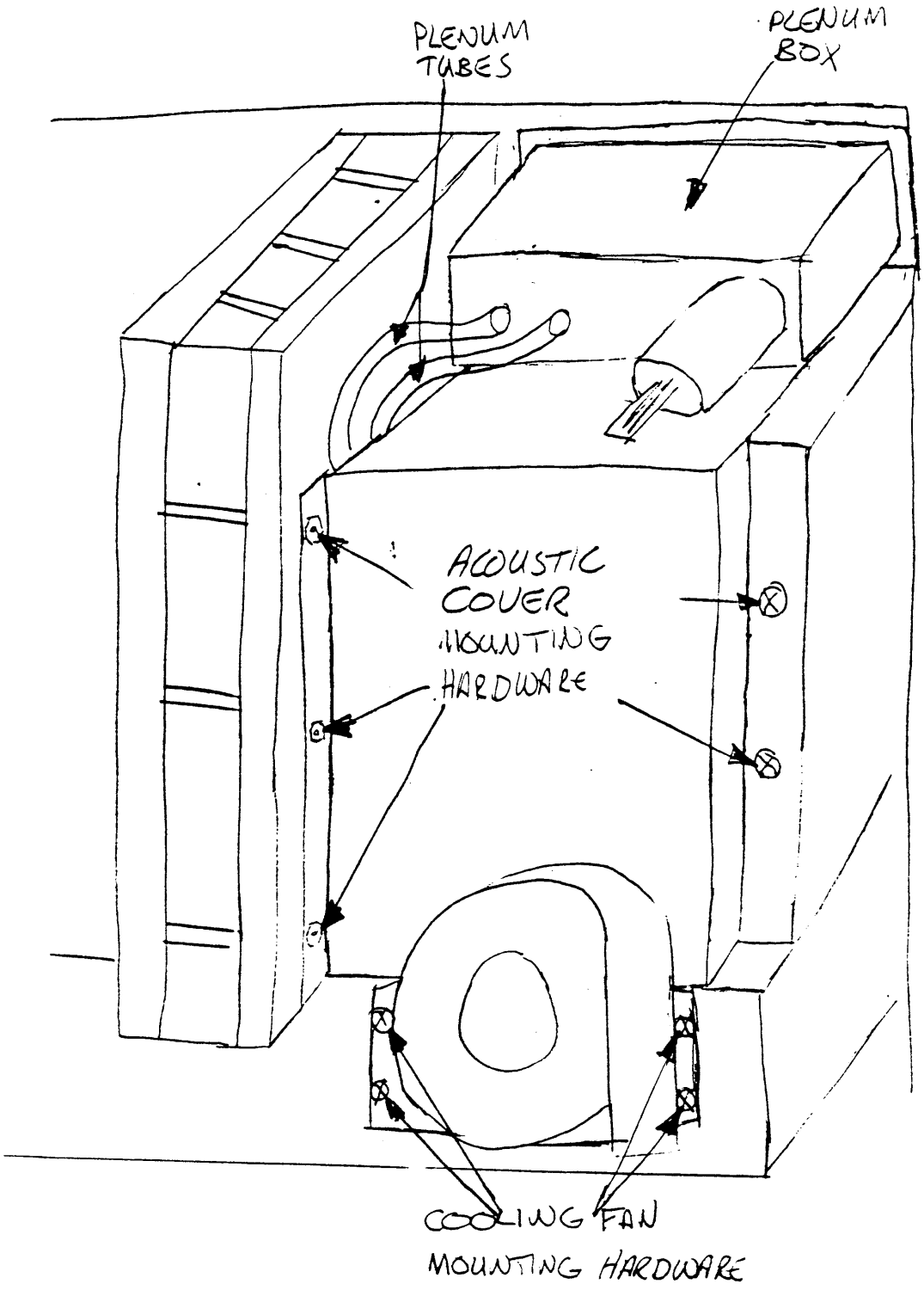

Figure 11 FCC Shield Removal

interconnections.

____Loosen the thumb screw from the upper and lower corners of the logic card cage.

This allows the 2 modules to be separated in order to view the formatter/control (F/C) module (Figure 11).

____Follow each cable from the F/C module to determine what it connects to at the other end.

NOTE

There are two cables because of the large number of signals to the host interface and the etch pattern of the F/C module.

The functionality of the R/W/S and F/C modules is examined closely in the Theory of Operation lesson.

Identify the following components.

____**Power Amplifier Module**
The power amplifier module (Figures 12 and 13) receives low voltage analog signals from the R/W/S module and outputs a higher voltage, high current 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**
The take-up reel motor (Figure 12) turns the take-up reel. It is a permanent-magnet DC motor.

____**1000-Line Tachometer**
The 1000-line tachometer is located under a cover on the back of the take-up reel motor. It is a two-phase tachometer.

The 1000-line tachometer signal is used in a calculation by the microprocessor to create 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 is turned an amount to maintain tape velocity. This is the velocity servo function and eliminates the need for a capstan.

____**Supply Reel Motor**
The supply reel motor (Figure 12) turns the supply reel. It is a permanent-magnet DC motor.

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

The 1-line tachometer acts as a counter of supply reel

30 this and reference it to tape deck

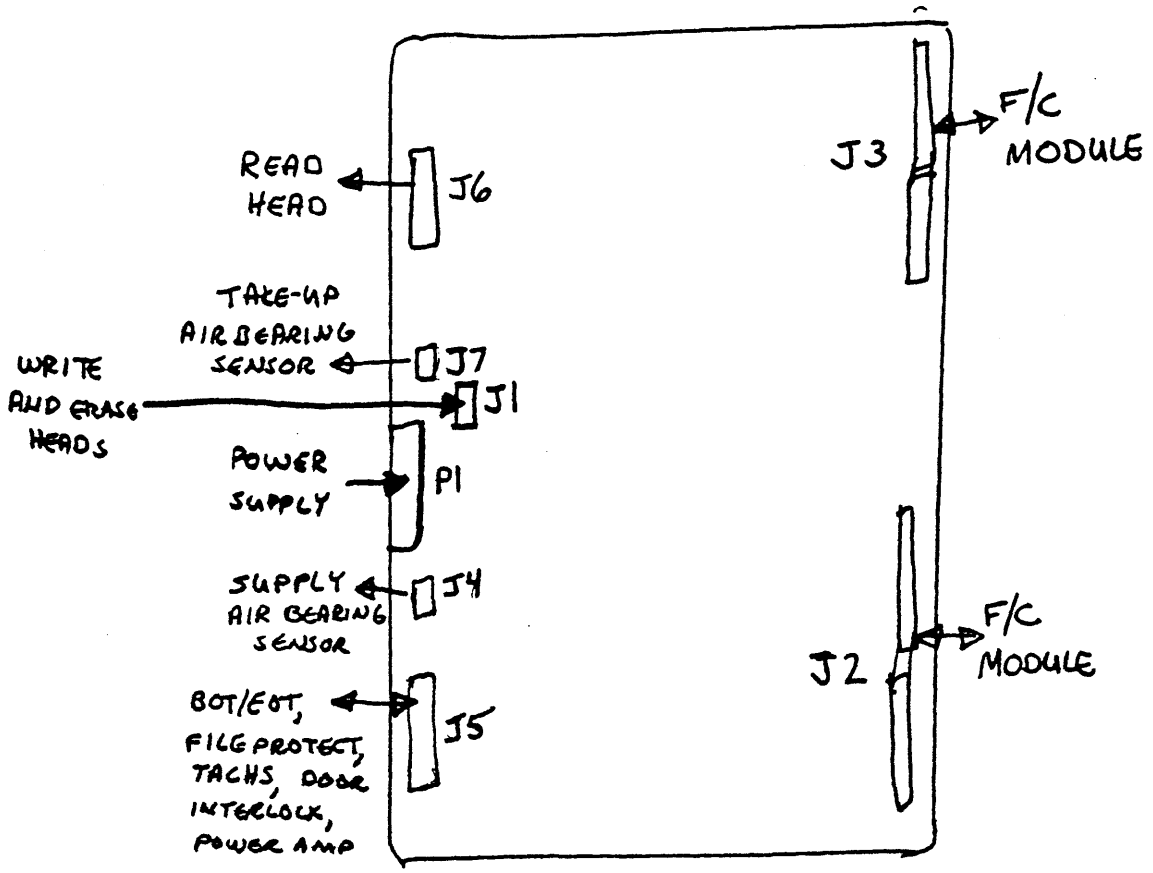

Figure 9 Read/Write/Servo (R/W/S) Module

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3D this and reference it to tape deck.

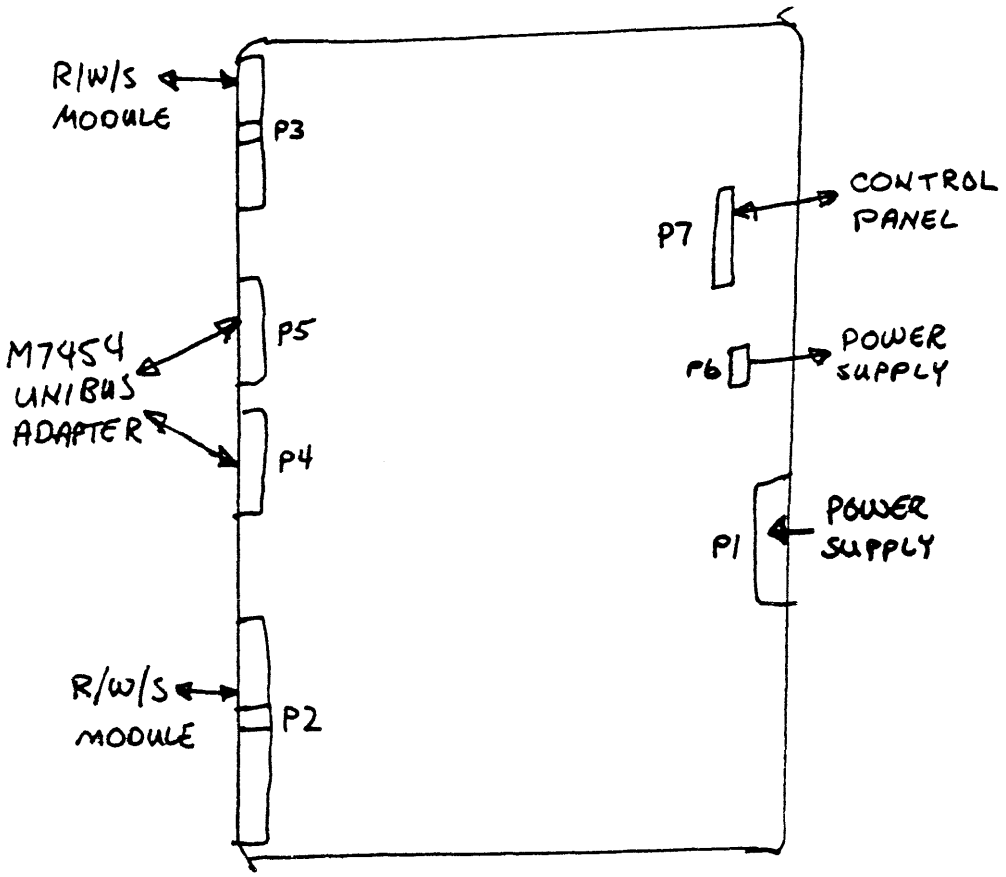

Figure 10 Formatter/Control (F/C) Module

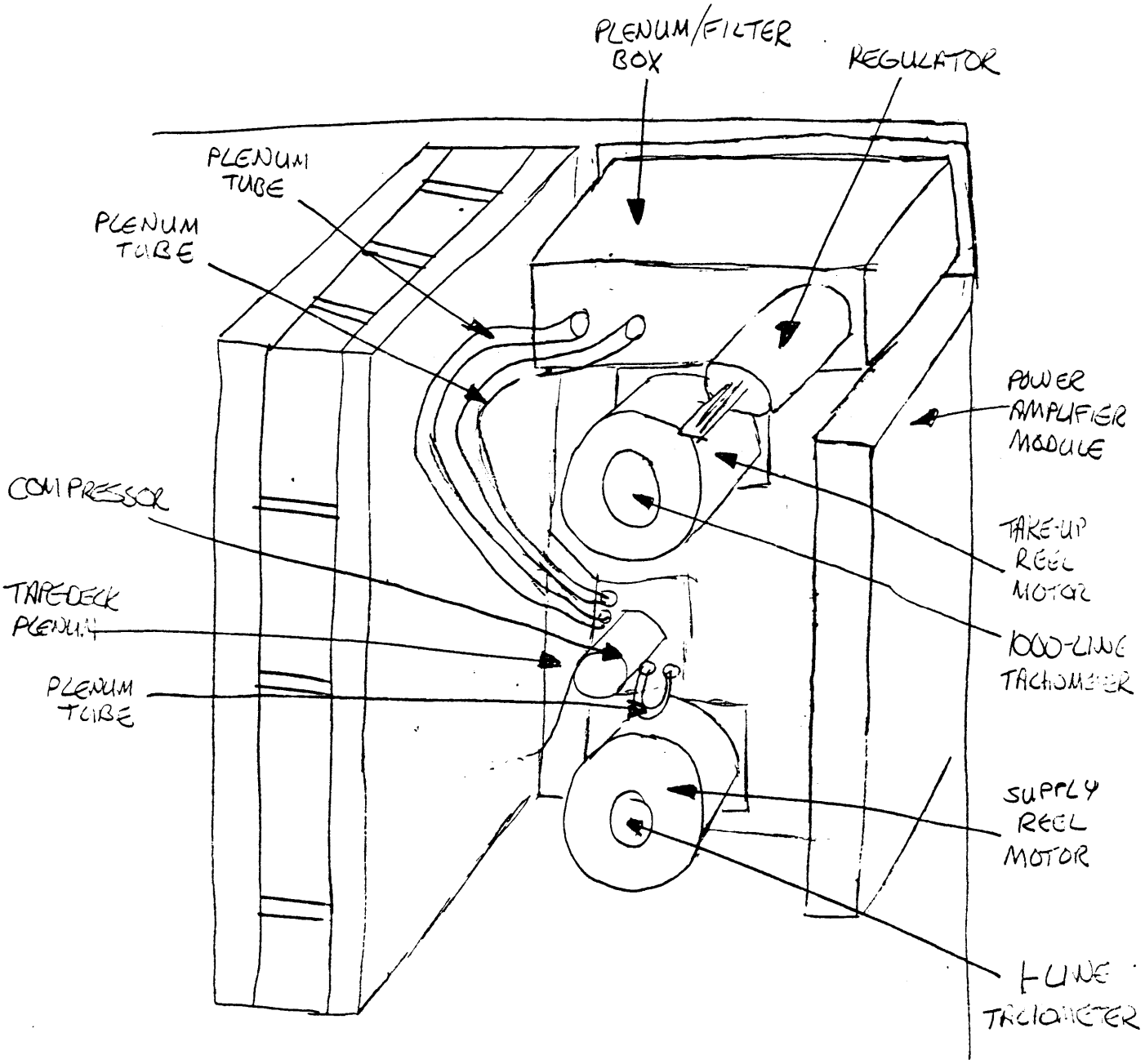

Figure 12 STU Components (Shield Removed)

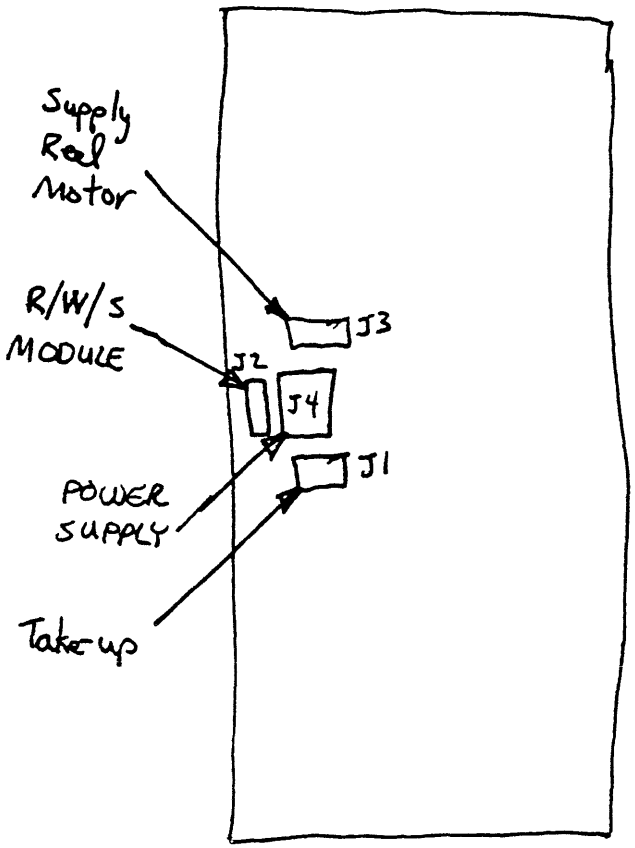

Figure 13 Power Amplifier Module

revolutions. The count starts when you load tape. It gives one count per revolution. As the tape goes forward, the count increments. As the tape to goes reverse, the count decrements.

The count is used in two ways. First, it keeps track of the amount of tape that has wound off of the supply reel. This is used during rewind to determine when to begin slowing 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 revolutions (8 counts) the demand velocity is recalculated using a new radius to maintain the correct tape velocity.

The following five components comprise the air system between the tape cleaner and the air bearings.

____Plenum Box
The plenum box contains a 2-micron filter to clean the air in the air system.

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

____3 Plenum Tubes
The plenum tubes connect components of the pressurized air system.

____Tape Deck Plenum
The tape deck plenum, along with the plenum tubes, connect components of the pressurized air system.

____Compressor
The compressor supplies all air vacuum and pressure needed by the TU8Ø. Vacuum is applied to the tape cleaner port, and pressure is applied to the air bearings.

Perform the following step to aquaint yourself with the complete air system of the TU8Ø.

____Go to the TU8Ø and follow the path the air takes as you read through the following description. Use figure 14 for assistance.

The path of air through the STU is:

1. Air is pulled in through the tape cleaner port and into the tape deck plenum.

NOTE
The tape deck plenum is made up of a

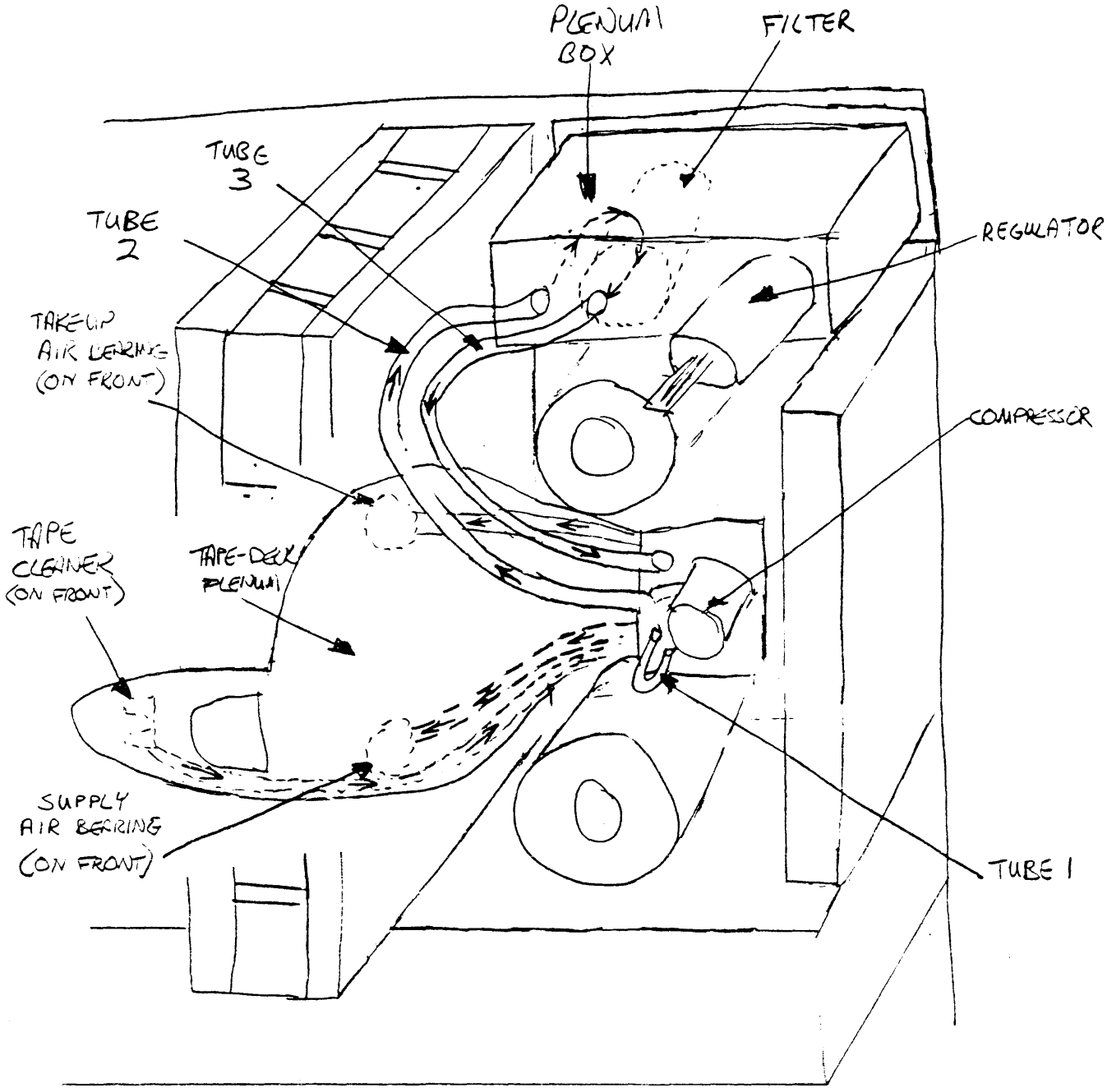

Figure 14 Vacuum/Pressure Air System

casting slot covered by a metal plate with the edge sealed with gasket cement.

2. Air goes through the tape deck plenum and enters plenum tube 1 which is just under the compressor.

3. Air exits the tube as it is pulled (vacuum) into the compressor.

4. Air is pushed out of the compressor (pressure) and enters plenum tube 2.

5. Air exits the tube into the plenum box where it is filtered and regulated.

6. Filtered/regulated air is pushed out of the plenum box into plenum tube 3.

7. Air exits the tube into another part of the tape deck plenum.

8. The pressurized air exits the tape deck plenum and the STU through the air bearings.

____Put the logic modules together using the thumb screws.

The screws go in easier if you tighten each one a little and alternate back and forth until they both are tight.

____Replace the FCC shield by locating it and tightening all the screws a half turn.

____Replace the acoustic cover by locating it and resinstalling and tightening the mounting screws.

____Reinstall the plenum tubes into the plenum box.

____Replace the cooling fan by locating it and reinstalling the mounting hardware.

M7454 Module

NOTE

The M7454 module is in the UNIBUS backplane of the host system. You will see it during the System Maintenance lesson.

The M7454 module (Figure 15) is the UNIBUS adapter or interface module. It is a quad-height module which fits into any standard small peripheral controller (SPC) slot in a UNIBUS backplane. The M7454 module has its own internal microprocessor. The module runs a self-diagnostic program when powered up.

Figure 15 M7454, UNIBUS Adapter Module

Every TU8Ø requires one M7454 to interface with the host. The host can be a VAX or PDP-11.

The M7454 connects to the TU8Ø via the 2 interface bus cables. The interface bus cables come from the formatter/control module. The cables go to a bulkhead connector in the TU8Ø cabinet, through the slot in the floor of the cabinet, over to a bulkhead connector in the host cabinet, and finally into the M7454.

____Trace the path of the cables on the TU8Ø.

TU8Ø FUNCTIONAL DESCRIPTION

You have identified all components of the TU8Ø. There are 3 modules, a power supply, some switches and sensors, and some mechanical hardware. How does it work together to read of write data?

The rest of this lesson provides a very general description of the functional routines of the TU8Ø. Refer to figure 16 throughout the rest of this lesson.

The TU8Ø subsystem has a microprocessor (uP) on the M7454, another on the F/C module, and a third on the R/W/S module. Each module has its own microcode programs which work together with the microprocessor.

The M7454 uP sets command lines in the F/C module, In turn the F/C uP sets command lines in the R/W/S module. The command lines for each module cause the corresponding uP to set the correct microcode sequence in motion for that module.

So, each module controls its own functions, but these functions must be initiated by an outside control source, In this way, all TU8Ø events are coordinated.

The M7454 controls the sequence of events throughout the TU8Ø subsystem. THE M7454 interfaces the TU8Ø with the host.

The formatter/control module formats read data and encodes write data. The module also monitors control panel interrupts (i.e. the operator pushes a button), read/write/servo module interrupts, and timing interrupts during read/write functions.

The read/write/servo module sequences and coordinates the functions to interface the data with the tape. This includesg data coming from (read) or going to (write) the head and reel movement (servo).

The following events occur to complete a read/write function. The TU8Ø must have tape loaded and be on-line.

1. For a write command:

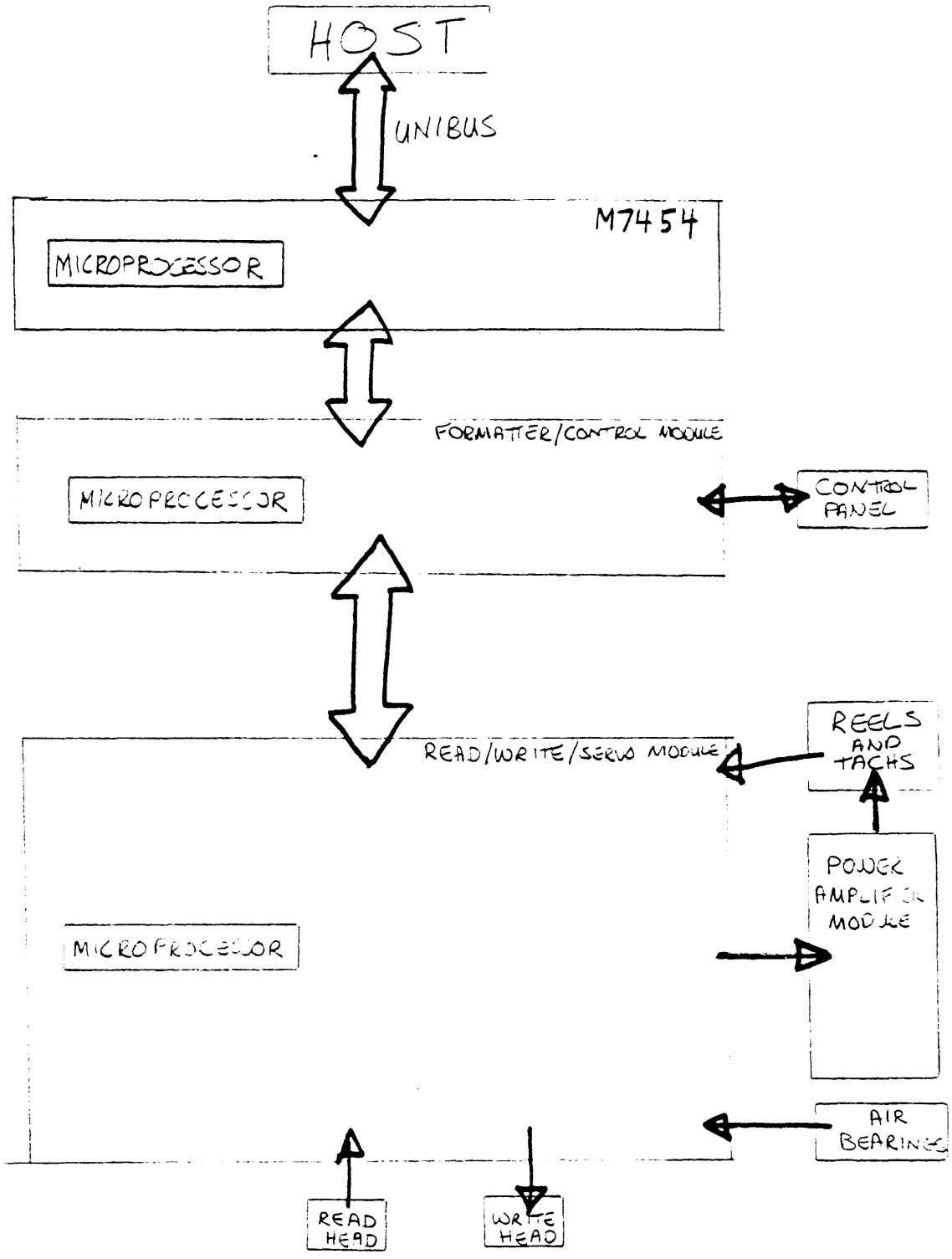

Figure 16 TU80 Basic Block Diagram

Data is brought in from the host through the M7454, sent through the write encoder of the formatter/control module, amplified, sent to the write head via the R/W/S module, and recorded onto tape.

2. For a read command:.

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

SUMMARY

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

To summarize this lesson, the main components of the TU80 are listed. You should know the following things about each component.

1. location
2. identity
3. function

If you have doubts or question about any component or other information, go back into the lesson and find the answers before leaving this lesson.

You identified 5 major external components on the TU80.

- Cabinet
- Streaming Tape Unit (STU)
- Deck plate
- Control panel
- Power controller

You located the following STU components on top of the deck plate.

- TU80 on/off switch
- Supply hub
- Take-up hub and reel
- Cover interlock switch
- 2 head assembly dust covers

Most of the tape path components are located on the deck plate under the dust covers.

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

The following STU components are located on the bottom of the deck plate.

- Power supply
- Cooling fan
- Acoustic cover
- Logic card cage
- Formatter/control module
- Read/write/servo module

The following components were identified after removing the

acoustic cover.

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

The M7454 module is the UNIBUS adapter for the TU80. It resides in the host and is connected to the TU80 by 2 interface bus cables. The M7454 defines the command requested by the host and sets command lines to the formatter/control module to initiate TU80 response. The M7454 also passes data back and forth between the host and the TU80.

The TU80 subsystem is microprocessor controlled. The M7454, the formatter/ control module, and the read/write/servo module each have a microprocessor for processing the functions the module performs.

The following functions are performed by the formatter/control module.

- Formatting and encoding data
- Sequencing TU80 events
- Servicing interrupts
- Communicates with the M7454

The following functions are performed by the read/write/servo module.

- Amplifies data and interfaces with the heads
- controls tape movement

This concludes the physical/functional description lesson.

OPERATION

INTRODUCTION

In this lesson you will perform all the TU8Ø operator functions. You will use many of these functions as a field service representative.

There are some operator functions that you may not use directly. However, the customer might use them and report the results to you. Therefore, you will need to be familiar with ALL the operator functions to make the best diagnosis of a problem.

OBJECTIVES

- Clean the TU8Ø tape path.
- Power up and power down the TU8Ø.
- Load tape and make the TU8Ø ready for on-line use.
- Perform the operator diagnostics procedure.

TAPE CARE

It is the responsibility of the operator to take proper care of the tape. It is your concern, in order to avoid nuisance calls, that the operator is aware of this responsibility and accepts it.

The tape needs to be kept clean. It should never touch the floor or be labeled with ink or any other substance. Dirt can harm the tape and TU8Ø components.

Tape should never be placed near machinery. Lines of magnetic force emanating from many types of motors can erase data stored on tape.

The climatic conditions of the room need to be within specification. In table 1 of the operation lesson, the operating temperature is listed as 5Ø°F to 1Ø4°F. This is correct for the TU8Ø specifiction. However, most tape media can operate or be stored at no higher than 9Ø°F. Most older tape must be stored at even lower termperatures. 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 making the surface bumpy producing error-prone tape.

The point is that the TU8Ø is only as good as the tape and the environment.

CLEANING THE TAPE PATH

Before you thread tape onto the TU8Ø, you should always perform a quick visual check of the tape path components and perform any necessary maintenance.

The components that make up the TU8Ø tape path can collect dirt quickly even with only a small amount of use. Both the environment and the quality of media used will affect this dirt build-up.

It is recommended that the tape path be cleaned every 8 hours of use. However, this may not be often enough in some cases. Make it a habit to check and, if necessary, clean the tape path every time a tape is installed onto the TU8Ø.

Tape path cleaning is the only preventive maintenance on the TU8Ø. It is the responsibility of the customer. As the field service representative, you should make sure that all of your TU8Ø customers are aware of this responsibility and know how to perform the procedure correctly. The procedure is in the TU8Ø User Guide.

To perform the following procedure, you will need a DEC TUCØ1, magnetic tape transport cleaning kit. A small mirror may help to visually inspect some of the components.

____Remove the two head assembly dust covers from the tape deck.

CAUTION

DO NOT USE ALCOHOL on any component. Alcohol may harm the bonding agents within an assembly.

Use the smallest amount of DEC cleaning fluid necessary. DO NOT SOAK the swab or wipe. Do not let the fluid run onto areas not being cleaned.

Freon spray cleaner may be used on the TU8Ø. However, do not spray it directly on a component. Spray it on a wipe or a swab first, and use the wipe or swab to clean the component.

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

____ BOT/EOT Sensor
____ Reflective strip
____ Tape cleaner blades

Clean the tape-contacting surface of the following components (Figure 1). Use a lint-free wipe moistened with cleaning fluid. Wipe in the direction of tape movement on each surface.

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

NOTE

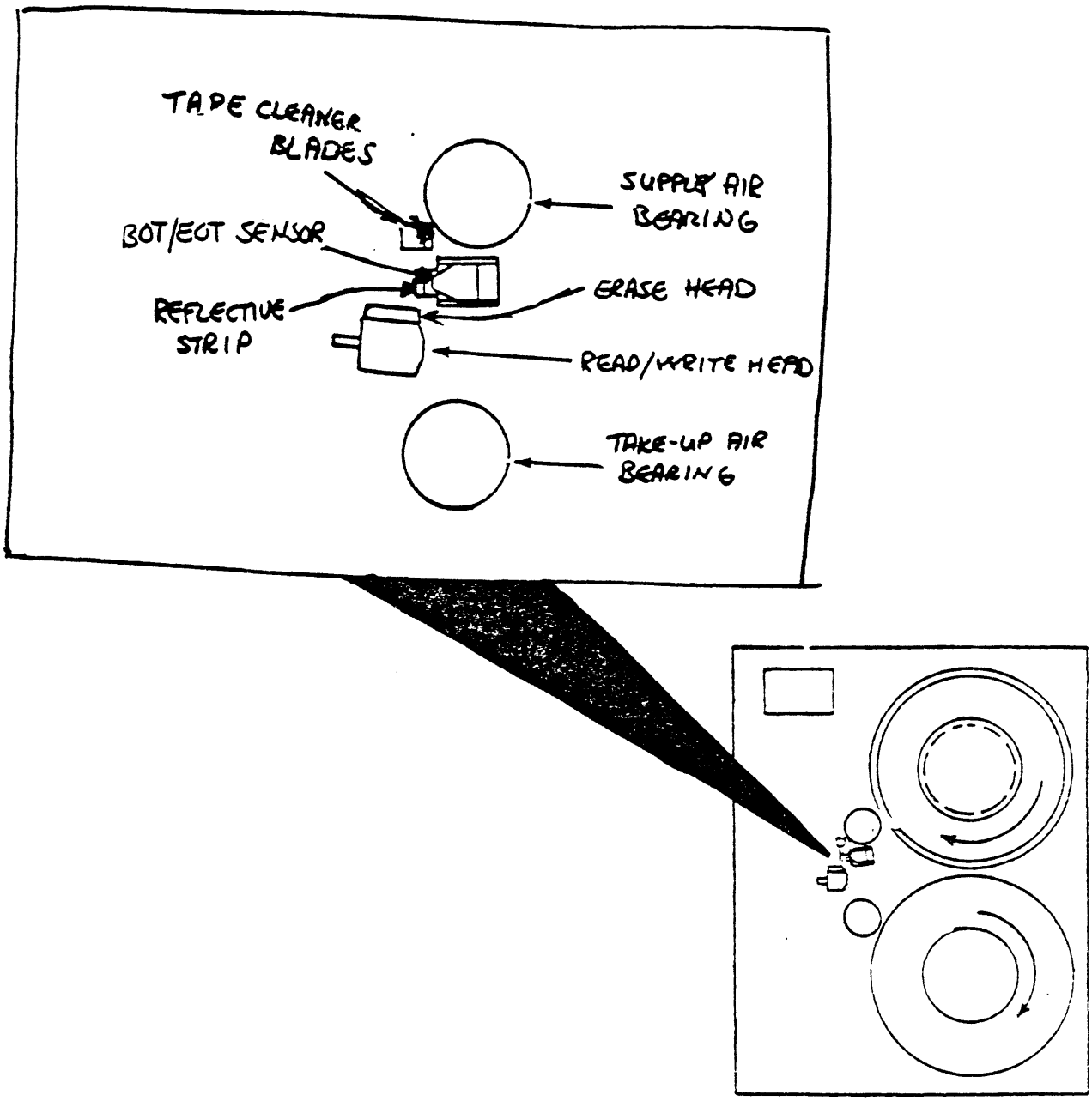

Figure 1 TU80 Tape Path Components

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

Use any cleaner which is safe for painted surfaces.

CONTROL PANEL

The TU8Ø operator uses control switches and status indicators located on the control panel (Figure 2) to control and monitor the tape drive. The control panel is located in the upper right-hand corner of the front of the cabinet.

The control panel consists of ten membrane switches, eight indicators, and one 2-digit display. The TU8Ø operator uses the switches and indicators to the left of the display during normal (diagnostics indicator OFF) operations.

The TU8Ø operator uses switches and indicators on both sides of the 2-bit digital display when performing diagnostic (diagnostics indicator ON) operations.

Each switch and indicator is functionally defined in the following paragraphs.

LOGIC OFF INDICATOR

The LOGIC OFF indicator represents the following conditions.

- Indicator ON ---- The power circuit breaker is on. No DC voltage is available to the STU circuits except to this indicator. The TU8Ø power supply generates DC stand-by voltages for TTL chips within the power supply. 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 TU8Ø circuitry is on. The STU is ready for use.

LOGIC OFF SWITCH

If the LOGIC OFF switch is pressed, power is removed from the STU and the LOGIC OFF indicator turns on.

LOGIC ON INDICATOR

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

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

LOGIC ON SWITCH

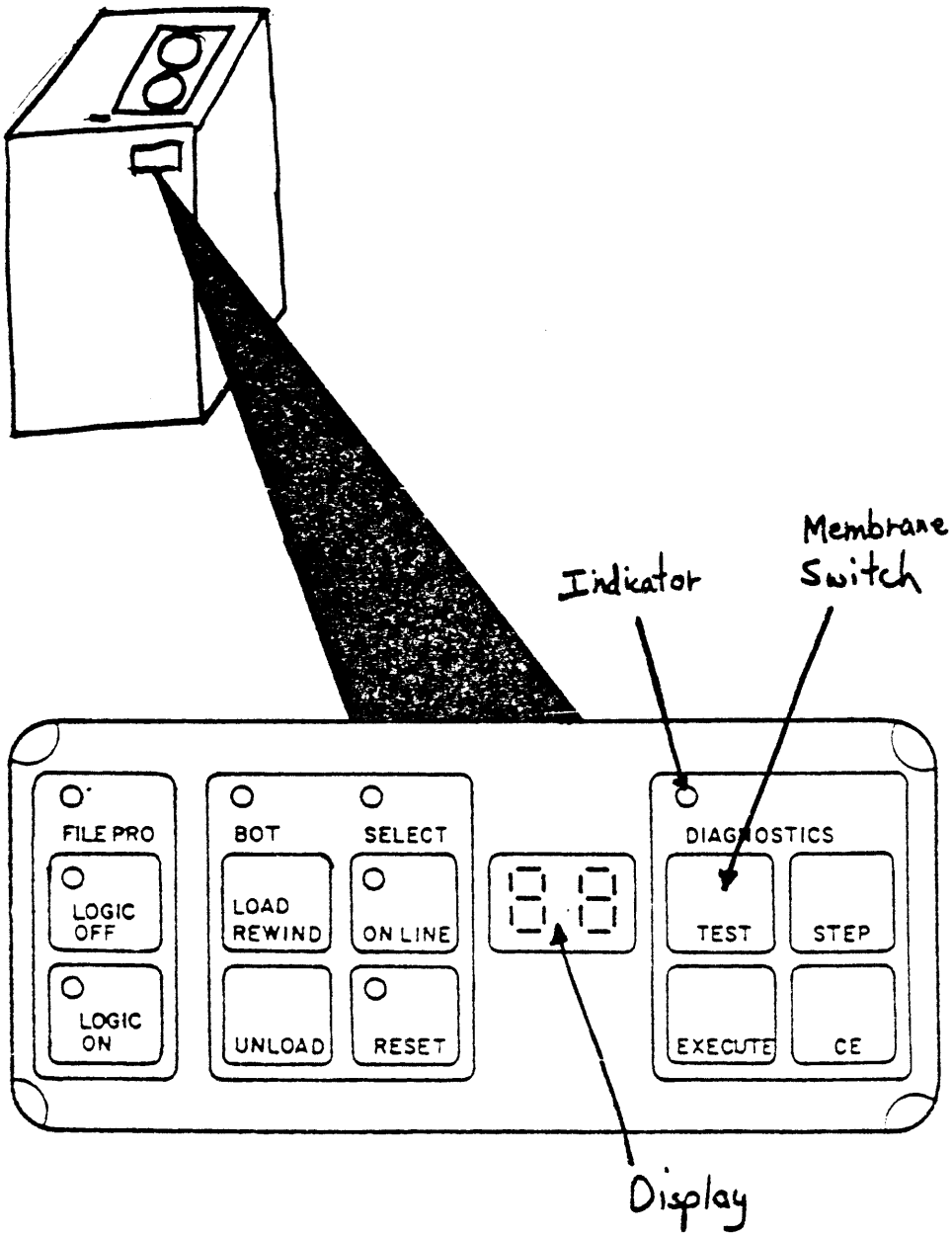

Figure 2 TU80 Control Panel

If the LOGIC ON switch is pressed and the power circuit breaker is on, the STU circuitry turns on making the STU ready for use.

FILE PROTECT INDICATOR
The File PRO 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.

SELECT INDICATOR
The SELECT indicator turns on when the TU8Ø is selected by a host system.

LOAD REWIND SWITCH
The LOAD REWIND switch has the functions listed under the following conditions.

- Tape Not Threaded ---- A fault code of 11 appears in the display. 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 will be displayed.

- Tape Loaded And Positioned At BOT ---- the 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 will follow if the marker has not been found within 4Ø feet.

BOT INDICATOR
The BOT (beginning of tape) indicator is on when a BOT marker is positioned adjacent to the BOT/EOT assembly.

ON LINE INDICATOR
When the on-line indicator is on and tape is loaded, the TU8Ø can be accessed by the host system.

All switches except RESET and LOGIC OFF are inhibited. Pressing RESET turns off the indicator and puts the TU8Ø off-line.

ON LINE SWITCH
Pressing the on-line switch when tape is loaded makes the TU8Ø available to the host system. The on-line indicator turns on.

This switch can be pressed while loading. The TU8Ø will go on-line immediately when loaded.

RESET INDICATOR
The RESET indicator is on when the 2-digit display contains a fault code or diagnostic termination code. These codes are explained in the diagnostic lesson.

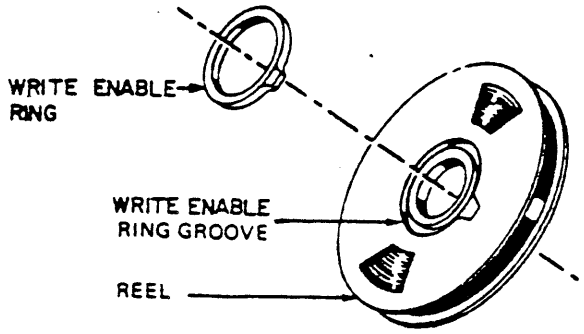

Figure 3 Write Enable Ring

The control panel is not operable when this indicator is on except for the LOGIC OFF switch.

Pressing RESET during any function causes a fault code of 15 to be displayed.

RESET SWITCH
Pressing the RESET switch performs the following functions.

- Resets (clears) a fault code or diagnostic termination code.
- Turns off the RESET indicator if it is on.
- Puts an on-line TU8Ø 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.

UNLOAD SWITCH
Pressing the UNLOAD switch performs the functions listed under the following conditions.

- Tape Loaded And Positioned At BOT ---- Tape unloads.
- Tape Loaded And Not Positioned At BOT ---- Tape rewinds to BOT and unloads.
- Tape Threaded Only ---- Tape slowly rewinds onto the take-up reel.

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 2-bit digital display indicator signifies one of the following.

- A fault code when in normal operation.
- A test number when in diagnostic mode and the operator is loading a particular test.
- A test complete and successful indication when a test has been run. In this case the displayed number is always ØØ.

DIAGNOSTICS
The four diagnsotics switches on the right hand side of the control panel are not used in normal operation. These switches are used only during testing by either the customer or the field service representative.

NOTE

Only the field service representative uses the CE switch. It is explained in the diagnostics lesson.

The function of the three diagnostic switches and indicator, which the customer and the field service representative use, is defined in the following paragraphs.

DIAGNOSTICS INDICATOR
The DIAGNOSTICS indicator will turn on when diagnostic mode is entered by either the customer or the field service representative. The indicator remains on until RESET is pressed.

TEST SWITCH
Pressing the TEST switch with tape threaded but not loaded places the STU in Operator Diagnostics mode.

STEP SWITCH
If the STEP switch is pressed when a test number is displayed in the 2-bit digital display, the test number will increment by 1.

EXECUTE SWITCH
If the EXECUTE switch is pressed when a test number is displayed, the test being displayed will start and run to completion or run until an error occurs.

A ØØ is displayed if the test runs to completion. A fault code is displayed if an error occurs.

The function of all operator switches and indicators has now been defined. In the following paragraphs, you will use the operator panel to perform operator functions on the TU8Ø.

POWER-UP
The following procedure powers up the TU8Ø.

____Check that your TU8Ø is plugged into the DIGITAL power controller (Figure 4).

____Check that the DIGITAL power controller is plugged into a circuit with appropriate voltage (12Ø VAC @ 6Ø Hz; 22Ø VAC @ 5Ø Hz) and that the circuit breaker is on.

____Check to see if a cable is plugged into any of the remote switching cable connectors on the power controller.

If so, and the cable connects to the host on the other end, the TU8Ø is configured to power-up remotely by the host ON/OFF switch.

If a cable is not installed, the TU8Ø is configured to power-up by the TU8Ø power switch.

____Check the position of the three-position switch on the power controller.

The position names are usually labeled on the controller panel. Following is a list of the names and explanations of

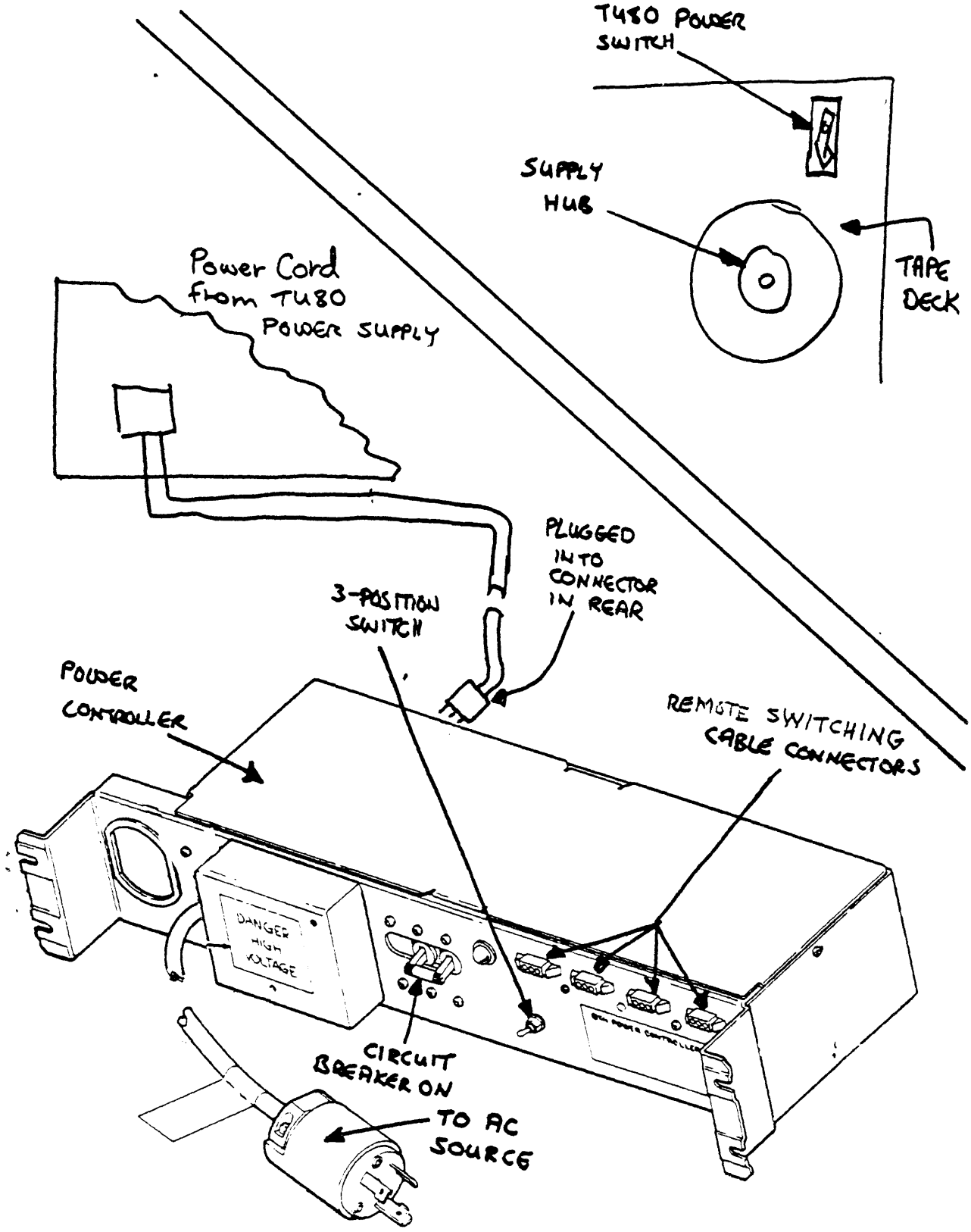

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Figure 4 TU80 Power-up Checks

each switch position.

- REMOTE ON -- this position (left of center) only functions if a remote switching cable is installed at one of the connectors on the power controller. The cable must come from 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 allows the controller to be powered on and off by the host ON/OFF switch. Thereby, many power controllers and their associated peripherals can be turned on and off with one host switch.

- OFF -- This position (center) allows no power to come from the controller.

- LOCAL ON -- this position (right of center) causes the controller to supply output voltages at all times as long as the controller has AC input power provided and the circuit breaker is ON.

____Check that the power controller switch is in the LOCAL ON position.

This is the best postion for this course, but is not what you usually find at the customer site.

Most TU8Øs are configured to be powered on/off by the host. A remote switching cable is installed, the 3-positon switch is in the REMOTE position, and the TU8Ø power switch is usually left on. All the customer has to do is turn on the host, push the LOGIC ON switch, and the TU8Ø is ready to use.

CAUTION

A TU8Ø configured to be powered up remotely will NOT power off with the host ON/OFF switch if the 3-position switch is left in the LOCAL position.

For this course, since the host may be needed by other students, the LOCAL ON position is the best to use.

____Push down on the 1 of the TU8Ø power switch. This switch also functions as the circuit breaker for the TU8Ø. The switch is located under the top cover.

This places the power supply in stand-by condition. The cooling fan and LOGIC OFF indicator turn on. The two STU logic boards have no power applied at this time.

____Push the LOGIC ON switch on the operator panel.

NOTE

Whenever the LOGIC ON switch is pushed, the TU80 performs a health check test. The indicators flash and 00 appears momentarily in the display.

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

On errors, the control panel display will display an error code which is explained later in this lesson.

All parts of the TU80 (power supply and STU) now have power. The LOGIC OFF indicator turns off, and the LOGIC ON, FILE PRO, and SELECT indicators turn on.

____Press the LOGIC OFF and LOGIC ON switches alternately to check the reaction of the operator panel.

This concludes the TU80 power-up procedure.

NOTE

During this course, power-down the TU80 by pressing the power circuit breaker to 0. The TU80 should be powered down whenever it is not to be used for a few hours.

TAPE THREADING AND LOADING

Perform the following procedure with power applied to the TU80. Check that the tape path is clean before threading tape. Use a tape with the write protect ring inserted.

Pressing the center button on the face of the supply reel hub (Figure 5) unlocks the hub. Pressing the periphery ring locks the hub. When a tape reel is installed on the hub, this causes the tape reel to be held tight with no slippage (locked) or loose (unlocked).

____Lock and unlock the hub several times. Always be sure it is fully locked when a tape reel is installed or errors may result.

____Remove the protective cover from the tape you are going to use. There are many types of covers with various kinds of mechanisms. Go to the course administrator is you need assistance.

____Unlock the supply hub.

____Slide the reel of tape over the supply reel hub such that the reel rests against the rear flange of the hub.

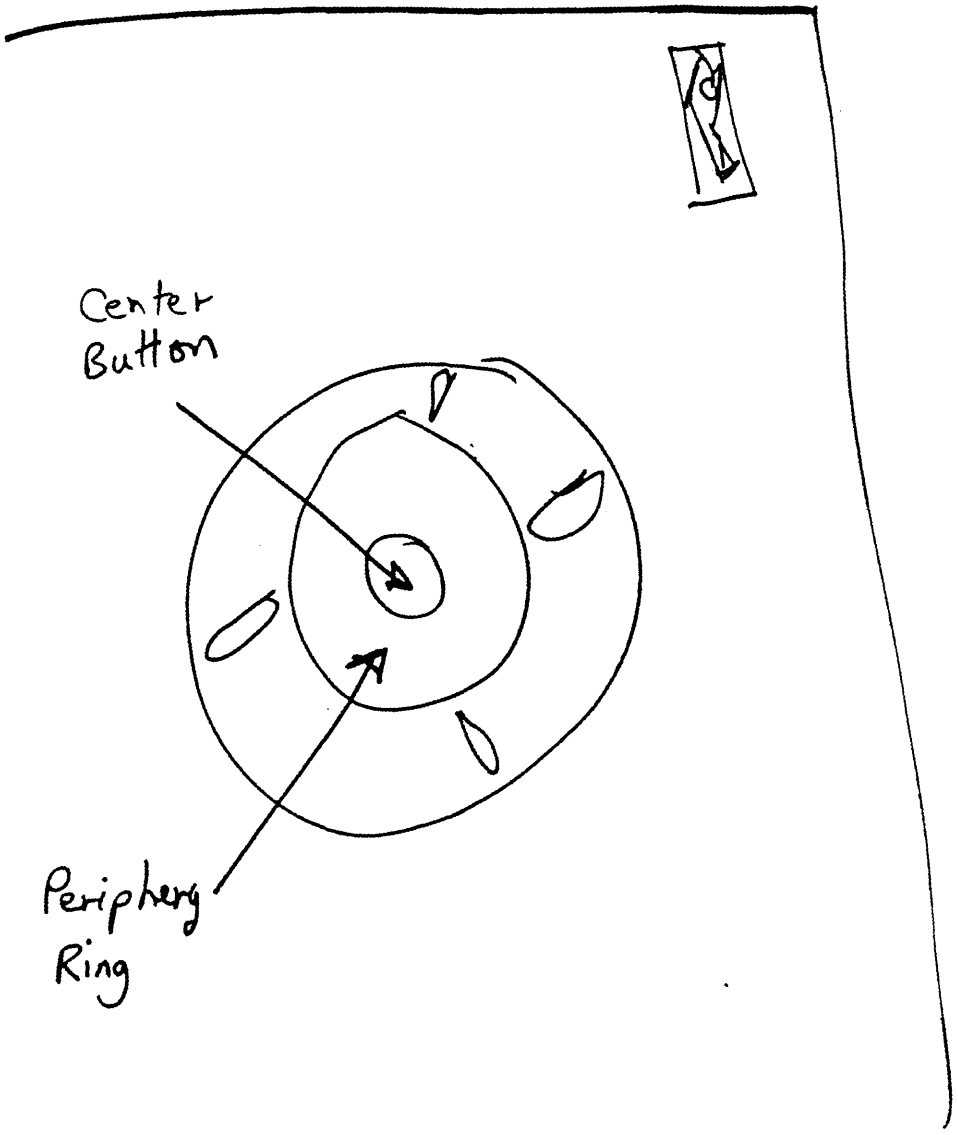


Figure 5 Supply Reel Hub

____Lock the reel on the hub by pressing on the periphery ring of the hub.

____Thread tape through the tape path as shown in figure 6. Wind approximately 4 turns of tape onto the take-up reel.

____Close the top access cover. This sets the interlock cover latch to allow movement of tape.

____Press LOGIC ON switch so indicator lights.

____Press the LOAD REWIND switch to load the tape to the BOT marker.

____Press the ON LINE switch to make the TU8Ø available to the host system. This switch may be pressed while the tape is loading. The TU8Ø will be placed on-line at the end of the load sequence.

The TU8Ø is fully loaded and ready for host system use.

UNLOADING TAPE

The following procedure unloads the tape.

____Press the RESET switch to put the TU8Ø off-line.

____Press the UNLOAD switch to remove tape from the tape path and wind it on the supply reel.

____Open the top access cover and press the center button of the face of the supply hub.

____Remove the supply reel. Always replace the protective cover on every reel of tape.

____Close the top access cover to keep dust and dirt away from the TU8Ø components.

This completes the unloading procedure.

OPERATOR DIAGNOSTICS

Any operator of the TU8Ø has the opportunity to observe, interpret, and even fix many common errors usually associated with magnetic tape subsystems.

The TU8Ø has very elaborate internal diagnostics and software monitoring systems which can help an operator cure a TU8Ø problem without field service intervention.

The TU8Ø diagnostic and monitoring systems include the following.

1. Upon power-up, when the LOGIC ON switch is pressed, the STU

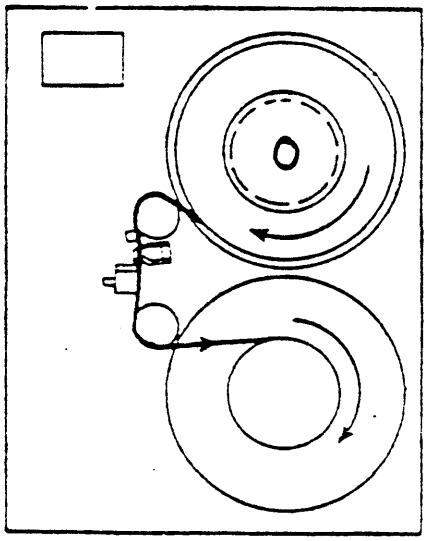


Figure 6 Threading Tape

performs the Power-up Health Check. This performs a quick check of the logic that can be tested without tape movement. The indicators flash and ØØ flashes in the display during the quick check. A fault code appears on the operator panel display if an error occurs during the check.

2. During operation, errors are constantly monitored and reported from all parts of the TU8Ø. These are sent to the host system which keeps track of them by means of the operating system error log. Some of these errors cause the TU8Ø to go off-line and display a fault code (Table 1) on the operator panel display.

> NOTE
> Remember, this lesson contains the OPERATOR action for a problem. A field service representative would follow another set of procedures (related to these) found in the diagnostic lesson of this course.

The TU8Ø operator performs the corrective action shown in table 1 whenever a fault code has been displayed.

What if there is an error but not a fault code? Or, the corrective action did not solve the problem. Or, several intermittent TU8Ø errors have been reported in the error log but no fault code has appeared. What then?

For any other TU8Ø error, the operator (i.e., customer) should attempt to run Operator Diagnostic Test Ø1. This test can be run at any time using the following procedure. The operator should always perform this procedure BEFORE calling field service.

You should make sure all your customers use Operator Diagnostic Test Ø1.

Perform the following procedure to run test Ø1.

____Power-up the TU8Ø.

If the Power-up Health Check has failed a fault code will be displayed at this point. The operator would go to table 1 for further instructions.

Also, with certain power problems, a fault code may not be displayed. After retrying the power-up procedure, the only option the operator has is to call Field Service.

____Clean the tape path after unloading tape. Intermittent read/write errors are often caused by dirt in the tape path.

____Thread, BUT DO NOT LOAD, a known good tape. Do not use the tape that was used when the error occurred.

This table to be modified extensively

FAULT CODE	CORRECTIVE ACTION
01 thru 09	Clean magnetic head and tape path ~~per instructions in OPERATOR CLEANING section of this manual~~.
10	Ensure front door is securely closed.
11	Thread tape.
12	Indicates supply reel hub is not latched.
13	Refer to tape threading diagram on tape deck to ensure tape is threaded correctly.
14	Check for BOT marker on tape. ~~Refer to Figure 2-5.~~
15	Indicates RESET switch pressed inadvertently by operator. Reinitiate test.
16	Check for presence of write enable ring in rear of supply reel. Install ring if not present.
17	Check for presence of EOT marker.
18	Indicates tape loaded when test was initiated. Thread tape, but do not press LOAD switch.
20 thru 29	Mount a tape of known good quality.
All Others	Run Test 9 if possible and Report fault code to maintenance personnel. ~~per procedure discussed in previous paragraphs~~.

Table 1 Operator Corrective Action when Fault Code is displayed.

NOTE

A standard amplitude tape or special test tape is NOT needed when testing the TU8Ø.

The customer must have a tape set aside that is used only for test purposes. Make sure that this is done by your customers.

____Press the RESET switch to clear the display.

If the display does not clear, go to table 1 for further instructions.

____Press the test switch. The DIAGNOSTICS indicator turns on and Ø1 is indicated in the display. Operator Diagnostic Test Ø1 has been loaded.

____Press the EXECUTE switch. This starts running the test.

The display increments from ØØ to 11 to 22 thru 99. At the same time all indicators are on except LOGIC OFF, BOT, and SELECT. This verifies the display segments and the indicator lights.

The test continues with various motion and read/write exercises. The test lasts for approximately 1Ø minutes when using 24ØØ feet of tape.

Upon successful completion of the test, the tape unloads, the RESET indicator lights, and ØØ is indicated in the display.

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

What happens if the test is unsuccessful?

A fault code will be indicated in the display and the RESET indicator will light when the test fails. Check table 1 to determine what should be the next course of action.

If the fault code persists, the operator contacts field service and reports the fault code.

There are two other tests, Operator Diagnostic Tests Ø2 and Ø3, which the operator runs IF REQUESTED TO DO SO BY FIELD SERVICE.

Perform the following procedure to run test Ø2.

____Thread but do not load tape.

____Press the RESET switch to clear the display.

____Press the TEST switch to put the TU8Ø into diagnostic mode. Test 1 is indicated on the display.

____Press the STEP switch. The display increments to Ø2.

____Press the EXECUTE switch. The test runs in less than a minute and displays ØØ when successfully completed. Report the fault code to field service if unsuccessful.

Perform the following procedure to run test Ø3.

____Clear the tape path of tape. Do not thread or load tape.

____Clear the display by pressing the RESET switch, and load test 1 by pressing the TEST switch.

____Press the STEP switch TWO times. The display now indicates the TU8Ø is ready to run test Ø3.

____Press the EXECUTE switch. Test Ø3 is very short and displays ØØ when successfully completed. Any fault codes are reported to field service.

You probably have a thousand questions concerning how these tests are used by field service to diagnose and fix TU8Ø problems. Good. You should have some questions at this point. But, in this lesson you are learning ONLY the operator actions. This is so you, as a field service representative, can relate to problems the customer reports to you.

So, hold on to those questions. They will be answered in the diagnostic lesson.

____Unload the tape and power-down the TU8Ø.

SUMMARY

You have become a qualified TU8Ø operator in this lesson.

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

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

The operator panel was explained and used. The panel includes the following elements. They should all be familiar to you.

- LOGIC OFF indicator/switch
- LOGIC ON indicator/switch
- FILE PROTECT indicator
- SELECT indicator
- LOAD REWIND switch
- BOT indicator
- ON LINE indicator/switch
- RESET indicator/switch
- UNLOAD switch
- 2-bit digital display indicator

You learned to thread, load, and unload tape from the TU8Ø.

You learned to run operator diagnostic tests Ø1, Ø2, and Ø3. Test Ø1 can be run by the operator at any time and must be run BEFORE calling field service to report a fault code. Test Ø2 and Ø3 are run by the operator ONLY AT FIELD SERVICE REQUEST. These tests will be explained in the diagnostic lesson.

This completes the Operation lesson.

THEORY OF OPERATION

INTRODUCTION

This lesson starts with an overview of phase encoded (PE) recording and a discussion of packet protocol and registers. Then each major Field Replaceable Unit (FRU) is functionally described using block diagrams for reference.

This lesson will only supply the TU80 theory information which is necessary in the normal field repair. In depth discussion of each major component, timing diagrams, and flowcharts can be found in the theory chapter of the TU80 Technical MANUAL.

OBJECTIVES

1. Identify and describe the TU80 recording method.
2. Identify the parts of the TU80 recorded format.
3. Identify the TU80 registers and describe their function.
4. Describe packet protocol.
5. Identify the steps the TU80 performs when it executes a command.
6. Identify the function of each block in a TU80 block diagram.

TU80 RECORDING TECHNIQUE

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

The TU80 features the following recording parameters.

9 tracks
1,600 bits per inch
A maximum of 3,200 flux reversals per inch
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
Phase encoded (PE) recording method

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 the 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.

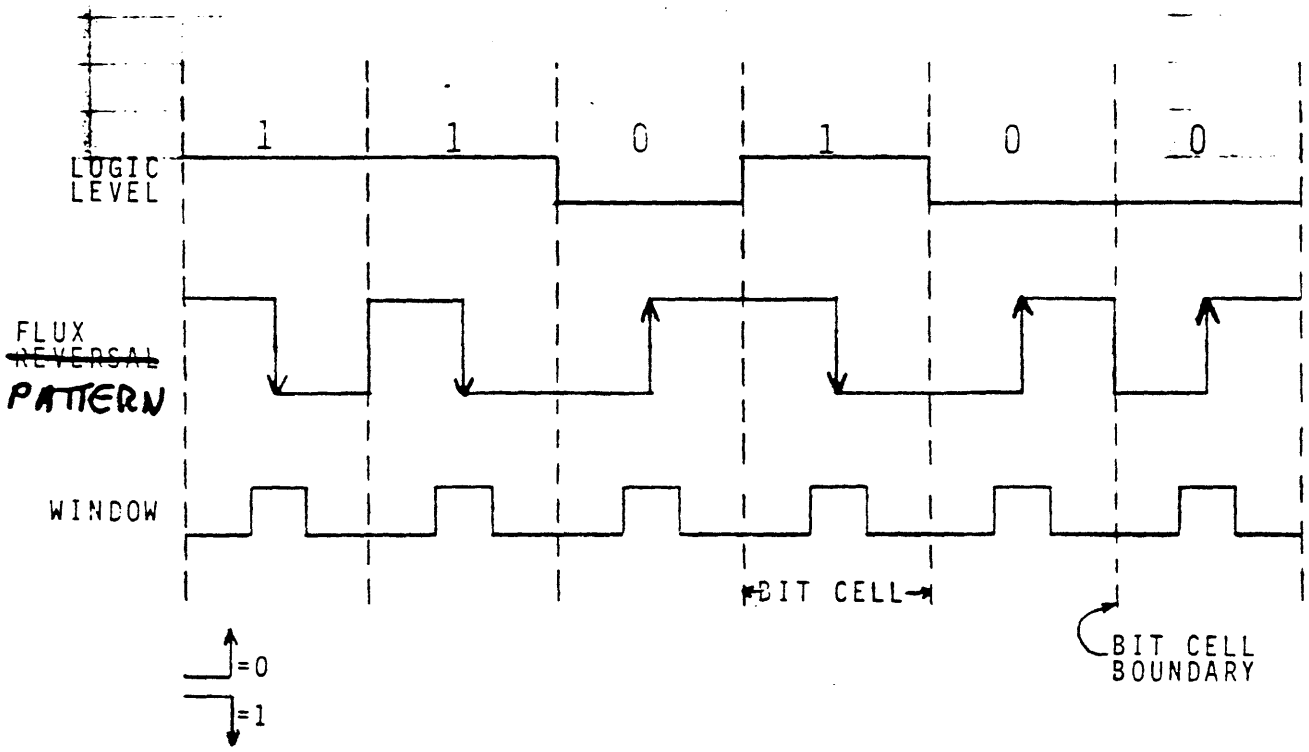


Figure #1 Phase Encoded (PE) Recording

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 the 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 tape. The **identification burst** (IDB) identifies a tape as PE format. The **initial gap** or **extended interrecord gap** is between the BOT marker and the first record.

A record has 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 may be referred to as a **block**.

Start/Stop Mode

Start/stop mode is the traditional mode of operation 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 0 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 and accelerate within every gap. This means there are lots (15000+) of ramps when transferring data over a full 2400 feet tape. So, ramp time must be short for the transport to transfer data fast.

Ramp times can be handled in two ways. First, a very costly servo system can be used to keep ramp times very short when stopping from high speed. Second, the tape operating speed can be dropped so less expensive servo components still can have ramp times which stop the tape within the gap.

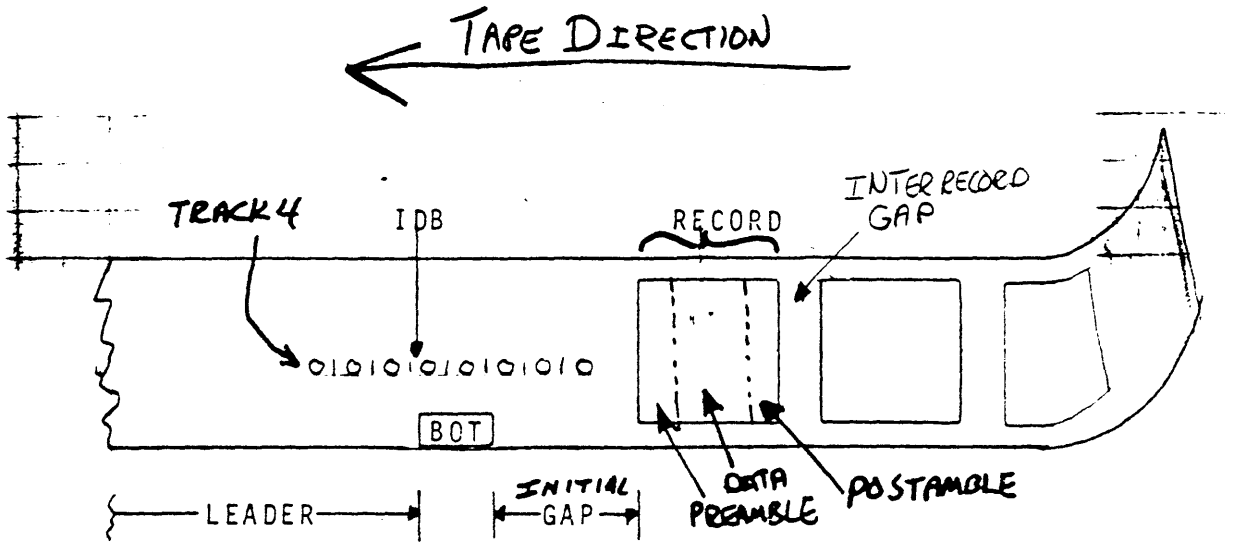


Figure 2 PE Format

Is there a way to have inexpensive transports which record in industry standard PE mode that are fast? Of course.

Streaming Mode

Streaming mode does not stop between each record in the interrecord gap. The TU80 can read or write a full tape at 100 ips without slowing or stopping. Interrecord gaps are written while moving. A new command is received on the move while the tape is within the gap.

This results in a very fast data transfer which can be accomplished while using an inexpensive transport like the TU80. Under optimal conditions the TU80 can transfer a 2400 ft. tape in less than 3 minutes.

Conditions are not always optimal. Certain conditions limit the value of using streaming mode.

Streaming Limitations

There are limitations to streaming mode in the TU80.

1. Slow data transfer rate.

   The TU80 is designed primarily 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 while streaming. This occurs only if the data transfer rate from the host is fast enough to keep data available at all times.

   Figure 3 identifies the **command reinstruct time** within the interrecord gap. A command must be received within this area for the tape to continue streaming.

   If a command is not received in time, the tape must reposition because the long ramp time will take it past the gap. A reposition cycle (Figure 3), made up of the repositioning and access times, can take 800-900 ms. when streaming at 100 ips. This is a lot of time when compared with most start/stop transports which take 2-16 ms. It follows that the timing advantage of streaming is rapidly lost if there is a lot of repositioning.

   What causes the command to be late? A new command will not be available if new data is not ready to be delivered. In other words if the data transfer rate is too slow. Three things can slow the data transfer rate.

   - The transfer rate of the peripheral sending or receiving the data. This is usually a disc.

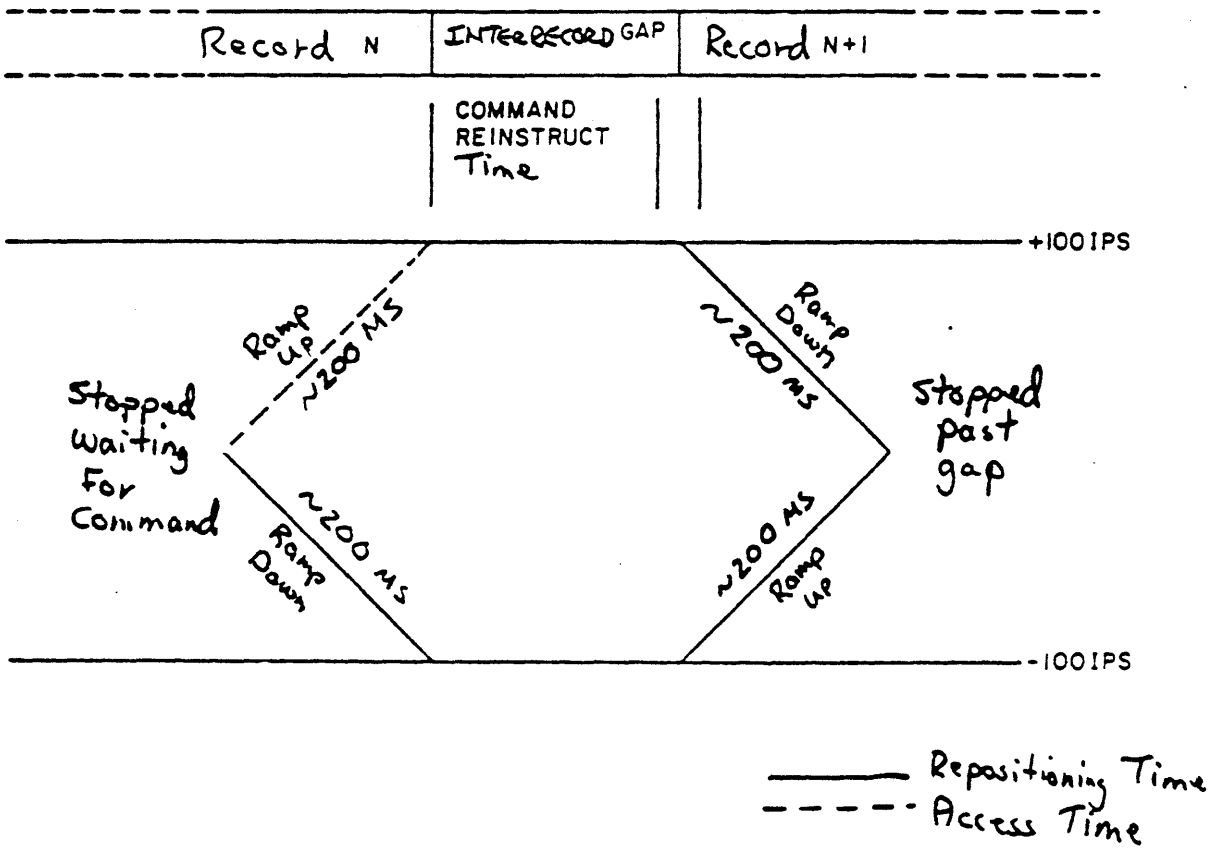


Figure 3 Repositioning Cycle

- The priority architecture of the host system.
- The size of the buffer in the host which contains the data being transferred.

2. Non-sequential record tape operations.

   There are still times when the records accessed are not stored sequentially on the tape. This occurs when only certain files are desired off 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 3 modes are available with the TU80.

TU80 OPERATION MODES

The TU80 operates in three modes. They are (1) start/stop 25 ips, (2) streaming 25 ips, and (3) streaming 100 ips. The optimal mode is selected automatically within the TU80 logic by sampling the data transfer rate.

Why not operate all the time at 100 ips? Isn't it the fastest?

No. Streaming at 100 ips is the fastest only when the data rate is fast enough that commands are always received during command reinstruct time within the interrecord gap after each record.

TU80 Mode Selection

The TU80 microcode selects the optimal mode of operation. The TU80 constantly monitors the data transfer rate of the host. The microcode selects the optimal mode of operation 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) the data is going to or coming from.

The operator and host software have nothing to do with mode selection. However there are sense bits which inform the host which mode is in current use.

Usually, the TU80 operates in the following manner.

- At 25 ips start/stop mode when accessing non-sequential records from a tape and slow sequential record transfers.
- At 25 ips streaming mode with sequential transfers and a moderate host data transfer rate.

- At 100 ips streaming with sequential transfers and a high data transfer rates.

However, the mode may switch at any time to another mode to maximize transfer rate.

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

To summarize, many (most?) TU80s are only used 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 TU80 is very fast in this situation and limited only by transfer rate of the interfacing system.

PARITY

Track 4 is the parity track. The parity track is written to provide a means for detecting and correcting tape data errors. During a read function, the read circuitry uses parity track information to correct data frames that have one track in error. This correction is made in two steps.

First: 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. This type of track is a dead track.

Second: Has a track dropped a zero or one? If a track has dropped a bit, the read circuitry checks the frame containing that bit for odd parity (an odd number of ones). If the number of ones is even, a one has dropped. If the number of ones is odd, a zero has dropped. The read circuitry 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.

PSG is not available yet

TU80 REGISTERS

The TU80 has eight registers.

Open the TU80 Pocket Service Guide to Appendix A. On the first page is a TU80 register summary.

The next four pages in the pocket service guide have figures that name each register bit. Refer to these figures for register

information. Chapter 5 of the TU80 Subsystem Technical Manual defines each register bit.

Individual register bits will be important to you when you use diagnostic and system error printouts.

The TU80 registers do not use the typical UNIBUS method of writing command, data, or status information to a UNIBUS register. The TU80 is not a MASSBUS device. Command, data, and status information is placed in host memory. Then the contents of a TU80 register points to this information. The UNIBUS adapter module (M7454) looks at the contents of this register to find out where needed information is in host memory.

Registers in the M7454 (UNIBUS Adapter Module)

The following three registers are part of the M7454.

- Bus address (TSBA) points to host memory locations that have been defined by the host as buffer (storage) areas.
- Data buffer (TSDB) is a word buffer area between the host and the transport. It converts between UNIBUS parallel data and TU80 serial data.
- Status (TSSR) is a one-word (16-bit) TU80 status register.

Only two UNIBUS addresses are used for these three registers. The host accesses TSBA and TSDB by using the same UNIBUS address. The host accesses TSSR by using a second UNIBUS address.

How is this done?

The first UNIBUS address is the base address. For the TU80, the base address is normally 772520 for drive 1. The host reads TSBA when it moves information out of the base address. (See Figure A-2 in the pocket service guide.) The host writes the TSDB when it moves information into the base address. (See Figure A-3 in the pocket service guide.)

The second UNIBUS address is base address +2. It is normally 772522 and is the TSSR. (See Figure A-4 in the pocket service guide.) Writing to the TSSR causes a subsystem initialize command. Reading the TSSR gives general, high-level TU80 status. Only the M7454 can write the TSSR based on TU80 status signals. The host can read the TSSR anytime.

PSG references will be updated when the PSG is available

Registers in Host Memory

The following registers are the five remaining TU80 registers. They are the extended status registers.

Residual frame count (RBCPR)
Extended status 0 (XSTAT 0)
Extended status 1 (XSTAT 1)
Extended status 2 (XSTAT 2)
Extended status 3 (XSTAT 3)

Find these registers in the pocket service guide (Figures A-5 through A-9). They will be important to you when you run on-line diagnostics or examine system printouts. They are updated at the end of every command or upon execution of a GET STATUS command.

The extended status registers are not read directly from the TU80 Adapter module. They are part of a packet of information that the TU8C places in the host memory buffer areas.

PACKET PROTOCOL

The TU80 subsystem uses registers differently than other DIGITAL mass storage devices. The TU80 subsystem uses M7454 microprocessor control to control all functions, including register access.

The TU80 uses packet protocol. Using packets for various types of transfers means using less device register locations on the UNIBUS. This advantage allows space for other devices.

What is packet protocol? Packet protocol means that certain types of information are made into a packet of several 16-bit words. Then they are stored in defined buffer locations in the host memory.

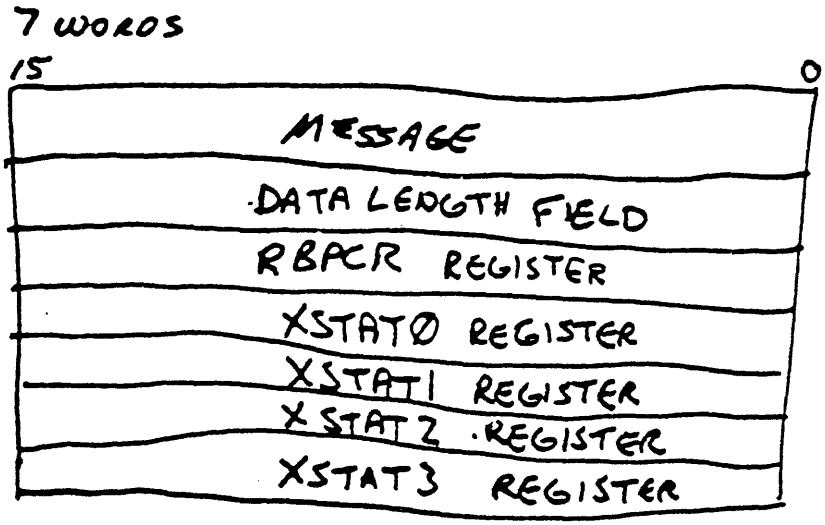
There are two types of packets.

- Command packets
- Message packets

The M7454 uses command packets to gain command and data location information. The command packet tells the M7454 what to do and, if necessary, where to find data.

Command packets can be one, two, or four 16-bit words long (Figure 4). The first word is the header word. The header word provides the command and mode bits that define the specific command to be executed by the TU80.

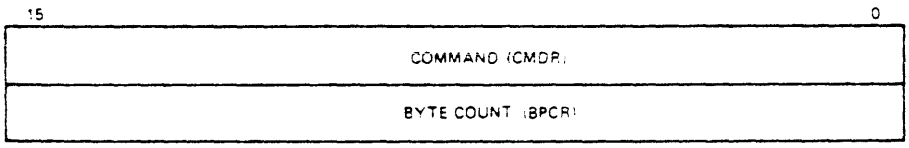
The second, third, and fourth words of the packet, if needed, usually define the data buffer address and the number of bytes in the transfer. The one exception to this rule is in the second word of the position command buffer. This word defines the number of



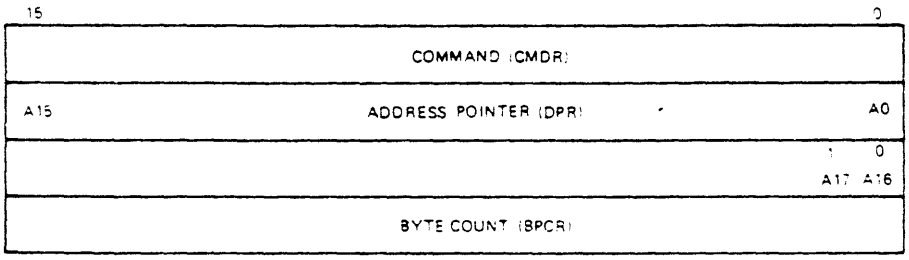
MESSAGE PACKET

A. 1 WORD TYPE

B. 2 WORD TYPE



C. 4 WORD TYPE



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COMMAND PACKETS

Figure 4 Packet Examples

tape marks or records to be moved.

The host uses message packets to gain TU80 status information.

Message packets are seven 16-bit words long (Figure 4). The first word is the header word. It provides a status message. The second word is the data length field. The third through seventh words are the extended status registers previously described in this lesson.

The packets and data are stored in buffer areas (Figure 5). The M7454 gets the command packet from the command buffer. The host loads the command buffer before every command. The host gets TU80 status information (message packet) from the message buffer. This status information is updated at the end of every command. Either the M7454 or the host can read or write data in the data buffer.

Whether the M7454 or host performs the transfer depends on the direction of the transfer taking place (read or write).

Buffers can be anywhere in memory. Therefore, every time a buffer is to be used, the host must define the buffer location.

The buffers are accessed with a pointer that has been placed in TSBA. Either the M7454 or host can load the pointer into TSBA depending on the transfer taking place.

To summarize, 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 command buffer in host memory.

TU80 extended status information is put in the host memory by the M7454 where it can be accessed by the host when needed. This information is called a message packet and is located in the message buffer in host memory. Buffer locations are defined by the host.

HOW DOES THE TU80 EXECUTE A COMMAND?

The M7454 sequences events for the TU80 subsystem. Depending on the command to be executed, a specific microcode subroutine loads and runs in the M7454 . The microcode information initiates events throughout the subsystem.

The M7454 uP initiates three types of transfers to execute commands.

- Data out (DATO)
- Nonprocessor request data out (NPR DATO)
- Nonprocessor request data in (NPR DATI)

As with all magnetic tape systems, the TU80's major functions are reading and writing. The following two sections describe how the

TU8C performs these functions in simplified steps. Use Figure 5 to follow the steps.

Read Function

The subsystem performs these steps to read one word from the tape into the data buffer.

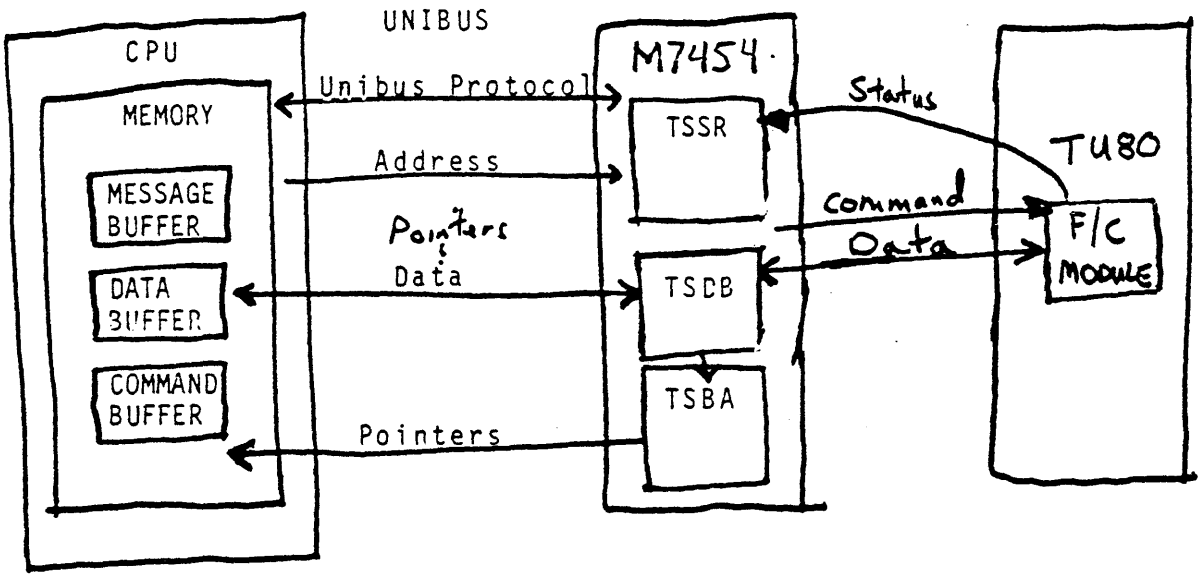
1. The host moves the command pointer to the M7454 (DATO).
2. The M7454 gets the command packet, including the data buffer address, one word at a time (NPR DATI).
3. The M7454 reads data from the tape into the data buffer in host memory (NPR DATO).
4. The M7454 updates the message buffer in host memory (NPR DATO).
5. The host can now use the data for its needs.

Write Function

The subsystem performs these steps to write one word from a buffer area onto the tape.

1. Before the host accesses the TU8C subsystem, it fills the data buffer with data to be written onto tape.
2. The host moves the command pointer to the M7454 (DATO).
3. The M7454 gets the command packet, including the data buffer address, one word at a time (NPR DATI).
4. The write data goes from the data buffer onto tape (NPR DATI).
5. The M7454 updates the message buffer in host memory (NPR DATO).

This completes the theory section of this lesson. As a review, do exercise 1.



Message and command buffers contain packets.

Figure 5 Packet Protocol Components

EXERCISE 1

Fill in the blanks with the correct letter.

1. Identify the data string shown in Figure E-1.

   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. Start/stop mode stops within every ____. Streaming mode can be slower than start/stop mode if the ____ is slow. On the TU8Ø, the mode is selected automatically by the ____.

   a. Data transfer rate
   b. Record
   c. Operator
   d. TU8Ø microcode
   e. Interrecord gap
   f. Read/write head

3. The three registers on the M7454 are the ____.

   a. TSBA, RBCPR, and TSDB
   b. XSTATØ, XSTAT1, and XSTAT2
   c. TSSR, TSDB, and TSBA
   d. TSBA, TSDB, and XSTATØ

4. The extended status registers are in ____.

   a. M7454 ROMs
   b. Downtown Des Moines
   c. TSSR words 2-6
   d. Host memory locations

5. Packet protocol uses buffers in ____. The ____ puts the address of the buffers' locations into the ____.

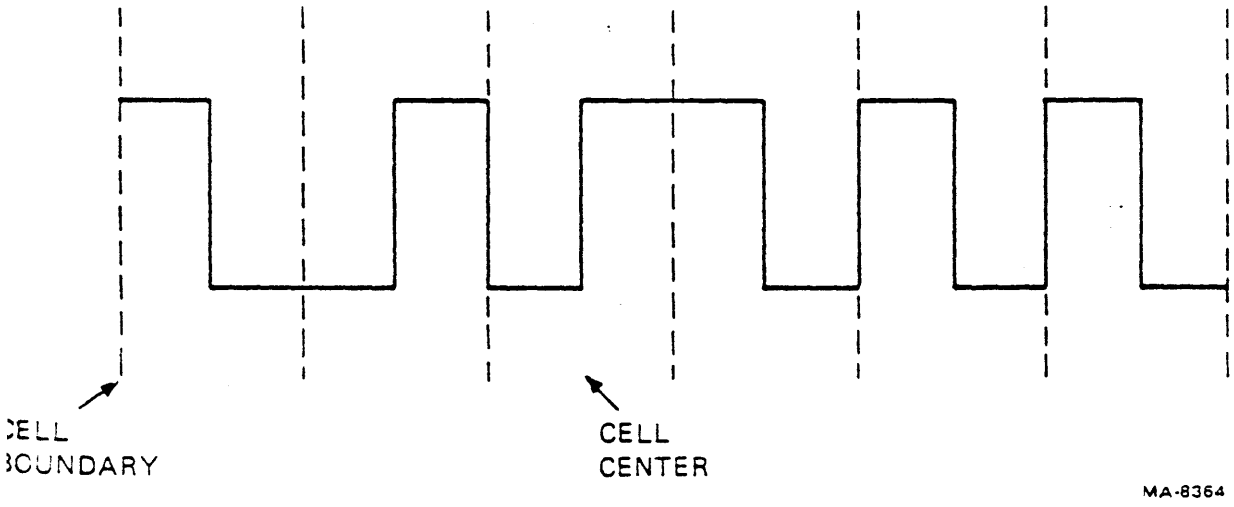
   a. TSBA
   b. TSSR
   c. Host
   d. Host memory
   e. M7454

6. The M7454 issues ____ packets ____ every command. The host issues ____ packets ____ every command.

   a. Command
   b. Before
   c. During
   d. Data
   e. After
   f. Message

7. The ____ executes the command by using ____ transfers. The ____ is updated with ____ information at the end of every command.

   a. M7454
   b. Interrupt
   c. NPR
   d. Extended status
   e. Message buffer
   f. Command buffer



E

Figure E-1 PE Data

EXERCISE 1 ANSWERS

Fill in the blanks with the correct letter.

1. Identify the data string shown in Figure E-1.

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. Start/stop mode stops within every ___e___. Streaming mode can be slower than start/stop mode if the ___a___ is slow. On the TU8Ø, the mode is selected automatically by the ___d___.

a. Data transfer rate
b. Record
c. Operator
d. TU8Ø microcode
e. Interrecord gap
f. Read/write head

3. The three registers on the M7454 are the ___c___.

a. TSBA, RBCPR, and TSDB
b. XSTATØ, XSTAT1, and XSTAT2
c. TSSR, TSDB, and TSBA
d. TSBA, TSDB, and XSTATØ

4. The extended status registers are in ___d___.

a. M7454 ROMs
b. Downtown Des Moines
c. TSSR words 2-6
d. Host memory locations

5. Packet protocol uses buffers in ___d___. The ___c___ puts the address of the buffers' locations into the ___a___.

a. TSBA
b. TSSR
c. Host
d. Host memory
e. M7454

6. The M7454 issues ___f___ packets ___e___ every command. The host issues ___a___ packets ___b___ every command.

a. Command
b. Before
c. During
d. Data
e. After
f. Message

7. The ___a___ executes the command by using ___c___ transfers. The ___e___ is updated with ___d___ information at the end of every command.

a. M7454
b. Interrupt
c. NPR
d. Extended status
e. Message buffer
f. Command buffer

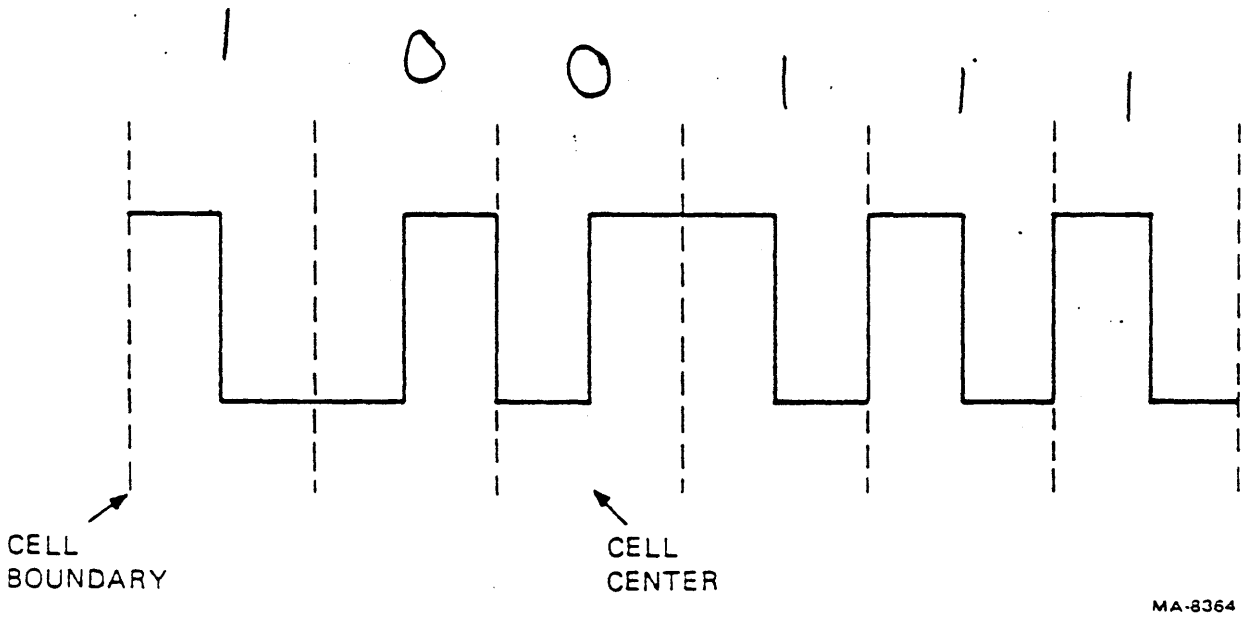


Figure E-1 PE Data

FUNCTIONAL DESCRIPTION

This section describes how various functional components interconnect and function together to make up a TU80 subsystem. The functional block diagram, figure 6, should be referred to throughout this lesson.

The TU80 can be broken into the following functional components.

1. Power supply and cooling
   - o Power supply
   - o Fan

2. Vacuum and pressure pump system
   - o Compressor
   - o 2 Air bearings
   - o Tape cleaner intake
   - o Plenum components

3. Format and control
   - o Formatter/control module
   - o Control panel

4. Servo
   - o Read/write/servo module
   - o Air bearing sensors
   - o Power amplifier module
   - o 1-line tachometer on the supply reel motor
   - o 1000-line tachometer on the take-up reel motor

5. Read/write/erase
   - o Read/write/servo module
   - o Read head
   - o Write head
   - o Erase head
   - o BOT/EOT sensors

6. Host interface
   - o M7454

Each of these functional components interconnect with the others as shown in figure 6.

The rest of this lesson provides brief descriptions of each of these functional components. If you desire further detail at any time during this lesson, refer to the TU80 Subsystem Technical Manual and the TU80 print set.

POWER SUPPLY AND COOLING

The function of the power supply (P/S) is to provide AC power to the cooling fan and compressor, generate the DC voltages used throughout the transport, and provide shut-down capabilities in the event of abnormal voltage conditions.

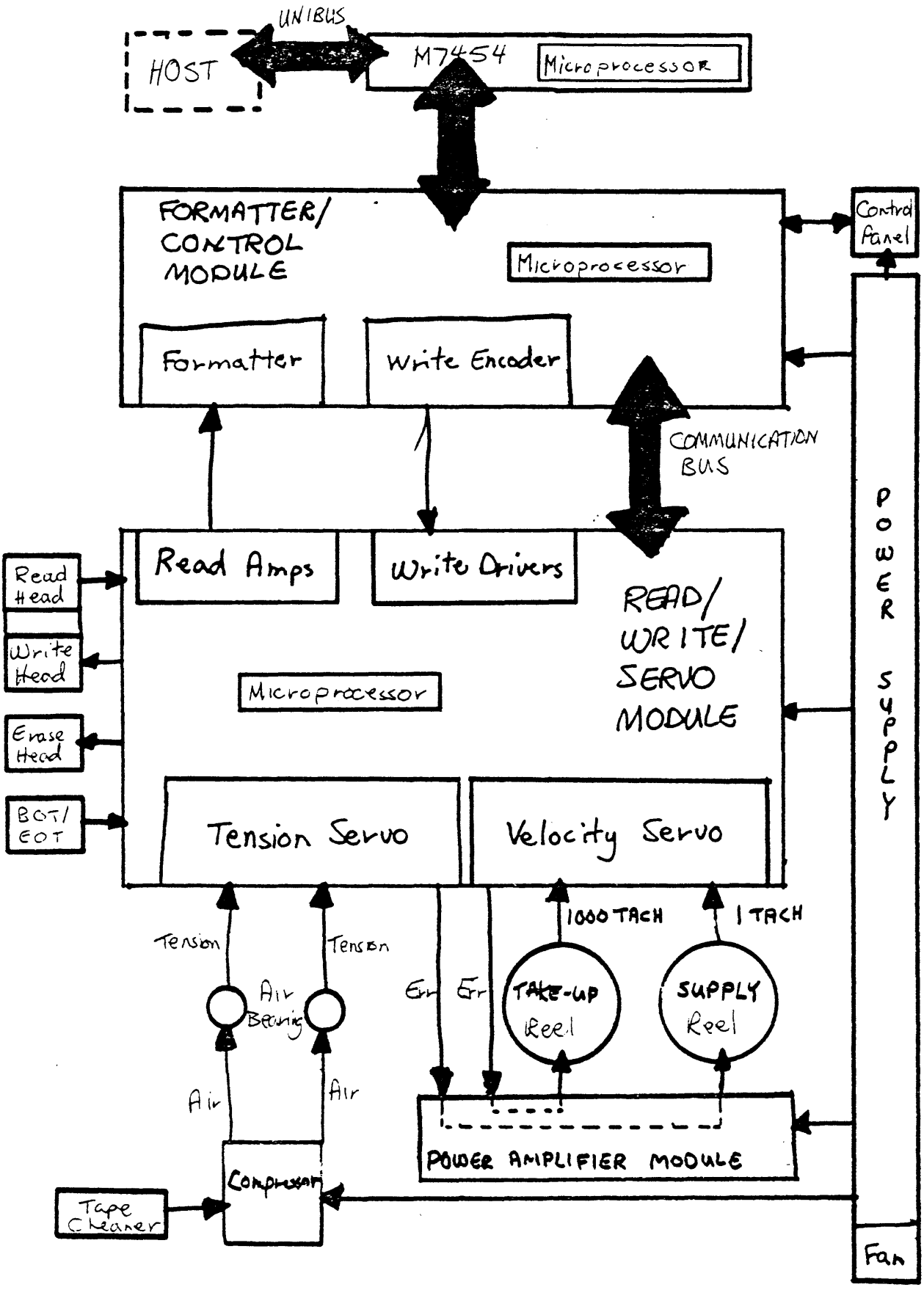


Figure 6 TU80 Functional Block Diagram

The power supply is a field replaceable unit (FRU). If a faulty voltage is being generated by the supply it should be replaced. The only reason the cover is ever removed from the power supply in the field is to convert between 115 VAC 60 Hz and 220 VAC 50 Hz.

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

The power supply consists of the following components (Figure 7).

- AC input receptacle
- Line filter (FL1)
- Circuit breaker (CB1)
- Voltage select module
- Power supply module
- Power supply control module (P/S Control)

The AC input receptacle connects the power supply to outside AC voltage via the switched recreptacles of a DIGITAL power controller.

The line filter suppresses noise on the input line.

The circuit breaker (CB1) is the 0/1 (off/on) switch in the corner of the transport nearest the supply hub. CB1 turns the power supply on and off. The power supply supplies AC voltage to the cooling fan motor whenever CB1 is on. Also, at power up the power supply turns on the LOGIC OFF indicator.

The voltage select module is vertically inserted in connector J1 of the P/S module. The voltage select module can be inserted two ways (Figure 8). Connector J1A is used for 120 VAC 60 Hz. Connector J1B is used for 220 VAC 50 Hz. Figure 8 shows the difference in the two circuits. Notice that fuse F2 is used only in the 120 VAC configuration. Fuse F3 is used in both configurations.

The power supply control module is vertically inserted into connector J8 of the P/S 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 detection circuits initiate a power shutdown if any voltage exceeds the limits shown in table 1.

The power supply module generates the DC voltages for all functions of the TU80. The voltages generated are +5, -6, ±15, +25, +38. These voltages are used in the circuits shown in Table 2.

add actual drawing of P/S with identical callouts as below ex- circuit Breaker CB1 Volt Sel Brd fuses F2:F3

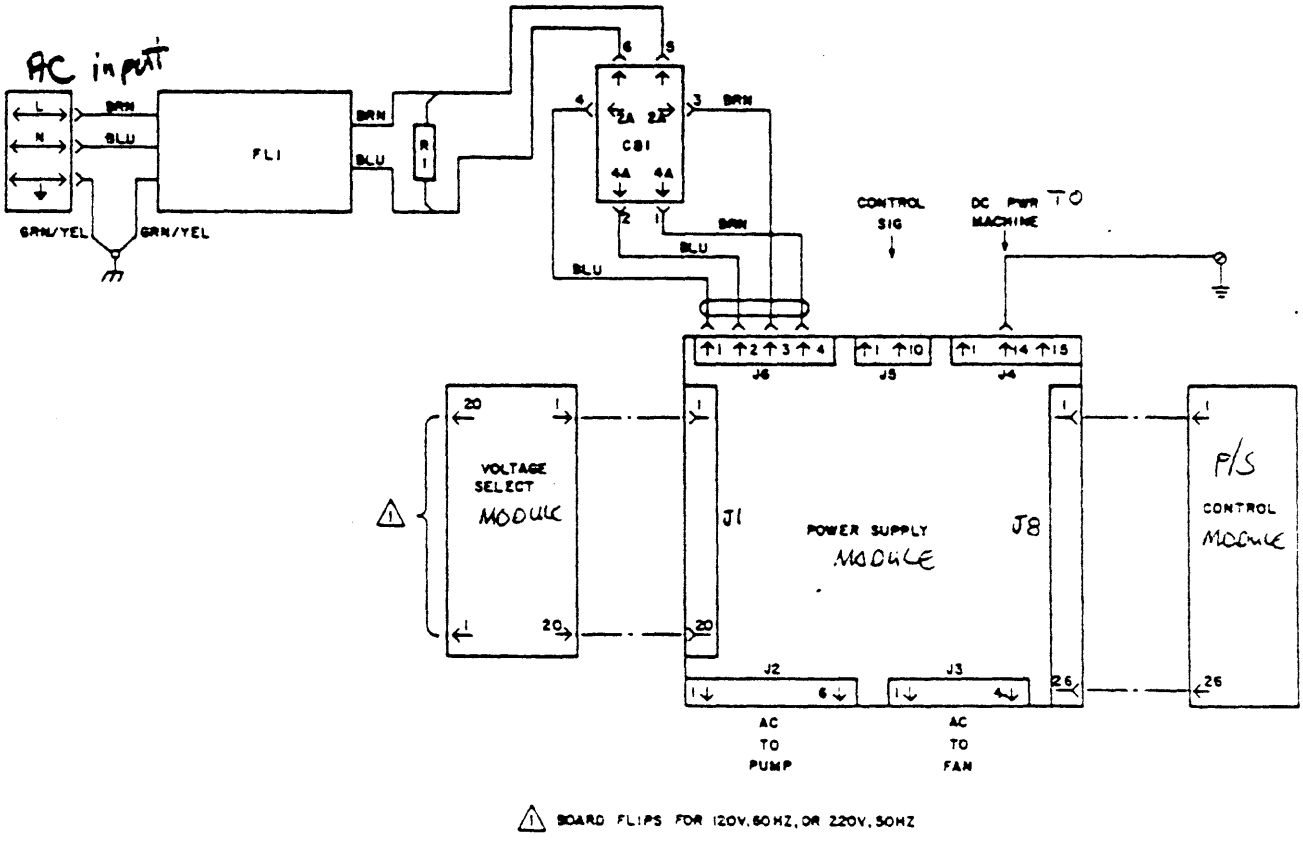
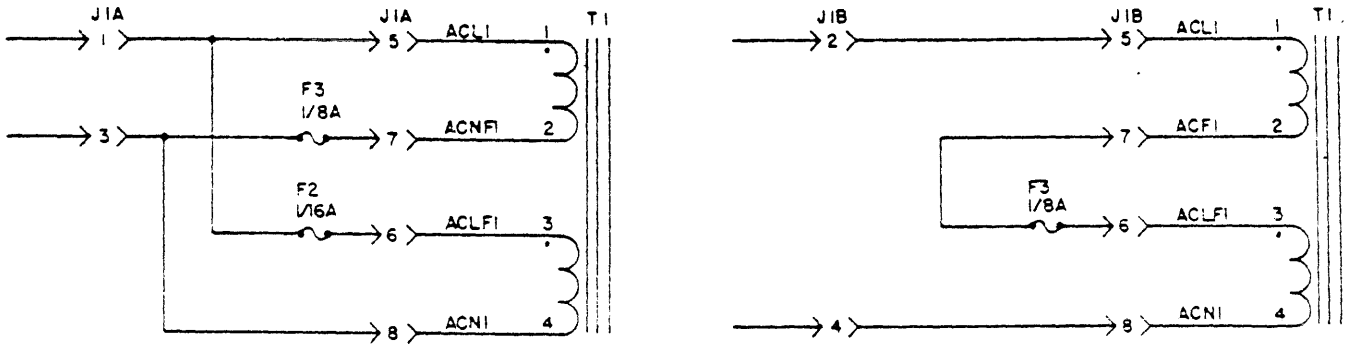


Figure 7 MAJOR POWER SUPPLY COMPONENTS

add picture of board designating J1A & J1B



A. 120 VAC 60 HZ Power Input

B. 220 VAC 50 HZ Power Input

Figure 8 VOLTAGE SELECT PC BOARD

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

Table 1 Shutdown Voltages

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

Table 2 TU80 DC voltages

Standby voltages of +20, +15, and +5 are generated on the P/S PC board for use within the power supply only. They are not used outside of the power supply except to illuminate the LOGIC OFF indicator.

The cooling fan provides cooling for all components contained within the TU80 cabinet.

VACUUM AND PRESSURE PUMP SYSTEM

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

This pump system generates and distributes the vacuum and pressure air requirements of the transport. This system functions using the following three steps (Figure 9).

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

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 4-blade, carbon vane pump.

The compressor is enabled by the read/write/servo microprocessor (R/W/S uP) during the load sequence. The air intake side of the compressor has a small regulator (bleeder) hole in the intake line in addition to the tape cleaner port. The vacuum affect at the tape cleaner is approximately 8.0 inches H_2O.

The plenum box attached to the rear of the tape deck routes the air through a high efficiency filter to clean the air. The filter is designed to last the life of the TU80. However, in case of an exceptionally dirty environment, it can be changed.

The filtered air enters a hollow shaft which has the pressure regulator attached to one end. The regulator is clamped onto the plenum box and is removed to change or examine the filter. The regulator maintains a pressure of 2.0 PSI by bleeding off any excess pressure. This air is next sent to the air bearings where it serves to hold the tape off the bearing to enhance tape movement and reduce tape wear.

Once the air exits 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

change figure to a cutaway view of the actual machine's components.

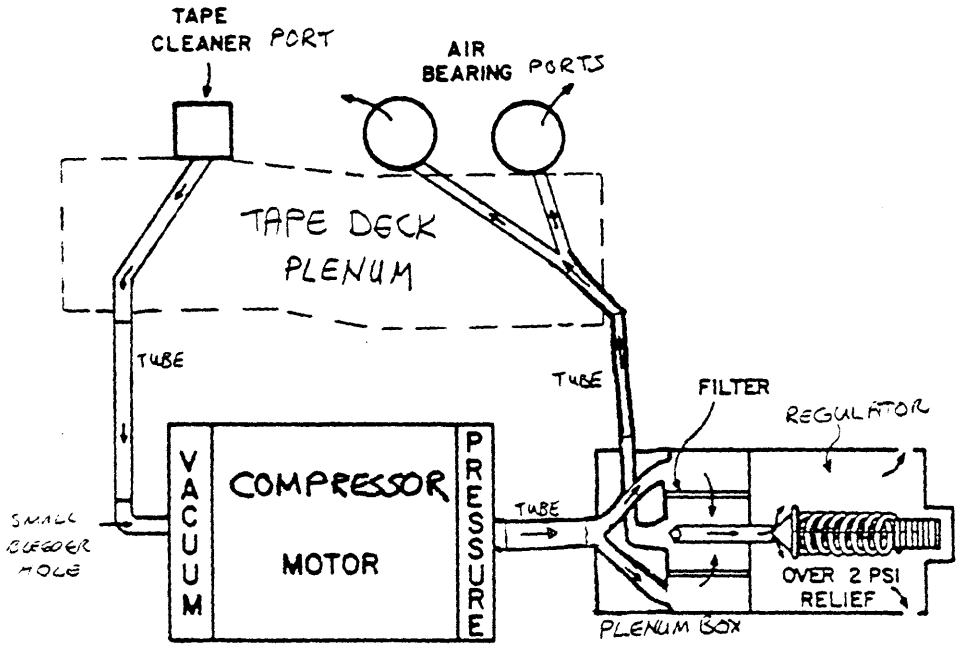


Figure 9 VACUUM AND PRESSURE DISTRIBUTION

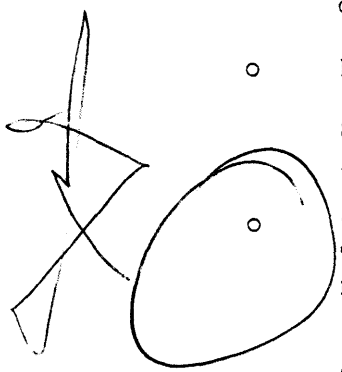
pressure and sends back information to the R/W/S uP to help maintain tape tension. This will be further expalined later in this lesson.

FORMATTER/CONTROL MODULE (F/C)

Format and control of TU8Ø events is performed by the Formatter/control module (Figure 1Ø). This module interfaces to all other parts of the TU8Ø and to the adapter card.

The following list describes the main components of the Formatter/control module.

- Microprocessor (uP, 68Ø2)
  This microprocessor (F/C uP) controls events in the TU8Ø. It treats other parts of the TU8Ø like peripheral devices.



- Read-Only Memory (ROM memory, 8K x 8)
  This ROM chip has a capacity of 8ØØØ 8-bit bytes (8K x 8). The functional and diagnostic programs used by the F/C uP are stored on this ROM.

- Select register
  This register is used to select a drive number on non-DIGITAL systems having one interface module for up to four transports.

  The register is always set to select drive Ø on DIGITAL systems. There is a 4-switch pack on the F/C module which ALWAYS has all switches off to select drive Ø.

- Status register (SR)
  This register sends TU8Ø status to the M7454.

- 5 Peripheral Interface Adapters (PIA, 6821)
  The PIAs interface the Formatter/control module to the following functional units of the TU8Ø (Figure 11).

  1. Read/write/servo module (PIA Ø).
  2. M7454 (UNIBUS Adapter card) (PIA 2).
  3. Operator panel (PIA 1).
  4. TU8Ø write circuits (PIA 4).
  5. TU8Ø read circuits (PIA 3).

  Each functional unit is treated like a peripheral by the F/C uP.

NOTE

Tape manipulation is controlled by the R/W/S uP discussed later in this lesson.

However, the F/C uP initiates the actions of the R/W/S uP. The F/C module

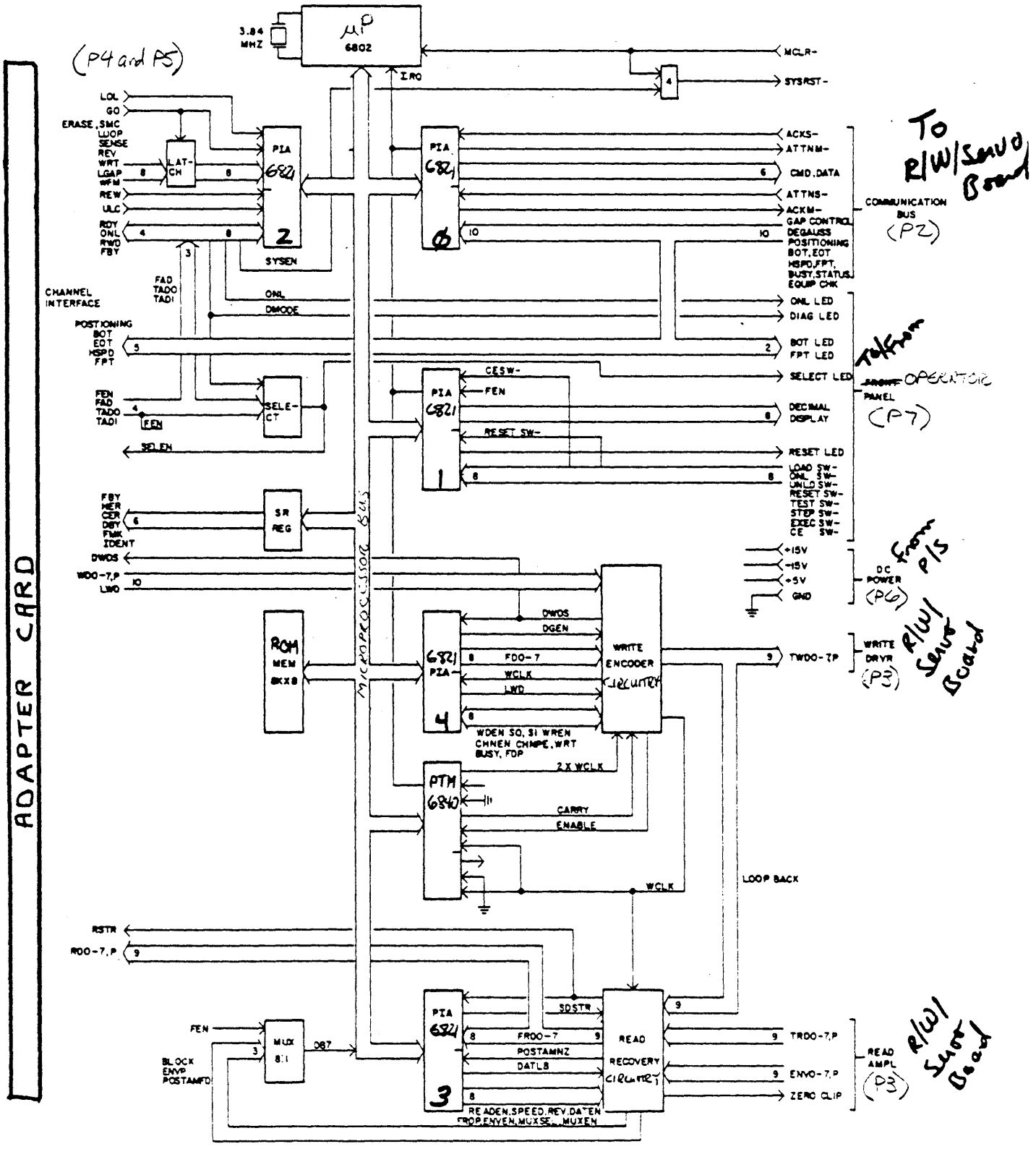


Figure 10 Formatter/Control Block Diagram

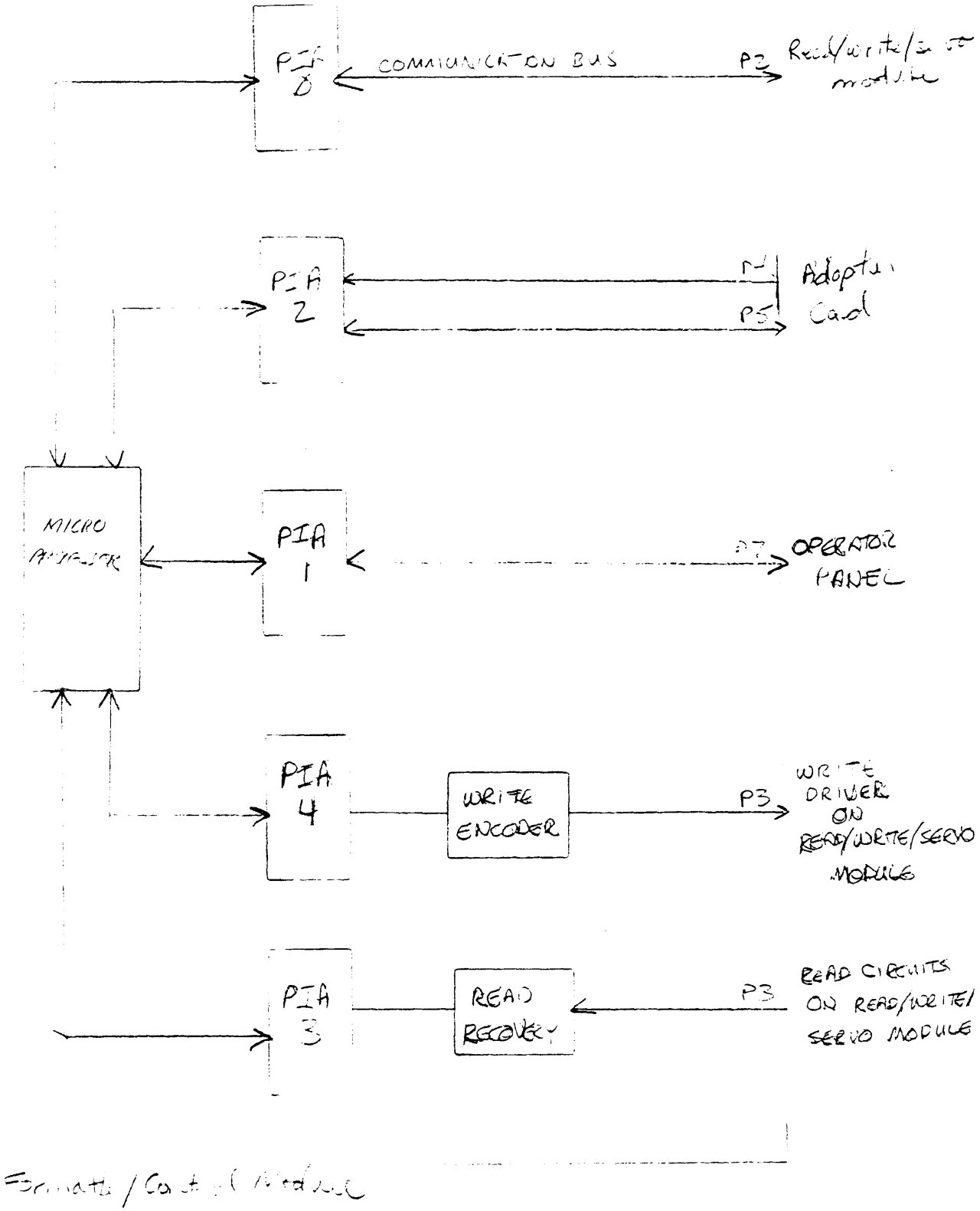


Figure 11 PIA Interfacing (F/C Module)

has ultimate control of TU80 events.

The F/C uP enables the needed PIA through a PIA select register. Each PIA has bi-directional data buffers, internal registers, and both internal and external interrupt/ control lines. The direction of the data lines and the interrupt/control lines are programmed by the F/C uP during system initialization.

- Programmer Timer Module (PTM, 6840)
  The PTM generates the write clock, various read/write delays, and a control line during write operations at preamble and postamble time.

- Write Encoder Circuitry
  This circuitry is controlled by the F/C uP via PIA 4 and the PTM. Formatting is controlled by a 32 x 8 bit PROM. Formatted write data (TWD) is sent from this circuitry to the write driver on the Read/write/servo module.

- Read Recovery Circuitry
  This circuitry is controlled by the F/C uP 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 (VFO), the deskew buffer for each track, and the read data error correction circuitry.

  The VFO is used for timing in synchronizing the nine tracks of read data. The deskew buffers ensure that all nine tracks of each frame of data are transferred to the host system at the same time.

  The error correction circuitry can correct single track errors without interruption to the data transfer. Multi-track errors cannot be corrected.

  Raw data goes directly to the M7454 after correction.

How do these components work together? Briefly, this is what happens. Follow along using figure 10.

A command is received by the F/C uP from the M7454 and PIA 2.

Also, an interrupt request may be issued by a PIA. It may be caused by a switch pushed on the control panel or one of various status signals from the Read/write/servo module.

The F/C uP starts a particular program routine stored in the ROM to execute the command or service the interrupt. The program routine causes the correct PIA to be enabled.

The PIA interfaces control signals between the peripheral area of

the TU80 and the F/C uP. The PIA interfaces data between the peripheral area of the TU80 and M7454.

PIA enabling lines can then initiate activity within the peripheral unit to which it interfaces.

At this point, with write commands, data is formatted. Formatting is controlled by a programmable ROM within in the write encoder circuits. Data is then sent to the R/W/S module to be recorded onto tape. The PTM provides clocking signals.

With read commands, data is brought in from the tape through the R/W/S module. The data is decoded, deskewed, and corrected in the read recovery circuits. It is then sent directly to the M7454 module.

Both the read and write functions progress without F/C uP intervention once a function has started.

Next, complete the following exercise covering the power supply and cooling, the vacuum and pressure pump system, and the F/C module.

EXERCISE 2

Fill in the blanks with the correct letter.

1. Abnormal voltages in the TU80 most likely are caused by the __C__.

   a. compressor
   b. heads
   c. power supply
   d. M7454 UNIBUS adapter module

2. To convert the TU80 between 50 Hz. and 60 Hz. voltages, you should __A__.

   a. insert the voltage select module differently in the backplane.

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

   c. change the wire connections on the voltage select module

   d. alter the switch settings on the F/C module.

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 F/C microprocessor controls __D__.

   a. the output of the power supply
   b. the amount of pressure maintained by the compressor
   c. intensity of the control panel
   d. all events in the TU80

5. The F/C microprocessor is interfaced with the rest of the TU80 subsystem by __B__.

   a. 50 pin cables
   b. 5 PIAs
   c. the communication bus
   d. read recovery circuits
   e. Interstate 95

EXERCISE 2 ANSWERS

Fill in the blanks with the correct letter.

1. Abnormal voltages in the TU80 most likely are caused by the __c__.

   a. compressor
   b. heads
   c. power supply
   d. M7454 UNIBUS adapter module

2. To convert the TU80 between 50 Hz. and 60 Hz. voltages, you should __a__.

   a. insert the voltage select module differently in the backplane.

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

   c. change the wire connections on the voltage select module

   d. alter the switch settings on the F/C module.

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 F/C microprocessor controls __d__.

   a. the output of the power supply
   b. the amount of pressure maintained by the compressor
   c. intensity of the control panel
   d. all events in the TU80

5. The F/C microprocessor is interfaced with the rest of the TU80 subsystem by __b__.

   a. 50 pin cables
   b. 5 PIAs
   c. the communication bus
   d. read recovery circuits
   e. Interstate 95

READ/WRITE/SERVO MODULE (R/W/S)

In figure 12 the velocity and tension servo circuitry is in the upper right-hand corner. The read and write circuitry is in the upper left-hand corner. Notice that each of these circuits has R/W/S uP control input lines and sense (status) lines. The uP lines initiate activity within the circuits and coordinate activity between the circuits. These circuits are described later in this lesson.

The lower half of figure 12 consists of the control components for the servos and the read/write circuits and the interfacing to the F/C module. The uP, PIA, and PTM are the same kind of chips used on the F/C module.

There is only one PIA. It interfaces with the F/C module via the communication bus. The PTM provides a real-time clock for the uP and counts servo tach pulses. These pulses are counted so the tape position is known during rewind.

The functional and diagnostic program for the uP resides on the 8K x 8 bit ROM chips. STU Status is stored in a 1K x 1 bit RAM.

A 64 x 4 bit electrically erasable programmable ROM (E^2 PROM) stores the read amplifiers gain values (EGC) and velocity servo offset values. These values are explained in the servo discussion later in this lesson.

SERVO (R/W/S MODULE)

A servo or servomechanism is a group of components that monitor an operation as it proceeds and makes necessary adjustments to keep the operation under control. The TU80 has two servo assemblies, the velocity servo and the tension servo. The electronics of both servos are located on the Read/Write/Servo module. The mechanics and sensors are on the tape deck.

The servo functions of the TU80 are performed quite differently from most tape recording devices. During the following discussion keep two things in mind to avoid confusion.

First, the take-up reel motor works in conjunction with the R/W/S uP, both tachometers, and the velocity servo circuitry to maintain constant tape speed. This is why there is no capstan.

Second, the supply reel motor works in conjunction with both pressure sensors in the the air bearings and the tension servo circuitry to maintain constant tape tension of 8 ounces. This is why there are no tension arms or vacuum columns.

VELOCITY SERVO

The velocity servo circuitry maintains constant tape velocity until an operaton is complete.

The take-up reel is turned to maintain tape velocity. The radius

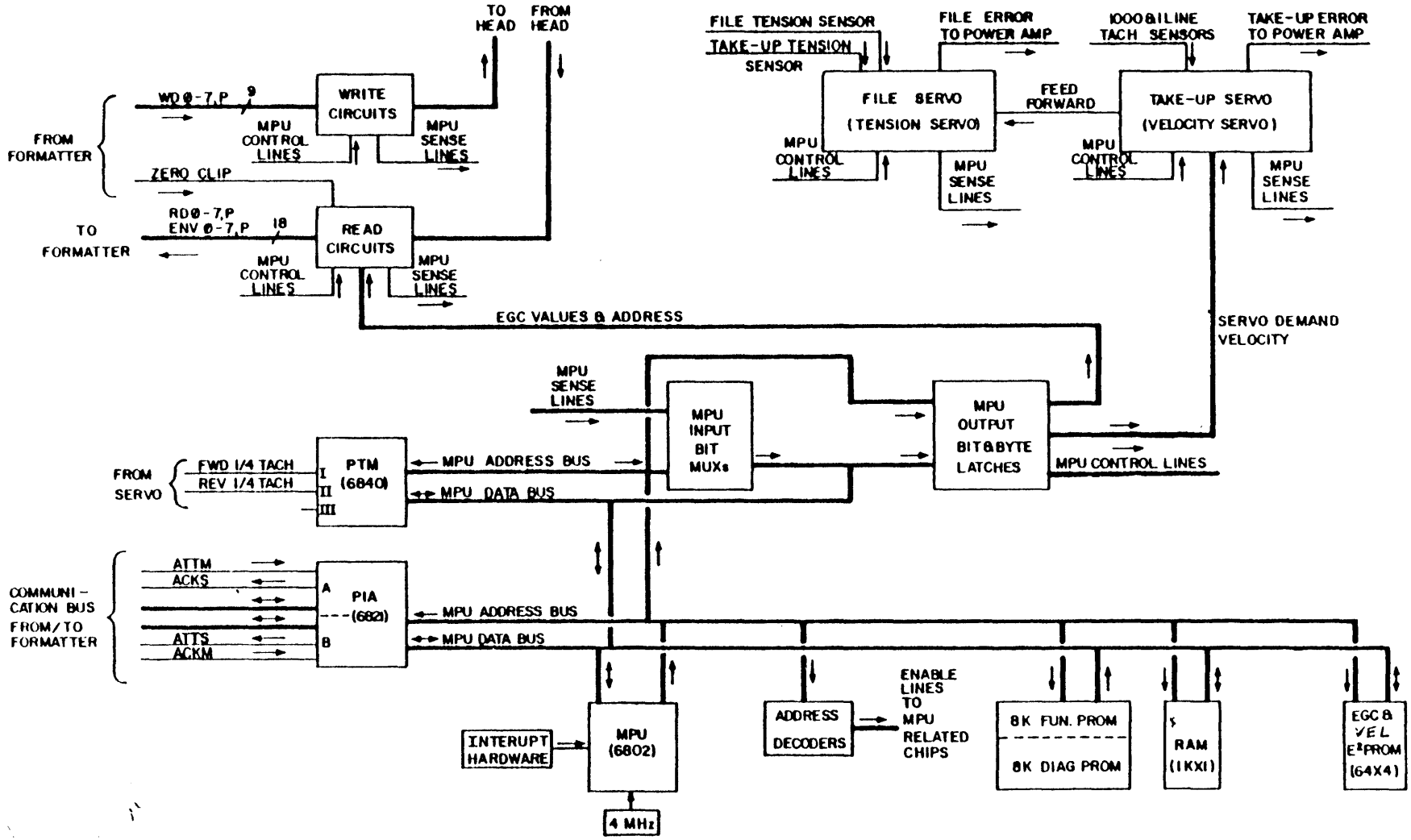


Figure 12 Read/Write/Servo Module Block Diagram

of the tape on the take-up reel is used to determine the amount the reel needs to turn to maintain velocity.

Wait a minute. How can this radius be measured? It changes all the time the tape is moving.

That is true. But, when tape is loaded to BOT, the take-up reel radius is assumed to be 2.56 inches. The R/W/S uP recalculates the radius every 8 revolutions of the supply reel. The 1-line supply tachometer acts as the counter for supply reel revolutions. In this way the radius is always known. The counter increments when tape is moving in the forward direction and decrements in reverse direction.

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

How is the correct amperage determined? Refer to figure 13 while reading the following description.

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

NOTE

The FWD signal determines direction to begin tape movement. Tachometer phasing determines direction to continue tape movement.

The directional and divided phase signals are then NANDed together, sent through descriminating and filtering logic, and create the ANALOG TACH signal.

Meanwhile, the R/W/S uP 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 operational speed to create a velocity error signal (TUER) which is sent to the power amplifier which turns the reel motor the desired amount.

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

TENSION SERVO

The tension servo circuitry (Figure 14) maintains constant tape

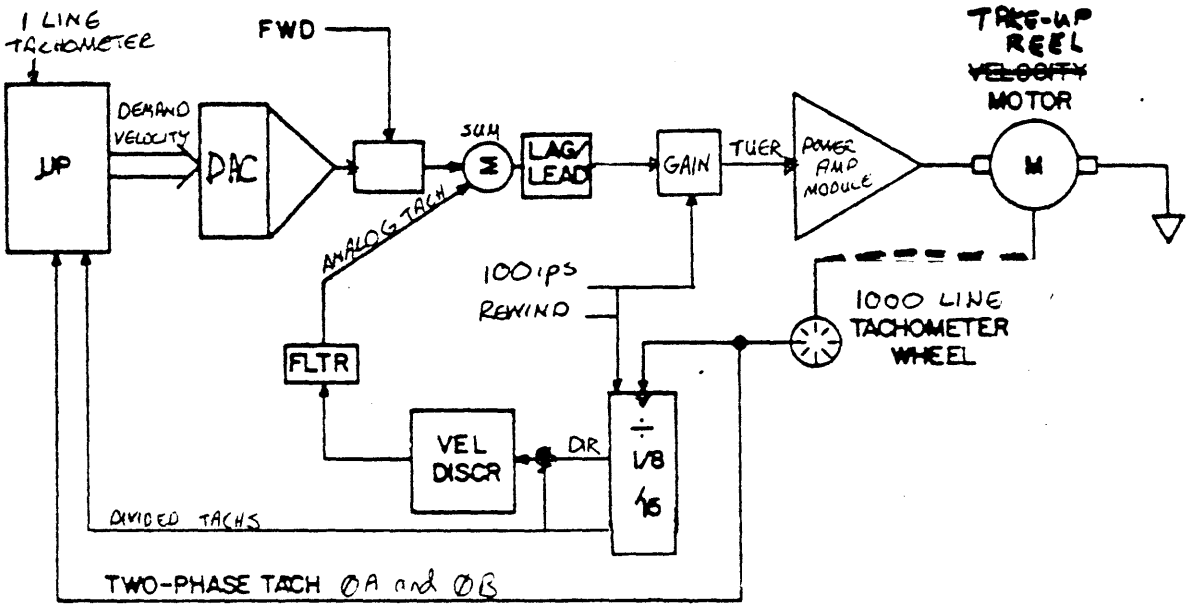


Figure 13 VELOCITY SERVO

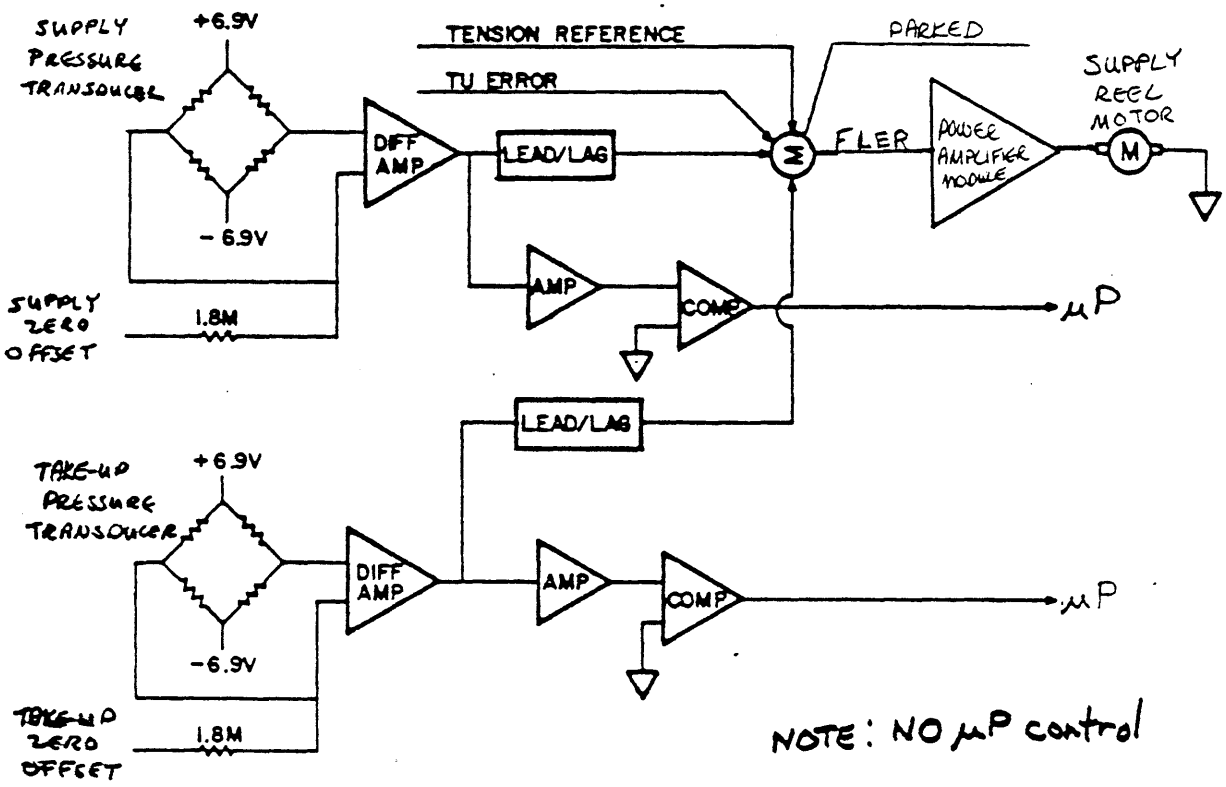


Figure 14 TENSION SERVO -

tension as long as a tape is loaded.

Several inputs to this circuitry need to be explained before describing 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 to compensate for these deviations. To eliminate adjustments, offsets are introduced into circuitry and they are tied together with sensing units via differential amplifiers. The offsets are automatically optimized periodically.

  On the TU80, the air bearing pressure transducers are tied together with the tension offsets which are calculated during each load sequence.

  During each load sequence, the microprocessor sweep both offset signals from maximum to minimum voltage. At the point at which the offset signals zero their respective op amps, the sweep stops, and the offset is set at that voltage level until the next load sequence. Therefore, 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)
  TUER is summed with the tension reference and the transducer inputs. This is 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
  The comparator signals sent to the microprocessor cause the microprocessor to shut-down the tension servo if too high or too low tension levels are sensed.

How does the circuit work?

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 is turned to maintain correct tape tension of 8 ounces on each air bearing.

READ (R/W/S MODULE)

The read circuits of the R/W/S module are responsible for detection of data, amplification of weak readback signals, and the conversion of the analog signal coming from the tape to a logic level.

The analog read data signal (Figure 15) is brought off the tape by the read head and goes through several stages of amplification and filtering.

In the third stage of amplification, the gain is determined by the electronic gain control (EGC) circuit. EGC replaces the gain adjustment potentiometers traditionally found on tape transports. In normal use the EGC input never changes. It is set to provide a third stage amplification output of 1.5 volts. However, time this output may vary due to component wear or replacement. If symptoms occur which indicate a possible read gain problem, the field service representative can invoke an internal diagnostic to reset the EGC level for each track. This procedure is found in the diagnostic lesson.

The data output of the third stage amplifier goes two places. First, it goes to a zero crossing comparator. This comparator converts the data signal to a positive or negative digital pulse which is sent to the F/C module.

Second, the third stage analog output goes to error detection circuitry. The output goes to the clip level comparator where it is compared to the clip level. The clip level is predetermined by the R/W/S microprocessor and varies according to the operation being performed by the TU°0. The clip level detector outputs a digital pulse which must be at least 30% as wide as the analog signal.

If the pulse is not at least 30% as wide as the analog signal, the level detect capacitor discharges causing the bias comparator to output a positive pulse to the F/C module. The formatter circuitry on the F/C module interprets this pulse (ENV) as an error, and the data is inhibited from appearing on the output lines to the host system.

NOTE

The envelope signal (ENV) is also used to set the EGC level when the internal diagnostic to reset the EGC level is invoked by the field service representative.

From this point the read data goes to the F/C module. Read the Formatter/control module section of this lesson to complete the read data path to the host system.

WRITE/ERASE (R/W/S MODULE)

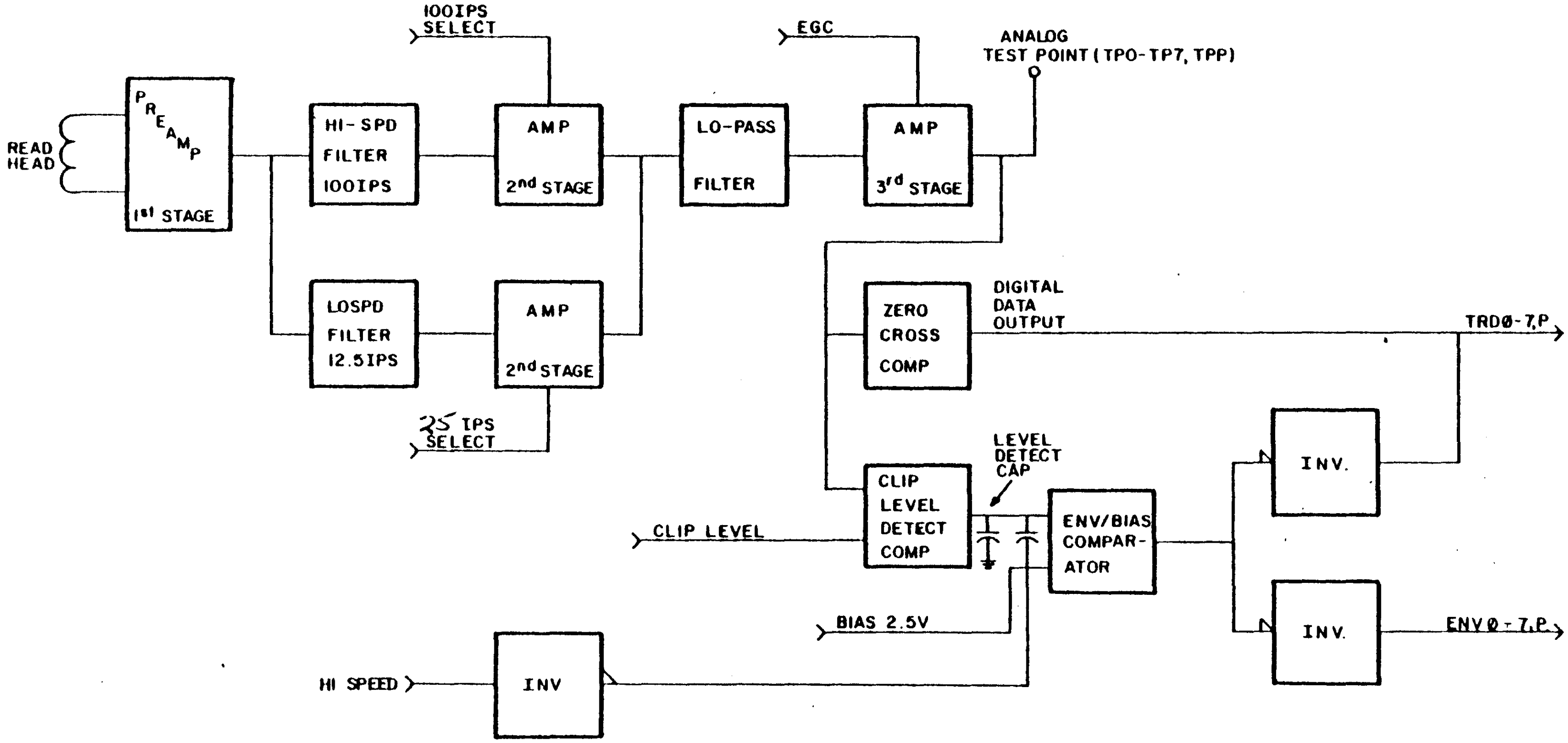


Figure 15 Read Circuits Block Diagram

The write/erase circuits shown in figure 16 record data onto tape. Formatted write data (TWD0-7,P) is input from the F/C module to the write drivers. Only one write driver is enabled at a time depending on if the data is a 0 or 1. To write onto tape the write enable signal (WR ENB) must be high and the file protect signal (FILE PRO) must be low.

Residual magnetism builds up on the heads during a write operation. If this magnetism was allowed to continue to build up, partial erasure could occur on the tape. To prevent this the TU80 performs a degauss operation to neutralize the residual magnetism at the end of every write function.

The tape is erased before crossing the write head during a write command. The erase head is a single full-tape-width element which uses DC saturation to accomplish erasure. The erase head operates only in the forward direction.

M7454 (UNIBUS ADAPTER MODULE)

The M7454 (Figure 17) interfaces the TU80 with a VAX or PDP-11 host system. It is contained in the host system. It is a quad height module which fits into a standard small peripheral controller (SPC) slot in a UNIBUS backplane.

The M7454 has self-diagnostics which are run automatically at power-up or any other initialization time. An LED is illuminated to indicate a successful pass of the self-diagnostics.

Two 50-conductor cables join the M7454 with the F/C module in the TU80.

The module contains its own microprocessor (AMD 2901), ROM, sequencer, data paths, and 1K byte buffer. The uP is the timing and control center of the M7454. The microprogram contained on the programmable ROM (PROM) sequences M7454 operations and operates the self-diagnostics. The buffer helps eliminate data lates and overruns which significantly slow data transfer.

The M7454 communicates with the host processor using the packet protocal scheme described earlier in this lesson. The TU80 does NOT communicate with packet protocal. The M7454 and TU80 communicate only with command and status lines and pass data bacl amd forth.

Three registers are on the M7454. They are the bus address register (TUBA), the data buffer register (TUDB), and the status register (TUSR).

The operation of the M7454 consists of passing parallel data back and forth between the host memory and the TU80. The M7454 also communicates with the host, identifies the command and sends a command (not the packet) to the TU80 F/C uP.

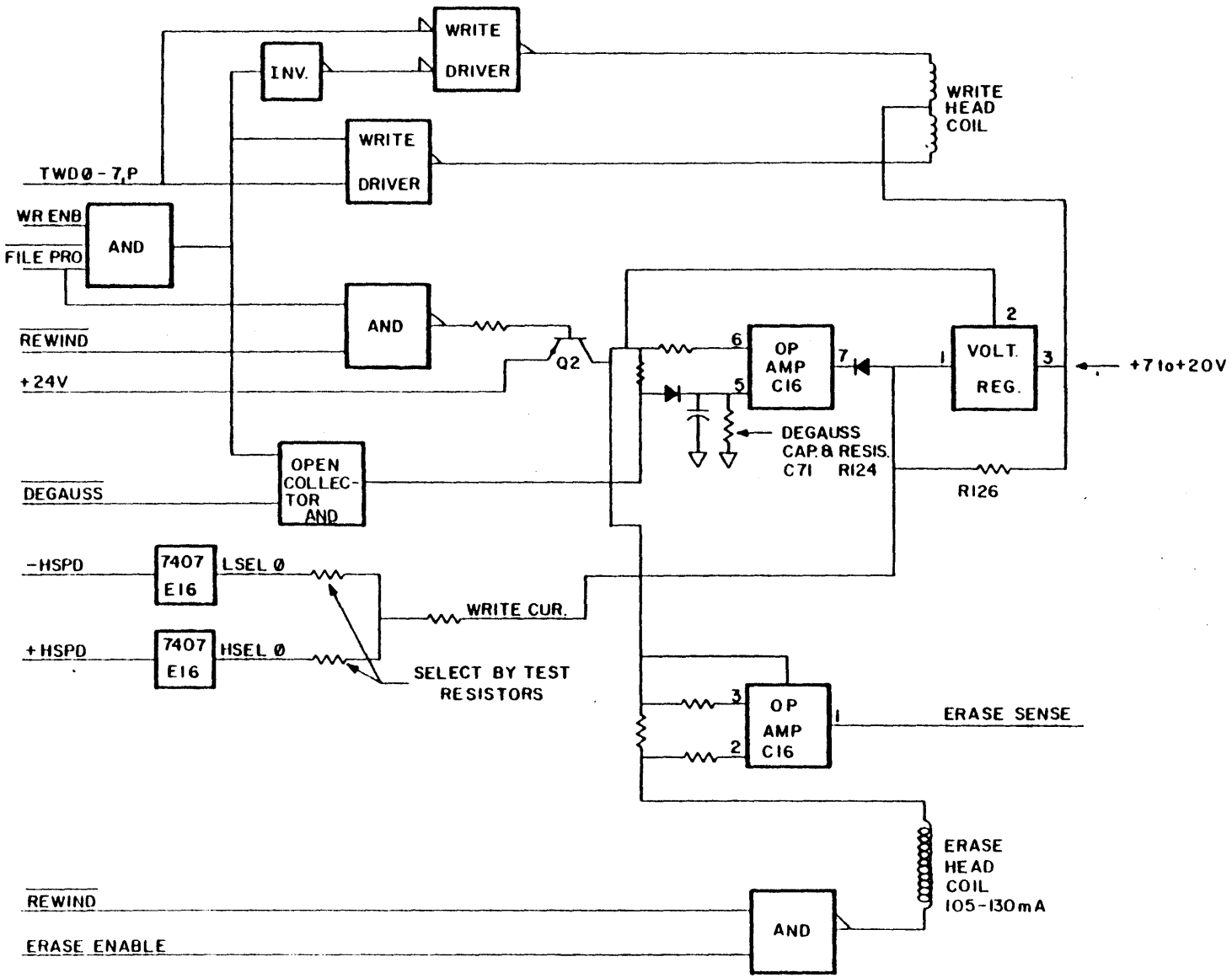


Figure 16 Write/Erase Block Diagram (CLOCKS Mode)

TBS

Figure 17 M7454 Block Diagram

NOTE

Operationally, the M7454 is a TS11 emulation. The M7454 performs functions of the TS11 interface and the TS11 main microprocessor. However certain status bits and maintenance commands will not be supported.

The M7454 is linked to the TU80 by a parallel bus unlike the TS11 which is linked serially to its interface.

Now, complete the third exercise covering the R/W/S module and the M7454.

EXERCISE 3

Fill in the blanks with the correct letter.

1. Within the TU80, the _____ microprocessor initiates events sequenced by the _____ microprocessor.

   a. read/write/servo
   b. main
   c. formatter/control
   d. M7454

2. The _____ reel motor is turned to maintain tape velocity. The _____ reel motor is turned to maintain tape tension.

   a. fishing
   b. take-up
   c. top
   d. bottom
   e. supply

3. If the one-line tachometer failed during operation _____.

   a. tape direction would be lost.
   b. incorrect air pressure would exit from the air bearings.
   c. tape velocity would become incorrect
   d. the 1000-line tachometer would go out of phase.

4. The read circuitry of the R/W/S module _____.

   a. amplifies and digitizes the analog data from the tape.
   b. sends data directly to the host memory.
   c. buffers data until errors are located.
   d. formats the data from the tape.

5. The M7454 self-diagnostics are _____.

   a. loaded from the host and run upon command.

   b. loaded from the host and run everytime the module is powered up.

   c. self-contained and run upon command.

   d. self-contained and run everytime the module is powered up.

EXERCISE 3 ANSWERS

Fill in the blanks with the correct letter.

1. Within the TU8C, the __c__ microprocessor initiates events sequenced by the __a__ microprocessor.

   a. read/write/servo
   b. main
   c. formatter/control
   d. M7454

2. The __b__ reel motor is turned to maintain tape velocity. The __e__ reel motor is turned to maintain tape tension.

   a. fishing
   b. take-up
   c. top
   d. bottom
   e. supply

3. If the one-line tachometer failed during operation __c__.

   a. tape direction would be lost.
   b. incorrect air pressure would exit from the air bearings.
   c. tape velocity would become incorrect
   d. the 1000-line tachometer would go out of phase.

4. The read circuitry of the R/W/S module __a__.

   a. amplifies and digitizes the analog data from the tape.
   b. sends data directly to the host memory.
   c. buffers data until errors are located.
   d. formats the data from the tape.

5. The M7454 self-diagnostics are __d__.

   a. loaded from the host and run upon command.

   b. loaded from the host and run everytime the module is powered up.

   c. self-contained and run upon command.

   d. self-contained and run everytime the module is powered up.

SUMMARY

The TU80 uses the phase encoded (PE) recording method which has a flux reversal at every bit-cell center. The data is organized into records.

The TU80 uses both start/stop (25 ips) and streaming (25 or 100 ips) modes. The fastest mode is selected automatically by the microprogram on the F/C module.

Track four is the parity track and can correct one dropped bit per frame.

The TU80 subsystem has 8 registers. The TUBA, TUDB, and TUSR are on the M7454. The 5 extended status registers, XSTAT0 through XSTAST3 and RBCPR, are located in the message buffer within the host system memory.

The TU80 subsystem transfers command, data and status information to and from the host system using packet protocol. This protocol technique utilizes the M7454 microprocessor, M7454 registers, and the host system memory to store and retrieve information as needed. The M7454 reads the packets and sends commands to the F/C microprocessor.

The TU80 can be broken into the following functional components.

1. Power supply and cooling
   - o Power supply
   - o Fan

2. Vacuum and pressure pump system
   - o Compressor
   - o 2 Air bearings
   - o Tape cleaner intake
   - o Plenum components

3. Format and control
   - o Formatter/control module
   - o Control panel

4. Servo
   - o Read/write/servo module
   - o Air bearing sensors
   - o Power amplifier module
   - o 1-line tachometer on the supply reel motor
   - o 1000-line tachometer on the take-up reel motor

5. Read/write/erase
   - o Read/write/servo module
   - o Read head
   - o Write head
   - o Erase head
   - o BOT/EOT sensors

6. Host interface
   - o M7454

This is the end of the Theory of Operation lesson.

DIAGNOSTICS

INTRODUCTION

This lesson describes and teaches you to make use of all diagnostics for the TU8C. TU8C diagnostics fall into four categories.

1. Power-on Health Check
2. M7454 (UNIBUS Adapter) self-diagnostic
3. Internal diagnostics
4. On-line diagnostics

The power-on health check program is located on internal ROMs and runs automatically every time the STU is turned on by the LOGIC ON switch.

The M7454 diagnostic is resident on ROMs on the M7454 and runs whenever that module is powered up; usually when the host is turned on.

Internal diagnostics are located on ROM chips within the TU8C. There are many of these diagnostics for various purposes. The internal diagnostics include the 3 operator diagnostics you ran in the Operation lesson and the field service diagnostics which you will operate in this lesson.

TU8C internal diagnostics can be run without taking the customer's system offline.

On-line diagnostics are loaded by the host from external storage media and run from the host (VAX or PDP-11) console terminal.

You will learn to run and interpret all TU8C diagnostics in this lesson.

OBJECTIVES

1. Identify the four categories of diagnostics.
2. Identify the pre-site procedures.
3. Identify the on-site procedures.
4. Use the pathfinder documentation to interpret errors.
5. Run any internal diagnostic.
6. Interpret any error code.
7. Identify the purpose of any internal diagnostic.
8. Run the VAX on-line diagnostics.
9. Interpret on-line diagnostic errors.

POWER-ON HEALTH CHECK

The health check (Figure 1) initializes and tests various portions of the TU80 logic. It does not check any logic or components directly concerned with tape motion.

Several fault codes may by displayed. Many of these fault codes are cleared by the RESET switch and the test is retried.

You must make your customers aware that some fault codes will clear by pushing the RESET switch. Also, even though a fault code may clear, it should be written down and given to the field service representative on the next service call. Information like this may help fix a TU80 quicker.

M7454 SELF-DIAGNOSTIC

The M7454 self-diagnostic checks only the M7454 module 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 lights to indicate successful test completion.

There are three possible indications that the selr-diagnostic has failed. First, of course, is the green indicator will be off.

Second, the host system will not be able to access the TU80. In most cases, the host will configure the system around the TU80 when the system is booted.

Third, the SELECT indicator on the TU80 front panel will not light. The TU80 (if powered up) should ALWAYS be selected if the M7454 is powered up.

M7454 failure when the host operating is running results in error messages on the system error log and/or console terminal error messages.

INTERNAL DIAGNOSTIC DOCUMENTATION

The internal diagnostics are run and interpreted using the pathfinder. There are three parts to the pathfinder documentation.

1. The PATHFINDER TABLES which lead you step by step to a problem. The pathfinder asks questions on current TU80 status, designates points where given internal diagnostics must be run, and points out the most probable solutions to the problem.

2. The TEST DESCRIPTIONS which describe what each internal diagnostic does, the sequence it runs through, and possible termination (error) codes.

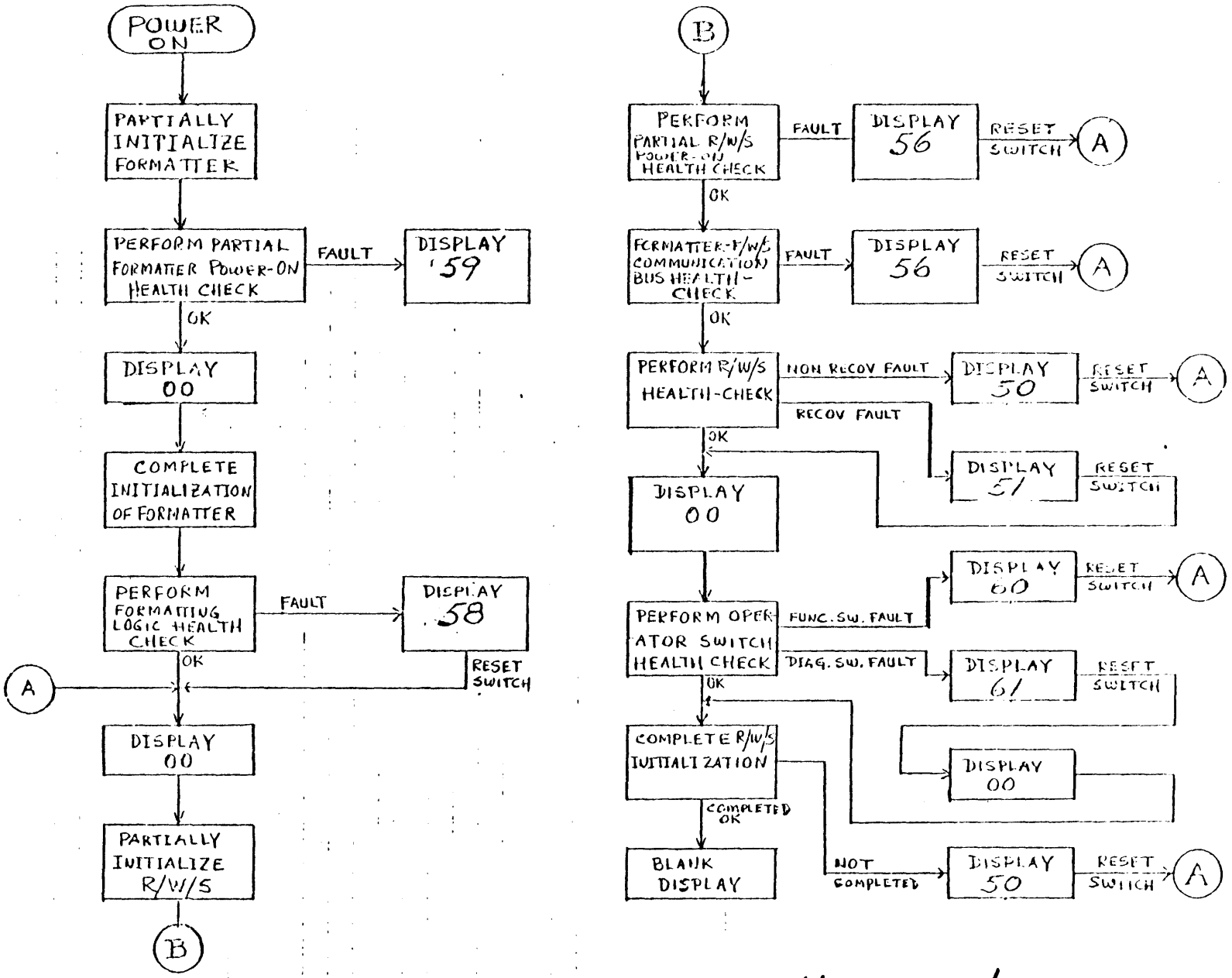


Figure 1 Power-On Health Check

3. The SUB-FAULT CODE DESCRIPTIONS which are used in conjunction with the pathfinder to more clearly define a problem.

NOTE

The TU80 documentation uses three terms which may be misinterpreted. They are error code, fault code, and termination code.

Error code and fault code are the same thing and can be used interchangably.

Termination code is the code received at the end (termination) of a pathfinder diagnostic. It may be a fault code or a 00 indicating the successful completion of the diagnostic.

You will use the pathfinder during the majority of this lesson. It is extremely important that you understand the pathfinders use, because it is the reference you will use in the field.

NOTE

The pathfinder is part of the CD kit and must always remain with the kit. The document is company confidential and must never be left with the customer.

The pathfinder is based on the fault codes which appear in the control panel display.

FAULT CODES

A fault code may occur during power-up, on-line use, or during diagnostic testing. The fault code will always appear in the 2-bit digital display on the control panel.

NOTE

ALL FAULT CODES, no matter when they are displayed, are handled as described in the following sections called pre-site and on-site.

You ran the three operator diagnostics in the Operation lesson. Recall that the operator has a short table of actions to take if a fault code was encountered. If the fault is not cleared by any of these actions, the operator then calls field service.

PRE-SITE

This section explains what you, the field service representative, does upon receiving the call from the operator or customer.

1. The first thing to do when in contact with the customer is determine if there has been a fault code on the TU80 or if the problem exists without a fault code.

> NOTE
> Most references in this lesson are to the pathfinder which is part of the TU80 course resources. This will familiarize you with its use. DO NOT write in the pathfinder. It will be used by other students.

2. If there has NOT been a fault code, refer to Malfunction Matrix table 2-2 in the pathfinder.

____Find table 2-2 in the pathfinder.

The top half of this table lists possible malfunctions. The middle three lines list operator action which you must suggest while on the phone. Where an "A" appears in a box, you must ask the customer to check those things.

The bottom part of the table lists the most likely failing components when particular symptoms occur. The most likely component has a 1 in the box, the second most likely a 2, and so on. Make sure you have all the possibilities with you when you go to the customer site.

> NOTE
> No matter what the failure, it is a good idea to check that the supply hub is latched (periphery ring pushed in) properly.
>
> 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.

3. If there has been a fault code, refer to Fault Code Matrix table 2-3 in the pathfinder.

____Find table 2-3 in the pathfinder.

This table is based on Operator Test 01 faults. The top line of the table on both pages lists faults codes. From the fault code the customer has reported, go down vertically to determine what the next action should be.

An X in any column means that is the final thing for the

customer to perform in that column. An A, B, or C means the customer should check each of those things to try to cure the problem. After any action, test 01 should again be run to see if the fault has cleared.

NOTE

Remember, the customer does not have these tables. YOU must tell the customer to perform these actions.

The bottom part of the table is for your use only. It lists the most probable failing assemblies for a given fault code. 1 is most likely, 2 is next, etc.

4. For certain test 01 faults, the customer is asked to run test 02 or 03. If a fault code is received with either of these tests, refer to Termination Code tables 2-4 through 2-9 in the pathfinder.

____Find tables 2-4 through 2-9 in the pathfinder.

These tables are based on specific fault codes which come up while running test 01.

For example, table 2-4 is used ONLY for fault code 22 when running test 01. Then test 02 is run and the fault code which results is matched with the numbers in the first line of the table (71-00). Then you follow through the table vertically in the same manner as the previous tables.

If the problem remains after the above steps are completed, it is time to grab the CD kit (or the components suggested as probable failures by the tables) and head for the customer site.

ON-SITE

Once you have arrived at the scene of the fault, the pathfinder will lead you to the specific failing component.

The pathfinder tables identify the great majority of TU80 problems. Pathfinder is the first mode of diagnosis to use after completing the standard troubleshooting procedures when arriving at the customer site. The standard troubleshooting procedures are described in the System Maintenance lesson.

PATHFINDER TABLES

Figure 2 is an example of a pathfinder table. Fault code 32 is used as the example.

The pathfinder tables are organized according to fault code numbers. The fault code is listed at the top of the table.

Under the fault code is the assumption. The assumption explains

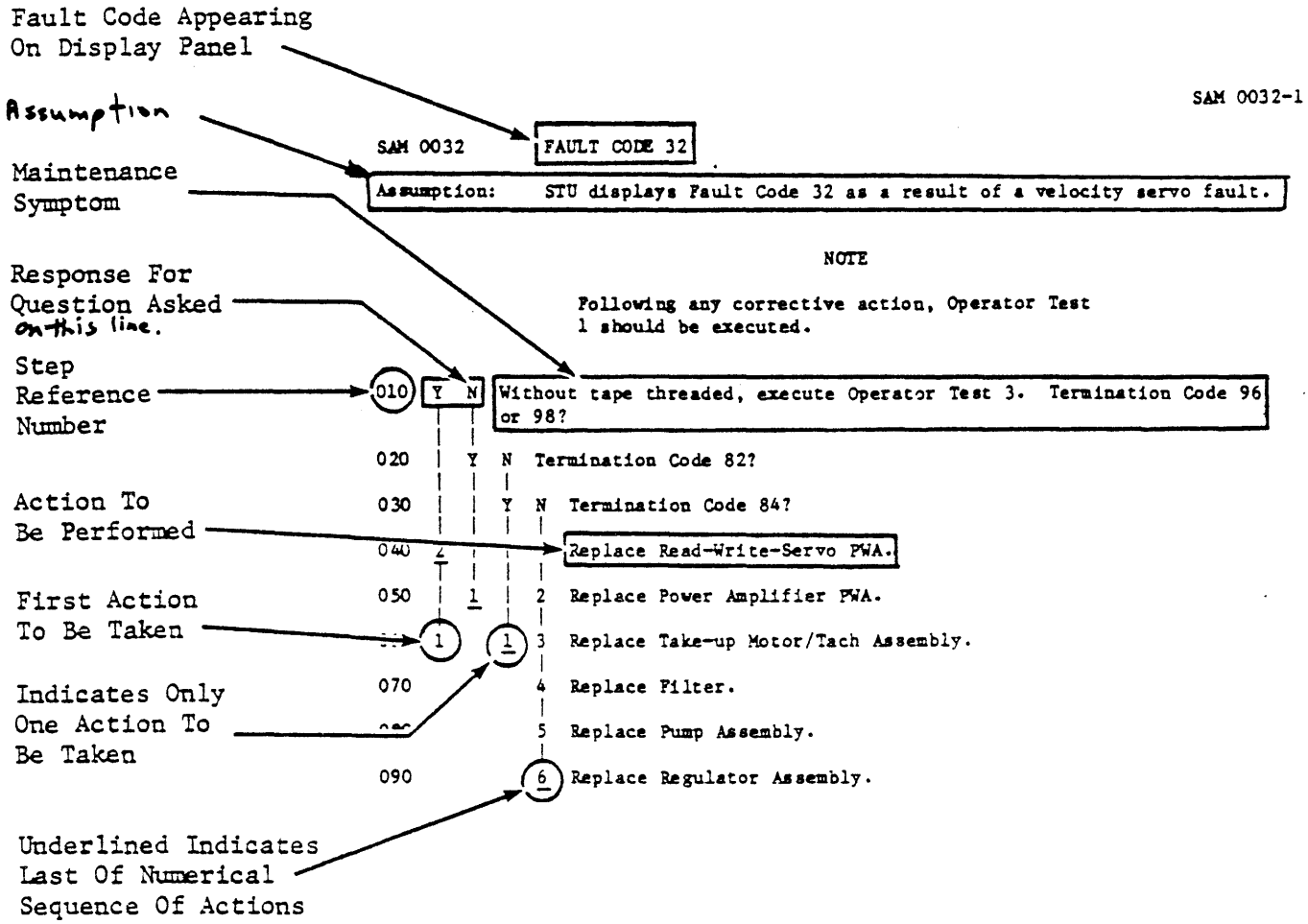


Figure 2 Pathfinder Table

the meaning and cause of the fault code.

The rest of the table is the flow chart to follow to identify the failing component. Always start with the first line of the flow (010).

The step reference numbers are for convenience. They are useful, for example, 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 question answers no, follow the N column.

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

In every case, when you reach numbers in the vertical column, the line with a 1 in it is performed first, 2 second, and so forth.

Example 1
To learn to use the pathfinder tables, start with fault code 29. The flow chart is very simple as shown in figure 3. If you get fault code 29, the first thing you do (line 010) is disconnect a cable, close the door, and press the LOAD switch.

Next you answer the question in line 010, "Fault Code 11?" If you got fault code 11, you answer yes and follow the Y column down until you find the 1 (line 030). Then you replace the BOT/EOT assembly.

Test 01 is run after every replacement or other corrective action to see if the the action fixed the TU80.

If test 01 now terminates with fault code 00, you have corrected the problem and the BOT/EOT assembly was bad.

If test 01 still terminates with fault code 29, the BOT/EOT assembly was good. So you reinstall the original assembly, and go to number 2 in the Y column of the table.

Number 2 (line 020) instructs to replace the R/W/S module. So you replace that module, and again check the repair by running test 01.

Notice the 2 on line 020 is underlined. The underlined number in any column means it is the last repair in that column.

Of course, what happens if the TU80 is still not fixed after

SAM 0029 FAULT CODE 29

Assumption: STU 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.

NOTE

Following any corrective action, Operator Test 1 should be executed.

	Y	N	
010	2	1	Disconnect cable from the EOT/BOT Sensor Assembly. Remove the reel of tape, close operator door, and press the LOAD switch. Fault Code 11?
020			Replace Read-Write-Servo PWA Assembly.
030	1		Replace BOT/EOT Sensor Assembly.

Figure 3 Pathfinder Example 1

replacing the R/W/S module?

The answer is that the table is very thorough. The odds are very low that the same fault code (29) will appear after every suggested fix has been attempted.

Another fault code can appear although the odds are low except in a multi-component problem. If another fault code is discovered, follow the pathfinder table for it. It may lead to a different failing component.

To go back to the question, if the original fault code persists, you will need to rely on your own troubleshooting experience and proceed accordingly. Afterall, nothing is foolproof.

EXAMPLE 2
Figure 4 outlines a somewhat more difficult example of using the pathfinder tables. Fault code 32 was displayed. By answering the questions beginning at line 010 and performing the actions called for, the field service representative (FSR) knew he had to replace the take-up motor/tach assembly (line 060).

Can you see the flow of the logic in arriving at line 060?

If not reread the paragraphs preceding example 1 and try again.

POWER AND FUNCTIONAL FAULTS
The last three pathfinder tables are numbered 1001 (POWER-ON 1), 1002 (POWER-ON 2), and 1003 (POWER-ON 3). These tables are NOT based on fault codes.

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

Also, some functional operation and sensors cannot be tested by the STU microprocessor without manual operation and visual feedback. There are steps within these tables to check these things.

Following is a brief description of each table.

- 1001
  This table is used to find AC power problems. It directs you to power supply and cooling fan problems.

- 1002
  This table is used to find DC power problems. Incorrect DC voltage to any part of the TU80 could keep the diagnostics from running.

- 1003
  This table helps to identify errors which 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.

____Look up these tables in the pathfinder tables. They are the last 3 tables listed.

Notice that table 1001 assumes nothing. Line 010 starts when you turn on the circuit breaker (on/off switch). So you could start troubleshooting at this point anytime you have nothing else to go on.

Also, you can start with table 1001 and go through 1003. All three are connected to each other within the flow chart.

SAM 0032 FAULT CODE 32

Assumption: STU displays Fault Code 32 as a result of a velocity servo fault.

NOTE

Following any corrective action, Operator Test 1 should be executed.

010	Y	N			Without tape threaded, execute Operator Test 3. Termination Code 96 or 98? No. (ASSUME YOU GOT 84)
020		Y	N		Termination Code 82? No
030			Y	N	Termination Code 84? Yes
040	2			1	Replace Read-Write-Servo PWA.
050		1		2	Replace Power Amplifier PWA.
060	1		1	3	Replace Take-up Motor/Tach Assembly.
070				4	Replace Filter.
080				5	Replace Pump Assembly.
090				6	Replace Regulator Assembly.

Example 2

Figure 4 How to Follow the Pathfinder

____Go to the TU80 and perform tables 1001-1003.

EXAMPLE 3
What would you do if a customer called and said he cannot load tape. Yet, no fault code is displayed.

You suggest checking power connections, pressing RESET, and running operator diagnostics. Still no fault code or tape movement.

You arrive on site and determine that the customer was right. Nothing works and no fault code is displayed. What now?

At this point the pathfinder tables are effectively eliminated except tables 1001-1003.

Let us say the F/C module is causing DC voltage errors in the control panel. How could you identify it?

On line 070 of table 1002, you are directed to replace the F/C module. If you examine the lines leading up to line 070, you find that this has been identified by connecting or disconnecting specific cables and modules concerned with DC voltage.

Of course, if you were using this table, you would eventually get to line 070 and replace the module.

Although these tables may not be used very often, you should keep them in mind. They can save you several hours of headaches when power problems occur.

INTERNAL DIAGNOSTIC DESCRIPTIONS
Table 1 lists all internal diagnostic tests for the TU80. 01-09 are operator test numbers. Currently there are only 3 operator tests with numbers 04-09 reserved for future test expansion if needed. OPTION KEY ?

10-97 are field service test numbers. Many of these are reserved also. Currently there are 38 field service tests. Any additional tests in the future would require ROM changes and would be announced in Tech Tips at that time.

Of the 38 existing tests, only 6 (those with a asterisk in table 1) are used in normal TU80 service. The other 32 may be used during troubleshooting at your discretion.

Field service tests should be run where designated in the pathfinder and removal/replacement procedures.

Figure 5 is an example of an internal test description. Every internal test (including operator tests) is described in the PATHFINDER.

Table 1

DIAGNOSTIC TESTS

OPERATOR TESTS

TEST NO.	DESCRIPTION
01	Functional Fault Detection Diagnostic
02	Tension Fault Isolation Diagnostic
03	Velocity Fault Isolation Diagnostic
04-09	Reserved

CE TESTS

TEST NO.	DESCRIPTION	OPTION
10	12.5 ips Forward to EOT (At EOT, enter Test 11.)	L
11	12.5 ips Reverse to BOT (At BOT, enter Test 10.)	L
12	12.5 ips Forward Ramps to EOT (At EOT, enter Test 13.)	L
13	12.5 ips Reverse Ramps to BOT (At BOT, enter Test 12.)	L
14	12.5 ips Repositioning	L
15	100 ips Forward Ramps to EOT (At EOT, enter Test 16.)	L
16	100 ips Reverse Ramps to BOT (At BOT, enter Test 15.)	L
17	100 ips Repositioning	L
18*	100 ips Forward to EOT (At EOT, enter Test 19.)	L
19	100 ips Reverse to BOT (At BOT, enter Test 18.)	L
20	Formatter Internal Fault Detection Diagnostic	B.
21	Write 2K Byte Records at 12.5 ips to EOT (At EOT, rewind to BOT.)	B.
22	Read at 12.5 ips to EOT (At EOT, rewind to BOT.)	B.
23	Write 256 Byte Records at 100 ips to EOT (At EOT, rewind to BOT.)	B.
24	Read at 100 ips to EOT (At EOT, rewind to BOT.)	B.
25-29	Reserved	
30	Check Read Amplitudes at 12.5 ips and 100 ips to be within tolerance of 0.5 volts.	B.
31*	Determine EGC gains at 12.5 ips and 100 ips and store gains in Backup Memory. Then check read amplitudes at 12.5 ips and 100 ips to be within tolerance of 0.1 volt.	X
32	Check read amplitudes at 12.5 ips and 100 ips with pre-recorded all 1's tape with tolerance of 0.3 volts.	B.
33	Determine EGC gains at 12.5 ips and store gains in Backup Memory.	X
34	Determine EGC gains at 100 ips and store gains in Backup Memory.	X
35	Check read amplitudes at 12.5 ips with tolerance of 0.1 volt.	B.
36	Check read amplitude at 100 ips with tolerance of 0.1 volt.	B.
37*	Determine velocity servo correction multiplier and store multiplier in Backup Memory.	X
38	Apply approx. 8 oz. tension by pulsing supply reel with take-up reel in stoplock.	X
39	Write all 1's to EOT at 12.5 ips (At EOT, rewind to BOT.)	B.
40	Write all 1's to EOT at 100 ips (At EOT, rewind to BOT.)	B.
41	Stoplock Take-up Reel	X
42	Enable Tension Servo	X
43*	Turn-on Pump	X
44*	Fast Search Forward For EOT	X
45	EGC DAC Scope Loop	X
46	Velocity DAC Scope Loop	X
47	R/W/S μP Outputs Scope Loop	X
48-60	Reserved	
61	Take-up Motor and Power Amp Marginal Fault Detection Diagnostic	X
62*	Take-up Fine-Line Tach Fault Detection Diagnostic	X
63-90	Reserved	
91	Functional Fault Detection Diagnostic (same as Operator Test 01 except: a- will start in loaded or unloaded condition and b- will not unload on completion.)	B.
92-97	Reserved	
[redacted]		

OPTION KEY

X = Do not use any options.
L = Test will loop. Do not use any options.
B = CE may use options.
- 00 = Halt on Error, Halt on Completion of Test (Default Option)
- 01 = Halt on Error, Loop on Test
- 02 = Bypass Error Halt, Loop on Test

CE TEST 20: FORMATTER INTERNAL DIAGNOSTICS

TEST REQUIREMENT: None.

TEST DESCRIPTION: Test 20 checks out the internal hardware of the formatter. It does not check host interface or device interface hardware.

TEST SEQUENCE:

a. Check out programmable timer hardware.

b. Check out hardware used to write ID or file mark.

c. Check out hardware used to write or read a block of data.

d. Check out hardware used to detect dead tracks and correct errors.

e. Check out hardware used for high speed and reverse operations.

POSSIBLE TERMINATION CODES:

00 - Test is Successful
58 - Formatter Internal Diagnostic Failure

Figure 5 Internal Test Description Example

____Turn to the TEST 02 description in the pathfinder.

Notice that each description gives test requirements, a short description, a step-by-step sequence, and all possible termination codes.

These descriptions are important. They list valualae informations about every internal diagnostic.

NOTE
The POSSIBLE TERMINATION CODES list some codes which are found no where else in TU80 documentation. DO NOT forget them.

If you have specialized troubleshooting methods which you like to use, these descriptions will be invaluable for your purposes.

EXAMPLE 4
Figure 6 is another example from the pathfinder tables.

In this example, line 010 requires you to execute test 43 and then asks a question based on that test. Then you follow the flow as in the earlier examples.

INTERNAL DIAGNOSTIC ACCESS
The internal diagnsotics are accessed from the control panel. The four keys left of the display are used to load and run a specific test.

Perform the following procedure.

____Power-up the TU80 and the streaming tape unit (STU).

____Load and run operator diagnostic 01. Review the Operation lesson if you have trouble.

____Open the pathfinder, turn to the test descriptions, and find the description for operator test 01. It is titled FUNCTIONAL FAULT DETECTION TEST.

Scan through the test sequence. You will notice that this test is very elaborate and performs nearly all TU80 functions. This is the reason it is used so often and the need for other tests is minimal.

____Stop the test after a couple of minutes by pressing the RESET switch.

To load the <u>field service diagnostics</u> perform the following procedure.

SAM 0013 FAULT CODE 13

Assumption: STU displays Fault Code 13 during a load operation as a result of not establishing tension within 10 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.

```
010  Y  N  Execute CE Test 43.  Does pump fail to start?
     |  |
020  |  Y  N  Does air pressure lift tape off air bearings?
     |  |  |
030  |  |  1  Replace Filter.
     |  |  |
040  1  |  2  Replace Pump Assembly.
     |  |  |
050  |  |  3  Replace Regulator Assembly.
     |  |
060  2  1  Replace Read-Write-Servo PWA.
     |
070  3  Replace Power Supply Assembly.
```

Figure 6 Example 4

____Press and hold the CE switch.

____Press the TEST switch. ØØ should appear in the display.

If the CE switch is NOT held in when the TEST switch is pressed, a Ø1 is displayed.

Ø1 indicates the operator diagnostics have been loaded. ØØ indicates the field service diagnostics have been loaded.

How is a specific field service test number loaded?

Consider the left digit in the display (Figure 7) as the 1Øs digit (1Ø, 2Ø, 3Ø, etc.) and the right digit as the 1s digit (1, 2, 3, etc.).

The STEP switch increments the 1s digit by one each time pressed. The TEST switch loads the current number in the 1s digit into the 1Øs digit and zeros the 1s digit. In other words the display rotates-left one place.

To demonstrate this, perform the following procedure to load field service test 65.

____With field service diagnostics loaded (ØØ in display after pressing CE and TEST switches), press the STEP switch six times.

Each time the switch is pressed the 1s digit increments by 1. A six should now be in the 1s digit.

____Press the TEST switch once. The six shifts-left and 6Ø is left in the display.

____Press the STEP switch five times. 65 is displayed.

Field service test 65 is now loaded.

What if you actually wanted test 46?

____Press the STEP switch several times until a 4 is displayed in the 1s digit.

____Press TEST once. 4Ø is displayed.

____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 TUØØ test.

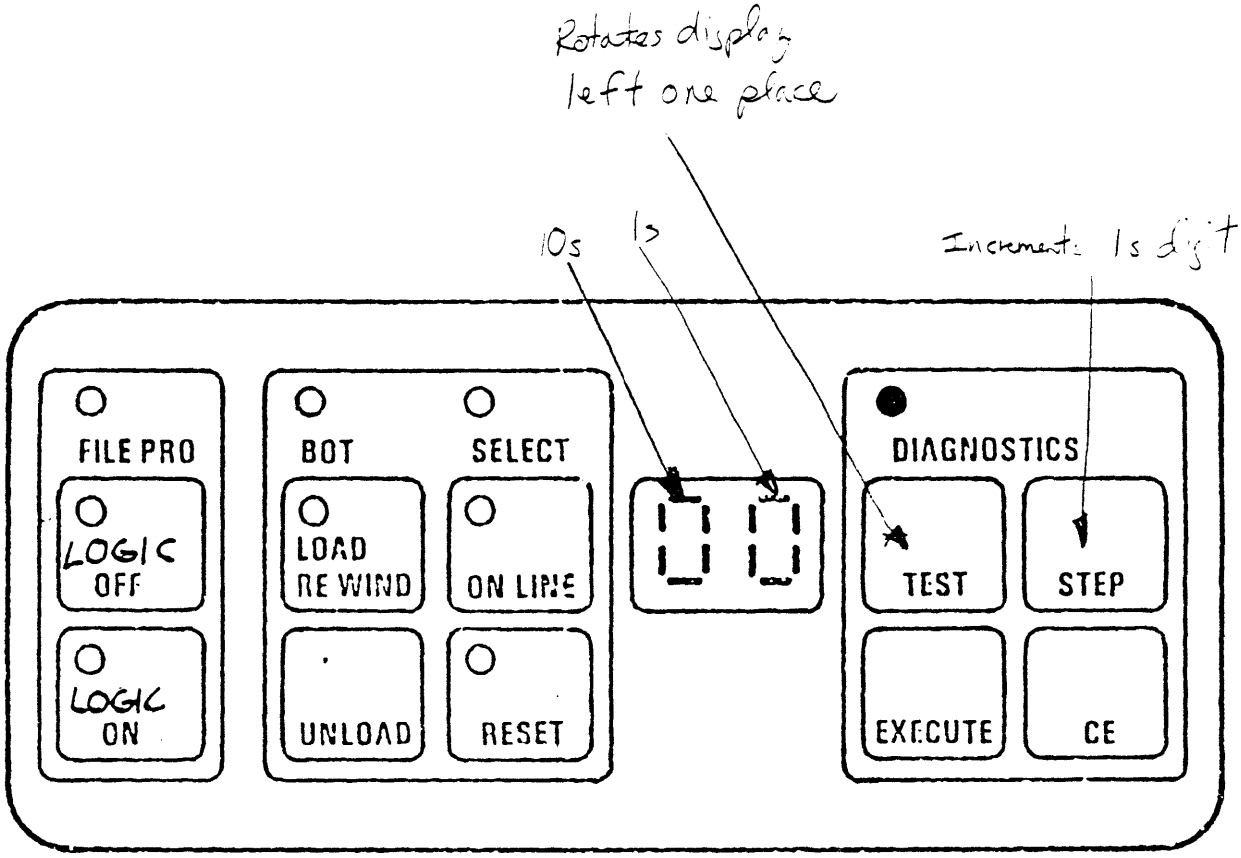


Figure 7 Control Panel With Field Service Diagnostics Loaded

As with the operator tests, each field service test has particular requirements under which it must be run.

To run a test, go the the test description and set up the TU80 to meet the requirementss. Then, load the number into the display and press the EXECUTE switch. A successful pass always displays a termination code of 00.

____Load test 18 with tape unloaded.

____Run the test by pressing the EXECUTE switch.

You will get a fault code of 70.

If you look fault code 70 up in the pathfinder tables, you will not find it listed! However, if you look up the test description for the test you just ran (18), it is listed under POSSIELE TERMINATION CODES.

____Determine what caused fault code 70, remedy the problem, and run the test.

If you have problems reread the previous paragraphs.

NOTE
All tests can be halted by pressing the RESET switch.

____Load and run several tests until you feel comfortable with the procedure.

All tests are listed in the test table at the start of the test descriptione in the pathfinder. Use the test table and the test descriptions to run the tests.

SUB-FAULT CODES
All fault codes have sub-fault codes which can be looked up when required. The sub-fault codes give additional information about the fault. The flow chart in the pathfinder tables may direct you to examine a sub-fault code and answer a related question.

EXAMPLE 5
The pathfinder table in figure 8 asks in three places if certain sub-fault codes are displayed. Upon arriving at any of these points, you would check for the sub-fault code, answer the question, and proceed as in the other examples.

____Load and run operator test 01. Field service test 91 tests identical functions.

SAM 0021 FAULT CODE 21

Assumption: STU displays Fault Code 21 as a result of a take-up tension fault.

NOTE

Following any corrective action, a tape load operation or Operator Test 1 should be executed.

010	1				Ensure that cable between Lower Air Bearing Assembly and Read-Write-Servo PWA is correctly connected.
020	Y	N			Sub-Fault Code 05?
030		Y	N		Sub-Fault Code 02 or 03 or 04?
040			Y	N	Disconnect cable between Lower Air Bearing Assembly and Read-Write-Servo PWA at Read-Write-Servo PWA Assembly. Try to load a tape. Fault Code 20, Sub-Fault Code 05?
050	1		1		Replace Lower Air Bearing Assembly. Reconnect cable.
060	2	1	2	1	Replace Read-Write-Servo PWA. Reconnect cable.

Figure 8 Example 5

____Open the door while the test is running.

A fault code of 10 is displayed.

You access the sub-fault code by pressing the CE switch with a fault code displayed.

____Press the CE switch.

The 10 changes to a number between 01-07. These are sub-fault codes.

____Look up fault code 10 in the sub-fault code descriptions of the pathfinder.

Under fault code 10 you find the 7 sub-fault codes for this fault code. The sub-fault code you got depends on what part of the diagnostic was running when the door was opened.

EXAMPLE 6
In some cases, you may get a sub-fault code which is actually two or more sub-fault codes added togther.

____Turn in the Sub-fault Code Description tables to fault code 25.

Notice the table is divided into four boxes. In some cases a sub-fault code many be a sum of one number from each box.

If you get a sub-fault code of 24 on fault code 25, it is a sum of 00 from box 1, 20 for box 2, 04 from box 3, and 00 from box 4. Remember, only one number from any box. The combination just listed is the only possible one.

The sub-fault codes are not referenced very often in the pathfinder tables. However, like the unused field service tests, they are one more additional tool for your use during troubleshooting.

MINI-SUMMARY
You have read about the following diagnostic tools on the preceding pages.

1. Internal diagnostics
2. Fault codes
3. Pathfinder tables
4. Test Descriptions
5. Sub-fault codes

The following exercise covers the use of the pathfinder

documentation.

EXERCISE 1

This exercise will further familiarize you with the pathfinder and its use. It is very easy to mix up the different parts of the pathfinder and how they fit together. So, take your time and be careful. Remember, used correctly, pathfinder will find 98% of the TU80 transport problems.

1. What is the error with a sub-fault code of 37 on fault code 06.

   a. Fault occured on down ramp
   b. Unable to establish tension during test load
   c. File mark detection error
   d. Short IBG detected

2. The customer calls with a fault code of 06. What is your first action 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 03.

   d. Tell the customer to clean the tape path components.

3. At the customer site with fault code 06 displayed, what are the first 2 actions you perform on the machine.

   a. Clean the tape path components and run test 01.

   b. Clean the tape path components and change the media.

   c. Power down the TU80 and disconnect the interface cables.

   d. Run test 01 and test 03.

4. While following the flow for fault code 06, you are directed to run test 03. You do so and get a termination code of 02. What are the first two things you do?

   a. Replace the R/W/S module and the take-up motor assembly.

   b. Replace the R/W/S module and run test 01.

   c. Replace the take-up motor assembly and run test 01.

   d. Replace the power amplifier module and run test 01.

EXERCISE 1 SOLUTION

1. What is the error with a sub-fault code of 37 on fault code 06.

   a. Fault occured on down ramp

   b. Unable to establish tension during test load

   c. File mark detection error (The answer is found under fault code 06 of the sub-fault code descriptions in the pathfinder.

   d. Short IBG detected

2. The customer calls with a fault code of 06. What is your first action 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. Only tests 01, 02, and 03 are ever run by the customer.)

   c. Tell the customer to run test 03. (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 all calls is to consult the pre-site matrix tables in the pathfinder. In pathfinder table 2-3, following vertically under fault code 06, the first item is labeled with an "A". It is to "Clean Head/Tape Path".)

3. At the customer site with fault code 06 displayed, what are the first 2 actions you perform on the machine.

   a. Clean the tape path components and run test 01. (Yes. Line 010 of the pathfinder for fault code 06 directs you to clean the tape path components, and the note says to run test 01 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 flow, but you have not run test 01 to check your first action.)

   c. Power down the TU80 and disconnect the interface cables. (No. Internal testing can be accomplished on the TU80 while connected to the host.)

   d. Run test 01 and test 03. (No. Both tests may be involved in correcting fault code 06, but not at this time.)

4. While following the flow for fault code 96, you are directed to run test Ø3. You do so and get a termination code of 82. What are the first two things you do?

   a. Replace the R/W/S module and the take-up motor assembly. (No. This is the replacement for termination code 98, and test Ø1 was not run.)

   b. Replace the R/W/S module and run test Ø1. (No. This would be correct for all termination codes <u>except</u> 96, 82, and 84.)

   c. Replace the take-up motor assembly and run test Ø1. (No. this would be correct if your fault code was 84.)

   <u>d. Replace the power amplifier module and run test Ø1.</u> (Yes. A yes answer to termination code 82 drops down to line 12Ø which directs to replace the power amplifier module.)

If you had trouble with this exercise reread this lesson. Following fault codes with the pathfinder is the most important part of this course.

When ready, proceed on with the remainder of this lesson.

ON-LINE DIAGNOSTICS

Whether the TU80 is connected to a PDP-11 CPU or VAX CPU, there are on-line diagnostics to run to check subsystem performance. Because the TU80 has elaborate internal diagnostics, the on-line diagnostics will not have to be depended on as much as they are with many DEC products.

However, the internal diagnostics do not check the M7454 or interface bus. To diagnose any problem in these two parts of the subsystem requires the use of on-line diagnostics.

Also, subsystem intermittant problems can often only be found by on-line diagnosis.

This course does not explain the procedure to start the system or load the on-line diagnostics because this is part of the course prerequisites.

This course will provide a general introduction to the diagnostics and then you can run them until you are confident with the procedure.

PDP-11 BASED DIAGNOSTICS

There are five PDP-11 based diagnostics for the TU80.

- CZTUV

  CZTUV (Figure 9) is the data reliability or exercisor test. This test causes data wraparounds through the TU80, interface bus, I/O silo, and formatter.

  The output of this test calls out a failing module when an error occurs.

  To run this test, tape must be loaded and on-line. It is usually the final test run. This test takes approximately one hour per pass. However, 20 minutes is enough when it is used as a data confidence test.

  This test can only be run with a 2400 foot tape. Others will fail.

- CZTUW, CZTUX, CZTUY, and CZTUZ are all logic tests. They are usually run in the order listed and progressively check more and more of the subsystem. An example of the diaglogue for each test is given in Figures 10-13.

  All of these tests require that the TU80 has tape loaded and is on-line except CZTUW. The status of the TU80 does not matter for CZTUW.

  These tests simulate a worst-case operation environment when operating in both start/stop and streaming modes.

```
.R CZTUVA
DRS LOADED
DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUV-A-0
DATA RELIABILITY TEST
UNIT IS TU80
DR>STA/FLA:PNT

CHANGE HW (L)  ? Y

# UNITS (D)  ? 1

UNIT 0
TSSR ADDRESS (O)  172522 ?
VECTOR (O)  224 ?

CHANGE SW (L)  ? Y\

NO DEFAULT
CHANGE SW (L)  ? ^C
DR>STA/TES:3

CHANGE HW (L)  ? N\Y

# UNITS (D)  ? 1

UNIT 0
TSSR ADDRESS (O)  172522 ?
VECTOR (O)  224 ?

CHANGE SW (L)  ? N

TAPE LENGTH MUST BE 2400 FT. TO CORRECTLY RUN THIS TEST!!
```

Figure 9 CZTUV Dialogue

```
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/TSDB)  (O)  172522 ?
INTERRUPT VECTOR     (O)  224 ?
INTERRUPT PRIORITY       (O)  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 10 CZTUW Dialogue

```
.R CZTUXC
DRS LOADED
DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUX-A-0
**** TU80 LOGIC DIAGNOSTIC - CHECK M7454,CABLES AND TRANSPORT IF ERROR ****
UNIT IS TU80
DR>STA/FLA:PNT

CHANGE HW (L)  ? Y

# UNITS (D)  ? 1

UNIT 0
DEVICE ADDRESS (TSBA/TSDB)  (O)  172522 ?
INTERRUPT VECTOR    (O)  224 ?
INTERRUPT PRIORITY      (O)  5 ?

CHANGE SW (L)  ?

NO DEFAULT
CHANGE SW (L)  ? N

TST: 001 FIFO Exerciser Test
TST: 002 Initialization #2 Test
TST: 003 Off-Line And Reject Rewind Test
TST: 004 Basic Write Test
TST: 005 Basic Read Data (Forward and Reverse) Test
TST: 006 Stand-alone Manual Intervention Not Executed Test
TST: 007 Stand-alone Configuration Typeout Not Executed Test
TST: 008 Stand-alone Scope Loops Not Executed Test
CZTUX EOP    1
    0 CUMULATIVE ERRORS
```

Figure 11 CZTUX Dialogue

```
.R CZTUYC
DRS LOADED
DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUY-A-0
**** TU80 LOGIC DIAGNOSTIC - CHK CABLES-TRANSPORT IF ERR ***
UNIT IS TU80
DR>STA/FLA:PNT

CHANGE HW (L)  ? Y

# UNITS (D)  ? 1

UNIT 0
DEVICE ADDRESS (TSBA/TSDB)  (O)  172522 ?
INTERRUPT VECTOR    (O)  224 ?
INTERRUPT PRIORITY      (O)  5 ?

CHANGE SW (L)  ?

NO DEFAULT
CHANGE SW (L)  ? N

TST: 001 Space Records Test
TST: 002 Rereads Test
TST: 003 Write Data Retry Test
TST: 004 Write/Read Tape Mark Test
CZTUY EOP    1
    0 CUMULATIVE ERRORS
```

Figure 12 CZTUY Dialogue

```
.R CZTUZC
DRS LOADED
DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUZ-A-0
**** TU80 LOGIC DIAGNOSTIC - CHECK TRANSPORT IF ERROR ****
UNIT IS TU80
DR>STA/FLA:PNT

CHANGE HW (L)  ? Y

# UNITS (D)  ?

NO DEFAULT
# UNITS (D)  ? 1

UNIT 0
DEVICE ADDRESS (TSBA/TSDB)  (O)  172522 ?
INTERRUPT VECTOR    (O)  224 ?
INTERRUPT PRIORITY      (O)  5 ?

CHANGE SW (L)  ? Y\N

TST: 001 Write Tape Mark Retry Test
TST: 002 Skip Tape Marks Test
TST: 003 NO-OP ('Clean Tape') And INITIALIZE Test
TST: 004 Erase And Operation Incomplete Test
TST: 005 Operations At EOT Test
TST: 006 Function Timing Test
CZTUZ EOP    1
    0 CUMULATIVE ERRORS
```

Figure 13 CZTUZ Dialogue

Errors may give you a message specifying what is the most probable cause. An example of an error on CZTUX is shown in Figure 14.

Figures 10-13 also list the subtests for each diagnostic. Each sub-test within the diagnostic is printed just before it runs using the format shown in the figures.

These tests are run like and are structured the same as most XXDP+ diagnostics.

The PSC also covers the basic console dialogue for these diagnostics in the paragraph called "Operating Instructions for PDP-11 Based Diagnostics".

VAX BASED DIAGNOSTIC

TBS

____Run the on-line diagnostics until you feel comfortable with them.

FINAL TESTING

After any repair final testing must be completed.

1. The STU should be turned off and back on to allow the health check to run.

2. Then test 01 should be run to completion. This takes approximately 10 minutes.

3. When the host system is available, the appropriate PDP-11 or VAX diagnostics should be run.

4. When the M7454 has been replaced or suspect, the UNIBUS box should be turned off and back on to allow the M7454 diagnostics to run.

```
.R CZTUXC
DRS LOADED
DIAG. RUN-TIME SERVICES  REV. D  APR-79
CZTUX-A-0
**** TU80 LOGIC DIAGNOSTIC - CHECK M7454,CABLES AND TRANSPORT IF ERROR ****
UNIT IS TU80
DR>STA/FLA:PNT

CHANGE HW (L)  ? Y

# UNITS (D)  ? 1

UNIT 0
DEVICE ADDRESS (TSBA/TSDB)  (O)  172522 ?
INTERRUPT VECTOR    (O)  224 ?
INTERRUPT PRIORITY      (O)  5 ?

CHANGE SW (L)  ?

NO DEFAULT
CHANGE SW (L)  ? N

TST: 001 FIFO Exerciser Test
TST: 002 Initialization #2 Test
TST: 003 Off-Line And Reject Rewind Test
TST: 004 Basic Write Test
CZTUX HRD ERR  00403 ON UNIT 00 TST 004 SUB 001 PC: 034270
TSSR Incorrect After WRITE Command, More Bits Set Than SSR

 TSSR = 100210
 TSSR Bits Set: SC,SSR
 Termination Class Code = Recoverable Error - Tape Position One Record Down
 *****PROBABLY MEDIA RELATED ERROR - BAD TAPE*****
 Packet Address = 036210
 Packet Word #0 = 140005
 Packet Word #1 = 062022
 Packet Word #2 = 000000
 Packet Word #3 = 033304


TST: 005 Basic Read Data (Forward and Reverse) Test
TST: 006 Stand-alone Manual Intervention Not Executed Test
TST: 007 Stand-alone Confisuration Tyseout Not Executed Test
TST: 008 Stand-alone Scope Loops Not Executed Test
CZTUX EOP    1
    | CUMULATIVE ERRORS
```

Figure 14 CZTUX Error Example

SUMMARY

This lesson covered all the diagnostic information you need to troubleshoot the TU80.

The M7454 diagnostic runs when power is applied to the TU80 host UNIBUS.

The power-on health check runs when power is applied to the STU by pressing the LOGIC ON switch.

Internal diagnostics are used by the customer (operator tests 01-03) and the field service representative (operator tests plus field service tests 10-99).

Fault codes are displayed for all internal diagnostic errors.

The pathfinder documentation stocked in the CD kit can direct you to 98% of the TU80 problems when properly used.

The pathfinder consists of:

- Pre-site procedures
- On-site procedures
- Fault code pathfinder tables
- Power-on pathfinder tables
- Internal test descriptions
- Sub-fault code descriptions

There are five on-line diagnostics for PDP-11 systems.

- CZTUV
- CZTUW
- CZTUX
- CZTUY
- CZTUZ

The on-line diagnostics for VAX systems is up in the air.

Internal test 01 should be run for all TU80 repairs and as a confidence test. On-line diagnostics should be run whenever the system is avaiable.

This concludes the diagnostic lesson.

REMOVAL/REPLACEMENT

INTRODUCTION

In this lesson you learn to remove and replace TU8? field replaceable units (FRUs). You will also learn the appropriate verification checks after each replacement.

These procedures are taken from the pocket service guide (PSG) and are altered to fit into the course format. The service manual also contains similar procedures.

Most of the verification checks are pathfinder tests. These tests are explained in depth in the test descriptions contained in the pathfinder.

OBJECTIVES

1. Remove and replace TU8? FRUs.
2. Run verification tests for replaced FRUs.

TAPE DECK COMPONENTS

The three FRUs you remove in the following paragraphs are located on top of the tape deck and accessed by opening the top cover.

BOT/EOT SENSOR

Removal

____1. Remove the head assembly dust covers by pulling them straight out.

____2. Disconnect the W3P1 plug from the BOT/EOT sensor (Figure 1). The mounting screw is under the cable.

NOTE
DO NOT loosen the screw on TOP of the sensor. This may cause sensor misalignment.

____3. Remove the mounting screw from the assembly base-mount and lift the BOT/EOT sensor off the tape deck.

Replacement

____1. Position the sensor in its place on the tape deck and install and slightly tighten the mounting screw.

____2. Thread a tape onto the take-up reel and adjust the BOT/EOT sensor so that it is aligned parallel with the

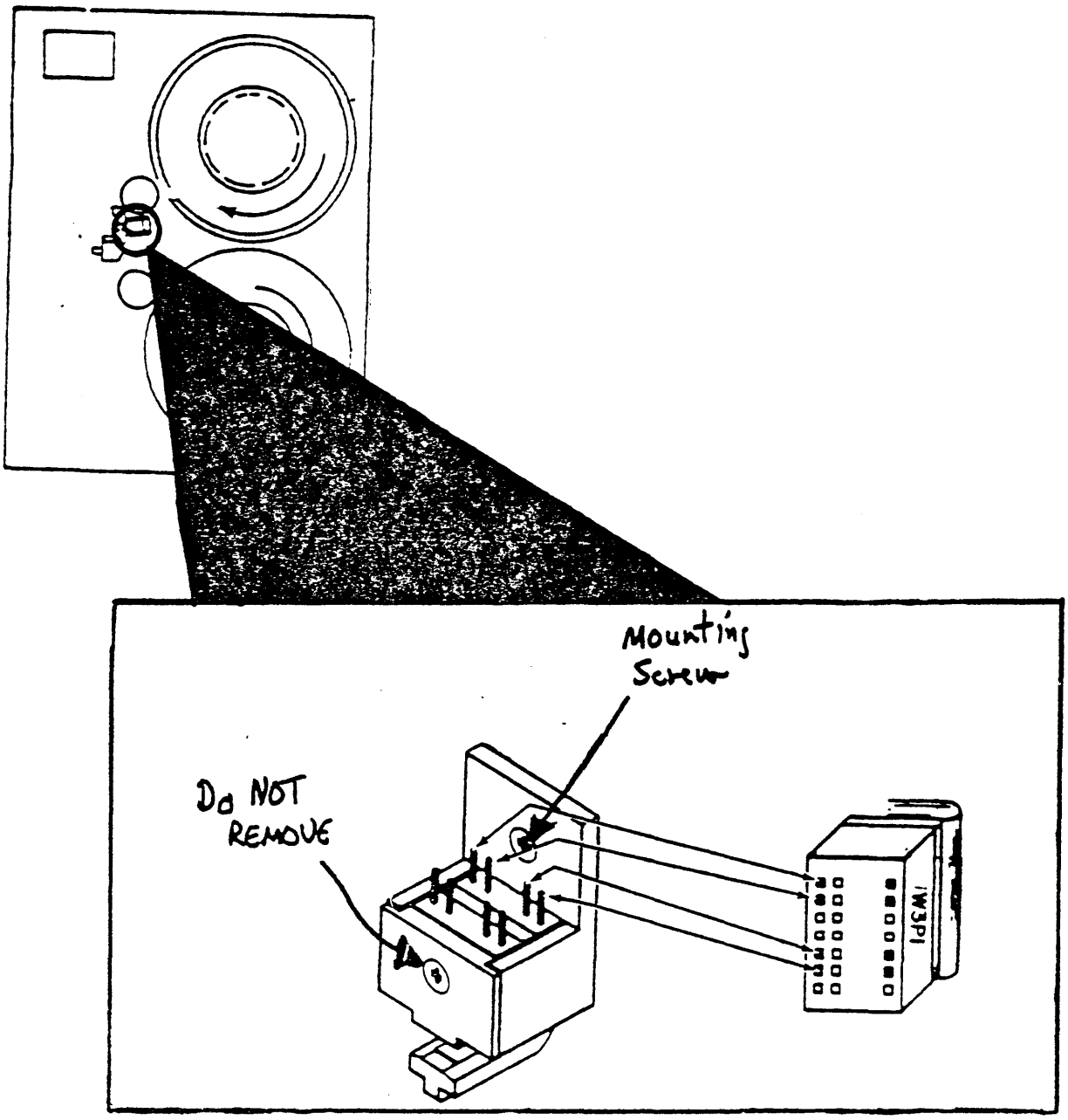


Figure 1 BOT/EOT Sensor

tape path. Sensor positioning is not critical.

____3. Tighten the mounting screw.

____4. Reattach the W3P1 plug to the sensor connector as shown. Be careful. It is very easy to misposition the plug onto the wrong pins. If excess cable exists, pull the excess under the tape deck.

Verification Check

NOTE
Use a 600-foot reel of tape (P/N 29-22020) if available with the properly installed EOT/BOT markers to reduce test time.

____1. Install a reel of tape onto the supply hub and thread the tape so that the BOT marker is located before the EOT/BOT sensor.

____2. Perform a LOAD operation and observe that the tape loads and positions itself at the BOT marker (BOT indicator illuminates) to verify the BOT sensor.

____3. Execute test 44 to verify operation of the EOT sensor.

Test 44 executes a fast forward to EOT.

____4. Unload the tape and power down the TU80.

TAPE CLEANER

Removal

____1. With the head covers removed, loosen two mounting screws and remove the tape cleaner (Figure 2) from the tape deck.

____2. Remove the screws, lockwashers and cover plate from the blade housing.

____3. Slide the platform mount out from the tape cleaner.

NOTE
A defective tape cleaner must be replaced as a complete assembly.

Replacement

____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

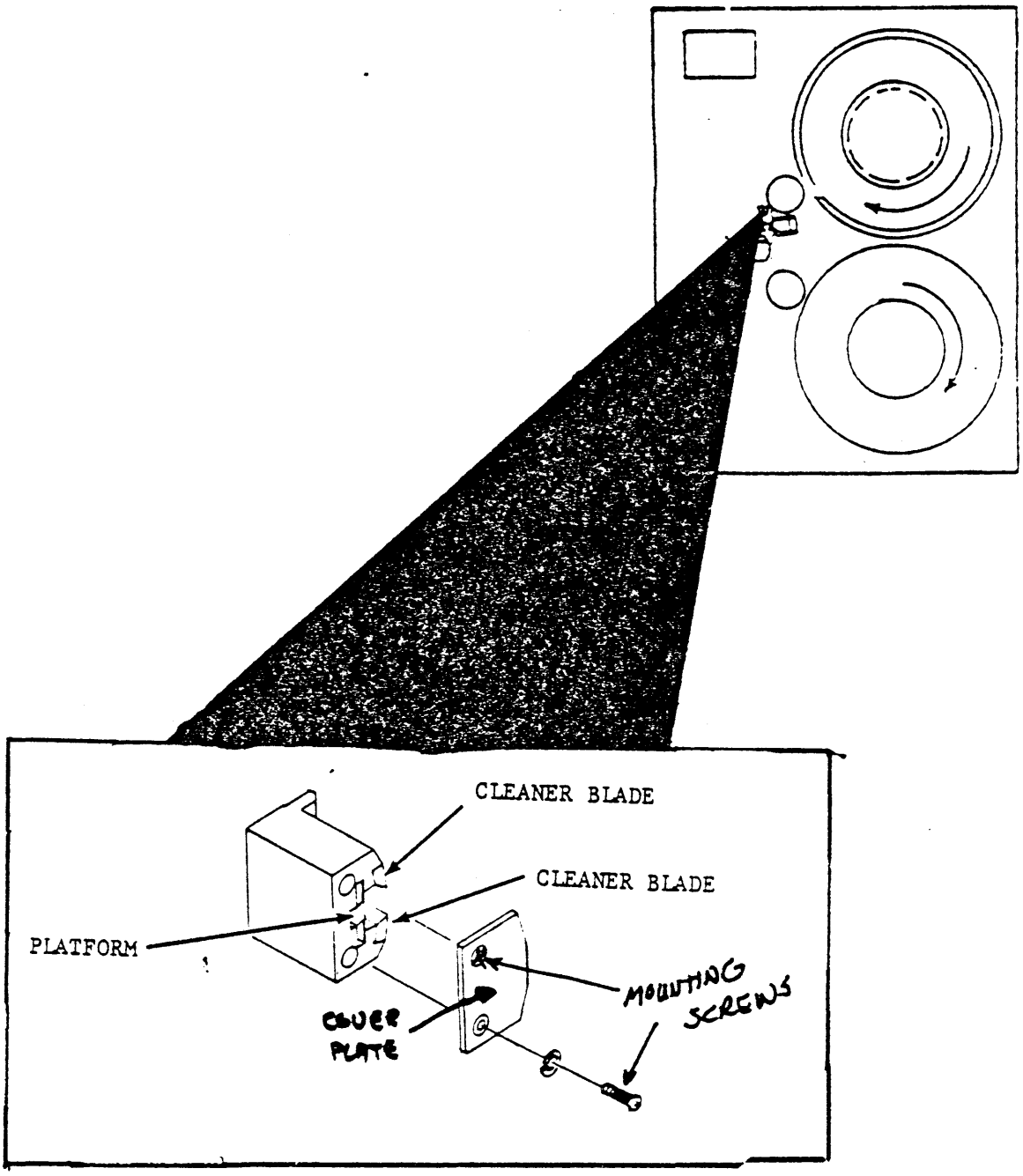


Figure 2 Tape Cleaner

reinstall.

When installing the platform, make sure that the flanges are such that the platform fits firmly inside the tape cleaner.

____3. Install the cover plate, two washers and mounting screws.

____4. Position the assembly onto the guide pins on the tape deck and tighten the screws.

Verification Check

No functional checks are necessary.

FILE PROTECT SENSOR

Removal

____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 securing the file protect sensor to the tape deck.

____4. Detach connector W3P6 from the sensor.

Replacement

NOTE
File protect sensor positioning is not critical.

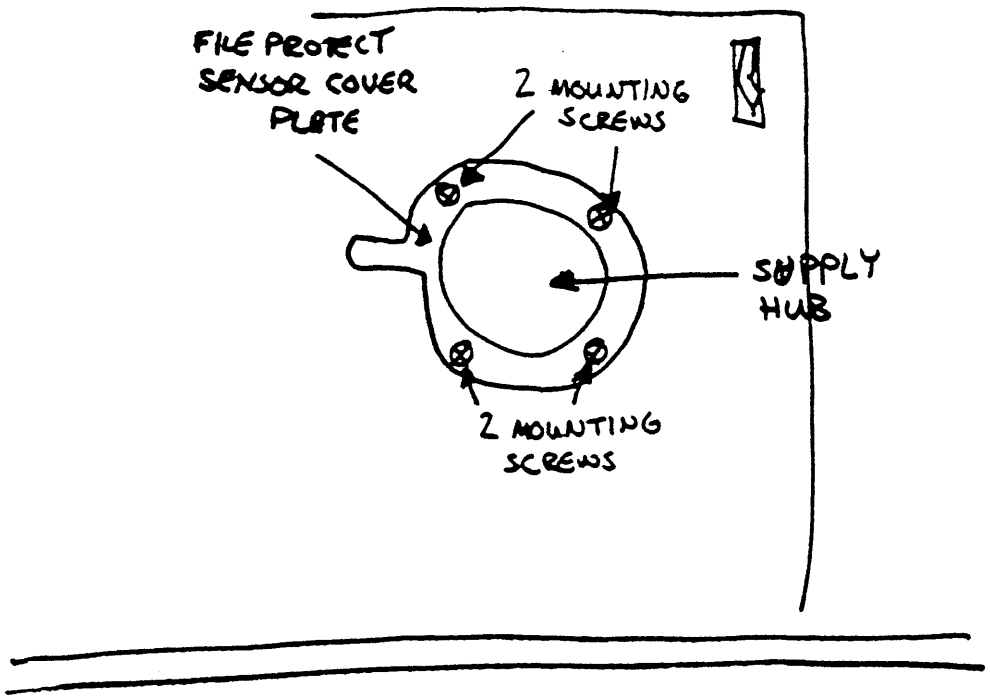
____1. Place the sensor on the tape deck as shown and secure it with the mounting screw and washer.

____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.

Verification Check



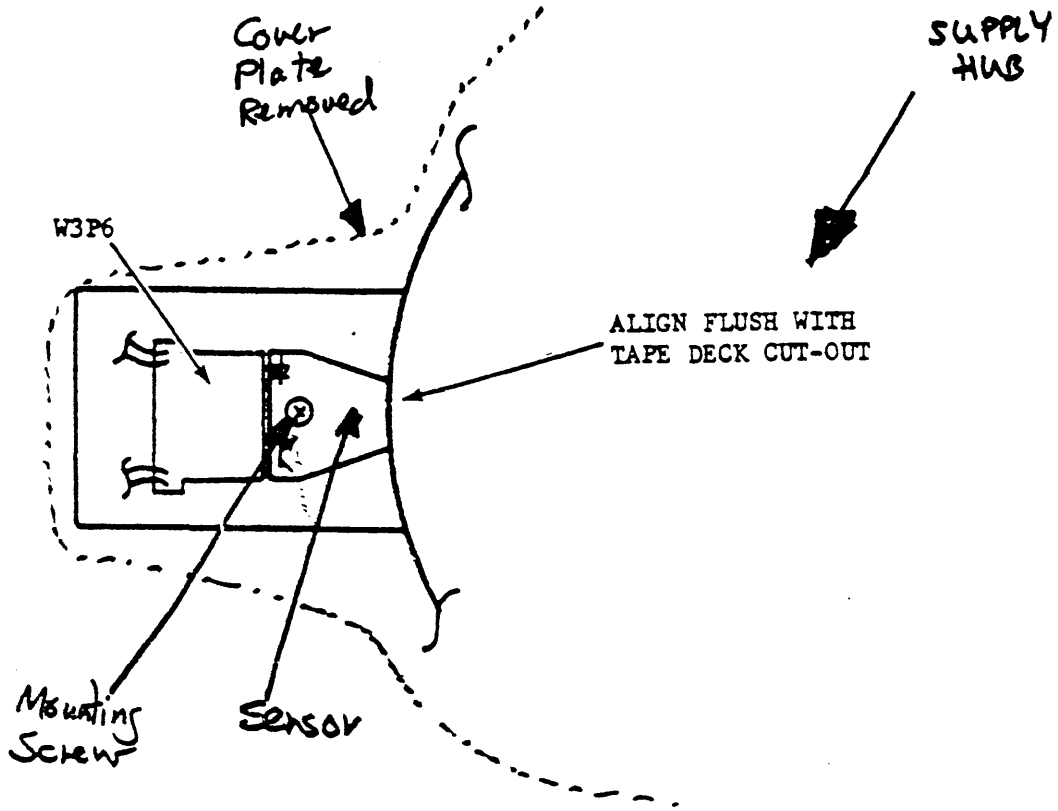


Figure 3 File Protect Sensor

____1. Perform power-on check #1003.

____2. Power-down the TU80.

INTERNAL COMPONENTS

The next several components you remove can only be accessed by placing the TU80 in service position and removing the FCC shield and the acoustic cover.

____1. Place the TU80 in service position.

Make sure the tape deck locks into position.

____2. Remove the cooling fan and acoustic cover.

MAGNETIC HEAD ASSEMBLY

CAUTION

The magnetic head and the two write resistors (Figure 4) on the R/W/S module (R224/R225) are matched components. If the head is being replaced, the write resistors must be replaced also. Resistors are supplied with the new head and are labeled with the head serial number, resistor "r" number (R224 or R225), the resistor value, and equivalent write current and DC voltage.

Removal

____1. Remove the head dust covers from the tape deck.

____2. Detach the read head connector W6P1 (Figure 5), the write head connector W5P1, and the erase head wires P3/P4 from the magnetic head. Move the cables out of the way.

NOTE

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

The head can easily hit the tape deck during removal.

CAUTION

DO NOT loosen the head alignment screws, otherwise, entire head must be replaced with a new assembly.

The head is factory positioned on the base and must never be moved.

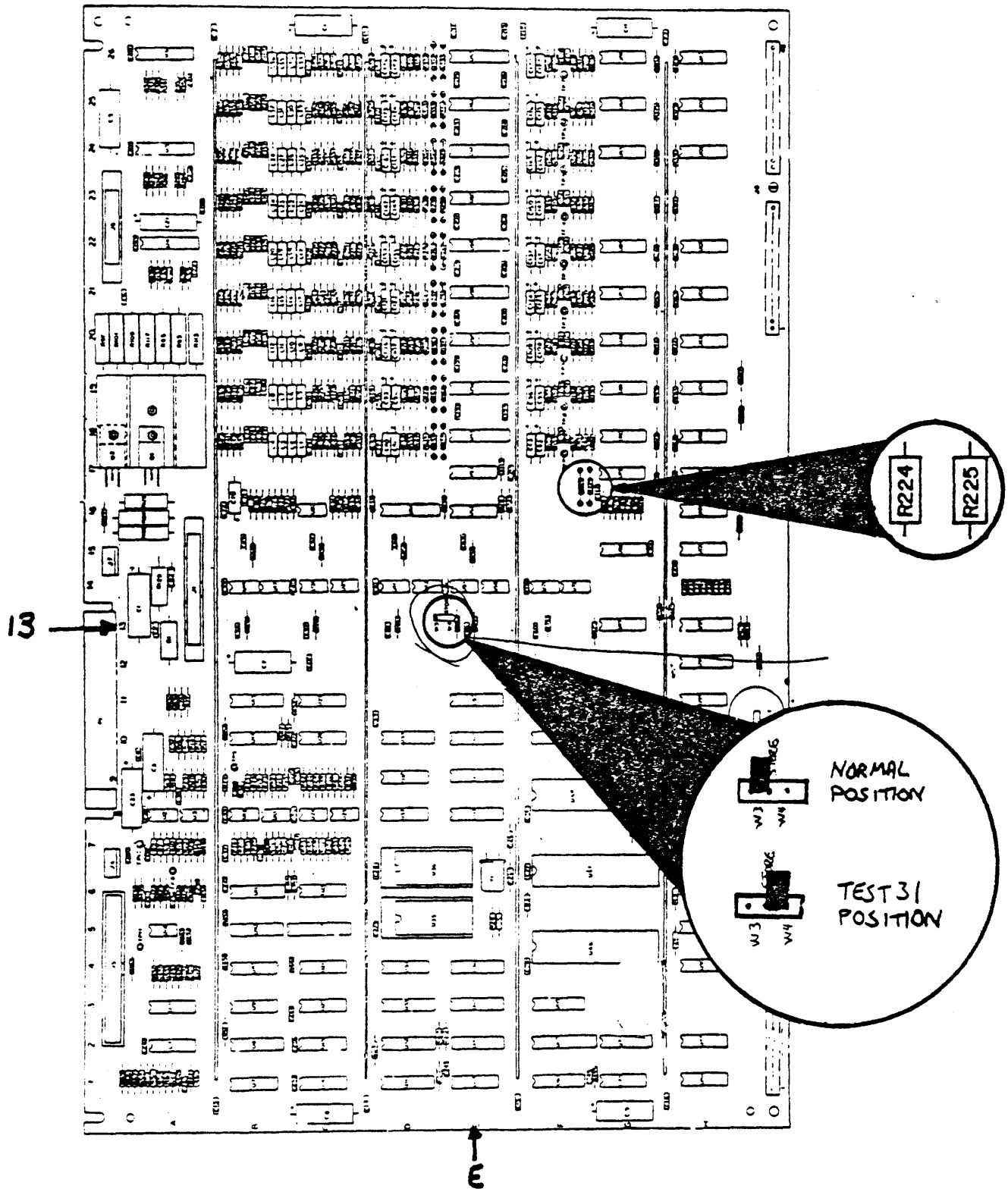
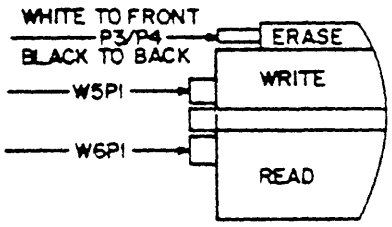
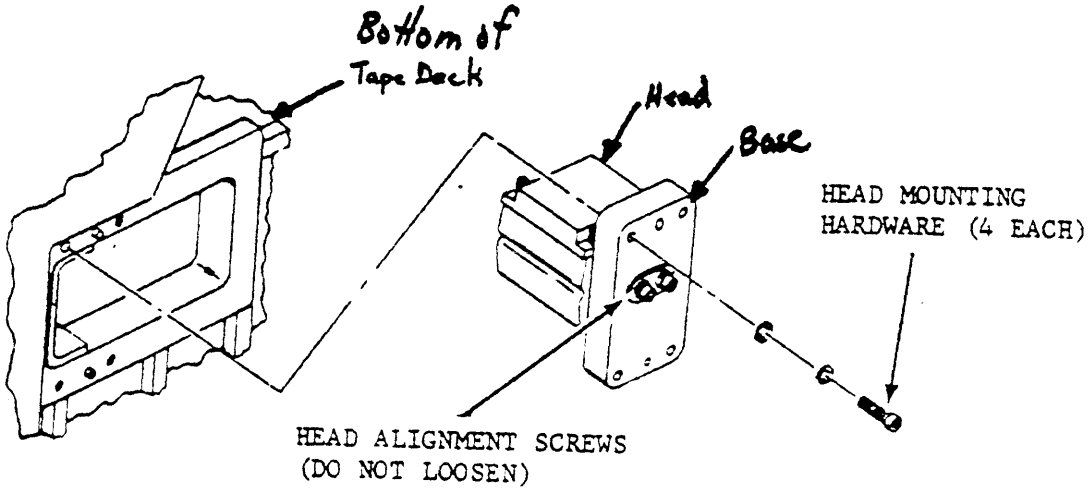


Figure 4 Read/Write/Servo Module



MAGNETIC HEAD CONNECTORS



MAGNETIC HEAD ASSEMBLY

Figure 5 Magnetic Head Removal

____3. Loosen the four head mounting screws. Hold the head assembly against the tape deck while removing the mounting hardware.

____4. Carefully withdraw the head from the tape deck.

____5. Remove the write resistors R224 and R225 from the Read/Write/Servo module (Figure 4) at location F17. These resistors are plugged in and can be removed without removing the board from the logic cage.

The write resistors are matched with the read/write head. They cause the write current sent to the head to be matched with the characteristics of the head. If the wrong resistors are used with a head, read/write errors may result.

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

Replacement

____1. Plug in new write resistors R224 and R225 onto the Read/Write/Servo module.

NOTE
Before installing a magnetic head, make sure that the recording surface is protected with soft, non-adhesive material.

____2. Put the magnetic head through the hole in the tape deck and position the head onto the guide pins.

____3. While holding the head in place insert the mounting hardware and tighten the screws.

____4. Guide the read and write/erase cables through the tape deck and attach them to the correct head as shown in figure 5.

____5. Remove the recording surface protective covering which you added.

Verification Checks

____1. Clean the magnetic head recording surface with a soft lint-free cloth moistened with tape transport cleaner. Wipe recording surface in same direction as tape motion.

____2. Load a known good write-enabled scratch tape and execute test 18 to move tape away from BOT. Press the RESET

pushbutton to stop tape after approximately 5 seconds.

____3. Move the jumper (Figure 4) at location 13E on the R/W/S module from the normal W3-STORE position to the test 31 W4-STORE position.

____4. Execute test 31.

Test 31 sets up and checks the read amplitudes for each track. A new head assembly may cause the amplitudes to change.

____5. After the test is complete (display ØØ), return the jumper from W4 (STORE) to W3 position. Close the logic cage.

Test Ø1 is the final verification test. It is used to verify many of the replacements you are going to do in this lesson. To save time, it is only run once at the end of this lesson.

AIR BEARING ASSEMBLY

NOTE

Replacement parts for the air bearing assembly are contained in the CD kit P/N XXXXXX. This kit contains two spring guides (one upper and one lower), a transducer, a small O-ring, and a large O-ring.

The air bearing assembly (Figure 6) should be completely refurbished whenever <u>any</u> part is replaced. This means all parts of the the CD repair kit should be used and a new kit ordered.

Both air bearings are removed with the same procedure. Therefore, you will remove only one air bearing (your choice) in this lesson.

Removal

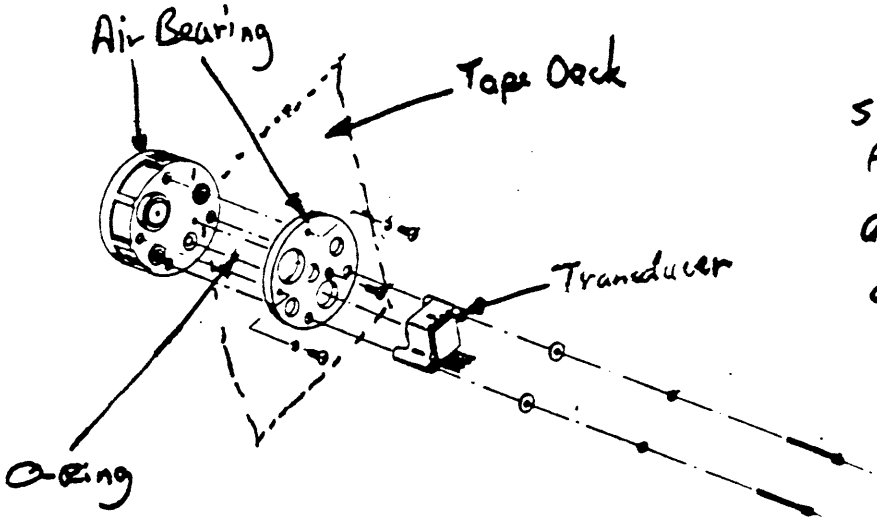
CAUTION

Make sure no air bearing parts are damaged during the removal procedure. You will use all the original parts during the replacement procedure.

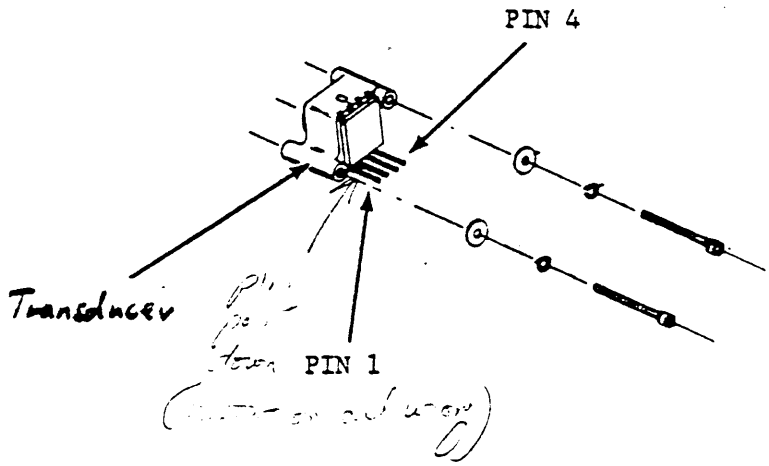
Be especially careful with the transducer pins when detaching the cable. They break very easily when bent.

____1. From the bottom of the tape deck, detach the cable connector from the transducer pins.

Check (and mark if necessary) the pins on the sensor and



show two Figures. One with assembly, 2 screws, and tape deck. The other with exploded assembly



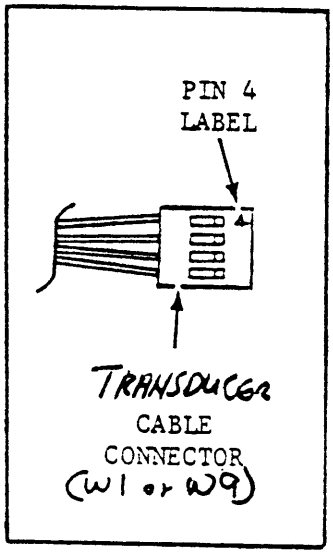


Figure 6 Air Bearing Transducer

the cable plug for proper reconnection. Improper connection may cause inaccurate fault symptoms.

CAUTION

Hold on to the air bearing when removing the mounting screws. Use tape if necessary. The air bearing can fall and be damaged if not held.

____2. Remove the two mounting screws securing the air bearing assembly to the bottom of the tape deck. DO NOT remove the screws securing the sensor to the air bearing at this time.

Remove the complete air bearing assembly from the top of the tape deck. Make sure that the large O-ring does not fall out of the air bearing.

____3. Place the assembly on a flat surface, and remove the two mounting screws securing the sensor to the air bearing.

A small O-ring is underneath the transducer. It can fall out of position. Be careful not to lose it.

____4. Remove the two screws from the front of the air bearing.

The spring guide can now be removed.

Replacement

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 sensor on the air bearing. Install and tighten the two mounting screws to secure the sensor.

____3. With the large O-ring seated properly, position the air bearing onto the tape deck, and secure it with the two mounting screws.

____4. Reattach the connector to the sensor pins.

Verification Check

Tests Ø2 and Ø1 are used to verify the transducer. They are run at the end of this lesson.

SUPPLY REEL HUB ASSEMBLY

Removal

____1. Press the center button on the hub to unlatch it.

____2. Locate the slotted opening (Figure 7) on the periphery of the reel cover. Insert a small blade screwdriver into the slot and twist to unsnap the hub cover from the hub assembly.

____3. Place the hub assembly in the latched position by depressing the cam carrier.

CAUTION

Make sure that the hub is latched before you proceed with further removal steps. Otherwise, the assembly may disassemble. It is difficult to reassemble.

____4. Remove three large mounting screws from the cam carrier. The hub assembly can then be removed from the tape deck.

Replacement

The replacement is done after the reel motor removal and replacement.

SUPPLY REEL MOTOR

Removal

____1. Detach the B1P1 connector from the J3 plug on the power amplifier module (Figure 8).

____2. Remove four mounting screws and the tach cover from the motor.

____3. Detach the W3P5 connector from the tach sensor on the motor.

This connector is not keyed. Make sure it is marked so that you will not reverse it.

____4. Remove four mounting screws securing the motor to rear of the tape deck. Use a 9/16" extender tool if neccessary.

____5. Carefully remove the motor from the transport.

Replacement

Both reel motors have the same part number on the TU80. Whenever you order a reel motor, it will arrive with the 1000-line tachometer attached. If you are replacing the supply reel motor,

turn exploded view arou
; show tap
dick

center button
cam carrier

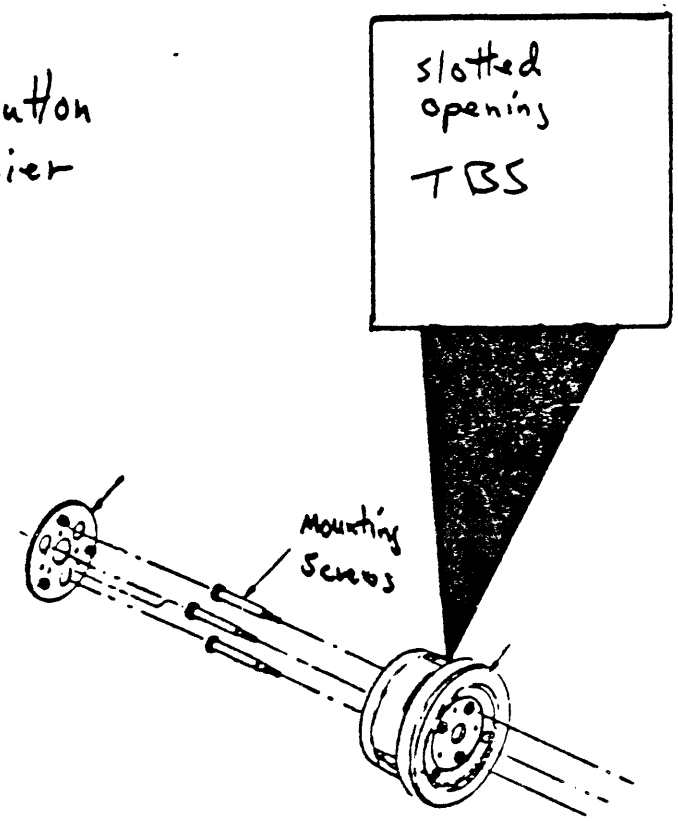


Figure 7 Supply Hub Assembly

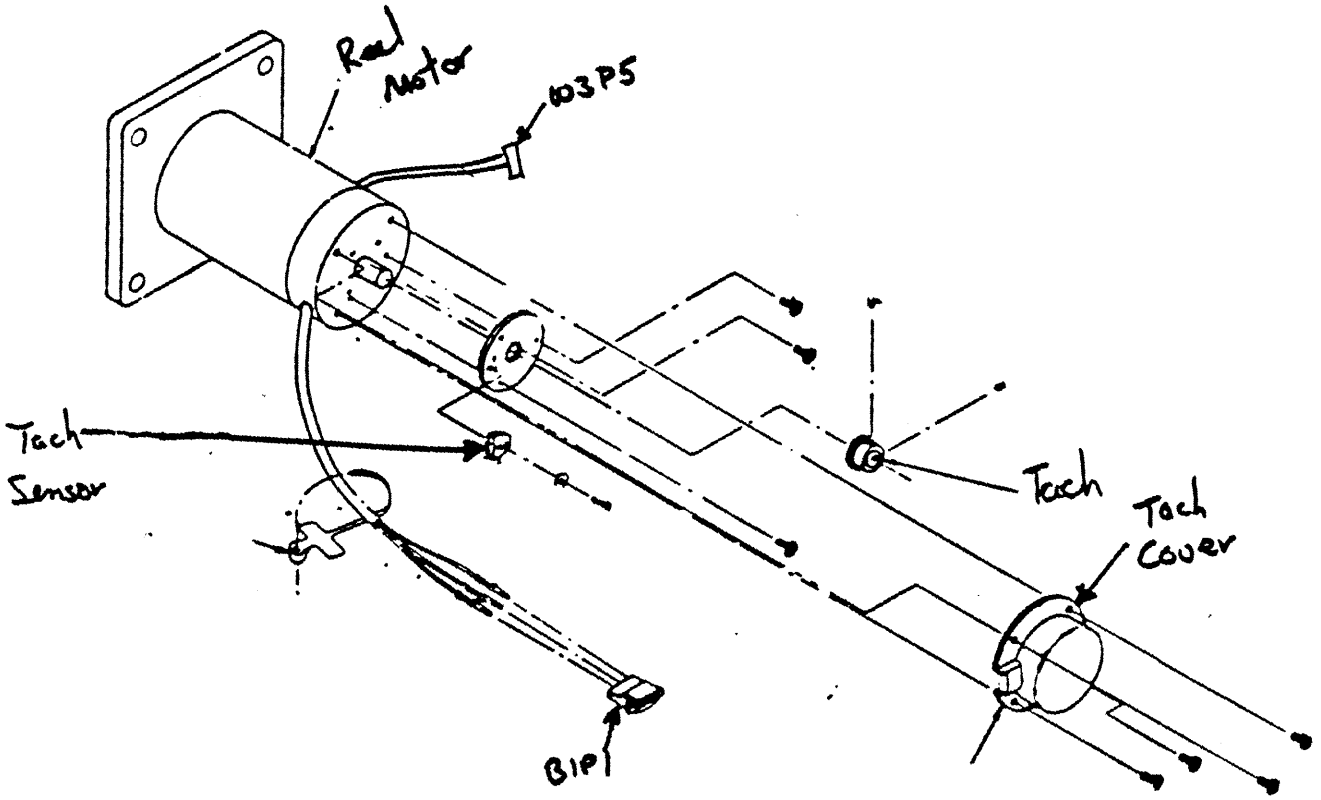


Figure 8 Supply Reel Motor Removal

you will have to install a one-line tachometer in place of the 1000-line tachometer. The procedure for tach installation can be found in the pocket service guide (PSG).

CAUTION

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

____1. Position the motor on the rear of the tape deck so that the sensor extends to the right of the motor assembly. Secure the motor to the deck with four mounting screws.

NOTE

If a new motor assembly is being installed, remove four mounting screws and the tach cover from the motor prior to installation.

____2. Connect the B1P1 cable to the 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 with four mounting screws.

Follow the rest of this procedure to replace the hub removed earlier.

____5. Position the hub assembly onto the motor shaft assembly and secure with three large shoulder screws.

____6. Install the reel cover on the face of the hub aseembly.

Verification Check

____1. Mount the tape reel onto the hub assembly. The reel should mount easily onto the hub and against the bottom flange.

____2. Latch the reel onto the hub. Make sure that the reel is securely fastened.

____3. Load a known good quality tape and observe the reel during tape motion. Tape should not contact the top reel flange.

Test 01 is the final verification check for both the reel motor and the hub. Test 01 is performed at the end of the lesson.

PRESSURE REGULATOR

Removal

____1. Remove the pressure regulator by unscrewing it (counter-clockwise) from the plenum box (Figure 9).

Replacement

____1. Screw the pressure regulator clockwise onto the shaft protruding from the plenum box until it is seated firmly against the plenum box.

Make sure an "O" ring is in place on the filter base so that a seal is maintained between the base and plenum box.

Verification Checks

Verification checks consist of tests Ø2 and Ø1. They are run at the end of this lesson.

PLENUM BOX AND AIR FILTER

Removal

____1. Remove the two plenum tubes (Figure 1Ø) from the plenum box.

These tubes CANNOT be mixed up. Make sure they are marked for easy replacement.

____2. Remove the plenum box by removing the four mounting screws.

Be careful that the screws do not fall into the cabinet. The screw in the lower left corner is especially difficult.

____3. Remove the air filter by pulling it straight out from the interior of the plenum box.

Replacement

____1. Position the filter onto 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 making sure they are not switched around.

Verification Checks

Use exploded view

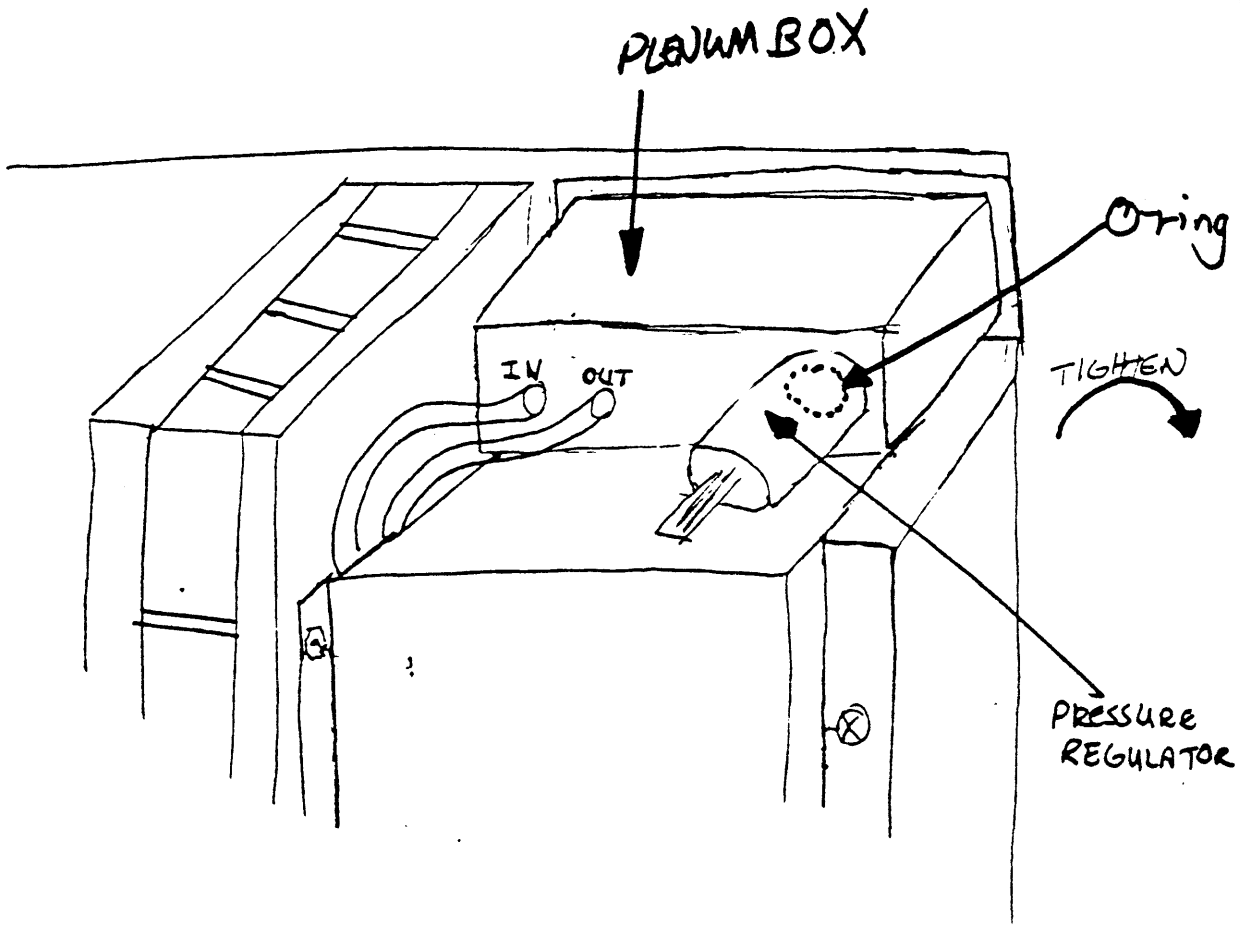


Figure 9 Pressure Regulator Removal

Used exploded view

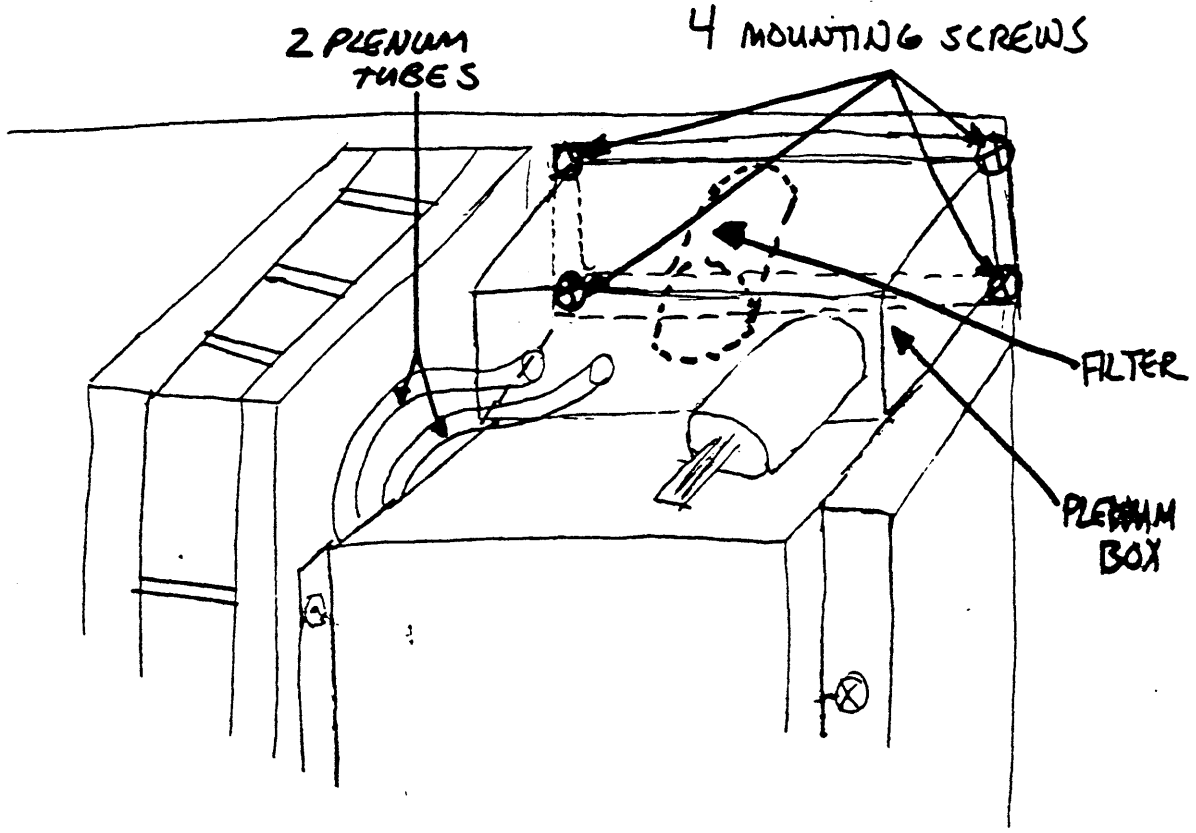


Figure 10 Plenum Box and Air Filter Removal

Verification checks consist of tests Ø2 and Ø1. They are run at the end of this lesson.

POWER SUPPLY add figure

Removal

____1. Open the rear door. Remove the frame stabilizing bar if it is high enough to be in the way.

____2. Unplug the power cord.

____3. Disconnect the power cable from the power supply and lay the cable aside.

____4. Detach the W4P4, W2P1, W7P1, W4P5 connectors from the power supply.

NOTE

The power supply weights approximately 8 lbs (3.6 Kg). Proceed with caution.

____5. Return the tape deck to its operating position. From the rear of the unit, remove the stabilizing plate mounting screw.

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

____6. Loosen but DO NOT REMOVE the two mounting screws on the left side of the power supply.

____7. Remove the two mounting screws on the right side of the power supply while supporting the power supply from the bottom.

____8. Slide the power supply out of the slots on the left, and carefully remove the power supply from the cabinet.

Replacement

CAUTION

If a new power supply is being installed, remove the top cover and observe the position of the Voltage Select Module. The position of this module must correspond to the input voltage as defined on the Equipment Identification Plate. The ends of the cord are stencilled with "120 V" and "220 V" and indicating arrows. Make sure that the module is connected to match

the input voltage.

The module can be disconnected, turned upside down, and reconnected to the main Power Supply module if required.

____1. Remove the top cover of the power supply.

____2. Check that the Voltage Select module (Figure 11) is installed in the correct position.

____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 stabilizing plate, and insert and tighten the mounting screw.

____8. Turn the tape deck into the service position.

____9. Attach the W4P4, W2P1, W7P1 and W4P5 connectors to the power supply plugs.

____10. Connect the power cable to the power supply and plug the power cord into the power outlet.

Verification Check

____1. DC Voltage Checks (Figure 12)-- Using a digital voltmeter (DVM) for all DC voltage measurements, connect the ground lead of the meter to either pin 4 or 6 of power connector on the Read/Write/Servo module (labeled P1 on the board). Connect the other meter lead to points listed in table 1 to test all DC voltages.

Table 1 DC Voltages and Tolerances

Location	Voltage	Tolerance
P1-5*	+ 5V	± 2% (4.90 to 5.10)
P1-2*	- 15V	± 10% (-13.5 to -16.5)
P1-3*	+ 15V	± 10% (+13.5 to +16.5)
P1-7*	+ 24V	± 10% (21.6 to +26.4)
P1-8*	- ^V	± 10% (-5.4 to -6.6)
J4-6**	+ 38V	± 10% (+34.2 to +41.8)

* P1 is the power connector on the Read/Write/Servo module.

add connectors and board callouts

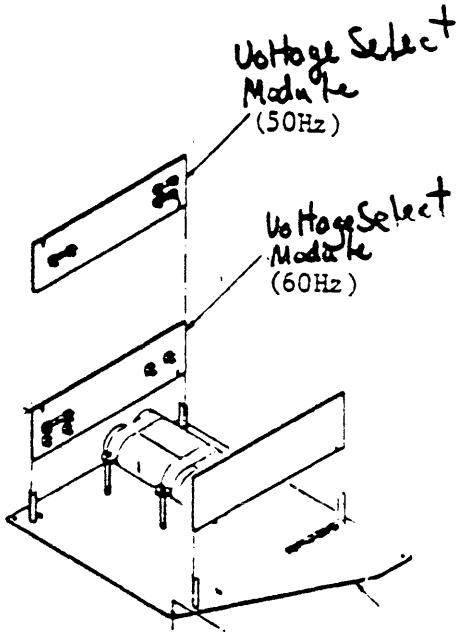


Figure 11 Voltage Select Module Orientation

TBS

Figure 12 DC Voltage Checks

**J4 is the power connector on the Power Amplifier module.

READ/WRITE/SERVO MODULE

Removal

____1. Turn off the power switch.

____2. Detach all cable connectors from the board connectors (Figure 13).

____3. Open the logic cage and separate the modules.

NOTE
Avoid undue stress on the modules by loosening the thumb screws alternately until the modules are separated.

There are two screws in each hinge of the logic cage (Figure 14). The screws are never removed. They are loosened only enough to clear the module they hold. The top screw in each hinge holds the R/W/S module.

____4. Loosen but do not remove the top screw in each hinge of the logic cage.

____5. Pull the R/W/S module from connector P1, and remove the Module from the logic cage.

3D this ord reference
.it to tape deck

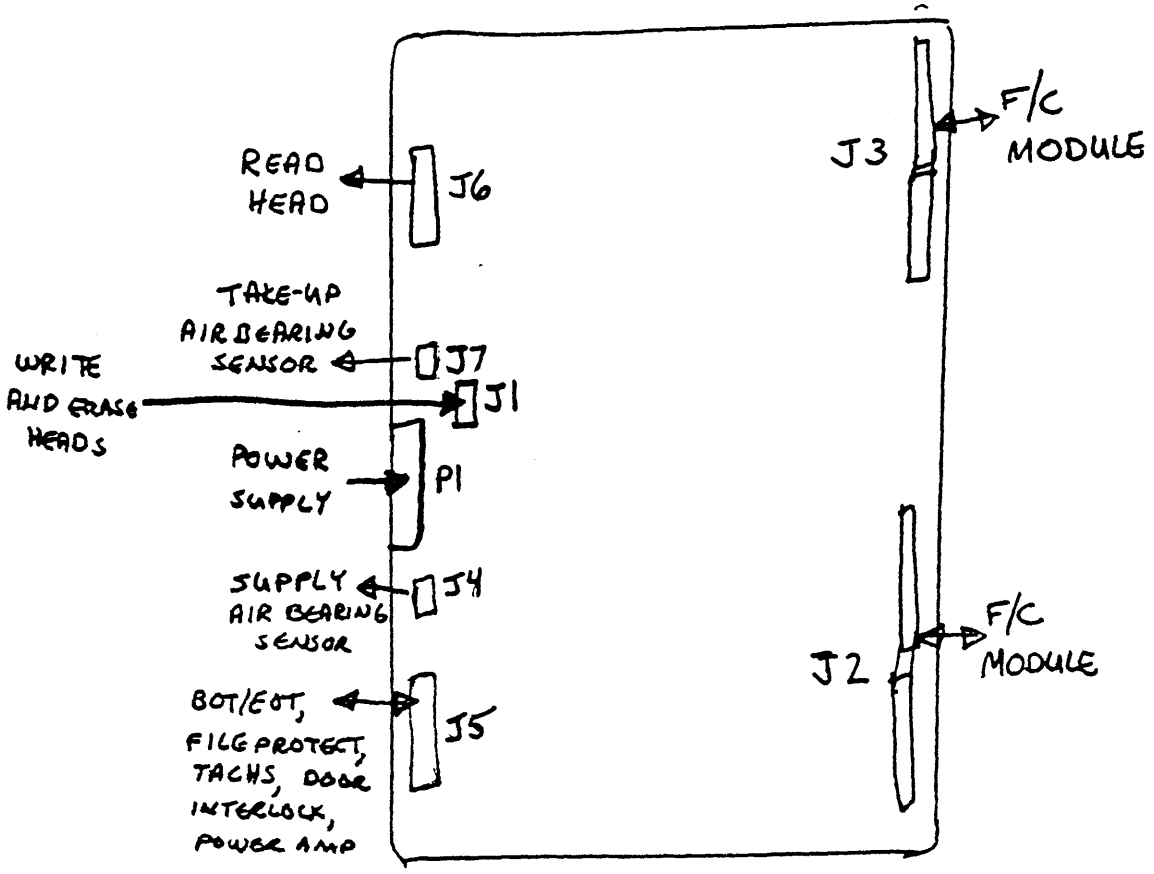


Figure 13 Read/Write/Servo (R/W/S) Module

Replacement

The R/W/S module is replaced after the F/C module removal.

FORMATTER/CONTROL MODULE

Removal

____1. Detach the two interface cables (Figure 15) from the P4 and P5 connectors.

____2. Detach all remaining cable connectors from the board connectors.

____3. Loosen but do not remove the bottom screw in each hinge of the logic cage (Figure 14) to release the F/C module.

____4. Remove the F/C module from the logic cage.

With the logic cage empty, notice the connector coming from the power supply to both modules. Always make sure the modules are fully seated in the connector.

Replacement

You replace both modules and then verify both in the following procedures.

NOTE

If a new R/W/S module (Figure 4) is being installed, remove R224 and R225 Write Resistors from the removed module and insert these resistors into the new module.

____1. Install the Read/Write/Servo Module in the logic cage. Make sure that the module is fully inserted into the top and bottom hinge slot (Figure 16).

____2. Insert and tighten the hinge screws (Figure 14) to lock the R/W/S Module in its position.

____3. Attach the cable connectors to the module plugs as listed below:

J1 -- W5P2 connector (Write/Erase Heads)
J4 -- W1 cable (supply tension sensor)
J5 -- W3P8 connector (BOT/EOT sensors, door interlock power simplifier, tachs)
J6 -- W6P2 connector (Read Head)
J7 -- W9 cable (Take-up Tension Sensor)

Now install the F/C module.

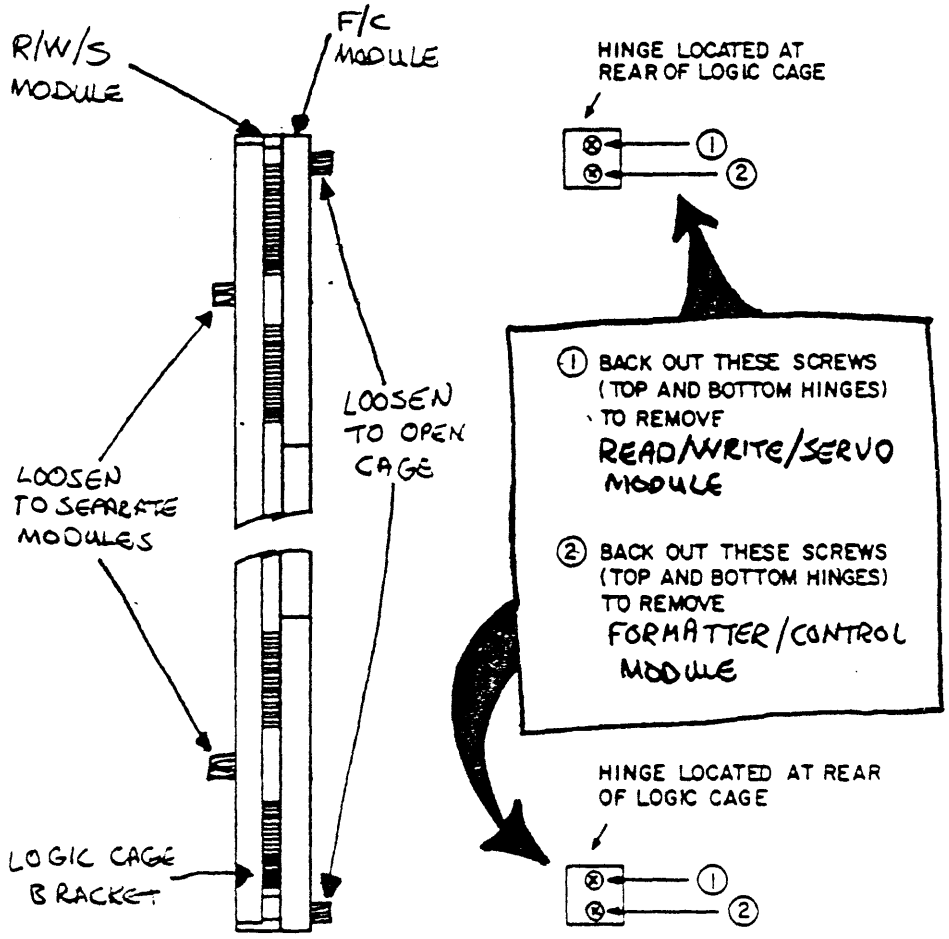


Figure 14 LOGIC CAGE ASSEMBLY

3D this and reference it to tape deck.

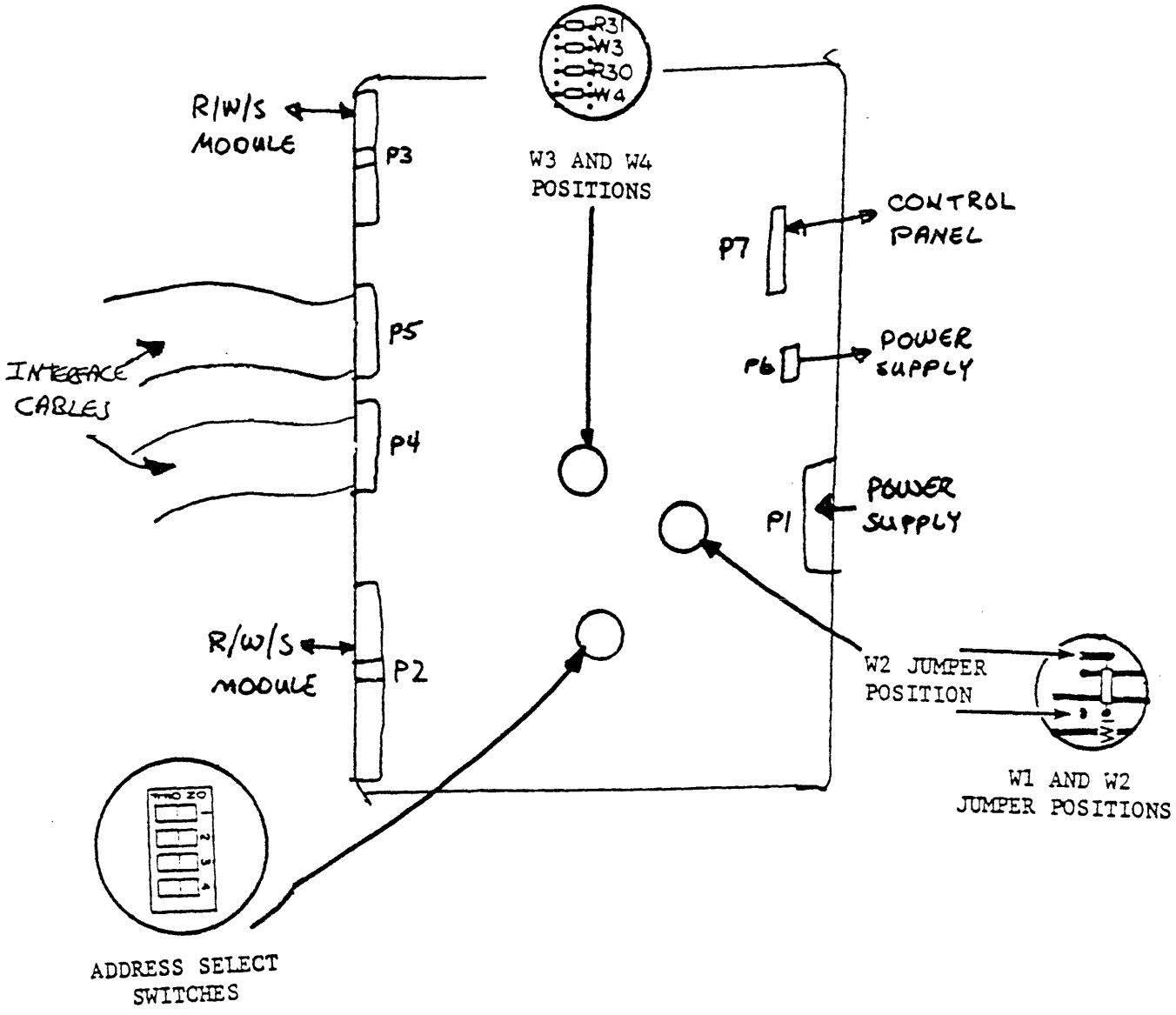


Figure 15 Formatter/Control (F/C) Module

TBS

Figure 16 Logic Cage Empty

NOTE

Prior to installing an F/C module (Figure 15), place the four-segment DIP switch at location D21 to same address as set in the removed module. Also make sure that the jumpers at location E16 are in the same position as in the removed F/C module.

____4. Install the F/C module in the top and bottom hinge slots of the logic cage. Make sure that the module is fully inserted.

____5. Insert and tighten the hinge screws (Figure 14) to lock the F/C module in its position.

____6. Attach the interface cables to P5 and P4 connectors on the module.

____7. Push the two modules together. Then align and tighten the thumb screws.

____8. Attach plugs P2 and P3 from the Formatter Control Module to connectors J2 and J3 on the R/W/S Module.

____9. Attach the F/C cable connectors to the module plugs as listed below:

P1 -- W7 cable (power amplifier module and power supply).
P2 and P3 -- Cables from J2 and J3 connectors on the R/W/S module.
P6 -- W2P1 cable connector (power supply)
P7 -- W8P1 cable connector (control penel).

Verification Checks

____1. With tape threaded, but not loaded, execute test Ø2.

____2. Move the jumper at location 13E on the R/W/S module from the normal W3-STORE position to the test 31 W4-STORE position (Figure 4).

____3. With tape not threaded, execute test 37.

Test 37 sets up the velocity correction multiplier used in the velocity digital-to-analog convertor (DAC). This is used in generating the correct demand velocity to the take-up reel motor.

____4. Load a good known quality write-enabled tape.

____5. Execute test 18 to move tape away from BOT. Press the RESET pushbutton to stop tape motion after approximately 5 seconds.

____6. Execute test 31.

Test 31 sets up and checks the read amplitudes for each track. You ran this test earlier after replacing the magnetic head assembly.

____7. After the test is complete (display ØØ), return the jumper from W4 (STORE) to W3 position.

You have now performed all the removal and replacements required for this course. As a final check, you will run test Ø1. Remember, that this is the final check on many of the FRUs you replaced. If you should get an error follow the procedures in the pathfinder documentation. A failure is not necessarily in the modules you just replaced.

____8. With tape threaded, but not loaded, execute test Ø1.

The test takes over 1Ø minutes to run. Read the rest of this lesson while you are waiting.

In the next lesson you will be identifying and fixing TU8Ø malfunctions inserted by the course administrator. To expediate this process, you can leave the acoustic cover off at this time if you wish to do so.

Also, if there are other removal procedures you want to perform, do so ONLY WITH THE COURSE ADMINISTRATOR'S AUTHORIZATION. Use the procedures in the pocket service guide.

SUMMARY

In this lesson you removed, replaced, and verified the FRUs listed in table 2.

Table 2 TU80 FRU Replacement/Verification

FRU Replaced	Verification Check
1. BOT/EOT Sensor	Test 44
2. Tape Cleaner	None
3. File Protect Sensor	Power-on test 1003
4. Magnetic Head Assembly	Clean the recording surface Test 31 Test 01
5. Air Bearing Transducer	Test 02 Test 01
6. Supply Reel Hub Assembly	Smooth reel movement Test 01
7. Supply Reel Motor	Smooth reel movement Test 01
8. Regulator/Filter	Test 02 Test 01
9. Power Supply	Check voltages at P1 and J4
10. Read/Write/Servo Module	Test 02 Test 37 Test 31 Test 01
11. Formatter/Control Module	Test 01

This completes the Removal/Replacement lesson.

GENERAL

This lesson outlines general troubleshooting procedures and lists troubleshooting aids specific to the TU8Ø. You'll be troubleshooting at least three TU8Ø problems installed by the course administrator.

OBJECTIVES

Use all available TU8Ø resources to identify and repair faults in the TU8Ø.

MAINTENANCE

Points to keep in mind when maintaining the TU8Ø are as follows.

1. There is no scheduled preventive maintenance (PM).

2. There are no manual adjustments. However, if read/write errors are the problem and the tape path is clean, the EGC circuit should be activated with test 31. This sets the read gains.

3. The customer should perform periodic tape path cleaning.

4. The customer should run operator diagnostic Ø1 whenever any problems are suspected. Periodically running test Ø1 is not required, but would serve as a convenient confidence test for the customer.

   NOTE

   ALL fault codes should be recorded by the customer whether or not field service is called.

5. The power-up health check runs when the transport is powered up by pressing the LOGIC ON switch. A fault code may result. If so, the RESET switch may clear it. The customer may report errors found by this check to Field Service.

6. The M7454 self-diagnostic runs when the host UNIBUS is powered up. Errors may be reported in the host error log. The customer may report errors found by this diagnostic

to Field Service.

7. The pathfinder documentation, if used correctly, will find 99% of the TU80 problems. However, it does NOT diagnose problems in the M7454 or associated cables.

PRE-SITE TROUBLESHOOTING

Complete the following steps when you first talk to the customer. These steps are to be completed BEFORE going to the customer site.

1. Find out exactly what problem the customer has experienced.

   - o Loading or moving tape problems
   - o Cosmetic problem (cleaning, cables, etc.)
   - o Errors reported in system printouts
   - o Intermittent or solid problems

   Use the Malfunction Matrix table in the pathfinder to suggest possible cures.

   NOTE

   If the hub is unlatched, random errors may occur. This might occur because the inner diameter of the plastic supply reels can vary from reel to reel.

   Always have the customer recheck that the supply hub is latched no matter what the reported problem.

2. Find out if a fault code is displayed and what it was a result of (i.e. running on-line, power-up, operator test 01, etc.).

3. Have the customer run test 01, and tell you the results.

   Use these results along with the Fault Code Matrix table in the pathfinder to suggest possible cures.

   DO not forget about operator tests 02 and 03 if applicable.

FIRST-PHASE ON-SITE TROUBLESHOOTING

Before performing any maintenance on the TU80, complete the following steps.

1. Have the customer reproduce the problem if possible. If the problem is intermittent, have the customer leave the TU80 in the failing state.

2. Note the state of all TU80 indicators on the control

panel.

3. Use your physical senses to survey TU80 status.

   Does anything smell wrong?

   Does anything sound wrong?

   What are the environmental conditions of the site?

   Are there any visual errors? Open access doors and look at everything: connectors, cables, modules, mechanical assemblies. Check for breaks, looseness, discoloration, etc.

These basic troubleshooting steps are often partially or totally overlooked. Do not overlook them. In the long run they save a lot of time, money, and headaches.

If these steps turn up a probable cause of the problem, proceed with appropriate testing and/or removal and replacement.

SECOND-PHASE ON-SITE TROUBLESHOOTING

If first-phase troubleshooting does not define any problems, perform the following steps.

1. Run test 01 using a known good tape. Follow up any fault codes in the pathfinder tables.

2. If test 01 cannot be run, perform pathfinder tables 1001-1003.

3. Check that the indicator light on the M7454 is lit. This indicates that the M7454 self-test passed successfully.

4. Run the appropriate on-line diagnostics. They are especially helpful with intermittent problems because of their extended running times.

5. If you have any idea of what the problem might be, use the table at the start of the test descriptions to determine if any specific internal test could be useful.

   If encountering a fault code, check for sub-fault codes, also.

If neither the pathfinder nor diagnostics provide the solution, what do you do then?

Check the Tech Tips, FCOs, ECOs, and option summary in the microfiche library. These tremendously helpful resources are often not used, resulting in many wasted hours. Most devices have changes after they have been introduced. You can find any

combination of changes when you arrive on site. The changes can be identified in the micro-fiche.

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 microfiches applicable to the TU8Ø.

Remember, important hardware changes can happen anytime. You must keep up with them as they are sent to you on microfiche.

Check software. System software patches are always being written to solve problems. Has the customer installed all appropriate patches?

You can learn of software updates from Software Dispatch and Small Buffer, published by DIGITAL monthly. DIGITAL also provides a software hotline.

Use the TU8Ø Subsystem Technical Manual.

Check that the host system has been checked thoroughly. If all tests run correctly on the TU8Ø, the host may be at fault.

THIRD-PHASE ON-SITE TROUBLESHOOTING

Once you find the probable cause of an error, swap the associated FRU.

If the first replacement does not fix the problem, replace the original FRU before proceeding with a second replacement. By working with more than one replacement, you run the possibility of introducing additional problems and complicating the repair.

ALWAYS run test Ø1 to completion as a final check at the end of every repair call.

When possible, run the appropriate on-line diagnostic to check the complete sub-system.

The last thing to do on every call is to 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 have very negative effects on the customer rating of DIGITAL field service.

PATHFINDER REVIEW EXERCISE

This exercise is inserted here to reemphasize the use of the pathfinder when troubleshooting the TU80 transport. Almost all troubleshooting information is contained in the pathfinder if you know where to find it.

1. What will cause a fault code of 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 will cause a fault code of 21 with a sub-fault code of 03?

   a. RESET pressed during an unload operation
   b. Tape slipping while decelerating
   c. Speed fault
   d. Greater than 9 oz. detected with no tension

3. What failing component will cause a fault code of 21 with a sub-fault code of 03?

   a. R/W/S module
   b. F/C module
   c. Take-up air bearing assembly
   d. Compressor

4. When running test 02, what kind of error will cause a fault code of 82?

   a. Take-up power amp fault
   b. Take-up comparator fault
   c. Tape loaded fault
   d. Compressor failure fault

5. When running test 02, where in the test sequence does a fault code of 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 amp works
   d. When checking the zero tension offsets

6. When running test 02, what component <u>most probably</u> causes a fault code of 82?

   a. R/W/S module
   b. F/C module
   c. Power Amplifier module
   d. Power Supply

PATHFINDER REVIEW EXERCISE ANSWERS

1. What will cause a fault code of 21?

   b. Take-up tension fault Yes, the assumption at the top of the FAULT CODE 21 page in the pathfinder tables states, "TU80 displays Fault Code 21 as a result of a take-up tension fault."

2. What kind of error will cause a fault code of 21 with a sub-fault code of 03?

   d. Greater than 9 oz. detected with no tension Yes, in the sub-fault code tables, this is plainly listed under fault code 21/sub-fault code 03.

3. What failing component will cause a fault code of 21 with a sub-fault code of 03?

   a. R/W/S module Yes, in the pathfinder table under fault code 21, if you answer yes on line 030 for sub-fault code 03, it leads down to line 060 which suggests replacing the R/W/S module.

4. When running test 02, what kind of error will cause a fault code of 82?

   a. Take-up power amp fault Yes, in the test 02 description under POSSIBLE TERMINATION CODES, code 82 is listed as a "TU Power Amp Fault".

5. When running test 02, where in the test sequence does a fault code of 82 occur?

   c. When verifying that the take-up reel power amp works Yes, in the test 02 description under TEST SEQUENCE, step d verifies the take-up reel power amp and displays an 82 is an error occurs.

6. When running test 02, what component <u>most probably</u> causes a fault code of 82?

   c. Power Amplifier module Yes, since the power amps 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 actual TU80 malfunctions. The course administrator will cause a malfunction (bug) in the TU80, and you will find and repair it.

You must identify and repair at least three malfunctions. You may do up to ten if you have time.

The following list is a reminder of the resources available to you as you troubleshoot the TU80.

- Pathfinder
  - Fault code tables
  - Tables 1001-1003
  - Test descriptions
  - Sub-fault code descriptions
- Pocket service guide
- Internal and on-line diagnostics
- Physical senses
- Technical manual
- Print set
- Microfiches
- Customer's description of the problem

> NOTE
> ALWAYS USE THE PATHFINDER TABLES. Used properly, they will always point you near the problem. Many problems are solved in less than a minute with the tables. No specialized troubleshooting or guesswork can match that timing.

Now complete the following procedure.

____1. Ask the course administrator to install the first TU80 malfunction.

____2. Identify the error and repair the problem.

____3. Ask the course administrator to check your work and request another malfunction.

____4. Repeat steps 1 through 3 at least three times or until you feel confident with the troubleshooting procedures.

INSTALLATION

GENERAL

This lesson covers installation. You will install the TU80 UNIBUS adapter module and associated cabling, and then do a final on-line test to make sure the TU80 is error free.

Chapter 6 of the TU80 User Guide covers site planning, unpacking, inspection, and cabinet installation. These are areas in which you have had previous training so they are not discussed here.

OBJECTIVES

Install an M7454 and associated cables.

M7454 UNIBUS Adapter Module

Perform the following procedure to remove the M7454.

____1. Power down the TU80 and the system to which it is attached.

The M7454 (Figure 1) is installed in the UNIBUS backplane of the host.

____2. Remove the two cables from the M7454. Make sure that the cables are marked so that it is easy to identify how they are inserted. If not, mark them.

These cables are not interchangeable and will not work if mixed up or reversed when inserted.

Notice how the cables are positioned to facilitate installation later in this lesson.

____3. Remove the M7454 from the backplane.

INTERRUPT VECTOR AND UNIT NUMBER

As with all UNIBUS interfaces, the M7454 must be configured for a specific UNIBUS address and vector. The M7454 you just removed is probably set up as the first TU80 on the UNIBUS. This is the standard configuration as shown in figure 1.

Jumpers J11-J14 are used by the manufacturer and are never used by DIGITAL.

The 10-switch DIP switchpack serves several purposes as shown in

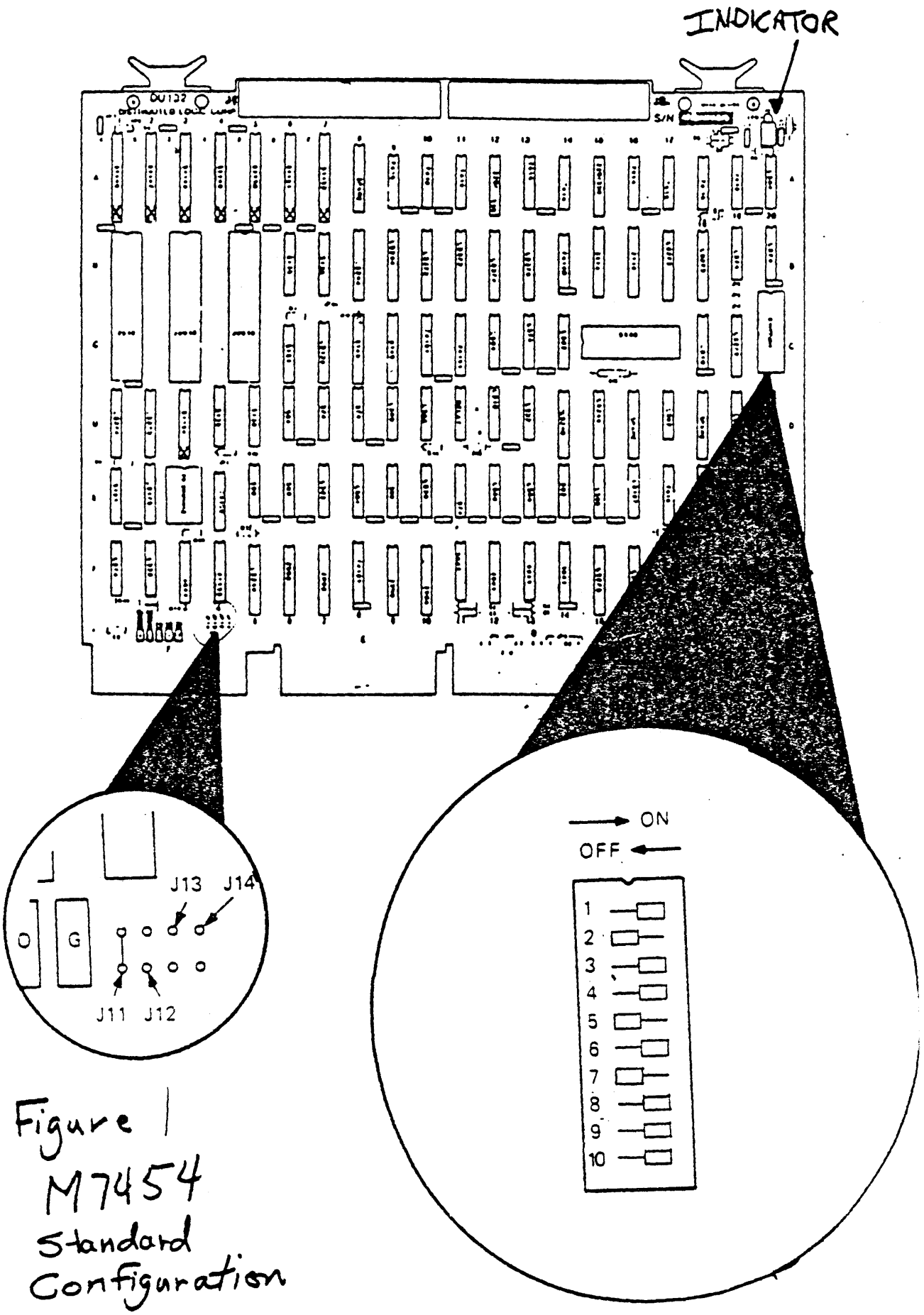


Figure 1
M7454
Standard
Configuration

figure 2. Switches 1-7 selects vector bit positions 8-2 respectively. The other vector bit positions never change so they are not selectable.

Switch 8 selects a two-word (ON) or four-word (OFF) burst size during data transfers. DIGITAL uses the two-word burst.

Switches 9 and 10 act as a 2-bit binary switch and select unit number 0-3. The unit number automatically selects the UNIBUS address (Table 1). You do not have to configure individual address bit switches for the TU80. The vector selected must match the unit number as shown in table 1.

NOTE

The vector and addresses are the same as the TS11. When using PDP-11 documentation listing vectors or addresses, adhere to the TS11 parameters.

Table 1 Compatible Unit Numbers and Vectors

Unit Number	UNIBUS Address	Interrupt Vector	Hexadecimal Equivalent
0	172522	224_8	094_{16}
1	172526	floating rank 37	
2	172532	floating rank 37	
3	172536	floating rank 37	

Note that an ON switch equals a logical 0, and an OFF switch equals a logical 1.

FLOATING VECTOR

How to determine floating vector assignments is taught in PDP-11 courses. The following is a brief overview of that process.

The standard vector for the first (unit number 0) TU80 on a UNIBUS is 224_8 (094_{16}). This is set and is always the same. Figure 1 shows 224 selected.

For the second, third, or fourth TU80 (unit numbers 1-3) on the UNIBUS, the vector is floating and must be based on the host system configuration.

Floating vectors start at 300_8 ($0C0_{16}$). All floating vector devices with a rank less than the TU80 (rank 37) must have a vector smaller than TU80s 1-3.

If the second TU80 is the only floating device on the system (highly improbable), its vector would be 300. You would configure switches 1-7 to represent 300. Rank wouldn't matter.

On the same system, the third TU80 would have a vector of 304_8 ($0C4_{16}$). This is because each TU80 takes up 4 words of space.

The fourth TU80 in our example would be vector 310_8 ($0C8_{16}$).

Of course, most systems will have other floating vector devices. Often the vector used for each device and rank of each device on a system can be found in the Site Management Guide for that system.

If not, you will have to look up a floating vector table. Floating vector tables are usually found in DIGITAL peripheral handbooks.

Remember, all floating vector devices on the system with a rank of less than 37 must have a floating vector smaller than TU80s 2-4.

EXERCISE
Now do the following steps to learn the M7454 switch settings.

____1. Pretend you are setting up the M7454 as the third TU80 on a system. Using your PDP-11or VAX training, you determine from the system configuration that the interrupt vector should be 420_8 (110_{16}).

____2. Use Figure 2 to set up the M7454 as unit number 2 with an interrupt vector of 420.

____3. Compare your configuration with the correct configuration in Figure 3.

If your configuration is not the same as the figure's, repeat the procedure until you are confident with setting the switches.

____4. Next, configure the switches for the first TU80 on a system.

____5. Compare your configuration with the correct configuration in Figure 4.

Once you are confident with setting the switches, go on to the remaining installation steps in the following steps.

Now you are ready to install the M7454 in the host UNIBUS backplane. Some of these steps are already complete because the M7454 you are using has previously been installed.

____6. Remove the bus grant continuity card (G727, G727Ø, or

G7272) from the SPC slot in the UNIBUS backplane in which you will install the M7454 (Figure 5).

A bus grant continuity card must be in connector D of any free SPC slot. If connector D is left open, bus grant continuity will be lost.

____7. Also in the same SPC slot, remove the nonprocessor grant (NPG) jumper, CA1 to CB1, on the pinside of the backplane (Figure 6).

The NPG jumper must be installed in any empty slot.

___ 8. Install the two ribbon cables into J1 and J2 on the M7454.

____9. Insert the M7454 into the UNIBUS backplane.

____10. Make sure the cable does not snag other components or block mounting box movement.

The cables go from the M7454 to the bulkhead connectors on the I/O panel in the back of the host cabinet. From there the signals go across the round interface cables to the connectors located on the logic cage mounting plate in the TU80 cabinet. From these connectors the signals go through short cables to connect to the F/C module.

____11. Take time now to follow the path of the parallel bus signals from the M7454 to the F/C module.

Notice the hardware involved in this path. It is simple to install, but you may have some questions when you first encounter this in the field. Answer those questions now to save yourself time when you are on the job.

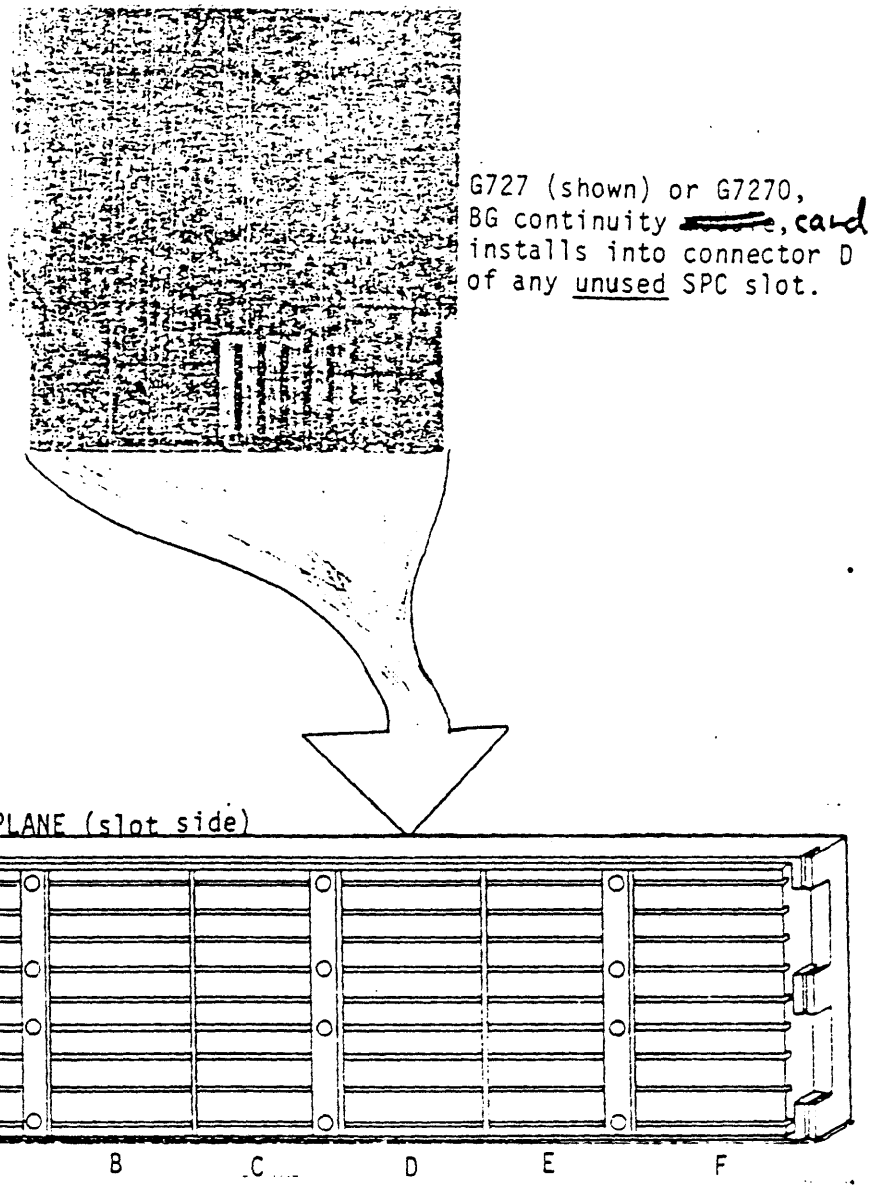
____12. Check that the Voltage Select module in the TU80 power supply is in the correct position for the power requirements in your location.

____13. Check that the jumpers and switches on the F/C module are in the correct position. All four switches should be off. Jumpers W1, W3, and W4 should be in. W2 is out.

____14. Power up the host system. Check to see that the M7454 indicator is on (Figure 1). If the indicator is lit, it signifies that the M7454 self-diagnostic has passed.

____15. Check that a remote switching cable is installed between the host power controller and the TU80 power controller.

____16. Check that the 3-position switch on both power controllers is in the REMOTE position. This allows any peripherals in either cabinet to be powered on by the



NOTE
If G7272 is installed, it fits into slots C and D.

Figure 5 BusGrant Continuity Card

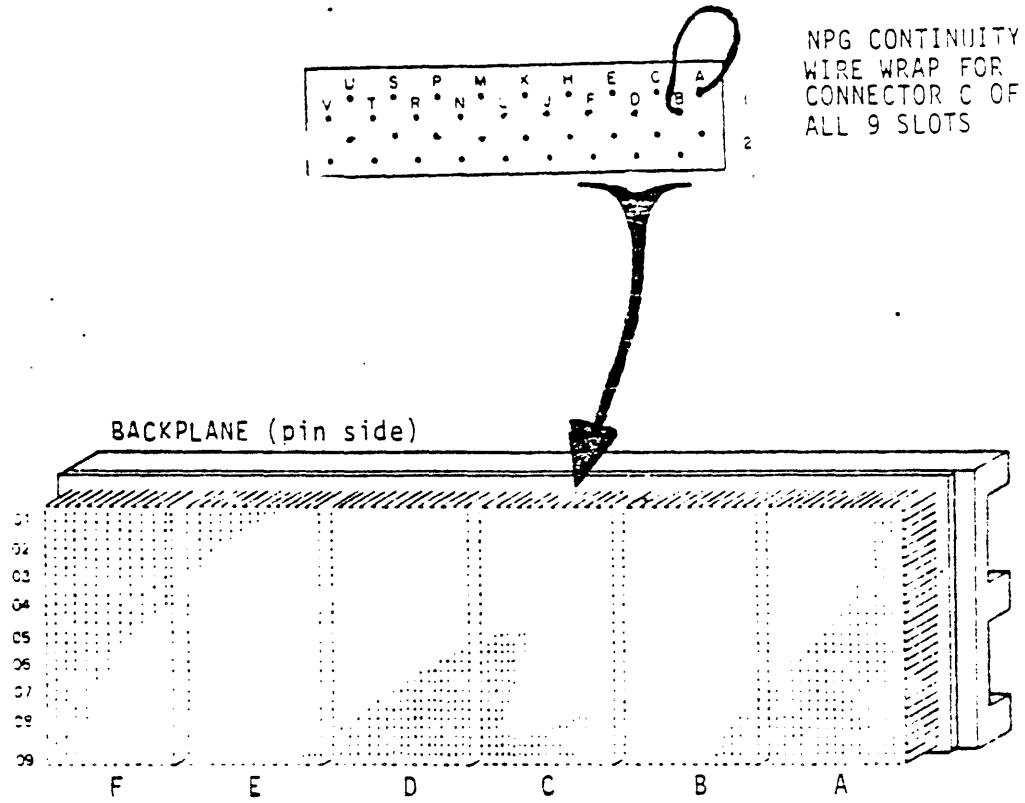


Figure 6 NPG Jumper

host ON/OFF switch.

____17. Power up the TU80.

____18. Verify all voltages.

NOTE
For the rest of this procedure, inform the course administrator if an error occurs and the test does not pass.

Now you run the acceptance diagnostics.

____19. Power up the transport by pressing the LOGIC ON switch.

This runs the Power-up Health Check. A fault code is displayed if an error occurs. This might be cleared by pressing the RESET switch.

____20. Thread a known good tape.

____21. Run test 01. It takes approximately 10 minutes for a 2400 ft. tape. Successful completion is signified by a 00 in the display.

____22. Load and start the on-line data reliability test.

Allow the test to run approximately 15 minutes. During this time take a break or prepare for the final test.

____23. Stop the test after 15 minutes. In the field you would allow this test to run to completion.

____24. Unload the tape and power down the system.

___ 25. Put the system back in customer operating condition. Make sure all covers are secure and cables are intact.

As mentioned before, Chapter 6 of the TU80 User Guide has detailed installation procedures. Also, Chapter 2 of your pocket service guide has a streamlined version of the procedures.

This is the end of your system maintenance lesson.

TEST 2

Next, complete the final test. You may use any TU80 resources available.

Review course materials to answer any remaining questions you have about the TU80.

Ask the course administrator for test 2 and return it for grading when complete.

Functional Checks

Perform Structured Analysis Method (SAM) Procedures 1001 thru 1003, as described in the Maintenance Section of this manual.

TRANSPORT CONFIGURATION

The STU has several optional features and selectable addresses that must be considered during the installation procedure. Option and address selection components are contained on the Formatter/Control PWA. The following table provides identification of these features and the physical location of component selection. Refer to the accompanying figure for component identification.

Table 1-2. STU CONFIGURATION

OPTION	COMPONENT/LOCATION	COMMENTS
Channel Parity Check	W1 Positions 1 and 2	As Shipped - Parity bit transferred with data.
	W1 Positions 2 and 3	Use if parity bit is not transferred with data.
Variable Short Gap (0.6" to 0.9")	W3 Positions 1 and 2	
Fixed Short Gap (0.6")	W3 Positions 2 and 3	As Shipped.
Variable Long Gap (0.6" to 1.2")	W4 Positions 1 and 2	
Fixed Long Gap (1.2")	W4 Positions 2 and 3	As Shipped.
Auto Speed (See NOTE 1)	W5 Positions 1 and 2	As Shipped. Disables auto speed select.
	W5 Positions 2 and 3	Enables auto speed select.
Formatter Address 0	S1 - OFF, Location 21D	As Shipped.
Formatter Address 1	S1 - ON	

Table 1-2. STU CONFIGURATION (Cont'd)

OPTION	COMPONENT/LOCATION	COMMENTS
Transport Address 0	S2 - OFF, S3 - OFF at location 21D	As Shipped.
Transport Address 1	S2 - OFF, S3 - ON	
Transport Address 2	S2 - ON, S3 - OFF	
Transport Address 3	S2 - ON, S3 - ON	

NOTE 1: Jumper W5 - Auto Speed Control. When this option is envoked, rather than selecting 25 ips mode when low speed is commanded, the transport will enter a mode, whereby, the most optimum speed will be chosen to match system requirements. If 100 ips mode gives the best throughput, then this mode will be used; the same applies to 25 ips streaming and 25 ips start/stop modes. This choice of operating mode will be done automatically by the transport and does not require any involvement by the system. This option allows the STU to be interfaced to a standard adapter and to run under standard 1/2 inch tape software, and yet, offer the advantage of streaming. With this option enabled, the unit will respond to a Set 100 IPS command in the normal manner.

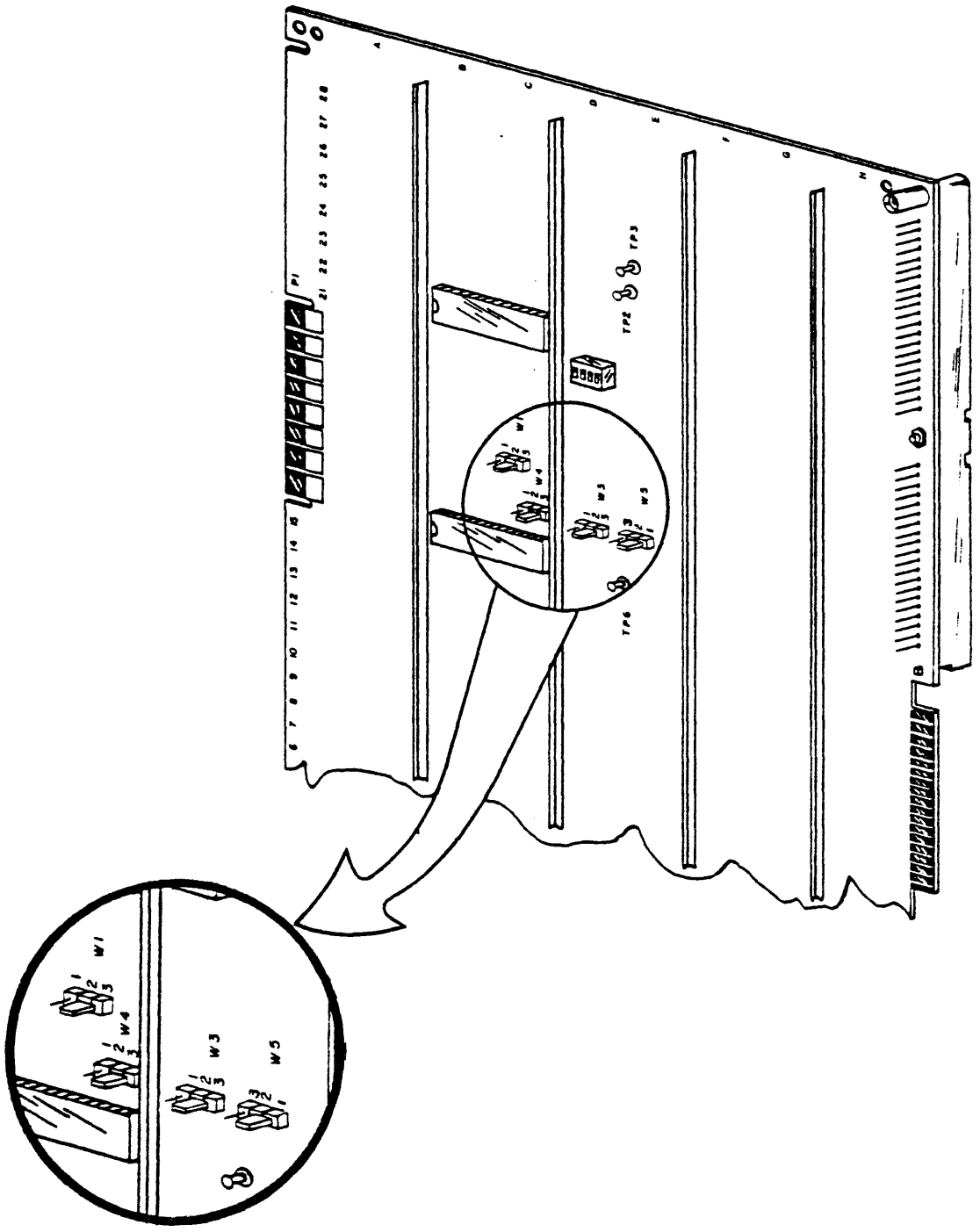
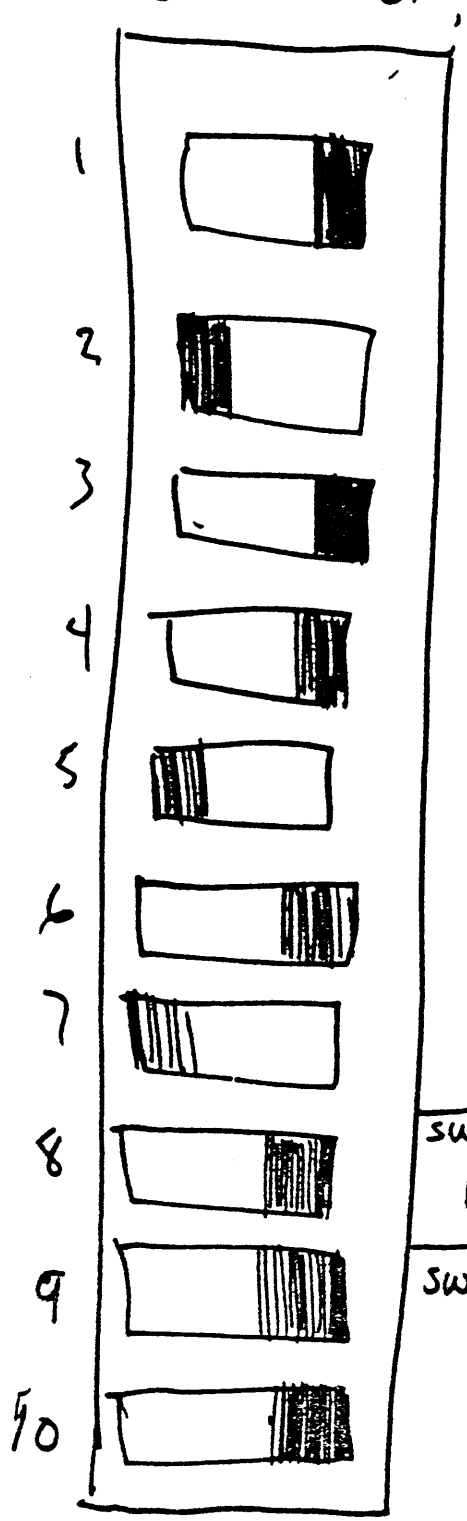


Figure 1-3. Jumper Plug Locations



SWITCHES 1-7 (VECTOR BITS 8-2)

SW1	SW2	SW3	SW4	SW5	SW6	SW7
VECTOR BIT	VECTOR BIT	VECTOR BIT	VECTOR BIT	VECTOR BIT	VECTOR BIT	VECTOR BIT
8	7	6	5	4	3	2

EXAMPLE

STANDARD VECTOR 224_8 (094_{16})

BINARY → 010 010 100

BIT # → 876 543 210

SWITCHES SET THESE BITS

1 = OFF

0 = ON

SWITCH 8 (WORD BURST SIZE, 2 or 4)

DEC uses 2 word burst always, SWITCH 8 ON

SWITCHES 9-10 (UNIT SELECT)

SW9	SW10	UNIT #
ON	ON	0
ON	OFF	1
OFF	ON	2
OFF	OFF	3

Figure 2 M7454 Switchpack Settings

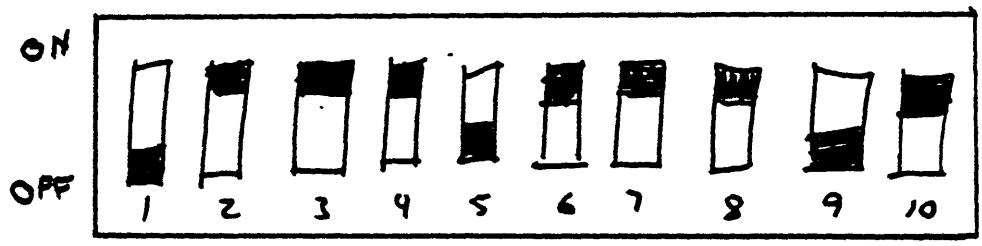


Figure 3 Vector 420_8, Unit Number 2

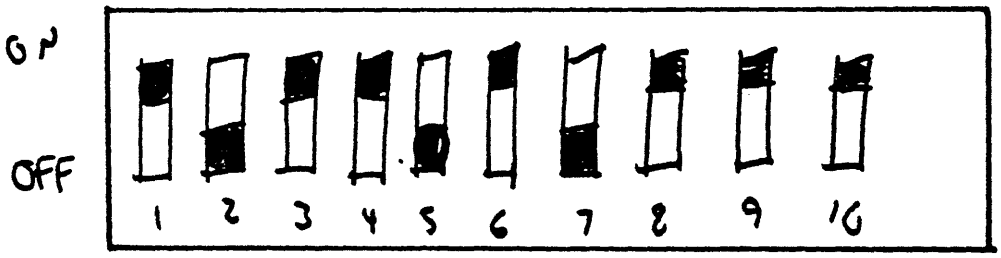


Figure 4 Vector 224_8, Unit Number Ø