cipher®
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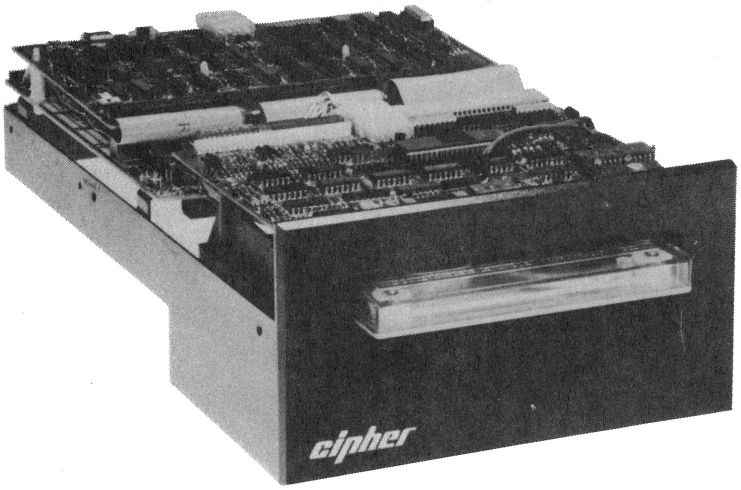
Quarterback™
¼-Inch Cartridge Tape Drive
Maintenance Manual

Volume 1



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RECORD OF REVISIONS

Revision	Description	Date
A	Original Publication	6/82
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SECTION I

GENERAL DESCRIPTION

1.1 INTRODUCTION

This manual contains all data essential to maintain optimum performance of the Series 400 Quarterback™ 1/4-Inch Cartridge Tape Drive, shown in Figure 1-1, manufactured by Cipher® Data Products, Inc., Garden Grove Division. The information is presented in two volumes and in an engineering drawing package. Volume 1 contains the following sections:

Section 1 General Description
Section 2 Installation and Operation
Section 3 Maintenance
Section 4 Fault Isolation

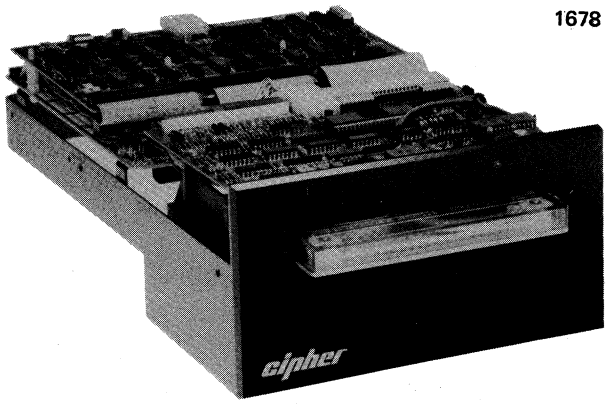

Figure 1-1. Quarterback 1/4-Inch Cartridge Tape Drive

Volume 2 contains the following theory sections:

Section 1 Introduction
Section 2 Magnetic Recording Format
Section 3 Interfacing
Section 4 Function Logic
Section 5 Control Electronics Logic
Section 6 Data Electronics Logic
Section 7 Error Processing and Recovery
Section 8 Reposition Timing

The engineering drawing package contains the following four sections:

Section 1 Logic Schematics
Section 2 Assembly Drawings
Section 3 Master Spare Parts List

NOTE

Where necessary, metric conversion may be easily accomplished by multiplying or dividing, as applicable, by the factors listed in Table 1-1.

Table 1-1. Metric Conversion Factors

From → To ←	→ To ← From	→ Multiply By ← Divide By
Inches	Centimeters	2.54
Inches	Millimeters	25.4
Feet	Meters	0.3048
Feet	Centimeters	30.48
Feet	Millimeters	304.8
Ounces	Grams	28.35
Pounds	Kilograms	0.4536

1.2 RELATED DOCUMENTS

To enhance user knowledge of the Quarterback Tape Drive, the following related documents are available:

Product Description 207102-001
Theory of Operation (Volume 2) 207100-003
Engineering Drawing Package. 207100-002

1.3 SPECIFICATIONS

Specifications for the Quarterback Tape Drive are listed in Table 1-2.

Table 1-2. Quarterback Tape Drive Specifications

Parameter	Characteristics
Data Handling	
Capacity, streaming	20.8 megabytes ± 3%
Number of recording tracks	4
Average streaming write transfer rate	
90 ips	86.70 ± 0.01 kilobytes (kbytes)/second (sec)
30 ips	28.90 ± 0.01 kbytes/sec
Maximum burst data transfer rate	200 kbytes/sec
Average streaming read transfer rate	
90 ips	86.70 ± 0.01 kbytes/sec
30 ips	28.90 ± 0.01 kbytes/sec
Recording form	4-track "serpentine", serialized

Table 1-2. Quarterback Tape Drive Specifications (continued)

Parameter	Characteristics	
Recording code	(0,2) run length limited	
Head type	Read-after-write with separate erase bar	
Mean time between failure (MTBF)	Greater than 3500 hours actual use (30% duty cycle)	
Power Requirements		
DC Voltage	+24 Volts (V) ± 10%	+5V ± 5%
Tolerance includes maximum peak-to-peak ripple of	500 millivolts (mV)	100 mV
Current		
Standby (intelligent)	0.2 Ampere(A) nominal	3.5 A maximum
Standby (basic)	0.1 A nominal	1.0 A maximum
Operating (intelligent)	0.8 A nominal	3.5 A maximum
Operating (basic)	0.8 A nominal	1.0 A maximum
Tape start surge (all models)	2.5 A maximum for up to 300 milliseconds (ms) but may be longer for defective cartridge	Not applicable
Maximum power-on surge (intelligent) through capacitance of:	1250 microfarads (uf)	100 uf
Maximum power-on surge (basic) through capacitance of:	1250 uf	50 uf
Maximum voltage rise time (all models)	100 ms	50 ms
Power sequence (all models)	Turn on + 24 Vdc prior to 5 Vdc or simultaneously	
Power dissiptation (intelligent)	35 Watts (W) typical, 60 W maximum	
Power dissipation (basic)	30 W typical, 50 W maximum	
Dimensions and Weight	Intelligent	Basic
Depth	16.00 inches (in.)	14.00 in.
Width	8.55 in.	8.55 in.
Height	4.5 in.	4.5 in.
Weight	4.0 pounds (lb)	3.0 lb

Table 1-2. Quarterback Tape Drive Specifications (continued)

Parameter	Characteristics
Environmental Requirements	
Operating temperature range	+41 to +95°F (+5 to +35°C)
Nonoperating temperature range	–22 to +140°F (–30 to + 60°C)
Operating relative humidity	20 to 80%, noncondensing
Nonoperating relative humidity	0 to 99%, noncondensing
Operating thermal gradient	1.8°F (1.0°C) per minute
Operating altitude	–200 to 15,000 feet (ft)
Nonoperating altitude	–200 to 50,000 ft

SECTION 2

INSTALLATION AND OPERATION

2.1 UNPACKING AND INSPECTION

The tape drive is shipped in a single, foam-in-place container. Before opening shipping container, inspect it for evidence of in-transit damage. Notify the carrier if damage is evident. Specify nature and extent of damage. To unpack and inspect, see Figure 2-1 and use the following procedure:

a. Place container on floor or workbench, cut side and center tapes that secure box top.

b. Pull box-top flaps down along sides of box. Remove shipping invoice, packing list, and instructions. Lift upper foam block from tape drive, remove tape drive and place on workbench.

c. Verify contents of shipping container by comparing contents with packing list. Notify a Company representative if a packing shortage is evident.

d. Verify serial number of tape drive corresponds with that shown on shipping invoice.

e. Inspect tape drive for physical damage. Notify carrier if damage is evident. Specify nature and extent of damage.

f. Check major component assemblies to determine if any assemblies or screws have been loosened. Tighten any loose screws or mounting hardware. Inspect input/output (I/O) connectors.

2.2 INITIAL CHECKOUT PROCEDURE

Before placing the tape drive in the system, perform the following checkout procedure:

a. Verify resistance between pins J2-1 and J2-2 (24V) power line on both Controller and Main printed wiring board (PWB) assemblies is approximately 4000 Ohms.

b. Verify resistance between pins J2-3 and J2-4 (5V) power line on both Controller and Main PWB assemblies is approximately 180 Ohms.

c. Connect plug P2 from external power supply to connector J2 on Controller or Main PWB (as applicable).

d. Turn on power supply. Verify head moves down, then up to track 0. Head carriage should make audible click at extreme down position. This head motion is an automatic recalibration operation tape drive should perform when power is first applied or when tape drive is reset. Remove power.

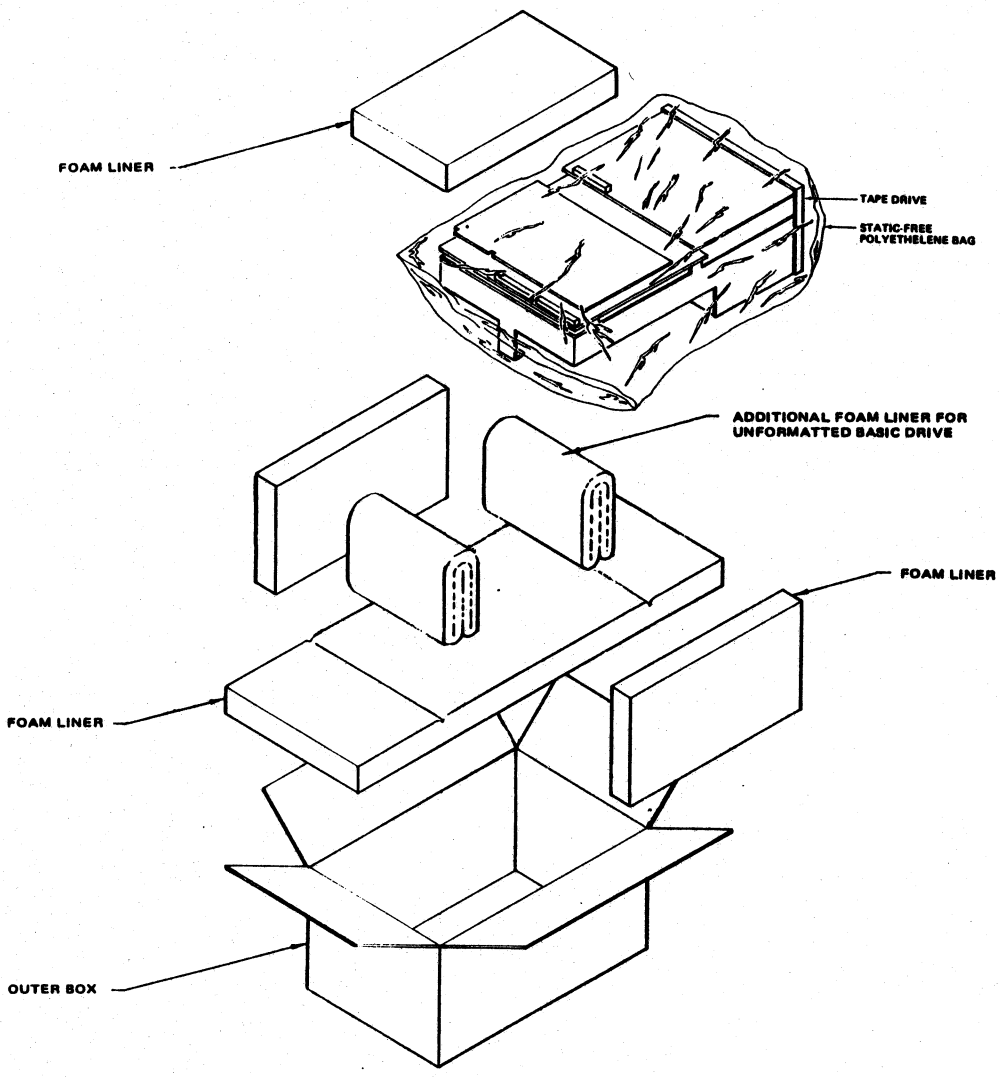

Figure 2-1. Tape Drive Unpacking/Repacking Procedure

2.3 RACK MOUNTING

The tape drive is mounted on a frame similar to a standard eight-inch floppy disk mounting frame. The frame with tape drive may be mounted horizontally or vertically in a standard 19-inch EIA or RETMA rack. Two tape drives may be mounted in a horizontal position or four tape drives may be mounted in a vertical position, as shown in Figure 2-2. Mounting dimensions for the tape drive are shown in Figure 2-3.

CAUTION

Do not mount tape drive in any position that allows material removed by tape cleaner to fall back onto tape surface; i.e., tape surface beneath tape cleaner. Main PWB must face upward in horizontal position or to right in vertical position. Free air flow around the tape drive is required to prevent ambient operating temperature from exceeding 95 degrees F (35 degrees C) during operation. If necessary, forced-air cooling should be used to achieve operating temperature requirements.

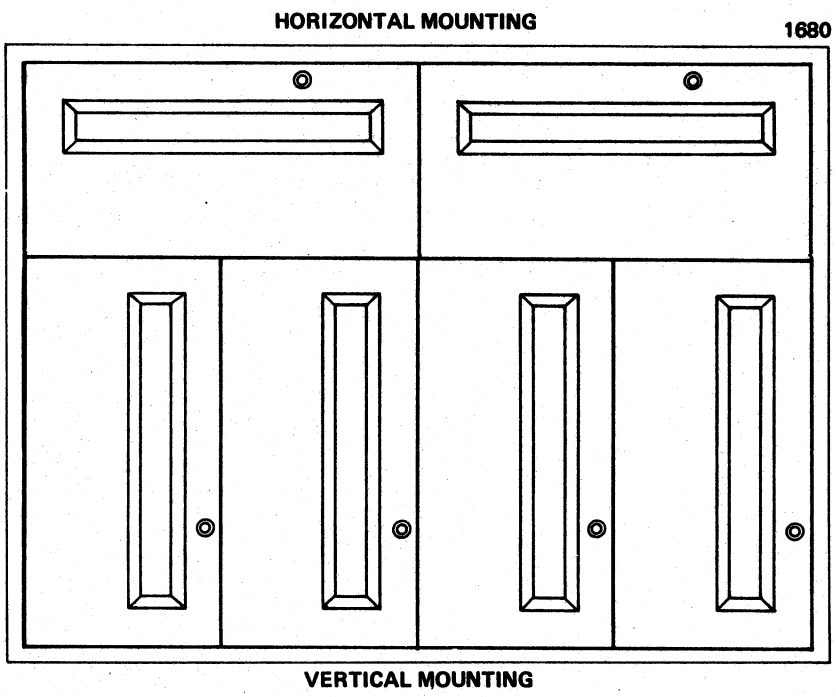

Figure 2-2. Rack Mounting Tape Drive

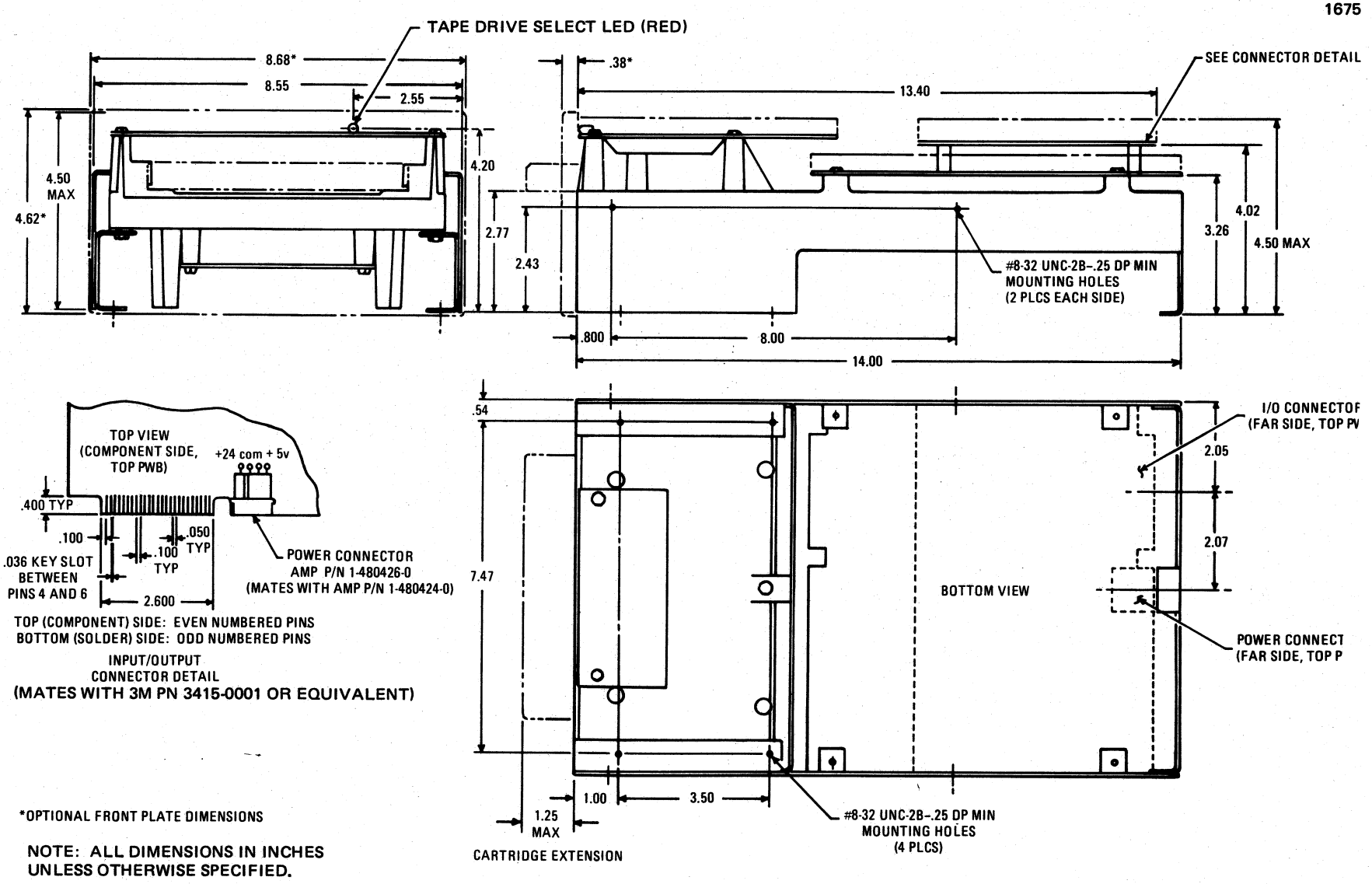

Figure 2-3. Quarterback Tape Drive Mounting Dimensions

The tape drive can be supplied with an optional front panel. The front panel is installed by reversing the steps in paragraph 3.3.1. There is no rear panel. All connections are made directly to the Main PWB on the basic tape drive, or to the Controller PWB on the intelligent tape drive via I/O ribbon cable 50-pin connector J1 and AMP-type power cable 4-pin connector J2.

If the tape drive is being mounted in a dirty environment, ensure that no potential contaminants can enter the tape drive.

2.4 INTERFACE

Interface connections from the host central processor unit (CPU) consist of a power interface and a signal interface.

2.4.1 POWER INTERFACE

The DC power interface is connected to connector J2 on the Controller PWB of the intelligent tape drive (and to connector J2 on the Main PWB of each slave basic tape drive, if multiple tape drives are interconnected by daisy chaining). Connector J2 is a four-pin AMP-type 1-480426-0 plug that mates with an AMP-type 1-480424-0 jack that contains AMP-type 60619-1 female contact pins. DC power requirements are listed in Table 2-1.

Table 2-1. DC Power Requirements

J2 Pin	DC Volts	Tolerance (Including Ripple)	Current	Maximum Ripple Peak-to-Peak
1	+ 24 Vdc	± 10%	2.5A Surge up to 300 ms 1.7A Maximum 0.8A Nominal	500 mV
2	+24 Vdc Return			
3	+5 Vdc Return			
4	+5 Vdc	± 5%	3.5A Maximum	100 mV

2.4.2 SIGNAL INTERFACE

The signal interface is connected to connector J1 on the Controller PWB of the intelligent disk drive (and to connector J1 on the Main PWB of each slave basic tape drive, if multiple tape drives are interconnected by daisy chaining). Connector J1 is a 3M-type 3415-0001 50-pin PWB edge connector. All even-numbered pins are on the component side of the PWB. All odd-numbered pins are connected to signal ground (GND) in the formatter and should be connected to GND in the CPU. A key slot is located between pins 4 and 6 to ensure correct connection.

All signals from the tape drive formatter to the CPU, and from the CPU to the formatter are carried at the following TTL levels:

FALSE	Logic 0 (high)	= + 2.00 to + 5.25 Vdc
TRUE	Logic 1 (low)	= 0.00 to + 0.80 Vdc

Signal interface TTL levels can be measured on connector P1/J1. The signals on the tape drive side of the interface are terminated with 180 Ohms to +5 Vdc and 390 Ohms to ground. The signals on the host CPU side of the interface should be terminated with 220 Ohms to +5 Vdc and 330 Ohms to ground. Control signals from CPU to formatter are terminated in the formatter. Control signals from formatter to CPU must be terminated in the CPU. The bidirectional data lines are terminated in the formatter and must also be terminated in the CPU. A typical driver/receiver termination configuration is shown in Figure 2-4. I/O signal pin assignments are listed and described in Table 2-2, and the physical interface is shown in Figure 2-5.

2.5 DAISY CHAINING

An intelligent tape drive may be daisy chained with up to three basic tape drives of the same tape speed in either of two configurations to allow operation of up to four tape drives with one formatter. In Figure 2-6, the formatter and the last tape drive in the daisy chain contain the driver/receiver terminator for the multiple tape drive operation. In Figure 2-7, driver/receiver terminators are located in the formatter and in tape drives 0 and 3. In either configuration, the recommended daisy-chain cable connector is a 50-pin 3M-type 3415-0001.

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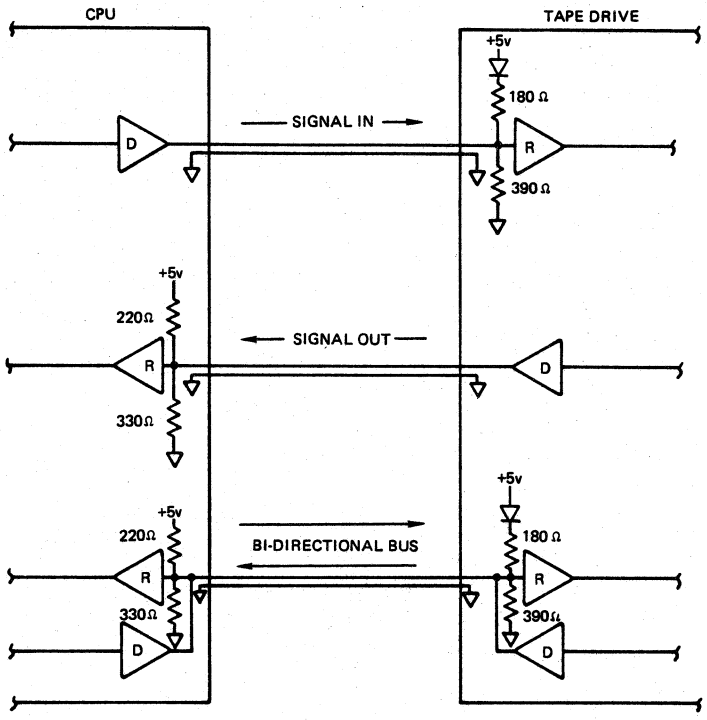

Figure 2-4. Line Driver/Receiver Terminations

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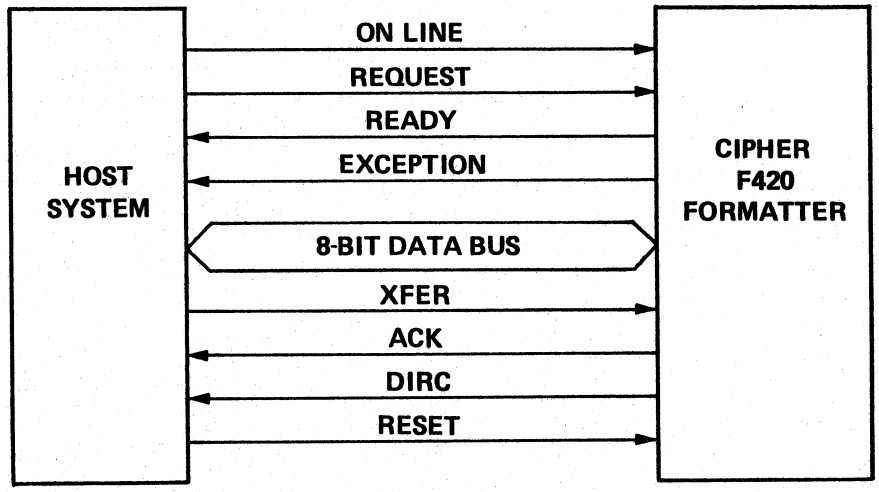

Figure 2-5. Physical Interface Between CPU and Formatter

Table 2-2. Input/Output Pin Assignments

All odd pins are signal returns, connected to signal GND at the formatter. They should also be connected to signal GND at the CPU. Letters in the "To" column have the following meanings:

X = UNDEFINED
B = BIDIRECTIONAL DATA BUS
F = FORMATTER
C = CPU

All signals described are low-active.

J1 Pin Number	Mnemonic Term	To	Signal Description
02	SPR	X	SPARE – Spare signal line.
04	SPR	X	SPARE – Spare signal line.
06	SPR	X	SPARE – Spare signal line.
08	RSV	X	RESERVED for future use.
10	RSV	X	RESERVED for future use.
12	HB7	B	CPU BUS BIT 7 – MSB
14	HB6	B	CPU BUS BIT 6
16	HB5	B	CPU BUS BIT 5
18	HB4	B	CPU BUS BIT 4
20	HB3	B	CPU BUS BIT 3
22	HB2	B	CPU BUS BIT 2
24	HB1	B	CPU BUS BIT 1
26	HB0	B	CPU BUS BIT 0 – LSB
28	ONL	F	ON LINE – CPU-generated control signal which is activated before transferring a Read or Write command and deactivated to terminate that Read or Write command.
30	REQ	F	REQUEST – CPU-generated control signal which indicates command data has been placed on data bus in Command mode or that status report has been taken from data bus in Status Input mode.
32	RST	F	RESET – Causes formatter to perform same initializing sequence as Power-On sequence.

8-Bit Bidirectional Data Bus

Table 2-2. Input/Output Pin Assignments (continued)

J1 Pin Number	Mnemonic Term	To	Signal Description
34	XFR	F	TRANSFER – CPU-generated control signal which indicates data has been placed on data bus in the Write mode or that data has been taken from data bus in the Read mode.
36	ACK	C	ACKNOWLEDGE – formatter-generated signal which indicates data has been taken from data bus in the Write mode or that data has been placed on data bus in the Read mode.
38	RDY	C	READY – formatter-generated signal which indicates one of the following conditions is present: a. Data has been taken from the data bus in Transfer command mode. b. Data has been placed on the data bus in Status Output mode. c. A command has been successfully completed. d. In the Write mode, a buffer is ready to be filled by the CPU, or a Write File Mark (WFM) command can be issued . e. In Read mode, a buffer is ready to be emptied by the CPU, or a Read File Mark (RFM) can be issued. Otherwise, formatter is ready to receive a new command.
40	EXC	C	EXCEPTION – formatter-generated signal which indicates an Exception condition exists in the formatter, and that the CPU must determine the cause by issuing a Read Status command and performing a Status Input function.

Table 2-2. Input/Output Pin Assignments (continued)

J1 Pin Number	Mnemonic Term	To	Signal Description
42	DIRC	C	DIRECTION – formatter-generated signal. False level causes CPU data bus drivers to assert their data bus levels and formatter data bus drivers to assume high-impedance states. True level causes CPU data bus drivers to assume high-impedance states and formatter data bus drivers to assert their data bus levels.
44	SPR	X	SPARE – Spare signal line.
46	SPR	X	SPARE – Spare signal line.
48	SPR	X	SPARE – Spare signal line.
50	SPR	X	SPARE – Spare signal line.

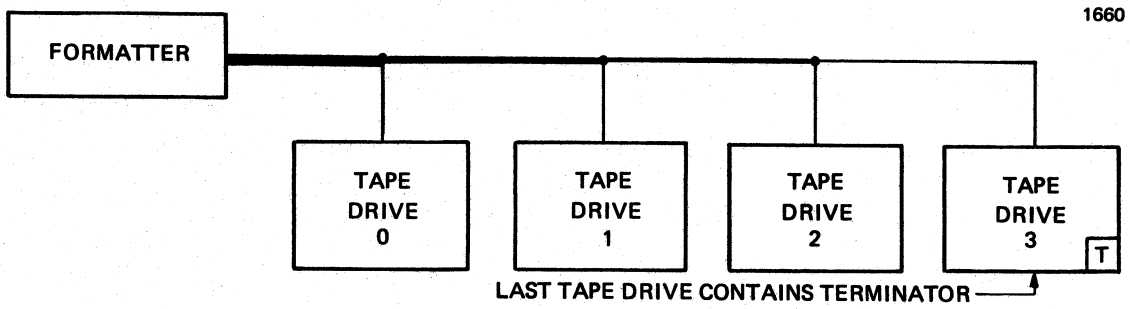

Figure 2-6. Daisy-Chain Configuration, Method 1

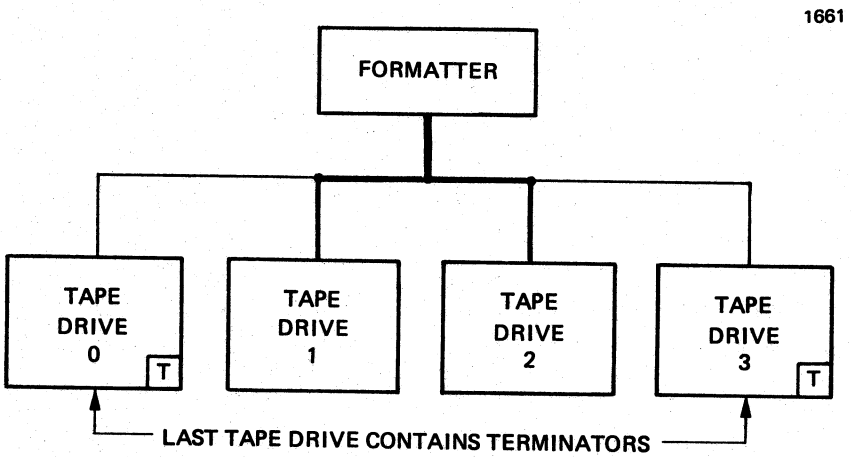

Figure 2-7. Daisy-Chain Configuration, Method 2

2.5.1 MULTIPLE TAPE DRIVE ADDRESS SHUNT

A 14-pin shunt, at location 2B on the Main PWB of the basic tape drive, can be jumpered, as shown in Figure 2-8, to allow the CPU to select each specific basic tape drive in the daisy chain through software control.

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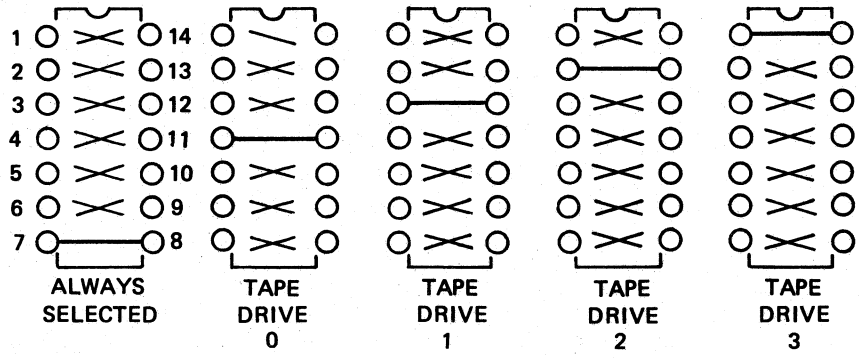


Figure 2-8. Multiple Tape Drive Address Shunt

2.6 CARE AND HANDLING OF TAPE CARTRIDGES

Handlers of magnetic tape cartridges should never open the tape access cover to expose the tape when the cartridge is not in use, and should never touch the tape. Touching the tape surface can contaminate the magnetic coating, or bits of the magnetic coating may be dislodged.

Dislodged magnetic coating results in two possibilities of data errors:

a. The area from which the magnetic coating has been removed can no longer accept data when it is written in that area, and conversely, data cannot be recovered from that area.

b. Redepositing of the loose bits of ferrous oxide coating may occur at some other location where they can cause the tape to be lifted from the head while passing over the head. This condition also causes improper writing or reading of data.

The tape cartridge should give long and reliable service if properly handled; i.e., no abrupt motions that could distort tape position, or hard impacts that could damage the plastic cover. Broken, chipped, or cracked cartridges should be discarded immediately.

CAUTION

Any attempt to use a damaged cartridge may damage tape drive.

2.6.1 CARTRIDGE LOADING

Depends on drive orientation. Hold tape cartridge with metal plate facing down or to right; i.e., facing away from LED indicator of tape drive in down or right direction, and with tape access door (in cartridge) facing cartridge loading slot in front of tape drive. Insert cartridge in slot and push to a hard stop.

CAUTION

Never attempt to remove cartridge when tape drive SELECTED indicator (red LED at front of tape drive) is lit. Damage to tape or cartridge could result from such an attempt.

2.6.2 CARTRIDGE UNLOADING

Verify SELECT indicator is not lit, then pull cartridge from slot in front of tape drive.

2.6.3 CARTRIDGE STORAGE

When tape cartridges are not in use, they should be stored under temperature and humidity conditions prescribed by the tape cartridge manufacturer. Tape cartridges should never be stored or placed near electric motors, transformers, or any other devices that generate strong magnetic fields.

SECTION 3

MAINTENANCE

NOTE

The information contained in this manual is not to be used as criteria for equipment acceptance verification. This manual is to be used in making field service replacements and/or adjustments.

3.1 INTRODUCTION

Before any Quarterback Tape Drive leaves the factory, each of its components has been thoroughly tested and all adjustments have been made to ensure reliable operation. Careless handling in transit or the effect of long use may necessitate replacement of some parts or readjustment of some components.

When repairs are needed, telephone one of the Cipher Data Products Repair Centers at (714) 891-3711 in the United States or 0276-682912 in Europe and ask for a Return Material Authorization (RMA) number. Be prepared to provide your Quarterback's model number and serial number, the reason for the return, and your purchase order number. A Quarterback in need of repair must be shipped postpaid in its original carton to:

CIPHER DATA PRODUCTS, INC.
OEM Marketing Division, Customer Service
7221 Orangewood Avenue
Garden Grove, CA 92641

OR

CIPHER DATA PRODUCTS, INC.
Repair Center
Compton Place, Surrey Avenue
Camberly, Surrey GU153DX
England

Table 3-1 lists a basic set of maintenance tools and supplies required for regular servicing of the tape drive. As the table suggests, some supplies should also be available to the operator for daily or shift-end cleaning. Oscilloscopes, probes, and meters must be maintained in calibration to manufacturer's specifications.

Table 3-1. Recommended Tools and Test Equipment

FOR THE OPERATOR			
Item	Supplier	Part No.	Quantity
Foam Floss Swabs	Texwipe Co. 51 Prospect Pl., P.O. Box 278 Hillsdale, NJ 07642	TX700 TX700B	50 500
Tape Transport Cleaner	IBM	453511	1
Cotton Swab, 6 in. long	Nortronics Co., Inc. Recorder Care Division 8101 Tenth Avenue North Minneapolis, MN 55427	QM502	100
Cleaning Swab, Foam, 6 in. long	Nortronics Co., Inc. Recorder Care Division 8101 Tenth Avenue North Minneapolis, MN 55427	QM505	25

FOR THE SERVICE ENGINEER	
Equipment	Model or Type
Socket wrench set	For 4-40, 6-32, 8-32, and 10-32 cap screws
Socket wrench set	For 4-40, 6-32, and 10-32 set screws
Open-end wrench	For 7/16-in. bolts
Long-nose pliers	
Screwdriver set	Standard blade
Screwdriver set	Phillips
Allen driver, 6-in. shank	For 3/32-in. socket

Table 3-1. Recommended Tools and Test Equipment (continued)

FOR THE SERVICE ENGINEER	
Equipment	Model or Type
Soldering aid	_____
Soldering iron	_____
Voltohmmeter (VOM)	Triplett Model 800, or equivalent
Oscilloscope	Tektronix Model 465B, or equivalent
X10 oscilloscope probes (3)	
Master Track Alignment Cartridge	
Master Azimuth Alignment Cartridge	
Scratch Cartridge 1/4-in.	Cipher P/N 160601-433
Wire feeler gauge set	For 0.40 gap measurement
Zenith Alignment Tool	Cipher P/N T-01288
Basic Tape Driver Exerciser	Cipher Model BE101
Stepper Motor Exerciser	Cipher Model
Host computer with diagnostic program	As applicable

3.2 PREVENTIVE MAINTENANCE

Table 3-2 offers a recommended schedule for preventive maintenance. Some of these functions are the responsibility of the tape drive operator; procedures for performing them are described in paragraphs 3.2.1 and 3.2.2. In addition to regular maintenance tasks performed by the operator, this section describes preventive maintenance tasks that must be performed by a service engineer in conjunction with the repair procedures for any assembly to which they pertain.

In the pages that follow, instructions are provided for replacements, readjustments, and fault isolation aids that can prove effective while the tape drive remains installed in the customer's computer system. The maintenance instructions are organized in terms of subassembly units. Some tasks of repair require test equipment not normally available in the field, or special alignment and adjustment tools that are not available to field engineers. Instructions for repair of this more complex kind are NOT included in this manual.

Table 3-2. Recommended Preventive Maintenance

Performed By	Maintenance Task	Interval (In Operating Hours)	Procedure Described In
Operator	Clean head and tape cleaner	8	Para 3.2.1.1
	Clean and check condition of capstan surface	8	Para 3.2.1.2
	Eliminate Tape Tension	As required	Para 3.2.2
Service Engineer	Check Track and Azimuth Alignment	2000	Para. 3.4.1 – 3.4.1.6

WARNING

VERIFY POWER IS OFF BEFORE CLEANING. ELECTRICAL SHOCK OR EQUIPMENT DAMAGE MAY OCCUR IF BODY PARTS OR JEWELRY TOUCHES ELECTRICAL CONDUCTORS WHILE POWER IS ON.

3.2.1 CLEANING

Proper and regular cleaning of the tape drive is necessary to keep the tape drive free of dirt or contaminants. At the high density of data on tapes written or read with the Quarterback Tape Drive, extremely small particles of dust or loose oxide from the tape are capable of causing data errors. See Figure 3-1. Careful attention to the cleaning procedures described here can ensure the greatest possibility of trouble-free operation.

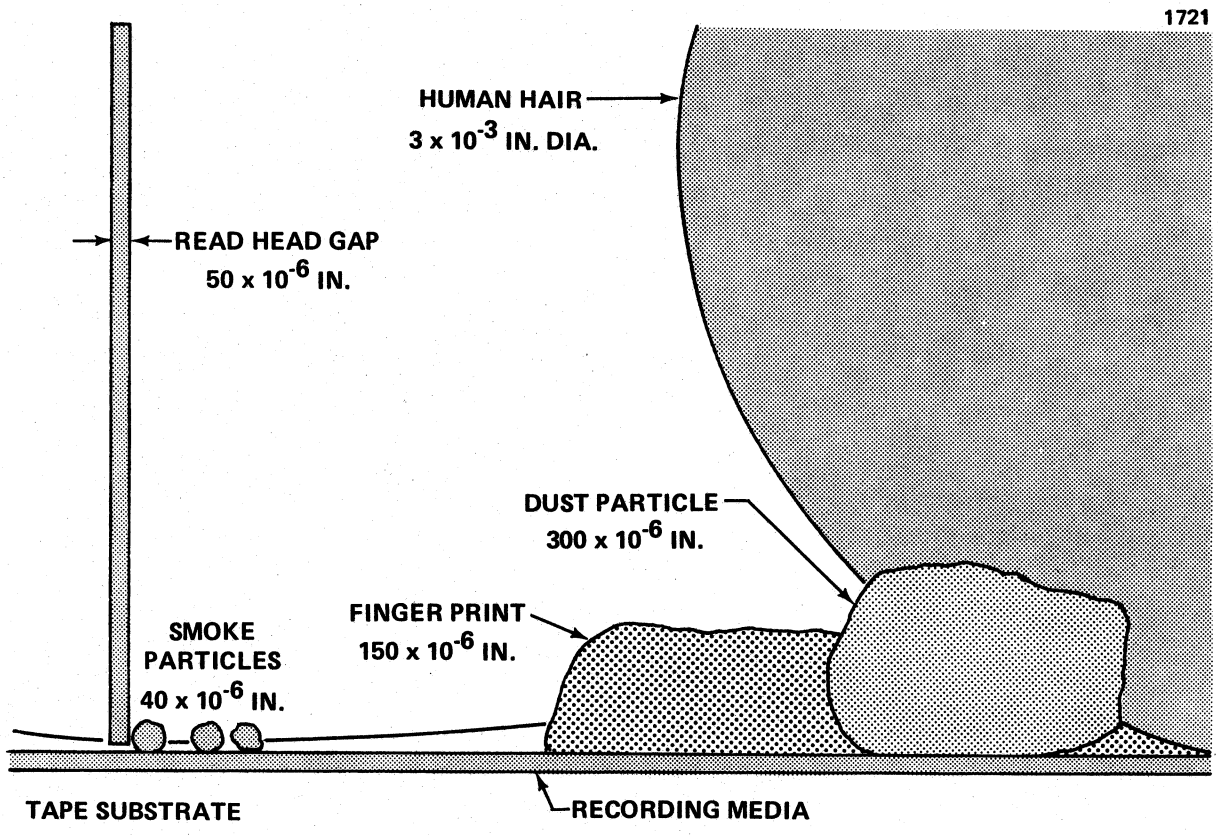


Figure 3-1. Contamination Particle Sizes in Relation to Width of Read Head Gap

3.2.1.1 Head Assembly and Tape Cleaner

The read-after-write head and tape cleaner should be cleaned after the first two hours of tape motion on a new cartridge. Normal cleaning, when not using new cartridges, should be performed after every eight hours of tape motion. To clean head assembly and tape cleaner, see Figure 3-2 and use the following procedure:

a. Turn off system power.
b. Unload tape cartridge, if still in tape drive.
c. Moisten lint-free swab with IBM cleaner (see Table 3-1) and swab head surface. Dry head surface with clean, lint-free swab.
d. Clean tape cleaner blades by using same procedure described in step a. Also remove accumulated oxide residue from cavity between blades.

3.2.1.2 Capstan

To clean the capstan, see Figure 3-3 and use the following procedure:

a. Turn off system power.
b. Unload tape cartridge, if still in tape drive.
c. Moisten lint-free swab with distilled water and swab capstan surface while manually rotating capstan. Do not touch capstan rubber surface with fingers.
d. Visually inspect capstan for abrasion or polish; if defects are observed, consult service engineer.
e. Dry capstan with a clean, lint-free swab.

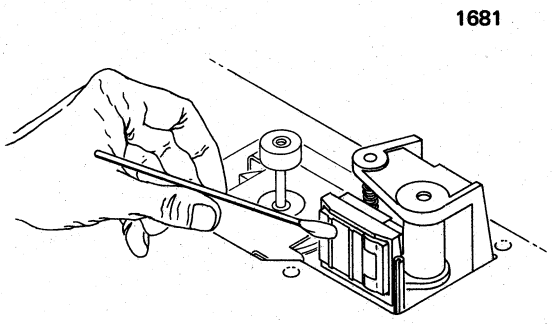


Figure 3-2. Head Assembly and Tape Cleaner Cleaning

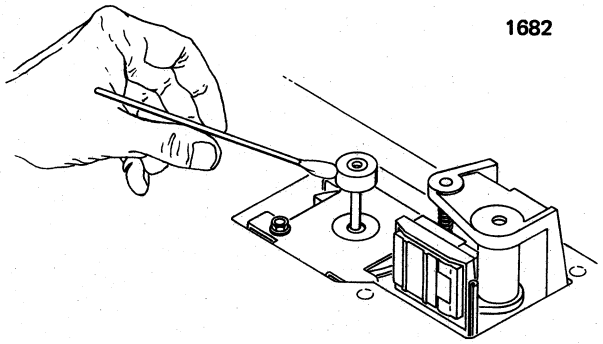


Figure 3-3. Capstan Cleaning

3.2.2 ELIMINATING TAPE TENSION

Excessive tape tension can build up on a tape cartridge if numerous Read Retry or Rewrite operations are performed, or if numerous short records or files are being read. A short record or file is one which does not exercise the tape from beginning of tape (BOT) to end of tape (EOT). This tape tension build up always happens whenever the records or files use very short amounts of tape footage.

To relieve the excessive tension built up in a cartridge, it is necessary to exercise the cartridge with a Retension cycle. A Retension cycle consists of the tape running from BOT to EOT and back to BOT with no intermediate stops. Two Retension cycles are recommended to condition a tape cartridge for optimum performance.

The Retension cycle should be considered whenever any one of the following conditions is experienced:

a. Cartridge is to be used for first time.
b. Cartridge has been stored for two weeks or longer.
c. Cartridge has had 20 short records or files written or read.
d. Cartridge has had a retry count and excessive tension is suspected.

3.3 REMOVAL AND REPLACEMENT PROCEDURES

The following paragraphs describe the procedures required for removal of assemblies and subassemblies for servicing or replacement in the Quarterback tape drive. To install an assembly or subassembly, simply reverse the order of the steps in the removal procedure.

WARNING

SYSTEM POWER MUST BE TURNED OFF BEFORE REMOVING ANY ASSEMBLY FROM THE QUARTERBACK TAPE DRIVE.

CAUTION

To unplug a connector, force must be applied only to the connector body. Pulling on wires attached to a connector can result in damage to wires or connector pins. When connecting a keyed plug to a keyed connector, verify that keying is aligned properly.

3.3.1 FRONT PANEL

The front panel is an optional accessory. To remove the front panel, see Figure 3-4 and use the following procedure:

a. Loosen, but do not remove, two screws that hold front of Main PWB to chassis.
b. Loosen, but do not remove, two screws that hold Motor Driver PWB to chassis.

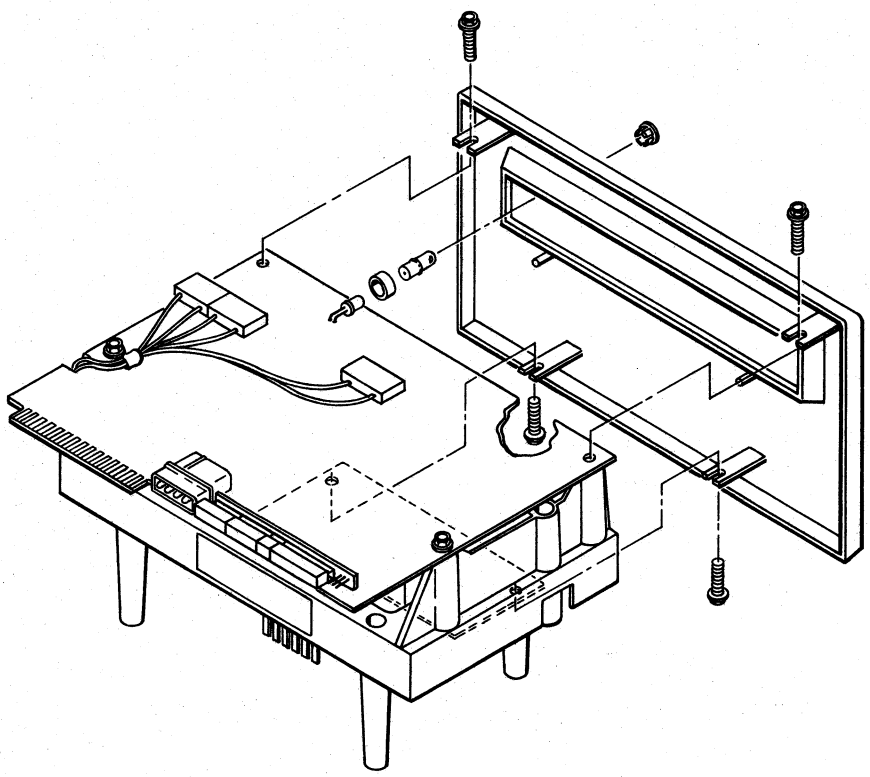


Figure 3-4. Front Panel Removal

c. Grasp front panel and gently pull directly away from front of tape drive.
d. Tighten screws loosened in steps a and b.

3.3.2 BASIC TAPE DRIVE

To remove the basic tape drive from the mounting frame, see Figure 3-5 and use the following procedure:

a. Disconnect plugs J1 and J2 from connectors J1 and J2, respectively, on Main PWB.
b. Remove three screws that hold basic tape drive chassis to mounting frame.
c. Lift basic tape drive assembly off mounting frame.

3.3.3 MAIN PWB

To remove the Main PWB from the basic tape drive chassis, see Figure 3-6 and use the following procedure:

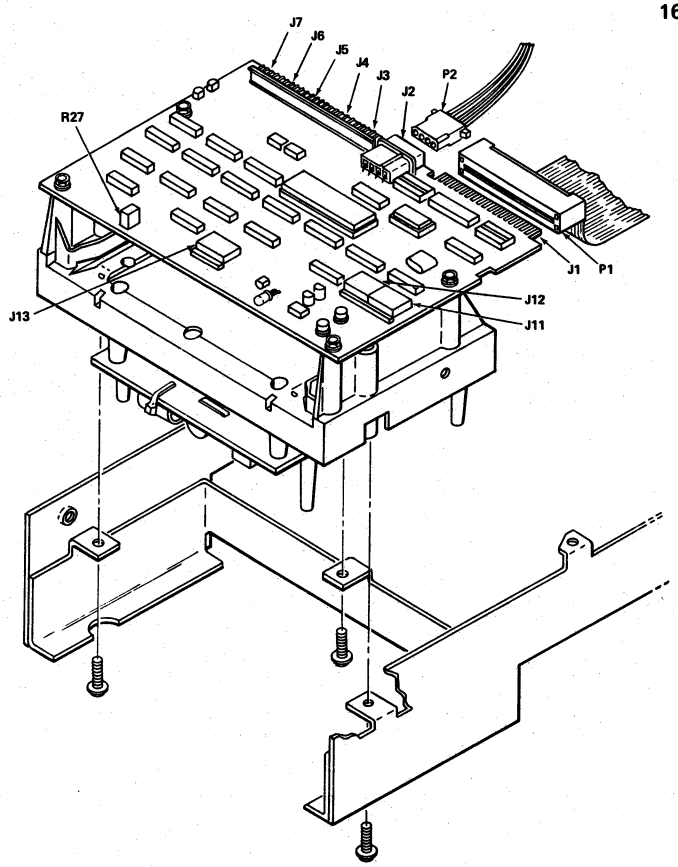


Figure 3-5. Basic Tape Drive Removal

a. Disconnect plugs P1, P2, P3, P4, P5, P6, P11, P12, and P13 from respective connectors J1, J2, J3, J4, J5, J6, J11, J12, and J13 (J7 is a spare) on Main PWB.
b. Remove four screws (two each side) that hold Main PWB to chassis.
c. Lift Main PWB away from chassis.

3.3.4 MOTOR DRIVER PWB

To remove the Motor Driver PWB from the basic tape drive chassis, see Figure 3-7 and use the following procedure:

a. Remove two screws that hold Motor Driver PWB to chassis.
b. Disconnect plug P8 from connector J8 on Motor Driver PWB.
c. If 90 ips tape drive, disconnect plug P4 from connector J4 on Main PWB and carefully pass plug P4 through chassis.

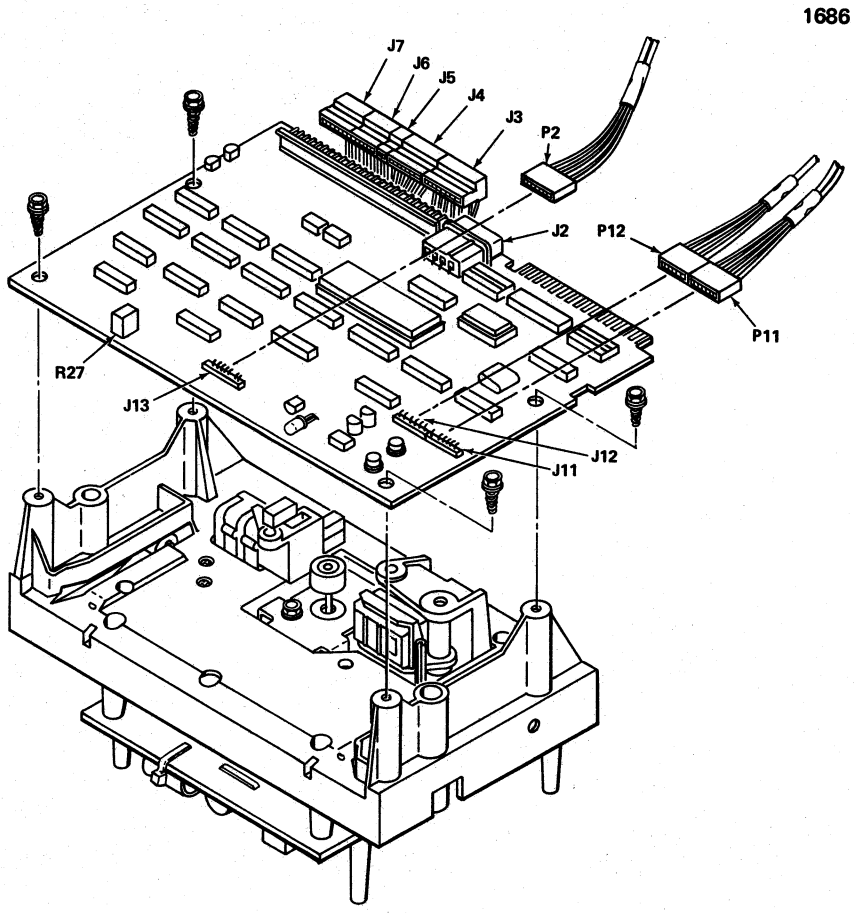


Figure 3-6. Main PWB Removal

d. If 30 ips tape drive, unsolder leads from Zener diode, mounted on bracket next to Motor Driver PWB. Disconnect plug P4 from connector J4 on Main PWB and carefully pass plug P4 through chassis.

e. When plug P4 is clear of chassis, carefully lift Motor Drive PWB away from chassis.

3.3.5 FORMATTER/CONTROLLER PWB

The Formatter/Controller PWB is used only on the intelligent tape drive. It consists of two PWB assemblies, hard-wired together by two 50-pin flat ribbon cables, and is separated by five plastic standoffs. The bottom PWB assembly contains a Microcomputer Expander PWB assembly which plugs into connector J10 near the right

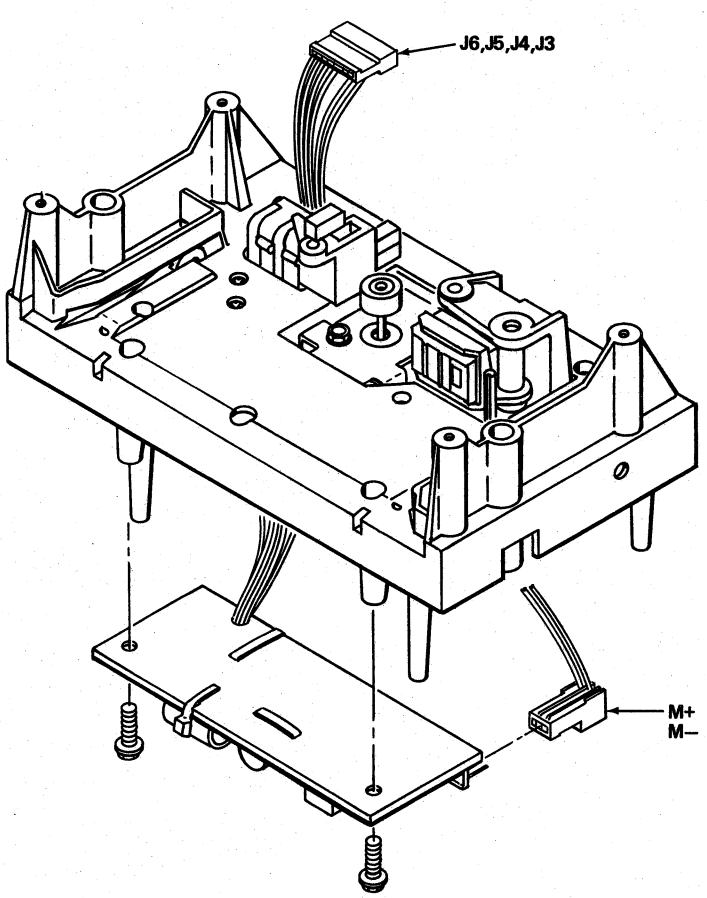


Figure 3-7. Motor Driver PWB Removal

rear corner, as viewed from the front of the tape drive. These three PWB assemblies are to be considered an integrated unit and are mounted on the mounting frame at the rear of the tape drive. To remove them, see Figure 3-8 and use the following procedure:

a. Disconnect P1 and P2 from respective connectors J1 and J2 on Main PWB.
b. Disconnect P1 and P2 from respective connectors J1 and J2 on upper PWB of Formatter/Controller PWB assembly.
c. Remove four screws (two each side) that hold lower PWB of Formatter/Controller PWB assembly to mounting frame.
d. Lift Formatter/Controller PWB assembly away from mounting frame.

3.3.6 MICROCOMPUTER EXPANDER PWB

To remove the Microcomputer Expander PWB from the Formatter/Controller PWB assembly, see Figure 3-9 and use the following procedure:

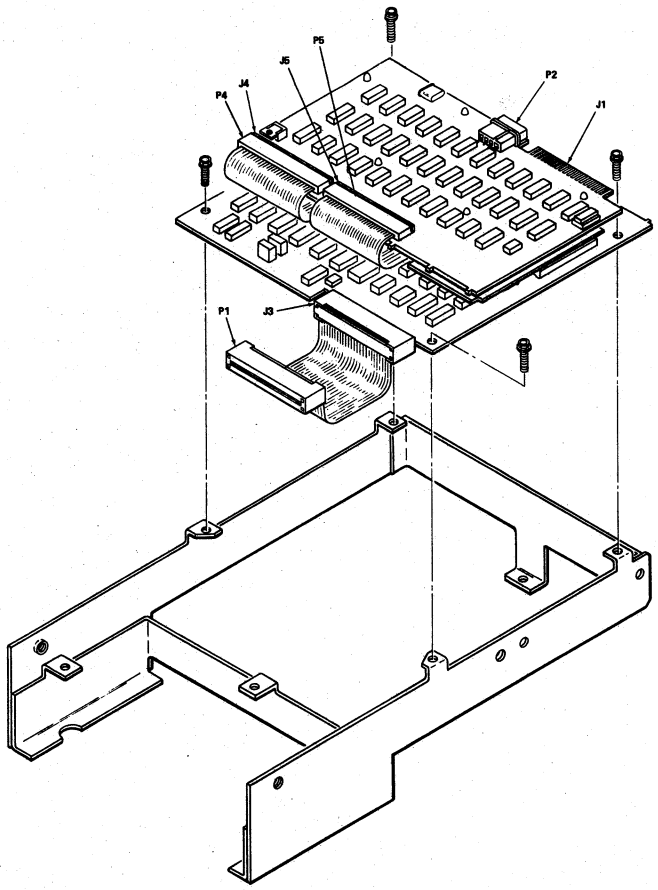


Figure 3-8. Formatter/Controller PWB Removal

a. Gently pull upper PWB of Formatter/Controller PWB assembly from five supporting standoffs and rotate PWB toward rear of tape drive. Do not attempt to remove ribbon cable connectors hard-wired to the PWB assembly. Lift off plastic insulator sheet.

b. Gently remove Microcomputer Expander PWB plug P10 from integrated circuit (IC) connector 2EF on lower PWB of Formatter/Controller PWB assembly.

3.4 ADJUSTMENT AND ALIGNMENT PROCEDURES

The Quarterback tape drive has been adjusted and aligned at the factory for optimum performance and interchangeability. Any adjustment or alignment problems that might occur require special tools and test equipment that is not likely to be available to the user.

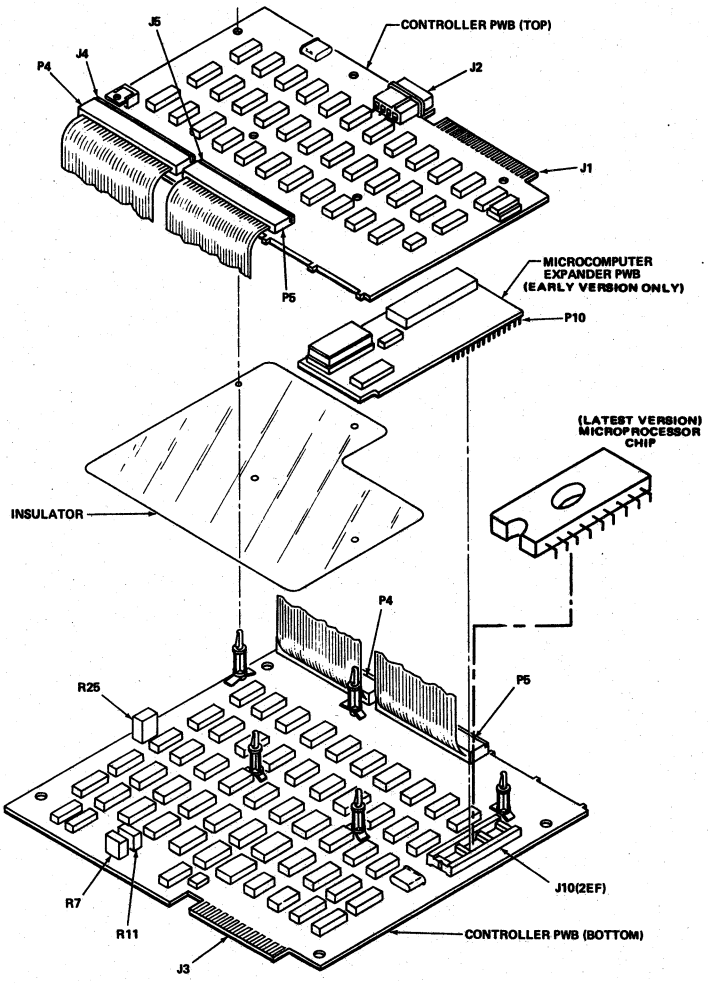


Figure 3-9. Microcomputer Expander PWB Removal

CAUTION

Alignment and adjustment procedures referenced here are to be performed by **ONLY** technicians at authorized Cipher Data Products Repair Centers.

3.4.1 TRACK AND AZIMUTH ALIGNMENT

The Track and Azimuth Alignment procedures are intended for use in aligning the read-after-write head in the tape drive to the correct position over the tape tracks, and in setting the gap line in the read-after-write head assembly to an acceptably small angular misalignment so that tape media can be interchanged between tape drives without loss of read/write capability. These procedures require the use of the Basic Exerciser 101

(BE101) and the Stepper Motor Exerciser (SME). The control panels for these exercisers are shown in Figure 3-10. Track and azimuth alignment is performed by using the following six procedures:

a. Zenith Alignment Check and Adjustment
b. BOT/EOT Checkout
c. Preliminary Track Alignment
d. Azimuth Alignment
e. Final Track Alignment
f. Final Track Alignment Check

The Track and Azimuth Alignment procedures must be performed in the sequence listed here.

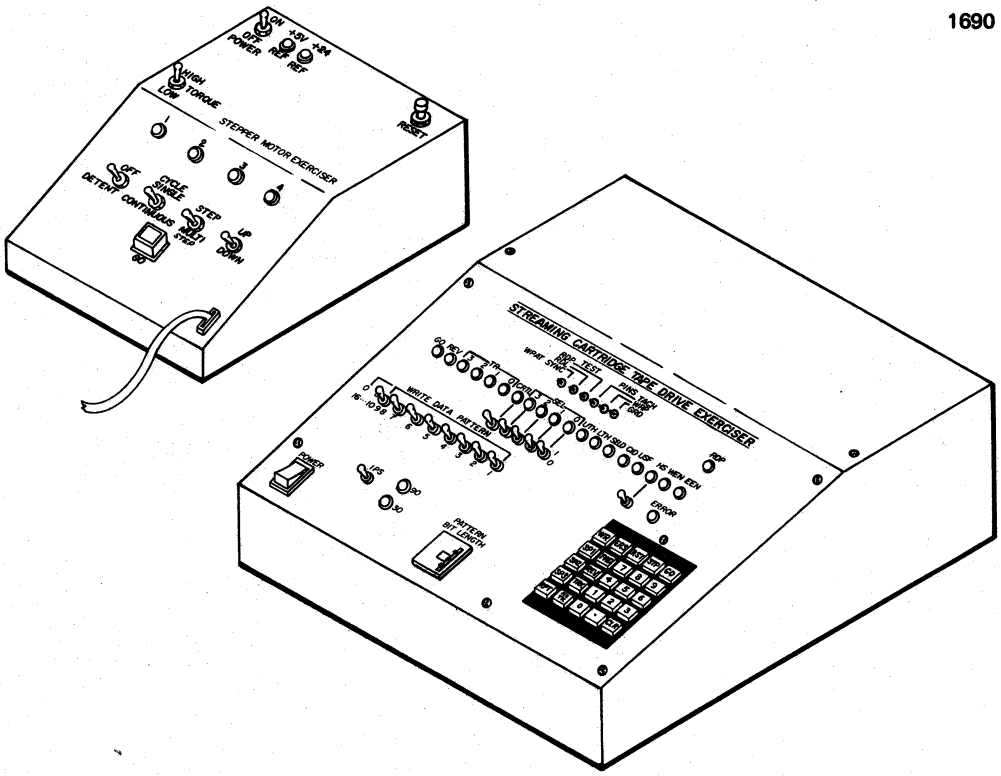


Figure 3-10. BE101 and SME Control/Indicator Panels

3.4.1.1 Zenith Alignment Check and Adjustment

Before testing and aligning tape drive track and azimuth, verify zenith alignment of head on tape drive by using the following procedure:

a. Unplug P3 from J3 of Main PWB.

b. Plug P3 into J3 of SME.

c. Set up the following switches on the SME:

   1. DETENT switch to "OFF"
   2. CYCLE switch to "SINGLE"
   3. STEP switch to "MULTI"
   4. DIRC switch to "UP"

d. Press "GO" switch on SME. Head should move up in 48 step increment. Press "GO" once more to assure that head/carriage assembly is in its fully UP position.

e. Set STEP switch to "SINGLE".

f. Set DIRC switch to "DOWN".

g. Press "GO" switch fifty (50) times. Head/Carriage assembly should single step down each time "GO" is pressed. Count can be verified by observing LED lamps 1 through 4 on SME. The head assembly is now centered.

NOTE

Verify that the reference/mounting nut on the head/carriage assembly is properly tightened before continuing with Zenith Alignment.

h. Load zenith alignment tool in tape drive cartridge slot in same way cartridge is loaded. When zenith alignment tool reaches hard stop, indicator should point between +15 and −15 minutes of arc shown in Figure 3-11.

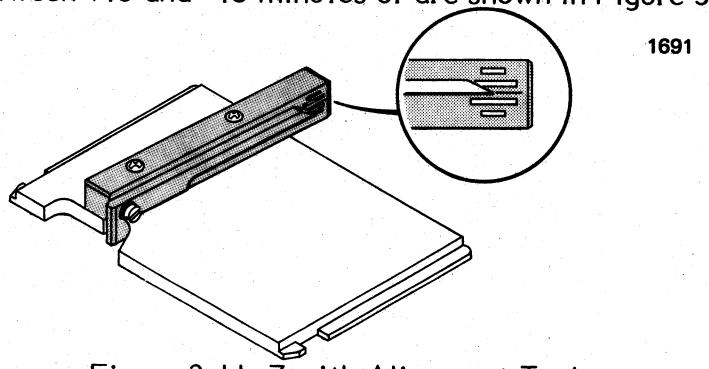


Figure 3-11. Zenith Alignment Tool

i. If indicator point is not between ± 15 minutes angular tolerance lines on zenith alignment tool, adjust rear jackscrew, shown in Figure 3-12, until the indicator point is as close to 0 minute as possible. To adjust jackscrew,

loosen screw that holds rear jackscrew in place. Tension should remain present on jackscrew due to Belleville springs, but jackscrew should be loose enough to be adjusted. When properly adjusted with indicator pointing between $\pm$ 15 minutes angular tolerance limits, zenith alignment is completed. When proper zenith alignment has been verified, and jackscrew tightened, verify zenith alignment and remove zenith alignment tool.

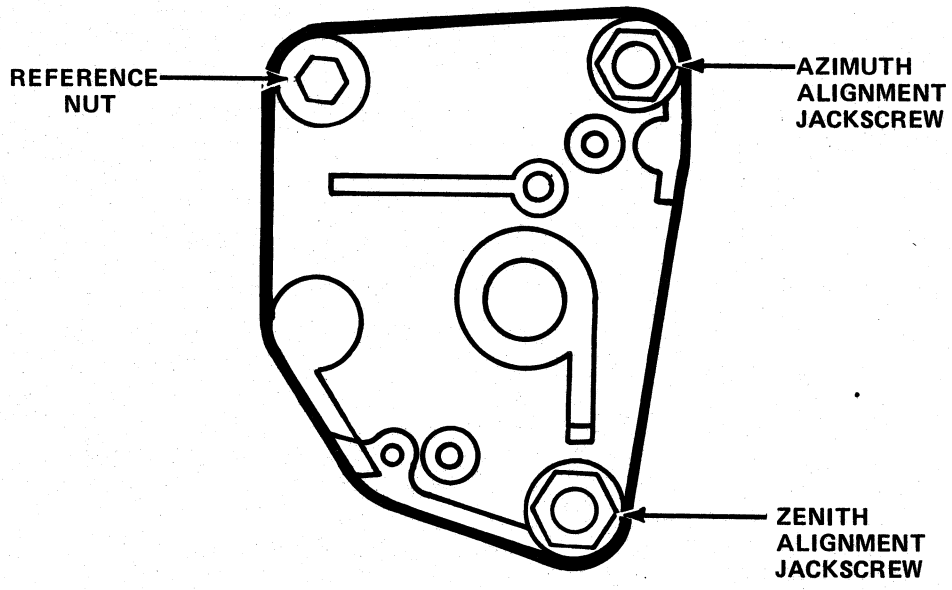


Figure 3-12. Jackscrew Locations on Head Carriage Assembly

3.4.1.2 BOT/EOT Checkout

To check beginning of tape (BOT) and end of tape (EOT) circuits and indicator functions, see Figure 3-10 and use the following procedure:

a. Prepare tape drive for testing and alignments by making the following cable connections:

   1. BE101 plug P2A to Main printed wiring board (PWB) jack J2.
   2. BE101 plug P1 to Main PWB jack J1.
   3. BE101 plug P2B to SME jack J2.
   4. SME plug P3 to tape drive stepper motor jack J3.

b. Manually align UTH and LTH holes on tape in safe BOT/EOT scratch cartridge to be on top of left guide roller.

c. Place POWER switch on both Exercisers in ON position.

d. Load safe BOT/EOT scratch cartridge in tape drive.

e. Turn exposed "ear" on cartridge counterclockwise (ccw) until UTH and LTH indicators on BE101 are lit. Verify Unsafe (USF) indicator on BE101 is not lit.

f. Unload (remove) safe BOT/EOT scratch cartridge from tape drive. Load scratch cartridge.

g. Press CLR, FWD, and GO pushbuttons on BE101 and run tape to EOT; verify tape motion stops and that LTH indicator is lit. Press REV and GO pushbuttons on BE101 and run tape to BOT; verify that tape motion stops, and that LTH and UTH indicators are both lit.

h. Unload scratch cartridge from tape drive.

NOTE

If loading of safe BOT/EOT scratch cartridge does not cause all conditions of steps e and g to occur, a malfunction is indicated. Remove safe BOT/EOT cartridge. Do not attempt further testing or alignment of tape drive until tape drive is repaired.

3.4.1.3 Preliminary Track Alignment

To perform preliminary track alignment, see Figure 3-10 and use the following procedure:

a. Set oscilloscope controls to the following positions:

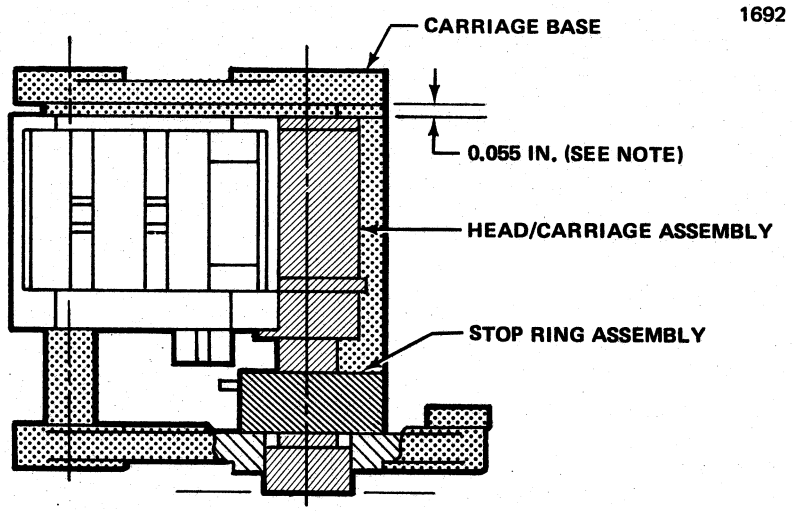
1. Channel 1: 0.1 Volt AC (VAC)/centimeter (cm)
2. Time: 5 microseconds (us)/cm
3. Trigger: AUTO

b. Connect channel 1 oscilloscope probe to test point TP4 on Main PWB of tape drive. This connection must be left intact until all track and azimuth alignment procedures in this subsection have been completed.

c. Set SME controls to the following positions:

1. TORQUE: HIGH
2. DETENT: OFF
3. CYCLE: SINGLE
4. STEP: SINGLE-STEP
5. DIRECTION: UP or DOWN as required

d. Press GO pushbutton on SME as required to position head carriage to approximate location shown in Figure 3-13. This location ensures that head carriage is always high with respect to required location.



NOTE

When head is at track 0 (minimum amplitude) position, gap between carriage base and head/carriage assembly should be 0.055 inch.

Figure 3-13. Positioning Head Carriage

e. Place DIRECTION control on SME in DOWN position.

f. Place tape drive in horizontal position and load Master Track Alignment Cartridge.

g. Sequentially press pushbuttons CLR, FWD, and GO on BE101.

h. Adjust VOLTAGE/VAR knob for channel 1 on oscilloscope to obtain eight divisions (cm) for initial calibration adjustment while reading calibration section of tape (beginning 70 feet).

i. Repeatedly press GO pushbutton on SME to move head one step at a time while reading alignment section of tape.

j. Observe oscilloscope screen as head moves down. Amplitude should decrease as repeated stepping continues, until a minimum amplitude is obtained on oscilloscope. With continued stepping, amplitude should increase.

k. Change DIRECTION switch on SME, as required, while continuing to repeatedly press GO pushbutton on SME until lowest possible amplitude is

observed on oscilloscope. Amplitude should be less than 0.4 cm. in horizontal and vertical tape drive position with tape motion in forward and reverse directions.

l. When preliminary Track Alignment has been completed, sequentially press STOP, REV, and GO pushbuttons on BE101. When LTH and UTH indicators on BE101 are lit, unload Master Track Alignment Cartridge and place it in its protective box.

CAUTION

Do not switch POWER switch on BE101 to OFF position. Do not change any setting on SME until Azimuth Alignment has been completed.

3.4.1.4 Azimuth Alignment

To perform azimuth alignment, see Figure 3-10 and use the following procedure:

a. Set oscilloscope controls to the following positions:
   1. Channel 1: 0.2 VAC/cm
   2. Time: 2 us/cm
   3. Trigger: AUTO

b. Loosen locking hold-down screws that hold jackscrews in place. Verify there is still spring tension on jackscrews and that marks on jackscrews are still aligned with marks on base.

c. Load Master Azimuth Alignment Cartridge in tape drive and place tape drive in vertical position. Sequentially press CLR, TRK, 0, FWD, and GO pushbuttons on BE101, and adjust VOLTAGE/VAR knob on oscilloscope for amplitude of 6 cm peak-to-peak.

d. Observe oscilloscope and note which direction causes amplitude increase while gently rocking stepper motor from side to side in each azimuth direction (sides).

e. Turn front jackscrew in equal amounts of 1/6 turn increments, in same direction until observed signal is at maximum amplitude. Verify amplitude is at maximum by adjusting slightly through maximum (amplitude begins to decrease) then back to maximum. Verify maximum amplitude condition is achieved for both forward and reverse direction of tape motion.

NOTE

Front jackscrew controls azimuth alignments;
rear jackscrew controls zenith alignment.

1. Readjust VOLTAGE/VAR knob on oscilloscope for amplitude of 6 cm peak-to-peak while applying torque to stepper motor, as in step d. Verify signal output amplitude does not increase by more than 0.1 cm peak.
2. Repeat step e.1 with tape drive in horizontal position while moving tape in both forward and reverse direction. Fine adjustment of jackscrew may be required.

f. Tighten hold-down screw for jackscrew to 6-in./lb of torque. Verify jackscrew does not turn while hold-down screw is being tightened.

g. Gently rock stepper motor and verify setting still meets 0.1 cm peak increase criterion, in horizontal and vertical positions, and with forward and reverse tape motion. Press STOP pushbutton on BE101.

h. Set SME controls to the following positions:
   1. STEP: MULTI-STEP
   2. DIRECTION: DOWN

i. Press GO pushbutton on SME once. Head on tape drive should move to track 1.

j. Sequentially press pushbuttons TRK, 1, FWD, REV, RPT, and GO on BE101. Recheck oscilloscope calibration for 6 cm peak-to-peak.

k. Gently rock stepper motor and verify setting still meets 0.1 cm peak increase criterion, in horizontal and vertical positions, and with forward and reverse tape motion. If necessary, adjust jackscrew (see step e). Press STOP pushbutton on BE101.

l. Place DIRECTION switch on SME in UP position.

m. Press GO pushbutton on SME once. Head on tape drive should move to track 0.

n. Sequentially press TRK, 0, FWD, RPT, and GO pushbuttons on BE101. Repeat step k, then unload Master Azimuth Alignment Cartridge and place it in its protective box.

3.4.1.5 Final Track Alignment

To perform final track alignment, see Figure 3-10 and use the following procedure:

a. Set oscilloscope controls to the following positions:
   1. Channel 1: 0.1 VAC/cm
   2. Time: 2 us/cm
   3. Trigger: AUTO

b. Set SME controls to the following positions:
   1. STEP: SINGLE-STEP
   2. DIRECTION: DOWN or UP, as required in subsequent steps.

c. Place tape drive in horizontal position. Load Master Track Alignment Cartridge and sequentially press CLR, FWD, and GO pushbuttons on BE101.
   1. Adjust VOLTAGE/VAR knob on oscilloscope for amplitude of 8 cm peak-to-peak during first 70 feet of tape motion (calibration section of tape).
   2. While in alignment section of tape, use DIRECTION and GO switches on SME to move head on tape drive UP or DOWN, as required, until optimum minimum amplitude is observed on oscilloscope. Always determine minimum amplitude while carriage is moving in UP direction. This amplitude should be less than 0.4 cm peak-to-peak.
   3. Sequentially press STOP, CLR, REV, and GO pushbutton on BE101 and repeat step c.2 in reverse direction.
   4. Verify final track alignment steps with tape drive in vertical position.

d. Note which PHASE LED on SME was lit when optimum minimum amplitude of less than 0.4 cm peak-to-peak was observed during all track alignment measurements for forward tape motion and reverse tape motion in horizontal and vertical tape drive positions.

e. Unload Master Track Alignment Cartridge and place it in its protective box.

f. Place two shorting clips, one on each of two phasing pins, at jumper block 5C located on Main PWB in tape drive, whose numbers coincide with PHASE LED number (see step d) that was lit when optimum minimum amplitude of less than 0.4 cm peak-to-peak was observed.

g. Set SME controls to the following positions:
   1. STEP: MULTI-STEP
   2. DIRECTION: DOWN

h. Press GO pushbutton on SME once.

i. Set SME STEP control to SINGLE position, then press GO pushbutton on SME once.

j. Lock stop ring assembly on lead screw in RECAL position.

   1. Remove screws that hold Main PWB to chassis and lift Main PWB.
   2. Set distance between stop ring assembly and carriage nut assembly with 0.040-inch wire feeler gauge.
   3. Lock stop ring in position by using 3/32-in. Allen driver through hole in right side of tape drive. When stop ring is locked in proper position, it enables 0.060-inch step pin to seat in step on head-carriage stop.

k. Set SME controls to the following positions:

   1. STEP: MULTI-STEP
   2. DIRECTION: UP

l. Press GO pushbutton on SME once.

m. Set SME STEP control to SINGLE-STEP position, then press GO pushbutton on SME once. Stepper motor in tape drive should position head in originally set track position and on the phase noted and tagged (see step f). Load Master Track Alignment Cartridge and verify amplitude is still at original level while tape drive is in both horizontal and vertical positions.

3.4.1.6 Final Track Alignment Check

To perform final track alignment check, see Figure 3-10 and use the following procedure:

a. Place POWER switch on BE101 in OFF position.

b. Disconnect SME from tape drive cable plug P3 and connect tape drive cable plug P3 to connector J3 on Main PWB of tape drive.

c. Place POWER switch on BE101 in ON position.

d. Verify that when power goes on, stepper motor in tape drive goes through normal RECAL sequence; i.e., stepper motor steps head position down until stop ring hits carriage stop, then steps head back to track 0 position.

e. Place tape drive in vertical position.

f. Sequentially press CLR, FWD, and GO pushbuttons on BE101.

g. Adjust VOLTAGE/VAR knob on oscilloscope to obtain amplitude of 8 cm peak-to-peak while reading calibration section of tape. Amplitude should drop to less than 0.4 cm peak-to-peak on oscilloscope after approximately 75 feet of tape has passed head.

h. Sequentially press STOP, CLR, REV, and GO pushbuttons on BE101. Amplitude should drop to less than 0.4 cm peak-to-peak on oscilloscope.

i. Place tape drive in horizontal position and repeat steps f through h. Verify that for both tape motion directions and both positions, amplitude observed on oscilloscope drops to a minimum level of less than 0.4 cm peak-to-peak.

j. Sequentially press STOP, CLR, REV, and GO pushbuttons on BE101. When LTH and UTH indicators on BE101 illuminate, unload Master Track Alignment Cartridge from tape drive and place it in its protective box.

1. Place POWER switch on BE101 in OFF position.
2. Disconnect power cable plug P2 from connector J2 on tape drive.
3. Disconnect 50-pin cable plug P1 from connector J1 on tape drive.
4. Disconnect channel 1 oscilloscope probe from test point TP4 on Main PWB of tape drive.
5. Verify all internal cabling on tape drive is securely connected.
6. Apply glyptol, or equivalent, to both jackscrew locking screws.
7. Carefully attach Main PWB to tape drive chassis.

k. Verify zenith alignment of head on tape drive is still within $\pm$ 15 angular minutes from zero minute zenith by using zenith alignment tool (see paragraph 3.4.1.1., step a). This verification completes the Track and Azimuth Alignment procedure.

NOTE

Cipher has developed a speed tape to check capstan speed under operating conditions. The speed tape is recorded at 447 kHz. When reading forward or reverse, the signal at test point TP4 on the Main PWB should be 447 kHz $\pm$ 10 percent for 90 ips tape drives. Due to possible tape slippage, readings should be taken in middle 50 percent of tape. Before checking tape speed, a tension pass should be made.

3.4.2 MAIN PWB RUN-IN TEST

The Main PWB Run-In Test procedures are intended to provide a checkout of all electronic circuit functions performed by the Main PWB. These procedures require the use of the BE101, and two types of tape cartridges. A Main PWB checkoff list, similar to

the checkoff sheet included with the tape drive when shipped from the factory should be used to maintain service records. A typical Main PWB checkoff sheet is shown in Figure 3-14. These procedures are presented in three phases:

a. Preliminary checkout
b. Functional Verification
c. Crosstalk/crossfeed measurements.

The Main PWB Run-In Test procedures must be performed in the sequence listed here.

cipher data products, inc.
Garden Grove Division

1693

MAIN BOARD CHECKOFF SHEET

SERIAL NO: _____ SPEED: _____ IPS

3.2 VOLTAGE CHECKOUT

3.2.1 +5 _____ OHMS
+24 _____ OHMS
3.2.3 +5 _____ OHMS
+24 _____ OHMS

NOTES _____

4.3 HEAD POSITIONING _____

NOTES: _____

4.4 TAPE HOLE CIRCUIT _____

NOTES: _____

4.5 EXERCISER SENSE TEST _____

NOTES: _____

4.6 MOTOR SPEED

4.6.2 (30 IPS) ONLY _____ MS
4.6.3 FWD _____ MS
4.6.4 REV _____ MS

NOTES: _____

4.7 SPEED VARIATION

4.7.2 FWD _____ VERTICAL DIV
4.7.3 REV _____ VERTICAL DIV

NOTES: _____

4.8 START/STOP TIME

4.8.4 FWD START TIME _____ MS
4.8.6 FWD STOP TIME _____ MS
4.8.7 REV START TIME _____ MS
4.8.7 REV STOP TIME _____ MS

NOTES: _____

4.9 ASSYMETERY ADJUSTMENT _____

NOTES: _____

5.0 CROSSTALK/CROSSFEED

5.0.3 CROSSTALK: POS 1 _____ MV
POS 2 _____ MV
POS 3 _____ MV
5.0.4 CROSSTALK POS 3 _____ MV
POS 2 _____ MV
POS 1 _____ MV

NOTES: _____

5.1 ERASE RESIDUE

5.1.1 RESIDUE (TRK 0) _____ MV
5.1.2 MOTOR NOISE _____ MV
5.1.3 RESIDUE (TRK 1) _____ MV

NOTES: _____

5.2 READ CIRCUIT OUTPUT

5.2.2 POS 1 _____ MV P-P
POS 2 _____ MV P-P
POS 3 _____ MV P-P
5.2.3 POS 3 _____ MV P-P
POS 2 _____ MV P-P
POS 1 _____ MV P-P

NOTES: _____

FORM 1096 (R 04/82)

Figure 3-14. Main PWB Checkoff Sheet

3.4.2.1 Preliminary Checkout

Preliminary checkout must be done before testing. To perform preliminary checkout, use the following procedure:

a. Visually inspect tape drive for defects. Pay particular attention to the following conditions:
   1. Microprocessor chip correctly installed.
   2. Loose or broken components, solder splashes.
   3. Jumpers on jumper block 5C installed per phase noted on stick-on label on head assembly (see paragraph 3.4.1.5, step f).
   4. Connector J2 properly keyed (very important).
   5. All connectors properly installed for sensor assembly, head assembly, and Motor Driver PWB.

b. Correct any problems discovered in step a before continuing.

c. Set range on VOM to 220 Ohms and measure resistance between +5-Volt line and ground; should be approximately 180 Ohms. Measure resistance between +24-Volt line and ground; should be approximately 4000 Ohms.

d. Verify POWER switch on BE101 in OFF position.

e. Connect tape drive to BE101.

f. Place BE101 POWER switch in ON position.

g. Measure voltage on +5-Volt line; should be +5 Volts $\pm$ 5 percent.

h. Measure voltage on +24-Volt line; should be +24 Volts $\pm$ 10 percent.

i. Place BE101 POWER switch in OFF position.

3.4.2.2 Functional Verification

To ensure tape-handling functions of the tape drive are functioning properly, see Figure 3-10 and use the following procedure:

a. Prepare tape drive for testing and alignments by making the following cable connections:
   1. BE101 plug P2A to Main printed wiring board (PWB) jack J2.
   2. BE101 plug P1 to Main PWB jack J1.
   3. Verify plug P3 is connected to tape drive stepper motor jack J3.

b. Set control switches on BE101 to the following positions:

1.	HS	Down
2.	SEL 0	Up

3. SEL 1, 2, and 3 — Down
4. WRITE DATA PATTERN — All Down
5. IPS — Appropriate Tape Speed (30 ips or 90 ips, as applicable)
6. BIT LENGTH — 1
7. CRTL — Down

c. Verify proper head positioning; use the following procedure:

1. Place BE101 POWER switch in ON position and observe head motion. Head should move to bottom of its travel limit and make a "clicking" sound as it hits stop ring. Head should then move back up to its uppermost position.
2. Press TRK, 2, and GO pushbuttons on BE101. Verify head moves to lower position.
3. Press TRK, 1, and GO pushbuttons on BE101. Verify head moves to upper position.
4. Press TRK, 3, and GO pushbuttons on BE101. Verify head moves to lower position.
5. Press TRK, 0, and GO pushbuttons on BE101. Verify head returns to upper position.

d. Verify tape hole sensing circuit is properly functioning; use the following procedure:

1. Set oscilloscope controls to the following positions:

Channel 1:	DC
Voltage:	2 V/cm
Time:	1 ms/cm
Trigger:	AUTO

2. Load BOT cartridge in tape drive.
3. Place oscilloscope ground lead on Main PWB test point TP3.
4. Place oscilloscope channel 1 probe on pin 13 of IC 6C.
5. Move tape back and forth past tape hole sensors by manually turning roller wheel, which is accessible through aperature in right corner of cartridge. Voltage should toggle as holes in tape move past sensors; i.e., when holes are aligned with light path from light-emitting diodes (LED) in tape hole sensor block, voltage should be high; when tape obstructs light path, voltage should be low, as shown in Figure 3-15.

6. Repeat step 5 but with oscilloscope channel 1 probe on pin 14 of IC 6C, then unload BOT cartridge from tape drive.

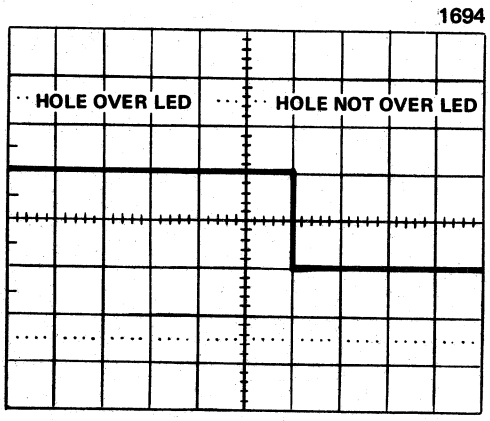


Figure 3-15. Tape Hole Sensing Voltage

e. Verify sensing circuits in tape drive are properly functioning; use the following procedure:

1. Observe cartridge-in (CIN) and unsafe (USF) LED indicators on BE101 not lit.
2. Load scratch cartridge that is not write protected in tape drive. CIN and USF indicators should illuminate.
3. Press CLR, FWD, and GO pushbuttons on BE101. Observe tape being wound from right spool to left spool, then press STP pushbutton on BE101.
4. Press REV and GO pushbuttons on BE101. Observe tape being wound from left spool to right spool. Tape should stop before left spool is empty and be repositioned just inside tape holes. Upper Tape Hole (UTH) and Lower Tape Hole (LTH) LED indicators on BE101 should illuminate and remain lit.
5. Pull cartridge slightly out of cartridge-loading slot in tape drive. CIN, UTH, and LTH indicators on BE101 should be extinguished. Release cartridge. Detent spring should pull cartridge back to fully loaded position and CIN, UTH, and LTH indicators on BE101 should again be lit.

f. Verify speed of capstan motor on tape drive is correct; use the following procedure:

1. Set oscilloscope controls to the following positions:

Channel 1:	DC
Voltage:	2V/cm
Time:	0.2 ms/cm (90 ips) or 0.5 ms/cm (30 ips)
Trigger:	AUTO

2. Connect channel 1 probe to pin 1 of IC 6C on Main PWB and connect ground to test point TP6 on Main PWB. Channel 1 should trigger on

rising edge of pulse. Trigger slope control on oscilloscope may need to be adjusted to provide stable trigger.

NOTE

TP3 is analog ground and TP6 is signal ground.

3. If tape drive is 90 ips, proceed to step 4. If tape drive is 30 ips, set High Speed (HS) switch on BE101 in UP position, then press CLR, FWD, and GO pushbuttons on BE101. Measure time lapse from rising edge of first pulse to rising edge of second pulse. Time lapse should be between two and four milliseconds. Press STP pushbutton on BE101 and return HS switch on BE101 to DOWN position.
4. Press FWD and GO pushbuttons on BE101. Measure time lapse from rising edge of first pulse to rising edge of second pulse. Time lapse should be between 1.5 and 1.7 milliseconds for 90 ips tape drive, or 4.7 and 4.9 milliseconds for 30 ips tape drive, as shown in Figure 3-16.
5. Press STP, REV, and GO pushbuttons on BE101. Observe time lapse for tape speed in reverse direction is same as for forward direction, as observed in step 4.

g. Verify tape speed of tape drive does not vary by more than three percent in forward and reverse tape motion direction; use the following procedure:

1. Set time control on oscilloscope to 0.1 ms/cm (90 ips) or 0.2 ms/cm (30 ips), as applicable. Press FWD and GO pushbuttons on BE101. Adjust time variation control on oscilloscope until rising edge of first pulse is on far left vertical line on oscilloscope screen and rising edge of second pulse is on far right vertical line on oscilloscope screen. Adjust horizontal position control on oscilloscope until negative pulse is in center of oscilloscope screen and press X10 MAG pushbutton on oscilloscope.

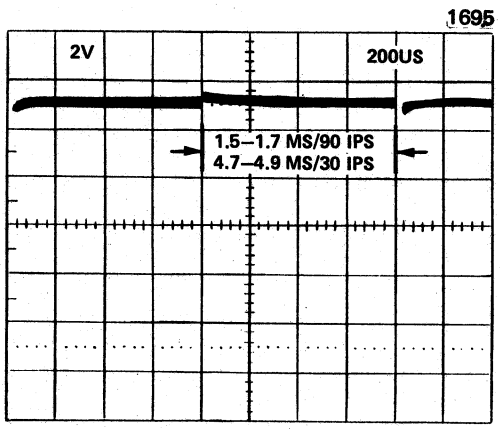


Figure 3-16. Capstan Speed Time Lapse

2. Press STP, CLR, REV, and GO pushbuttons on BE101. Repeat measurement observed in step 1. Position of pulse observed on oscilloscope screen should not vary more than three cm divisions, as shown in Figure 3-17.

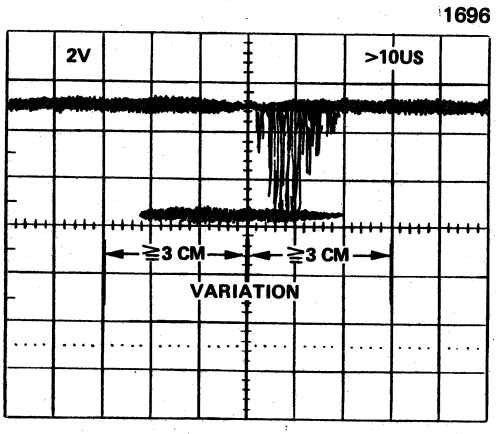


Figure 3-17. Tape Speed Variation

3. Return oscilloscope controls to normal; i.e., X10 MAG in OUT position, time variation control fully clockwise so that UNCAL LED indicator is not lit and horizontal position control is in midrange.

NOTE

Cipher has developed a speed tape to check capstan speed under operating conditions. The speed tape is recorded at 447 kHz. When reading forward or reverse, the signal at test point TP4 on the Main PWB should be 447 kHz ± 10 percent for 90 ips tape drives. Due to possible tape slippage, readings should be taken in middle 50 percent of tape. Before checking tape speed, a tension pass should be made.

h. Verify Start/Stop time for tape drive is properly functioning; use the following procedure:

1. Load scratch cartridge. To accomplish desired results, scratch cartridge must have data recorded on track 0. If test sequence is followed in order, data from previously tested tape drive should be recorded on scratch cartridge. If tape condition is unknown or erased, set WRITE DATA PATTERN switch 1 on BE101 in UP position, and set BIT LENGTH switch on BE101 to 1 position. Return tape to BOT, if not already at BOT, then press CLR, TRK, 0, ERS, WR, FWD, and GO pushbuttons on BE101. Allow tape to run to EOT, then press CLR, REV, and GO pushbuttons on BE101.

2. Set oscilloscope controls to the following positions:

   Channel 1: AC, 0.1V/cm

   Channel 2: DC, 2V/cm, display OFF

3. Connect channel 1 probe to test point TP1 on Main PWB, and connect channel 2 probe to pin 12 of IC 1B on Main PWB.

4. Press FWD and GO pushbuttons on BE101. Adjust VOLTAGE VAR and VERTICAL POSITION CH 1 controls on oscilloscope until signal is full height of oscilloscope screen (eight horizontal divisions). Return tape to BOT.

5. Set trigger control on oscilloscope to NORM, 10 ms/cm. If 30 ips tape drive being tested, set time/division control on oscilloscope to 20 or 50 milliseconds, as applicable.

6. Press CLR and FWD pushbuttons on BE101, then repeatedly press GO and STP pushbuttons on BE101 in sequence. Note time lapse from when oscilloscope triggers until time when modulated signal has reached amplitude of six horizontal divisions on oscilloscope screen, as shown in Figure 3-18. Time lapse should be less than 75 milliseconds for 90 ips tape drive, or less than 225 milliseconds for 30 ips tape drive.

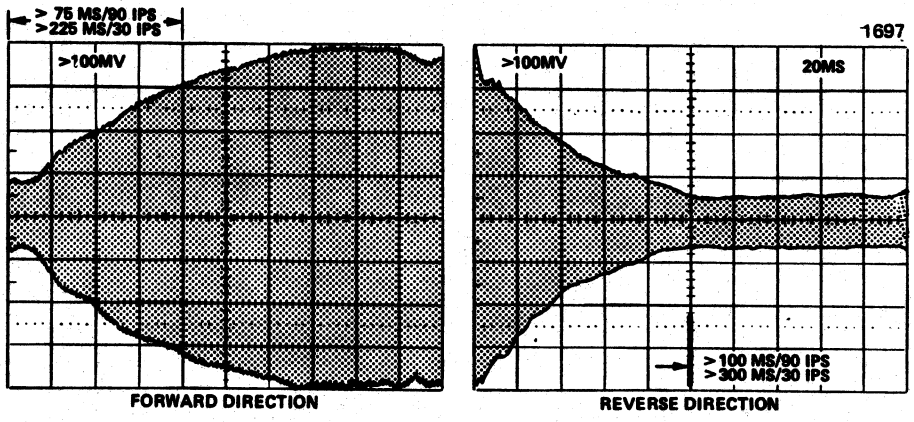


Figure 3-18. Start/Stop Time Pattern

7. Repeat step 6, except press CLR and REV pushbuttons on BE101 so that start time is measured for tape motion in reverse direction.

8. Repeat step 6 for stop time. Stop time measurement procedure is similar to start time procedure, except channel 2 is triggered on minus and slope control is adjusted slightly counterclockwise to minus side of zero. When repeatedly pressing GO and STP pushbuttons on BE101 in sequence, note time lapse from when oscilloscope triggers until time

when modulated signal amplitude has decreased to a flat line. Time lapse should be not more than 100 milliseconds for 90 ips tape drive, or not more than 300 milliseconds for 30 ips tape drive.

9. Repeat step 8, except press CLR and REV pushbuttons on BE101 so that stop time is measured for tape motion in reverse direction.
10. Return VOLTAGE VAR control on oscilloscope to OFF position and verify UNCAL LED indicator on oscilloscope is extinguished.

i. Verify proper asymetry adjustment; use the following procedure:

1. Turn potentiometer R27 on Main PWB, from one extreme to the other, while observing read data pulse (RDP) LED indicator on BE101.
2. Potentiometer R27 is correctly adjusted when RDP indicator is at its brightest.

3.4.2.3 Crosstalk/Crossfeed

Crosstalk/crossfeed measurements should be made only after the preliminary checkout and functional verification procedures are done. These measurements determine "noise" from erase residue, and peak-to-peak voltages of the read circuit output. To prepare the tape drive for these measurements, use the following procedure:

a. Load scratch cartridge in tape drive.
b. Connect oscilloscope channel 1 probe to test point TP1 on Main PWB.
c. Set oscilloscope controls to the following positions:

Channel 1:	AC, 50mV/cm (division)
Time:	2 ms/cm
Trigger:	AUTO

d. Set WRITE DATA PATTERN switch 1 on BE101 to 1 (up) position and set all other WRITE DATA PATTERN switches on BE101 to 0 (down) position. Set IPS switch on BE101 to appropriate tape speed; 90 ips or 30 ips.
e. Press CLR, WR, TRK, 0, and GO pushbuttons on BE101. No tape motion should occur, but a small signal-level change (less than 15 millivolts) should be observed on oscilloscope.
f. Rotate PATTERN BIT LENGTH thumbwheel switch on BE101 from position 1 to position 2, then to position 3. Signal level on oscilloscope should not exceed 75 millivolts peak-to-peak for 30 ips tape drive, or 100 millivolts peak-to-peak for 90 ips tape drive, as shown in Figure 3-19.

g. PRESS TRK, 1, and GO pushbuttons on BE101, and rotate PATTERN BIT LENGTH thumbwheel switch on BE101 from position 3 back to position 1. Signal observed on oscilloscope should be same as in step f.

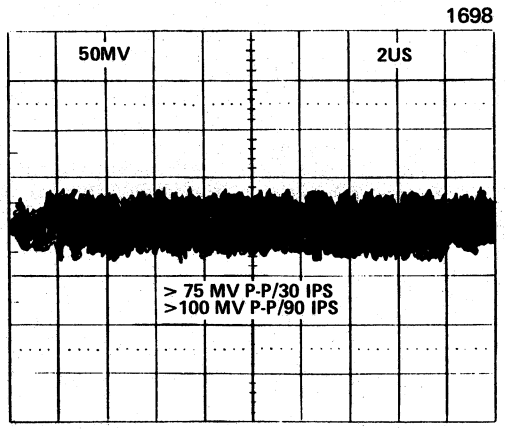


Figure 3-19. Pattern Bit Length Voltage

NOTE

All measurement of peak-to-peak signals at test point TP1 on Main PWB may appear fuzzy. Measurements should not include fuzz, but should be recorded as if each signal is a thin line through the middle of the trace.

3.4.2.3.1 Erase Residue. To measure erase residue signals, use the following procedure:

a. Load scratch cartridge in tape drive.

NOTE

Tape in scratch cartridge used for test is assumed to have data written on it from previously tested tape drive or data written while conducting start/stop test. If condition of tape is unknown, or known to have been erased, use procedure for recording data on tape (see paragraph 3.4.2.2, step h).

b. Verify tape is at BOT. Press CLR, TRK, 0, ERS, FWD, and GO pushbuttons on BE101. Let tape run to EOT, then press CLR, REV, and GO pushbuttons on BE101. On oscilloscope screen, observe erase residue signal level from test point TP1 on Main PWB while tape is returning to BOT. Signal level should not exceed 75 millivolts for 90 ips tape drive, or 60 millivolts for 30 ips drive, as shown in Figure 3-20.

c. Set oscilloscope channel 1 time control to 10 ms/cm, then press CLR, FWD, and GO pushbuttons on BE101. Signal may show motor "noise" with normal circuit noise. Motor noise consists of sharp, randomly spaced spikes above and below the mean signal level. Amplitude of motor "noise" spikes must not exceed 300 millivolts base-to-peak, as shown in Figure 3-21.

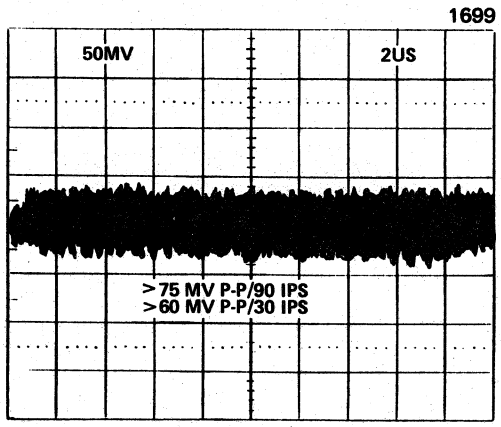


Figure 3-20. Erase Residue Voltage

d. While tape is in motion, press TRK, 2, and GO on BE101, pause and observe signal; then press TRK, 0, and GO on BE101, pause and observe signal. Observe erase residue signal level on each track. Signal level and motor "noise" spikes should not exceed limits established in steps b and c. Let tape run to BOT.

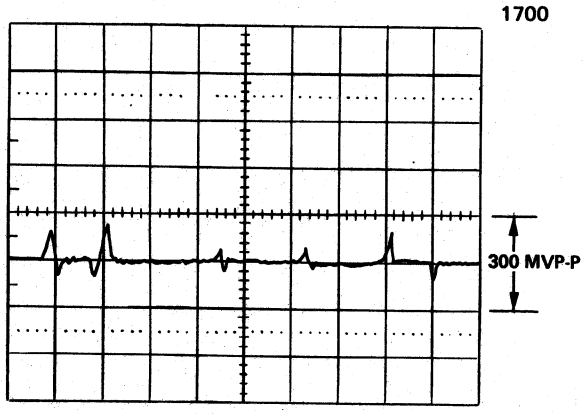


Figure 3-21. Noise Spike Limits

3.4.2.3.2 Read Circuit Output. To measure read circuit output, use the following procedure:

a. If not already connected, connect oscilloscope channel 1 probe to test point TP1 on Main PWB.

b. Set oscilloscope controls to the following positions:

Channel 1: AC, 0.2V/cm (90 ips) or 0.1V/cm (30 ips)

Time: 0.1 ms/cm

c. Press CLR, WR, TRK, 0, FWD, and GO pushbuttons on BE101. On oscilloscope screen, observe peak-to-peak voltage from TP1 on Main PWB. Record this voltage. Typical voltage pattern is shown in Figure 3-22.

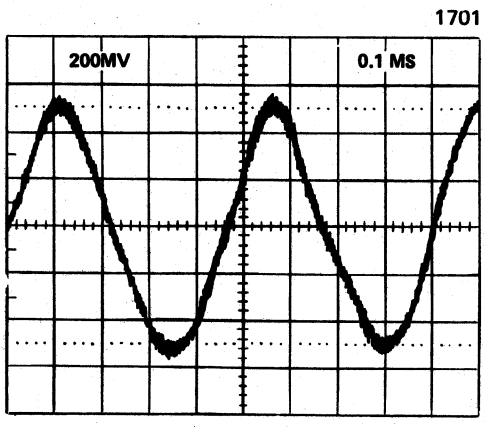


Figure 3-22. Read Circuit Output Voltage

d. Rotate PATTERN BIT LENGTH thumbwheel switch on BE101 from position 1 to position 2 and record observed peak-to-peak voltage.

e. Rotate PATTERN BIT LENGTH thumbwheel switch on BE101 from position 2 to position 3 and record observed peak-to-peak voltage.

f. Press WR, TRK, 1, REV, and GO pushbuttons on BE101. Observe and record peak-to-peak voltages while rotating PATTERN BIT LENGTH thumbwheel switch from position 3, to position 2, then to position 1.

g. Use Table 3-3 or 3-4, as applicable, to determine if peak-to-peak voltages recorded in steps c through f are within acceptable limits.

NOTE

To use Tables 3-3 and 3-4, find number in Position 1 column that is nearest to peak-to-peak voltage observed and recorded while PATTERN BIT LENGTH thumbwheel was at position 1. Then observed and recorded peak-to-peak voltages for positions 2 and 3 of the PATTERN BIT LENGTH thumbwheel switch should be between the upper and lower limits in the corresponding adjacent line in the Position 2 and Position 3 columns. EXAMPLE: 90 ips tape drive. Position 1 peak-to-peak voltage recorded is 1.02 Volts. Position 2 peak-to-peak voltage recorded should be between 1.427 and 1.816, and Position 3 peak-to-peak voltage recorded should be between 1.536 and 2.000.

Table 3-3. Read Circuit Peak-to-Peak Output Voltages for 30 ips Tape Drive

Pattern Bit Length Thumbwheel Switch Position				
	Position 2 Limits		Position 3 Limits	
Position 1	Lower	Upper	Lower	Upper
0.334	0.478	0.609	0.515	0.669
0.359	0.512	0.652	0.552	0.718
0.384	0.548	0.698	0.590	0.768
0.408	0.584	0.743	0.629	0.817
0.433	0.618	0.787	0.666	0.866
0.457	0.654	0.832	0.704	0.915
0.482	0.688	0.876	0.714	0.964
0.506	0.724	0.921	0.780	1.013
0.530	0.758	0.965	0.916	1.061
0.554	0.792	1.009	0.853	1.109
0.578	0.827	1.052	0.890	1.157
0.602	0.861	1.096	0.927	1.205
0.626	0.895	1.139	0.964	1.253
0.650	0.929	1.183	1.001	1.301

Table 3-4. Read Circuit Peak-to-Peak Output Voltages for 90 ips Tape Drive

Pattern Bit Length Thumbwheel Switch Position				
	Position 2 Limits		Position 3 Limits	
Position 1	Lower	Upper	Lower	Upper
0.800	1.142	1.454	1.230	1.600
0.850	1.214	1.545	1.307	1.700
0.900	1.285	1.636	1.384	1.800
0.950	1.357	1.727	1.461	1.900
1.000	1.427	1.816	1.536	2.000
1.050	1.498	1.907	1.613	2.100
1.100	1.569	1.998	1.690	2.197
1.150	1.640	2.087	1.766	2.296
1.200	1.711	2.178	1.843	2.395
1.250	1.781	2.267	1.918	2.493
1.300	1.851	2.356	1.993	2.591
1.350	1.921	2.445	2.069	2.689
1.400	1.991	2.534	2.144	2.787
1.450	2.061	2.623	2.220	2.885
1.500	2.131	2.712	2.295	2.983
1.550	2.201	2.801	2.370	3.081
2.000	2.271	2.890	2.446	3.179

3.4.3 CONTROLLER PWB TESTS

The Controller PWB Test procedures are intended to provide checkout and adjustments of functions performed by the Controller PWB on the intelligent tape drive models. These procedures require the use of a scratch cartridge, host CPU or CPU simulator, and suitable external power supply. These procedures must be conducted in the following sequence:

a. Power Lines and Voltage Checkout
b. Gap Circuitry Adjustment
c. Phase Locked Loop Adjustment
d. Functional Test

These test procedures assume the technician is thoroughly familiar with the operation and display of the test program for the applicable host CPU system. Commands in these procedures are referenced to the Apple II microcomputers and its diagnostic program, and are presented in the following format:

Command: (command designator), press Return key

For brevity, "press Return key" is not noted but is always implied.

3.4.3.1 Power Line and Voltage Checkout

To check power line and voltage, use the following procedure:

a. With VOM, measure resistance between pins 3 and 4 on connector J3 of Controller PWB; should be 200 $\pm$ 20 Ohms. J2 pins 3 and 4 are for +5-Volt line from external power supply. Measure resistance between pins 1 and 2 on connector J2 of Controller PWB; should be approximately 4000 Ohms. J2 pins are for +24-Volt line from external power supply.
b. Measure voltage from external power supply. Voltage between pins 3 and 4 of plug P2 should be +5 Volts $\pm$ 5 percent. Voltage between pins 1 and 2 of plug P2 should be +24 Volts $\pm$ 10 percent. When proper voltages from external power supply have been verified, turn off external power supply and connect plug P2 from power supply to connector J2 on Controller PWB.

3.4.3.2 Gap Circuitry Adjustment

To adjust gap circuitry, use the following procedure:

a. Connect I/O cable from CPU to connector J1 on Controller PWB. If not yet connected, connect I/O cable from connector J3 on Controller PWB to connector J1 on Main PWB of tape drive. Turn on power to tape drive.

b. Command: (S). Status on CPU display should read: POWER UP, CARTRIDGE NOT IN, WRITE PROTECTED.

c. Command: (L). Status on CPU display should read NO CARTRIDGE. Selected LED (CR16) on Main PWB of basic tape drive should illuminate and remain lit.

d. Set oscilloscope controls to the following positions:

Channel 1: DC, 2V/cm
Time: 0.02 us/cm (90 ips) or 0.05 us/cm (30 ips)
Trigger: Positive-going edge of channel 1 signal

e. Connect channel 1 probe to test point TP4 on Controller PWB and connect ground to test point TP1 on Controller PWB.

f. Adjust oscilloscope slope level so that rising edge of signal on test point TP4 is at farthest left vertical line on oscilloscope display screen.

g. Adjust potentiometer R25 on Controller PWB until positive pulse width observed on oscilloscope is 4.44 microseconds (30 ips tape drive) or 1.48 microseconds (90 ips tape drive), as shown in Figure 3-23.

3.4.3.3 Phase Lock Loop Adjustment

To adjust phase lock loop, use the following procedure:

a. On Controller PWB, adjust potentiometer R7 fully clockwise and potentiometer R11 fully counterclockwise.

b. Set oscilloscope controls to the following positions:

Channel 1: DC, 2V/cm
Channel 2: DC, 2V/cm
Sweep Speed: 0.2 us/cm
Trigger: Channel 1

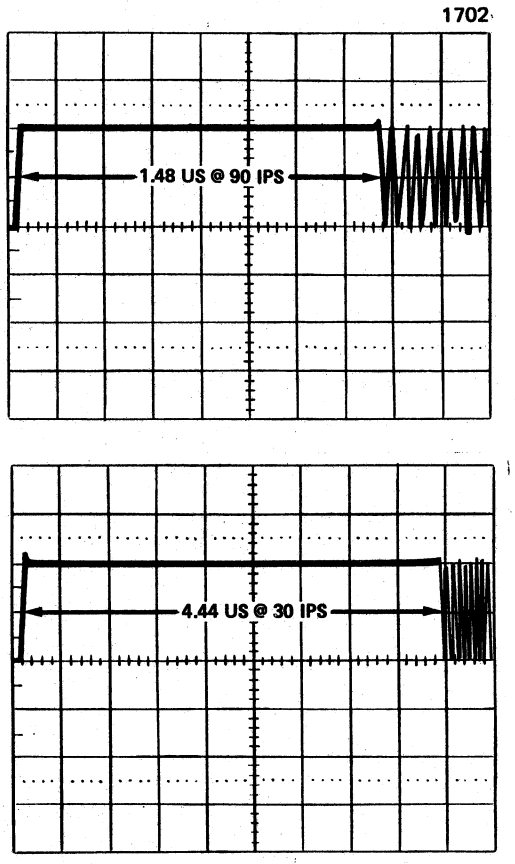


Figure 3-23. Gap Adjustment Display Pattern

c. Connect oscilloscope channel 1 probe to test point TP7 on Controller PWB. Connect oscilloscope channel 2 probe to test point TP8 on Controller PWB.

d. Slowly adjust potentiometer R11 until trailing edges of channels 1 and 2, observed on oscilloscope, are approximately phase locked as shown in Figure 3-24.

e. Ground pin 4 of IC 9B on Controller PWB.

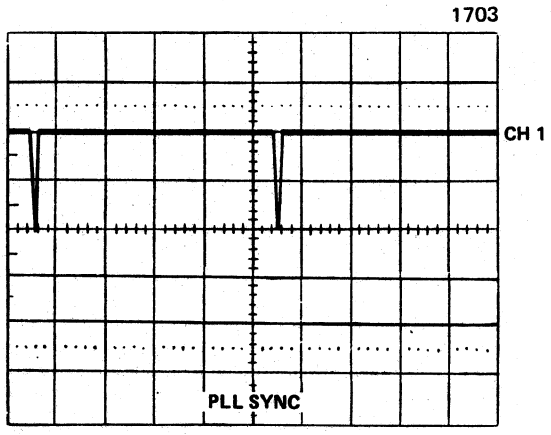


Figure 3-24. Phase Lock Display

NOTE

It may be easier to clip ground lead onto right end (end closest to connector J2) of resistor R79. Be careful to ground correct end of R79; other end is +5 Volts.

f. Fine adjust potentiometer R11 to bring channels 1 and 2 into phase lock.

g. On Controller PWB, jumper test points TP10 and TP11 together.

h. Adjust oscilloscope time/cm control to display one full cycle of channel 1 over full width of oscilloscope (10 cm), as shown in Figure 3-25.

i. Adjust potentiometer R7 until there is approximately 16 percent (+8 percent and –8 percent) jitter on oscilloscope channel 2 display, as shown in Figure 3-25.

j. Remove jumper between test points to TP10 and TP11 on Controller PWB (see step g).

3.4.3.4 Functional Test

To perform functional test of Controller PWB, use the following procedure:

a. Load scratch cartridge in tape drive. Command: (B). Tape should move short distance, then stop.

b. After tape stops, Command: (S). Status should read: BOT.

c. Command: (X2), Command: (N400), Command: (F29). This group of commands causes program to write two 400-block files of 29 pattern.

d. Command: (W). Tape drives should move tape and block counter on Controller PWB should increment from zero. While tape is in motion, press ESCAPE. Tape motion should stop. Press SPACEBAR. motion should momentarily reverse, then start forward, and block counter should resume incrementing from where it left off.

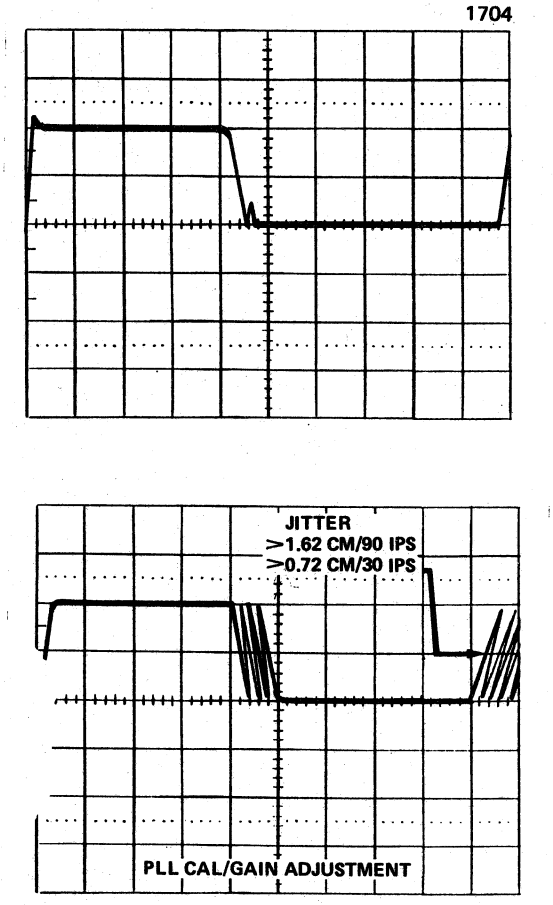


Figure 3-25. Phase Lock Loop Adjustment

e. As soon as first 400-block file is written, tape motion should momentarily stop and block counter should stop incrementing and reset to zero. Tape motion should then reverse until file mark on tape is repositioned under head. Tape should then start forward and second 400-block file should be written and block counter should start incrementing.

f. When both files have been written, tape motion should stop. Error register should have less than 10 write errors, and there should be only one write buffer overrun condition counted.

g. Command: (R). Tape drive should rewind tape to BOT and then successfully read files written in steps c through e.

h. Tape drive should stop tape motion after reading two files (step g). Observe FILE MARK in status display area of screen.

i. Command: (P). Observe data in read buffer on Controller PWB. Data should be all "29" and embedded file count should be 2. Press RETURN and observe second half of read buffer. Embedded block count should be 400.

3.4.3.5 VCO Balance

To adjust VCO balance, use the following procedure:

a. Connect oscilloscope channel 1 probe to test point TP5, ground to test point TP1.
b. Connect oscilloscope channel 2 probe to test point TP13.
c. Set oscilloscope controls to the following positions:
   1. Channel 1 — 2Vdc/division (cm), 50 us/cm
   2. +VE TRIG — Trigger on channel 1, display channel 2 only
   3. GND reference — Channel 2 at bottom of graticule
d. Initiate Read operation of "29" pattern written in pararaph 3.4.3.4.
e. Adjust potentiometer R11 until voltage during phase lock portion of gap is 2.400 $\pm$ 0.024 Volts DC as shown in Figure 3-26.
f. Return to BOT.
g. Remove power.
h. Unplug expander, I/O cable.

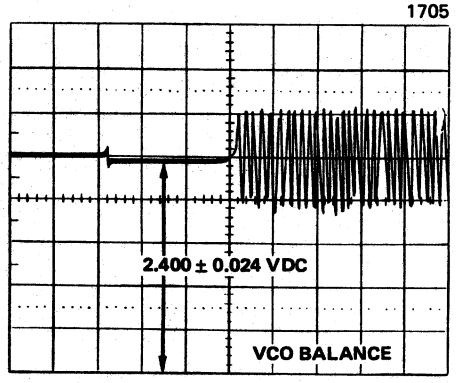


Figure 3-26. VCO Balance

3.4.4 TEST FAILURES

If a tape drive fails any of the tests in this subsection (3.4), or if proper function fails after making adjustments, the defective PWB should be removed and replaced. If replacement of component does not restore proper function, send entire tape drive assembly to the Custom Service Repair Center. See paragraph 3.1.

SECTION 4

FAULT ISOLATION

4.1 GUIDES

Table 4-1 is a System Fault Isolation Guide that should be used as a diagnostic aid for the isolation of faults within the tape drive. This table lists possible symptoms, probable causes for the malfunction, and corrective actions. A reference column cites the text or drawing, relative to any particular event, which should be consulted for further information and verification. Section 4, Illustrated Parts Breakdown (IPB), in the Engineering Drawing Package should be used to identify and locate assemblies and subassemblies in the tape drive.

The technician who performs fault isolation procedures should have an understanding of the theory of operation of the Quarterback tape drive and associated equipment, and be thoroughly familiar with the equipment operating instructions. Operating instructions should be carefully followed, and all equipment should be checked for proper connections, damaged or overheated components, and unusual noises while the equipment is operating. Noisy equipment may indicate a mechanical malfunction.

If a part or assembly is suspected of being defective, and a replacement is available, try to determine the external or internal cause of the failure before replacing the defective part or assembly. Replacement without eliminating the cause of failure might cause the replacement part or assembly to fail also.

NOTE

If correction of any malfunction involves azimuth or track alignment, the tape drive should be shipped to the Customer Service Repair Center.

4.2 TIMING DIAGRAMS

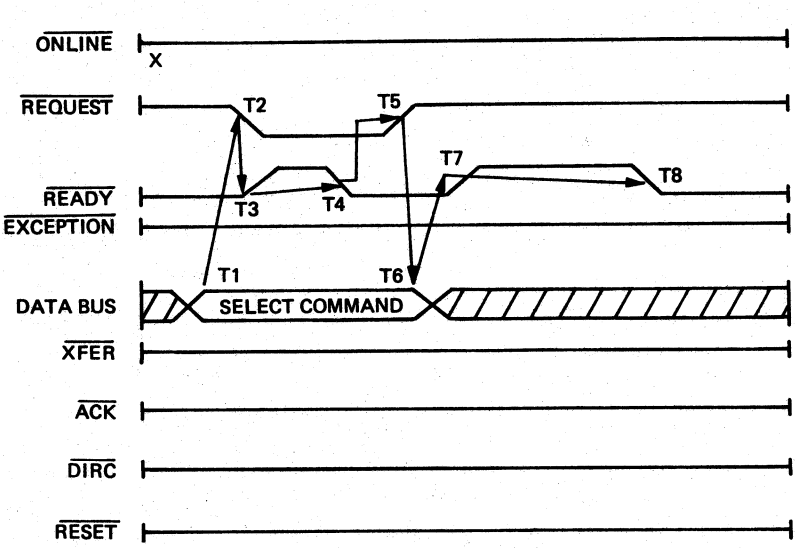
Timing diagrams of operations performed by the Quarterback tape drive are shown in Figures 4-1 through 4-8, and should be used to follow the event sequences that occur during command execution. The timing diagrams are fully explained and analyzed in the Theory of Operation Manual.

Table 4-1. Fault Isolation Guide for Quarterback Tape Drive

Symptom	Probable Cause	Remedy	Reference
Excessive data dropout	Dirt on head or damaged tape	Check and clean and/or load new certified computer tape cartridge	Para 3.2.1.1
Tape drive does not function	Fuse open in DC power supply	Replace fuse in power supply	———
	J2/P2 connector not properly connected	Check and properly seat connector	———
Tape drive does not accept commands	Improper interface	Check interface with TTL logic and correct as necessary	Sch Dwg 207002-200 and 207005-200
Tape tensioned but slips	Dirty capstan	Clean capstan	Para 3.2.1.2
Tape moves during a stop condition	Defective capstan assembly	Return to factory for replacement of capstan assembly and realignment of capstan servo	———
	Motor voltage not zero	Return to factory for repair or adjustment of zero offset	———
Computer does not read tapes correctly	Data format incorrect	Use correct data format	Theory of Operation Manual
	Record length exceeds computer memory capability	Use correct record length	Theory of Operation Manual

Table 4-1. Fault Isolation Guide for Quarterback Tape Drive (continued)

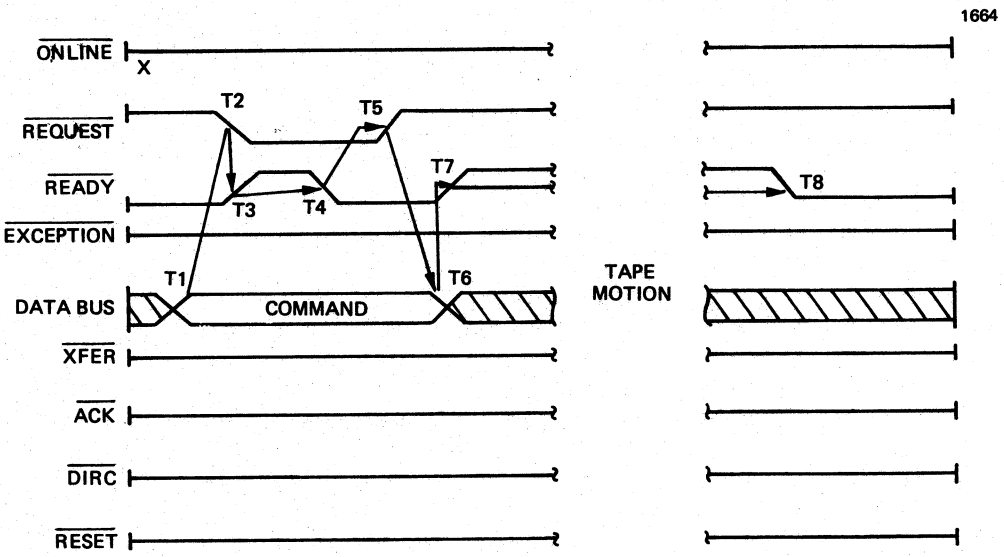
Symptom	Probable Cause	Remedy	Reference
Tape drive does move tape in response to Write or Read commands	Defective interface cable or line receiver(s)	Check levels at outputs and inputs of line receiver(s) on Formatter/ Controller PWB, or replace interface cable or PWB	Para 3.3.5 and Sch Dwg 207005-002
	Tape drive not in Ready mode	Bring tape to load point (BOT)	Fig. 4-2
	Faulty ramp generator or capstan servo amplifier	Replace Formatter/ Controller PWB or Motor Driver PWB	Para 3.3.4 and 3.3.5
Tape cannot be read	Defective interface cable or line driver(s)	Check levels at outputs and inputs of line driver(s) on Formatter/ Controller PWB, or replace interface cable or PWB.	Para 3.3.5 and Sch Dwg. 207005-200
	Head cable not plugged in	Check J13 on Main PWB	———
	Read timing out of adjustment	Replace Formatter/ Controller PWB. Return PWB to factory for adjustment of R25	Para 3.3.5 and Sch Dwg 207005-200
	Dirt on head	Clean head	Para 3.2.1.1
	PLL phase relationship incorrectly adjusted	Replace Formatter/ Controller PWB. Send PWB to Service Center for adjustment of R7 and R11	Para 3.3.5 and Sch Dwg 207005-200
	Other component fault in read channel	Check test point data. Replace Main PWB. Send PWB to Service Center for repair.	Para 3.3.3 and Sch Dwg 207002-200



ACTIVITY	CRITICAL TIMING
T1 CPU COMMAND TO BUS	N/A
T2 CPU SETS REQUEST	T1→T2 > 0US
T3 FORMATTER RESETS READY	T2→T3 < 0.25US
T4 FORMATTER SETS READY	50 < T3→T4 < 500US
T5 CPU RESETS REQUEST	T4→T5 > 0US
T6 BUS DATA INVALID	T4→T6 > 0US
T7 FORMATTER RESETS READY	20 < T5→T7 < 100US
T8 FORMATTER SETS READY	T7→T8 > 20US

X – DON'T CARE

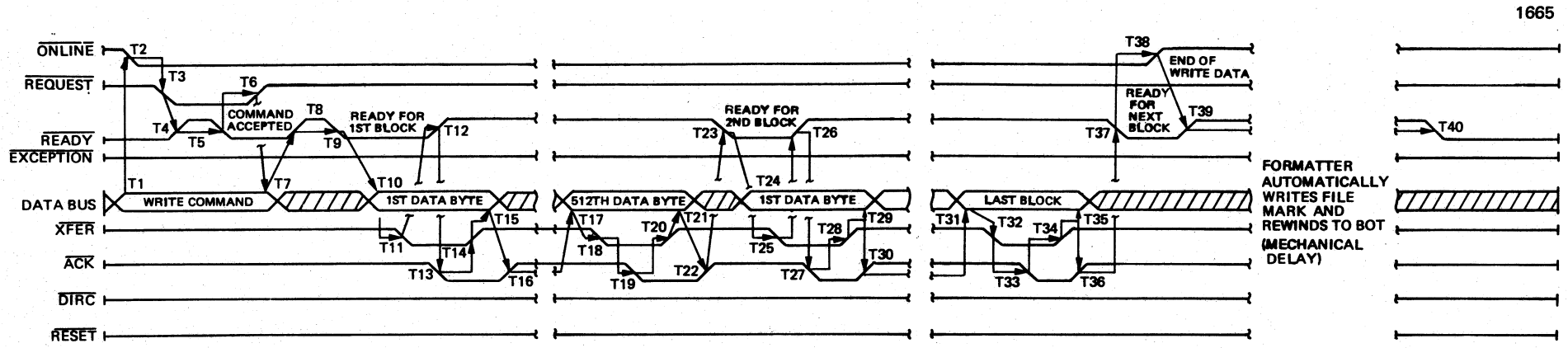
Figure 4-1. Select Timing



ACTIVITY	CRITICAL TIMING
T1 CPU BUS DATA VALID	N/A
T2 CPU SETS REQUEST	T1 → T2 = > 0US
T3 FORMATTER RESETS READY	T2 → T3 = < 0.25US
T4 FORMATTER SETS READY	20 < T3 → T4 < 500US
T5 CPU RESETS REQUEST	T4 → T5 = > 0US
T6 BUS DATA INVALID	T4 → T6 > 0US
T7 FORMATTER RESETS READY	20 < T5 → T7 < 100US
T8 FORMATTER SETS READY	T7 → T8 = > 20US

X – DON'T CARE

Figure 4-2. BOT, Retension, or Erase Timing

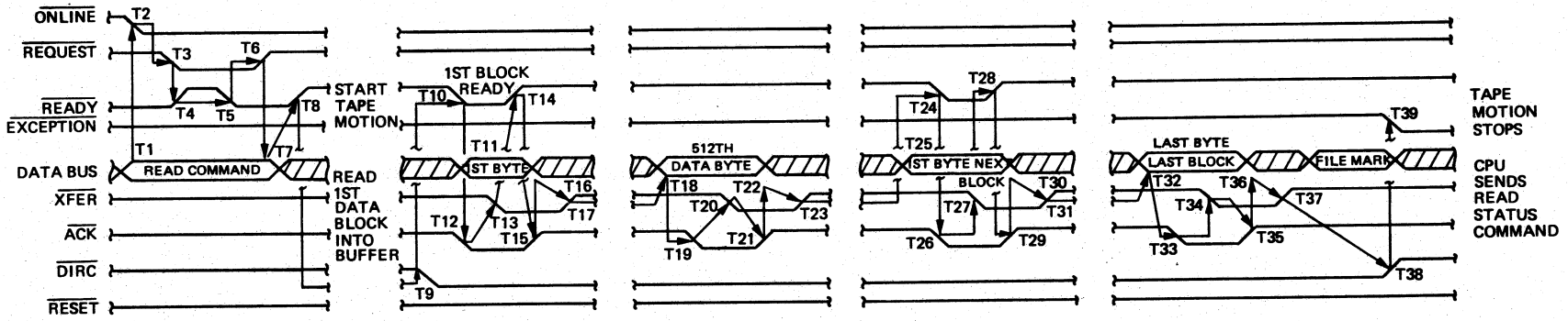


4-5

WRITE DATA COMMAND

ACTIVITY		CRITICAL TIMING	ACTIVITY		CRITICAL TIMING	ACTIVITY		CRITICAL TIMING
T1	CPU COMMAND TO BUS	N/A	T15	BUS DATA INVALID				
T2	CPU SETS ONLINE	N/A	T16	FORMATTER RESETS ACK	T13→T15 > 0 US	T28	CPU RESETS XFER	SAME AS T14
T3	CPU SETS REQUEST	T2→T3 > 0 US	T17	CPU DATA TO BUS	0 < T14→T16 < 56 US	T29	BUS DATA INVALID	SAME AS T15
T4	FORMATTER RESETS READY	T3→T4 < 25 US	T18	SAME AS T11	N/A	T30	FORMATTER RESETS ACK	SAME AS T16
T5	FORMATTER SETS READY	20 < T4→T5 < 500 US	T19	SAME AS T13	SAME AS T11	T31	CPU DATA TO BUS	N/A
T6	CPU RESETS REQUEST	T5→T6 > 0 US	T20	SAME AS T14	SAME AS T13	T32	CPU SETS XFER	SAME AS T18
T7	BUS DATA INVALID	T5→T7 > 0 US	T21	SAME AS T15	SAME AS T14	T33	FORMATTER SETS ACK	SAME AS T19
T8	FORMATTER RESETS READY	20 < T6→T8 < 100 US	T22	SAME AS T16	SAME AS T15	T34	CPU RESETS XFER	SAME AS T20
T9	FORMATTER SETS READY	T8→T9 > 20 US	T23	FORMATTER SETS READY	SAME AS T16	T35	BUS DATA INVALID	N/A
T10	CPU DATA TO BUS	N/A	T24	CPU DATA TO BUS	T22→T23 > 100 US	T36	FORMATTER RESETS ACK	SAME AS T22
T11	CPU SETS XFER	T10→T11 > 40 NS	T25	CPU SETS XFER	N/A	T37	FORMATTER SETS READY	SAME AS T23
T12	FORMATTER RESETS READY	T11→T12 < 0.25 US	T26	FORMATTER RESETS READY	SAME AS T11	T38	CPU RESETS ONLINE	N/A
T13	FORMATTER SETS ACK	56 < T11→T13 < 4.47 US	T27	FORMATTER SETS ACK	SAME AS T12	T39	FORMATTER RESETS READY	N/A
T14	CPU RESETS XFER	T13→T14 > 0 US			SAME AS T13			

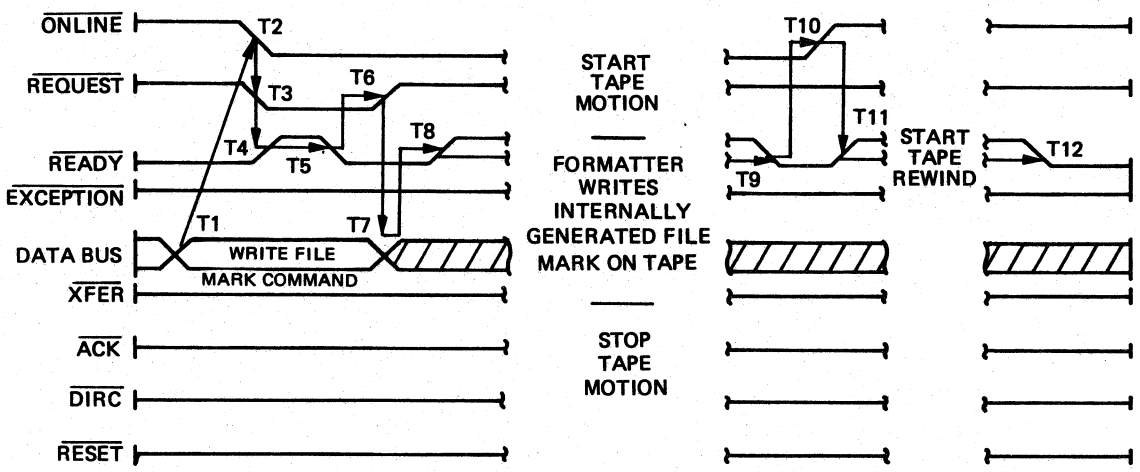
Figure 4-3. Write Data Timing



READ DATA COMMAND

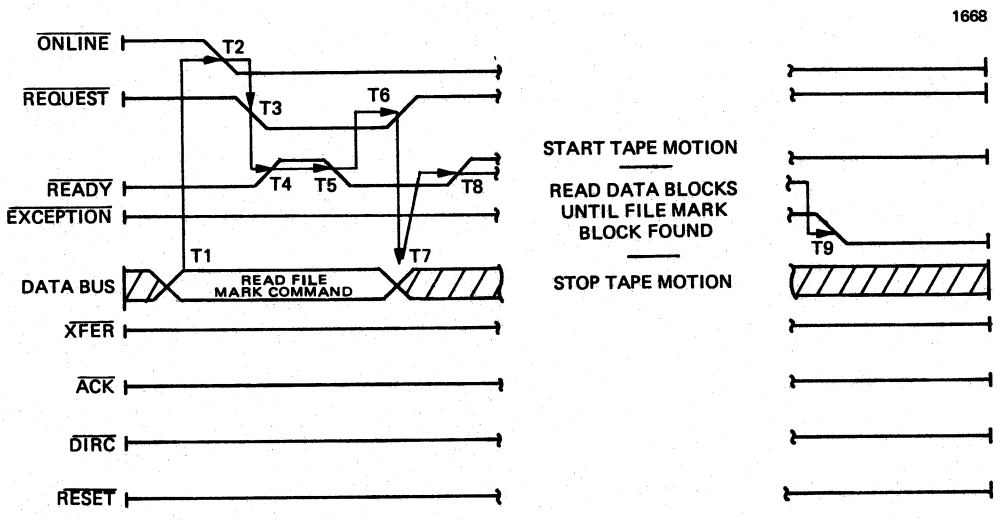
	ACTIVITY	CRITICAL TIMING
T1	CPU COMMAND TO BUS	N/A
T2	CPU SETS ON LINE	N/A
T3	CPU SETS REQUEST	T2 → T3 > 0 US
T4	FORMATTER RESETS READY	T3 → T4 < 0.25 US
T5	FORMATTER SETS READY	20 < T4 → T5 < 500 US
T6	CPU RESETS REQUEST	T5 → T6 > 0 US
T7	BUS DATA INVALID	T5 → T7 > 0 US
T8	FORMATTER RESETS READY	20 < T6 → T8 < 100 US
T9	FORMATTER CHANGES DIRC	N/A
T10	1ST DATA BYTE TO BUS	N/A
T11	FORMATTER SETS READY	N/A
T12	FORMATTER SETS ACK	T11 → T12 > 40 NS
T13	CPU SETS XFER	T12 → T13 > 0 US
T14	FORMATTER RESETS READY	T13 → T14 < 25 US
T15	FORMATTER RESETS ACK	56 < T13 → T15 < 1.12 US
T16	BUS DATA INVALID	T13 → T16 > 0 US
T17	CPU RESETS XFER	T15 → T17 > 0 US
T18	BUS DATA VALID	N/A
T19	FORMATTER SETS ACK	SAME AS T12
T20	CPU SETS XFER	SAME AS T13
T21	FORMATTER RESETS ACK	SAME AS T15
T22	BUS DATA INVALID	SAME AS T16
T23	CPU RESETS XFER	SAME AS T17
T24	FORMATTER SETS READY	N/A
T25	1ST BYTE TO BUS	N/A
T26	FORMATTER SETS ACK	SAME AS T12
T27	CPU SETS XFER	SAME AS T13
T29	FORMATTER RESETS READY	SAME AS T14
T29	FORMATTER RESETS ACK	SAME AS T15
T30	BUS DATA INVALID	SAME AS T16
T31	CPU RESETS XFER	SAME AS T17
T32	LAST BYTE TO BUS	N/A
T33	FORMATTER SETS ACK	SAME AS T12
T34	CPU SETS XFER	SAME AS T13
T35	FORMATTER RESETS ACK	SAME AS T15
T36	BUS DATA INVALID	SAME AS T16
T37	CPU RESETS XFER	SAME AS T17
T38	FORMATTER SETS EXCEPTION	N/A
T39	CHANGE BUS DIRECTION	N/A

Figure 4-4. Read Data Timing



ACTIVITY	CRITICAL TIMING
T1 CPU COMMAND TO BUS	N/A
T2 CPU SETS ONLINE	T1 → T2 > 0US
T3 CPU SETS REQUEST	T2 → T3 > 0US
T4 FORMATTER RESETS READY	T3 → T4 > 0.25US
T5 FORMATTER SETS READY	20 < T4 → T5 < 500US
T6 CPU RESETS REQUEST	T5 → T6 > 0US
T7 BUS DATA INVALID	T5 → T7 > 0US
T8 FORMATTER RESETS READY	20 < T6 → T8 < 100US
T9 CPU RESETS ONLINE	N/A
T10 CPU RESETS ONLINE	T9 → T10 > 0US
T11 FORMATTER RESETS READY	N/A
T12 FORMATTER SETS READY (AT BOT)	N/A

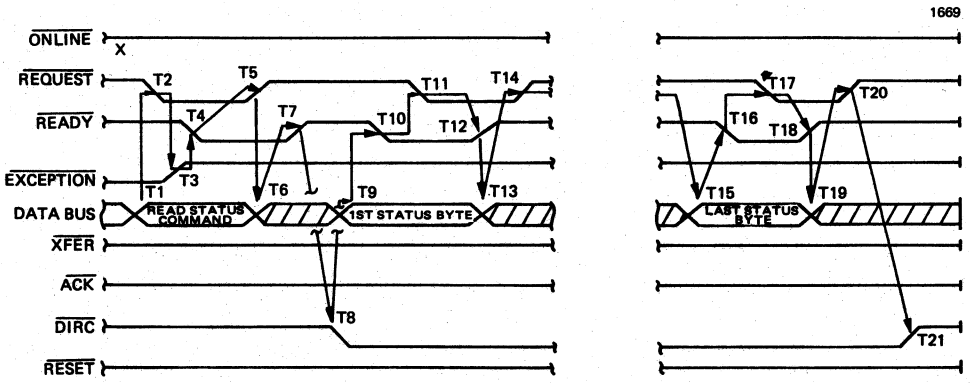
Figure 4-5. Write File Mark Timing



ACTIVITY	CRITICAL TIMING
T1 CPU COMMAND TO BUS	N/A
T2 CPU SETS ONLINE	T1 → T2 > 0US
T3 CPU SETS REQUEST	T2 → T3 > 0US
T4 FORMATTER RESETS READY	T3 → T4 < 0.25US
T5 FORMATTER SETS READY	20 < T4 → T5 < 500US
T6 CPU RESETS REQUEST	T5 → T6 > 0US
T7 BUS DATA INVALID	T4 → T7 > 0US
T8 FORMATTER RESETS READY	20 < T6 → T8 < 100US
T9 FORMATTER SETS EXCEPTION	N/A

* SYSTEM MUST ISSUE READ STATUS COMMAND

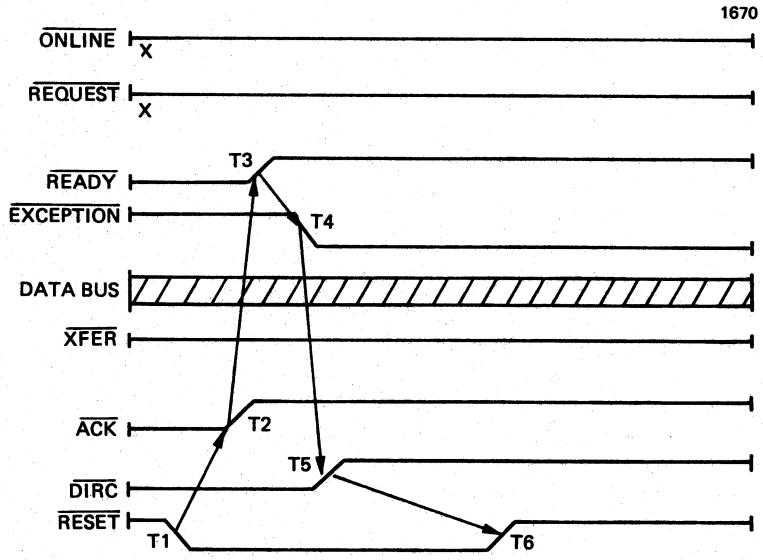
Figure 4-6. Read File Mark Timing



ACTIVITY	CRITICAL TIMING
T1 CPU COMMAND TO BUS	N/A
T2 CPU SETS REQUEST	T1 → T2 > 0US
T3 FORMATTER RESETS EXCEPTION	T3 → T4 > 10US
T4 FORMATTER SETS READY	20 < T2 → T4 < 500US
T5 CPU RESETS REQUEST	T4 → T5 > 0US
T6 BUS DATA INVALID	T4 → T6 > 0US
T7 FORMATTER RESETS READY	20 < T5 → T7 < 100US
T8 FORMATTER CHANGES BUS DIRECTION	N/A
T9 1ST STATUS BYTE TO BUS	N/A
T10 FORMATTER SETS READY	T7 → T10 > 20US
T11 CPU SETS READY	T10 → T11 > 500US
T12 FORMATTER RESETS READY	T11 → T12 < 0.25US
T13 BUS DATA INVALID	T11 → T13 > 0US
T14 CPU RESETS REQUEST	20 < T11 → T14 < 500US
T15 LAST STATUS BYTE TO BUS	N/A
T16 SAME AS T10	SAME AS T10
T17 SAME AS T11	SAME AS T11
T18 SAME AS T12	SAME AS T12
T19 SAME AS T13	SAME AS T13
T21 SAME AS T14	SAME AS T14
T21 FORMATTER CHANGES BUS DIRECTION	N/A

X – DON'T CARE

Figure 4-7. Read Status Timing



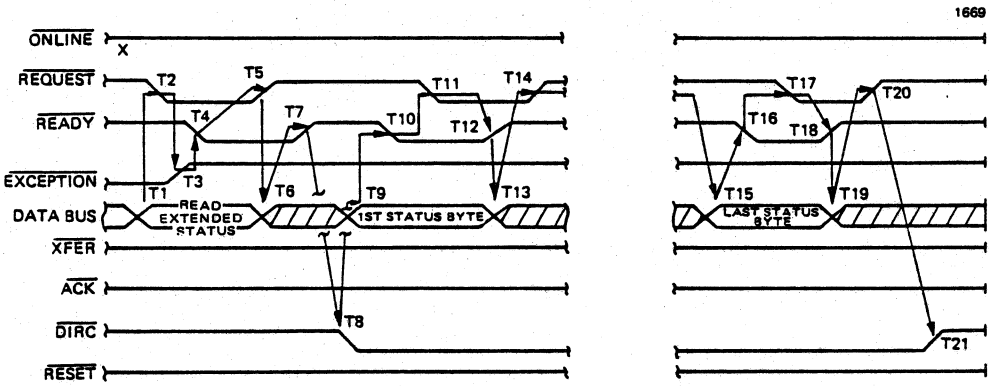
ACTIVITY	CRITICAL TIMING
T1 CPU ASSERTS $\overline{\text{RESET}}$	N/A
T2 FORMATTER DISABLES $\overline{\text{ACK}}$	T1 → T2 < 0.25US
T3 FORMATTER DISABLES $\overline{\text{READY}}$	T1 → T3 < 0.25US
T4 FORMATTER ASSERTS $\overline{\text{EXCEPTION}}$	T1 → T4 < 3US
T5 FORMATTER DISABLES $\overline{\text{DIRC}}$	T1 → T5 > 3US
T6 CPU DISABLES $\overline{\text{RESET}}$	T1 → T6 < 13US

X – DON'T CARE

Figure 4-8. Reset Timing

4.3 READ EXTENDED STATUS COMMAND

The Read Extended Status Command has been implemented as an aid in determining the area of fault within a failing Quarterback drive. The command is executed by placing the appropriate bit pattern for the Read Extended Status command (E0) on the bus and following the signal protocol on the timing diagram. All 64 status bytes must be transferred by using the Ready/Request handshake. Command timing is shown in Figure 4-9, and the status byte values are listed in Table 4-2.



ACTIVITY	CRITICAL TIMING
T1 CPU COMMAND TO BUS	N/A
T2 CPU SETS REQUEST	T1 — T2 > 0US
T3 FORMATTER RESETS EXCEPTION	T3 — T4 > 10US
T4 FORMATTER SETS READY	20 < T2 — T4 < 500US
T5 CPU RESETS REQUEST	T4 — T5 > 0US
T6 BUS DATA INVALID	T4 — T6 > 0US
T7 FORMATTER RESETS READY	20 < T5 — T7 < 100US
T8 FORMATTER CHANGES BUS DIRECTION	N/A
T9 1ST STATUS BYTE TO BUS	N/A
T10 FORMATTER SETS READY	T7 — T10 > 20US
T11 CPU SETS READY	T10 — T11 > 500US
T12 FORMATTER RESETS READY	T11 — T12 < 0.25US
T13 BUS DATA INVALID	T11 — T13 > 0US
T14 CPU RESETS REQUEST	20 < T11 — T14 < 500US
T15 LAST STATUS BYTE TO BUS	N/A
T16 SAME AS T10	SAME AS T10
T17 SAME AS T11	SAME AS T11
T18 SAME AS T12	SAME AS T12
T19 SAME AS T13	SAME AS T13
T21 SAME AS T14	SAME AS T14
T21 FORMATTER CHANGES BUS DIRECTION	N/A

X - DON'T CARE

Figure 4-9. Read Extended Status Command

Table 4-2. Extended Status Read Command Bytes

RBO – Used with the read and write loops for temporary storage and flags for write operations as follows:

Byte	Definition
BYTE 0	R0 used as data memory pointers, and general scratch registers.
BYTE 1	R1 used as data memory pointers, and general scratch registers.
BYTE 2	R2 is the last block Address read from the tape.
BYTE 3	R3 flags for the next host buffer.
BYTE 4	R4 flags for the active host buffer.
BYTE 5	R5 flags for the available (empty) buffers.
BYTE 6	R6 flags for the full buffers. Where the bit assignments for: R3 through R6, NXWTBF, REWBF, NXRDBF, CREBF & EXBUF are: Bit 7 = 0 Bit 6 = 0 Bit 5 = Buf 3 Bit 4 = Buf 2 Bit 3 = Buf 1 Bit 2 = 0 Bit 1 = 0 Bit – = 0 ALLBUF = 00111000B
BYTE 7	R7 is the write flags as follows: Bit 7: Flag from read channel telling write channel to use RWBUF/BLK instead of NXWTBF/BK. Bit 6: Indicates a duplicate block is being written because of an overrun. Bit 5: Indicates the buffer bit in R3 (next host) is valid. Bit 4: Indicates the host channel has been started but not finished. Bit 3: Indicates the buffer bit in NXWTBF is valid. Bit 2: Indicates a file-mark has been started by the write channel.

Table 4-2. Extended Status Read Command Bytes (continued)

Byte	Definition
	Bit 1: Indicates a write-file mark command, or an offline-during-write has occurred but the file-mark has not yet been written. Bit 0: Indicates that an offline has occurred during write, or the early-warning hole has been detected (causes the buffers to be flushed)
BYTE 8	Stack Byte
BYTE 9	Stack Byte
BYTE 10	Stack Byte
BYTE 11	Stack Byte
BYTE 12	Stack Byte
BYTE 13	Stack Byte
BYTE 14	Stack Byte
BYTE 15	Stack Byte
BYTE 16	Stack Byte
BYTE 17	Stack Byte
BYTE 18	Stack Byte
BYTE 19	Stack Byte
BYTE 20	Stack Byte
BYTE 21	Stack Byte
BYTE 22	Stack Byte
BYTE 23	Stack Byte
RB1 is used for command setup as follows:	
BYTE 24	R0 used as data memory pointers
BYTE 25	R1 used as data memory pointers
BYTE 26	R2 is the alternate drive control register
BYTE 27	R3 is the CMD being executed
BYTE 28	R4 is a CNT of bad RCRDS for RD or WRT. Bit seven is time out
BYTE 29	R5 is the DRV SEL and TRK SEL pointer
	Bit 7 TRK 3 (MSB); This is a four-bit track number which can have the values 00 through 15
	Bit 6 TRK 2

Table 4-2. Extended Status Read Command Bytes (continued)

Byte	Definition
	Bit 5 TRK 1 Bit 4 TRK 0 (LSB) Bit 3 SEL 3 This is a radial select code which is used to select one of four drives. Not more than one bit should be on at a time. Bit 2 SEL 2 Bit 1 SEL 1 Bit 0 SEL 0 TRKBTS = 11110000B
BYTE 30	R6 is the DRV control REG Bit 7 CARTRDG LOCK ; Turning this signal on locks the cartridges in/out of ALL drives. Bit 6 WRITE ; Turning this signal on enables write current in the write head. Bit 5 ERASE ; Turning this signal on enables current in the erase head. This signal should only be turned on while selecting track 00 Bit 4 REVERSE ; This signal on selects the reverse (from EOT to BOT) direction; off selects the forward (from BOT to EOT) direction. Bit 3 GO ; Turning this signal on causes the capstan to move tape on the selected drive in the direciton indicated by the REVERSE signal. Bit 2 HIGH SPEED ; This signal, in conjunction with the GO signal causes the drive to move tape at 90 ips whether or not it is a 90 ips drive. This signal is sampled only when the tape is stopped. (If a shift to high speed is desired while tape is moving, GO must be turned off for at least 5 milliseconds to ensure that HIGH SPEED gets sampled.)

Table 4-2. Extended Status Read Command Bytes (continued)

Byte	Definition
	Bit 1 ZERO THRESHOLD ; This signal tells the basic drive to remove any and all amplitude threshold margining of the read signal, and is used in a last-ditch effort to recover hard-to-read blocks. (Not used.)
	Bit 0 (NOT USED)
BYTE 31	R7 is the flag reg
	POSFLG EQU 10000000B; Bit 7: We are at a known position
	SWTRK EQU 01000000B; Bit 6: We are switching tracks (turn around)
	WRTPOS EQU 00100000B; Bit 5: We are positioning for a write
	ATEOM EQU 00010000B; Bit 4: We have written past early warnings hole
	LOOKBIE EQU 00001000B; Bit 3: Last retry, look for BIE
	FNDBIE EQU 00000100B; Bit 2: Indicates BIE was found
	PSTEOM EQU 00000010B; Bit 1: Indicates attempt to read past EOM
	MORDTA EQU 00000001B; Bit 0: Inhibits NO-DATA-DETECTED status
BYTE 32	Status Byte 0
BYTE 33	Status Byte 1
BYTE 34	Status Byte 2
BYTE 35	Status Byte 3
BYTE 36	Status Byte 4
BYTE 37	Status Byte 5
BYTE 38	NXWTBF ; This location indicates the next buffer to be written (read on a Read command) only one bit should be on at a time
BYTE 39	NXWTBK ; This location indicates the next block address to be written (read on a Read command)
BYTE 40	NXRDBF ; This location indicates the next buffer that is going to be read-after-write-checked. It is not actually written to on the read back, but is saved here to be used on a re-write. (Not used on a Read command.)

Table 4-2. Extended Status Read Command Bytes (continued)

Byte	Definition
BYTE 41	NXRDBK ; This location indicates the next block address to be used on a read-after-write check. (Not used on a read command.)
BYTE 42	RWBUF ; This location tells the write logic which buffer to use on a re-write.
BYTE 43	RWBLK ; This location tells the write logic which block address to use on a re-write.
BYTE 44	CRDBF ; This location tells the read channel which buffer is currently being read-after-write checked. It is not actually written to but is saved here to be used when flaging re-writes. (It is the buffer currently being filled by the read channel on a Read command.)
BYTE 45	CRDBK ; This location indicates which block address should come out of the read channel next.
BYTE 46	EXBUF ; This location holds the buffer bit for the block that initiated a re-write. The re-write flag is not turned off until the block containing this buffer is read back from the tape.
BYTE 47	BADONT ; This is a counter to keep track of compounded retries. When it reaches 16 it is a HARD error.
BYTE 48	This byte holds the two's complement of the highest track address allowable +1.
BYTE 49	Old Status Byte
BYTE 50	Old Status Byte
BYTE 51	Old Status Byte
BYTE 52	Old Status Byte
BYTE 53	Old Status Byte
BYTE 54	Old Status Byte
BYTE 55	Last command executed
BYTE 56	The number of bad records on last Read or Write operation

Table 4-2. Extended Status Read Command Bytes (continued)

Byte	Definition
BYTE 57	Old value of Bank 1 register 5 R5 is the DRV SEL and TRK SEL pointer Bit 7 TRK 3 (MSB) ; This is a four-bit track number which can have the values 00 through 15 Bit 6 TRK 2 Bit 5 TRK 1 BIT 4 TRK 0 LSB) Bit 3 SEL 3 ; This is a radial select code which is used to select one of four drives. Not more than one bit should be on at a time. Bit 2 SEL 2 Bit 1 SEL 1 Bit 0 SEL 0 TRKBTS = 11110000B
BYTE 58	Old value of Bank 1, Register 6 R6 is the DRV control REG Bit 7 CARTRDG LOCK ; Turning this signal on locks the cartridges in/out of ALL drives Bit 6 WRITE ; Turning this signal on enables write current in the write head Bit 5 ERASE ; Turning this signal on enables current in the erase head. This signal should be turned on only while selecting track 00 Bit 4 REVERSE ; This signal on selects the reverse (from EOT to BOT) direction; off selects the forward (from BOT to EOT) direction Bit 3 GO ; Turning this signal on causes the capstan to move tape on the selected drive in the direction indicated by the REVERSE signal

Table 4-2. Extended Status Read Command Bytes (continued)

Byte	Definition
	Bit 2 HIGH SPEED ; This signal, in conjunction with the GO signal, causes the tape drive to move tape at 90 ips whether or not it is a 90 ips drive. This signal is sampled only when the tape is stopped. (If a shift to high speed is desired while tape is moving, GO must be turned off for at least 5 milliseconds to ensure that HIGH SPEED gets sampled.)
	Bit 1 ZERO THRESHOLD ; This signal tells the basic drive to remove any and all amplitude threshold margining of the Read signal, and is used in a last ditch effort to recover hard-to-read blocks. (Not used.)
	Bit 0 (NOT USED)
BYTE 59	Old value of Bank 1, Register 7 R7 is the flag reg. POSFLG EQU 10000000B; Bit 7: We are at a known position SWTRK EQU 01000000B; Bit 6: We are switching tracks (turn around) WRTPOS EQU 00100000B; Bit 5: We are positioning for a Write operation ATEOM EQU 00010000B; Bit 4: We have written past early warnings hole LOOKBIE EQU 00001000B; Bit 3: Last retry, look for BIE FNDBIE EQU 00000100B; Bit 2: Indicates BIE was found PSTEOM EQU 00000010B; Bit 1: Indicates attempt to read past EOM MORDTA EQU 00000001B; Bit 0 status Inhibits NO-DATA-DETECTED

Table 4-2. Extended Status Read Command Bytes (continued)

Byte	Definition
BYTE 60	Firmware Release Number
BYTE 61	Firmware Version Number
BYTE 62	Select Drive Light Bit (Bit 7)
BYTE 63	Holds the count of phony rewrites that are done at the start of all track to get past cold point. (Phony CNT should be 7 plus 1).

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