Technical Service Manual

for

QUALSTAR®

Corporation

1260 Series
Magnetic Tape Transport

Document Number 500244 H

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Introduction 1

This manual describes the operating instructions, theory of operation, maintenance, replacement of the major circuit PCBAs, field adjustments, error conditions and diagnostics for the Qualstar Model 1260 Magnetic Tape Transport, hereafter refered to as *the tape drive*, or *the drive*. The basic tape drive in each of the models is functionally identical. This manual provides maintenance and service instructions for the basic tape drive. Included in the appendices is a glossary of tape drive terminology to assist persons unfamiliar with the essential principals of tape drives.

Familiarity with the User's Manual and a working knowledge of oscilloscopes and digital voltmeters is required to service the tape drive. Before beginning any procedures, the settings of the option switches on the Write/Controller PCBA should be noted so they may be returned to their original positions.

All of the operating instructions and maintenance procedures given in this manual must be followed to prevent personal injury or damage to the equipment. This manual contains the following three kinds of warnings:

DANGER ! **PERSONAL INJURY MAY RESULT IF THE HANDLING, OPERATING OR SERVICE INSTRUCTIONS FOUND IN DANGER TEXT ARE NOT OBSERVED.**

Caution! ***EQUIPMENT DAMAGE OR DATA LOSS may result if the handling, operating or service instructions found in CAUTION text are not observed.***

Note: *SPECIAL ATTENTION to explanatory statements found in NOTE text will help avoid mistakes.*

1.1 Related Documents

NUMBER	DOCUMENT TITLE
500180	Model 1260 Product Specification
500200	Buffered Interface Supplement
500358	SCSI Interface Manual
500250	1260 User's Guide

Table 1-1 Related Documentation

1.2 Scope of This Manual

The intent of this manual is to assist with the general maintenance and modular level repair of inoperative drives. A list of Field Replaceable Unit (FRU) parts is given in Appendix B. Replacement of parts below the FRU level are beyond the scope and intent of this manual; any reference to specific components (such as U28) is for information only and is not intended as a component-level troubleshooting reference. Every attempt has been made to ensure the accuracy of this manual; however, Qualstar is not responsible for any errors or omissions.

1.3 Model Descriptions

The Model 1260 tape drives read and write digital data at 1600 characters per inch (cpi) in the phase encoded (PE) format, at 6250 cpi in the group code recording (GCR) format, and optionally, at 3200 cpi in the Double PE (DPE) format. These models feature an embedded formatter using the industry standard formatter interface. This manual does not address special interfaces (such as the Buffered Interface and the SCSI interface), and applies only to the basic drive of the following models:

1260:	The standard model.
1260B:	Adds a 256K buffered interface.
1260E:	The chassis is 1.1 inches deeper than the standard 1260 model to accommodate a customer-supplied interface PCBA.
1260S:	Adds a SCSI interface compatible with ANSI X3T9.2 Revision 15.
1260T:	Adds a 3200 cpi DPE operation (this option no longer available).

A door option may be added to any model.

1.4 Functional Description

1.4.1 General

The drive is designed to be operated as a self-contained unit. It is generally used in the desk-top configuration, but a rack mount option is also available. The unit contains an embedded formatter which is compatible with the industry standard formatter interface.

The drive provides a high-speed Space and Search Filemark function in the GCR mode which quadruples search speed. The drive can read tapes with interblock gaps (IBGs) as short as 0.28 inch. It also reads and typically writes tapes with 0.3 inch IBGs in GCR and 0.6 inch in PE and can handle tape reels ranging from 6 to 10.5 inches in diameter with up to 3600 feet of tape.

1.4.2 Read-After-Write

The drive writes in the forward tape direction and reads both forward and reverse. A hard-faced erase/write/read head enables simultaneous read while write operation. The data transfer rate is held to a constant 80K per second by switching tape speeds between the densities, as shown in Table 1-2. The data transfer rate at the interface of Model 1260B (buffered) can vary from 40K to 312K per second, peak.

DENSITY	SPEED
1600 Cpi	50 ips
3200 Cpi	25 ips
6250 Cpi	12.5 ips

Table 1-2 Density versus Speed

1.4.3 Optional Settings

Front panel switches are used to load and unload tape, control online status, select the file protect mode, and to select the operating density. Internal jumpers select line voltage, formatter address, formatter enabling and status control signals. Internal option switches define the compatibility options between the 1260 and drives of other vendors, default density, filemark and IBG lengths. Refer to the 1260 User's Guide (500250) for details about the front panel switches, internal jumpers and switches.

1.4.4 Error Detection

Error conditions arising from operator error, host error and drive faults are detected and displayed as a code of flashing lights on the front panel. Refer to the 1260 User's Guide (500250) for a description of detected errors.

1.4.5 Diagnostic Capabilities

Eight diagnostic tests are available and can be selected by the internal option switches. Refer to Chapter 4 for more information.

Data Formats 2

This chapter is included in the manual to provide the service technician with a basic understanding of the PC and GCR recording formats, and with enough information to understand the operation of the various write encoding and read recovery circuitry. DPE (3200 cpi) operation, available only on the Model 1260T, is identical to PE (1600 cpi) operation, except that the packing density on tape is twice that of PE. During DPE operation the tape speed is cut in half to 62.5 ips, allowing the interface data transfer rate to remain the same as during PE operation.

Both PE and GCR data are recorded on nine tracks which are physically located on tape according to ANSI standards. A *track* is the actual path along tape that a particular bit stream follows, referenced by its physical position relative to the reference edge (the edge furthest from the base) of the tape. A *channel* (as seen by the host) refers to the path along tape that a particular bit follows as referenced by its logical position in the data byte. The relationship between tracks and channels is shown in Figure 2-1 on page 2-2.

Bit P is the parity bit. Channel 0 is considered the most significant bit for ASCII tape formats.

The track width on tape is 0.043 inch minimum per track. The centerline distance between tracks is 0.055 inch nominal. The centerline of track 1 is 0.029 inch ±0.003 inch from the reference edge (nearest the labeled side of the tape reel).

In both PE and GCR recording, a *character* is a group of nine bits (0-7 and parity) written in parallel on the tape. A character consists of eight data bits (a byte) and a parity bit. The data is written through a magnetic head which polarizes the tape particles in one direction or another. A *flux reversal* (also called a flux transition) is a change in the alignment of magnetically polarized oxide particles on the surface of the tape.

2.1 PE Format

PE (Phase Encoded) is the most widely used format for recording data on tape. The density is 1600 cpi (63 characters per millimeter) nominal. Bit values are determined by the direction of a flux reversal on tape. A *one* data bit is defined as a flux reversal with the same polarity as the IBG, when reading in the forward direction. A *zero* data bit is defined as a flux reversal with the opposite polarity of the IBG, when reading in the forward direction.

In PE, sequential bits of the same value must be separated by an additional flux reversal called an *interphase transition*. Refer to Figure 2-2 on page 2-2. The interphase transition allows each bit to be represented by a flux reversal. If the interphase transitions were NOT present, two ones would be written with the same direction of magnetization and there would be no change on tape until the opposite bit value were written. This would be impossible to read. Because of the addition of interphase transitions, the recording efficiency of the PE format does not exceed 50%.

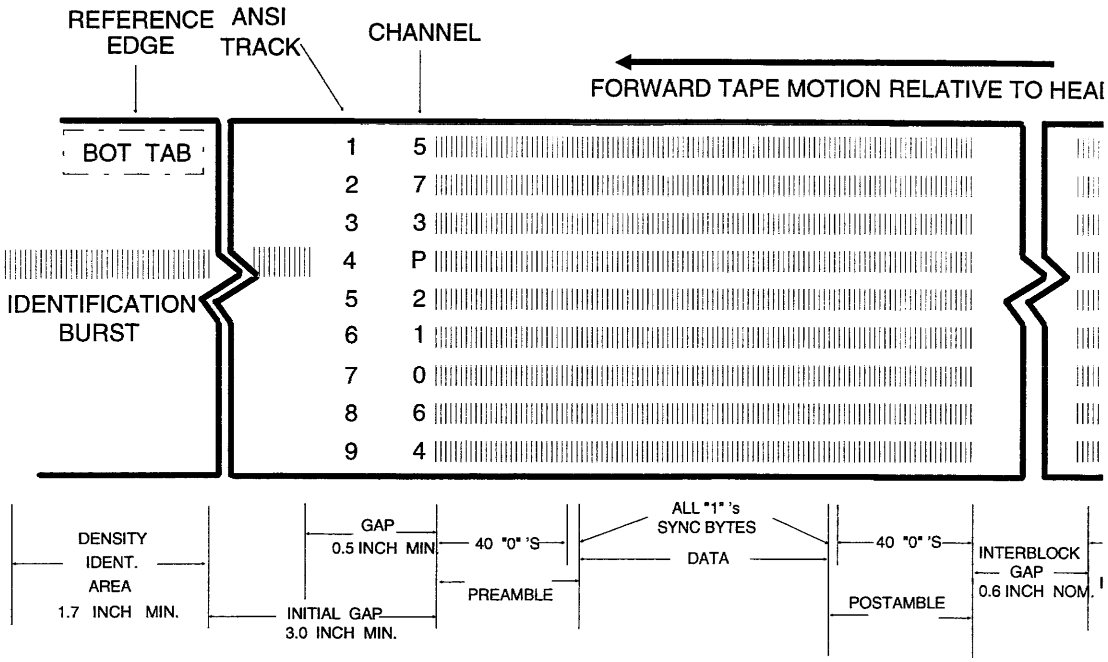


Figure 2-1 PE Data Tape Format

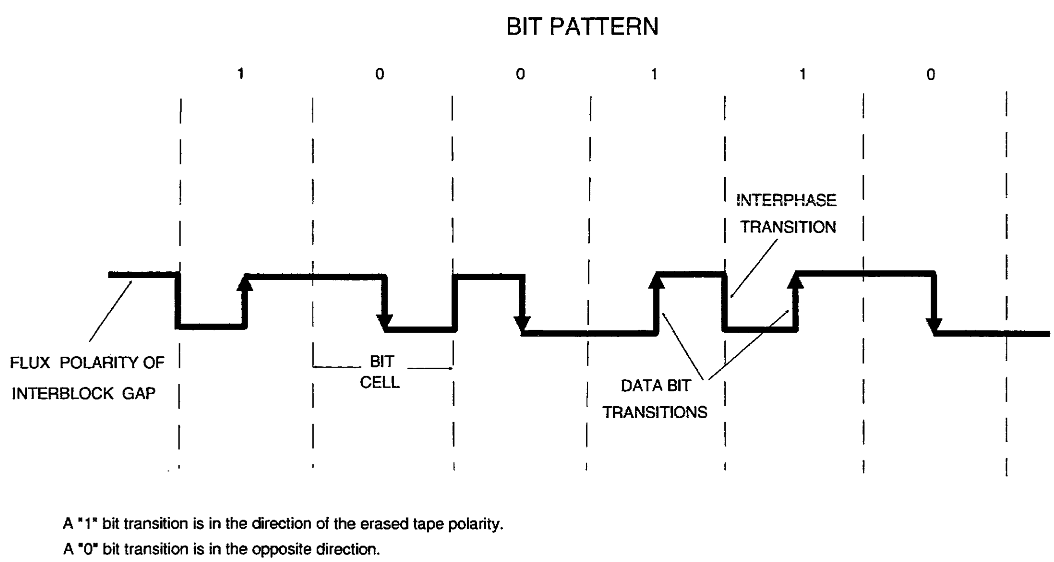


Figure 2-2 PE Data Bit Pattern

The general tape format for PE is shown in Figure 2-1 on page 2-2. The nominal character spacing, exclusive of interphase transitions, is 625 microinches. Data bits in a character cannot be displaced (skewed) more than 625 microinches from any other data bit in the same tape character, as measured perpendicular to the reference edge.

2.1.1 PE Data

The data portion of an ANSI-compatible block contains a minimum of 18 ASCII characters and a maximum of 2048 characters. A *preamble* consisting of 41 characters precedes the data in each block. The first 40 characters contain zeros in all tracks, and the 41st character contains ones in all tracks.

A *postamble* consisting of 41 characters follows the data in each block. The first character of the postamble contains ones in all tracks, and the remaining 40 characters contain zeros in all tracks. The postamble is a mirror image of the preamble to enable reading in reverse.

Unlike NRZ and GCR, no additional check characters are recorded.

2.1.2 PE IBG Length

The IBG (the erased portion of tape between blocks) length in PE is 0.6 inch nominal, 0.5 inch minimum, and 25 feet maximum.

2.1.3 PE ID Burst

PE tapes are identified by a recorded burst in the area of the BOT marker. This burst consists of flux reversals on track 4 (channel P) while the remaining tracks are DC erased. The identification (ID) burst begins 1.7 inches minimum before the trailing edge of the BOT marker and ends at least 0.5 inch before the first block.

An initial gap lies between the trailing edge of the BOT marker and the first recorded character. The length of this initial gap is three inches minimum and 25 feet maximum.

2.1.4 PE Filemark

A PE filemark consists of 64 to 256 flux reversals at 3200 flux reversals per inch in tracks 2, 5, and 8. Tracks 3, 6 and 9 are DC erased. Tracks 1, 4, and 7 may be erased, or they may be recorded the same as 2, 5 and 8 (as is the case with the Qualstar Model 1260).

2.2 GCR Format

The *effective density* of GCR (Group Code Recording) is 6250 cpi. The actual density, including *overhead*, is 9042 bytes per inch. The recording efficiency of GCR is 80%.

The bit values are determined like the NRZI recording method, with a flux reversal indicating a one and the absence of a flux reversal indicating a zero. However, the data is coded in the formatter prior to being written so that no more than two consecutive zeros will ever occur on tape, regardless of the incoming data stream. The coding also provides self-clocking, error detection, and error correction abilities.

The overall GCR tape format is shown in Figure 2-3 on page 2-4. GCR tapes are identified by a GCR ID burst in the area of the BOT marker. This burst is in the PE frequency range on channel 1 (track 5), with the remaining tracks DC erased. The ID burst begins 1.7 inches (43.18 mm) minimum before the trailing edge of the BOT marker and continues past the trailing edge of the BOT marker.

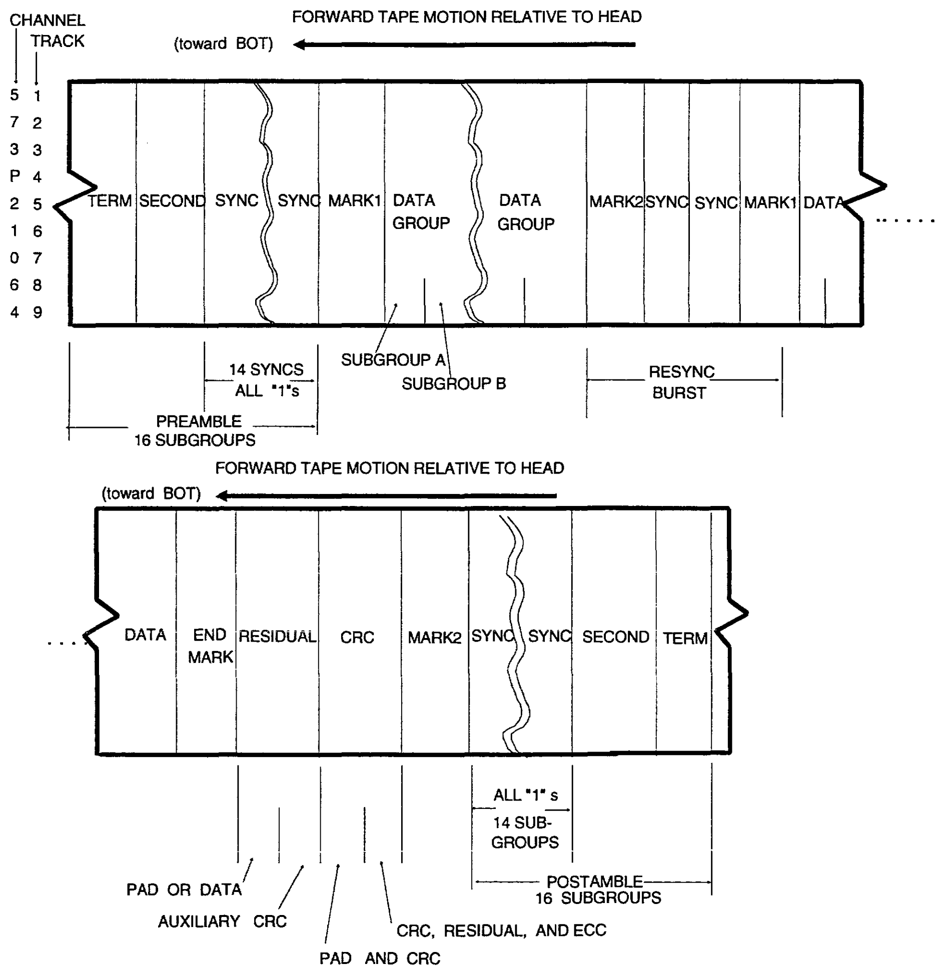


Figure 2-3 GCR Data Tape Format

2.2.1 ARA Burst

An Automatic Read Amplification (ARA) burst, consisting of an *all ones* pattern in all tracks, immediately follows the ID burst, and is separated from the ID burst by a gap of undefined length. Its purpose is to allow gains of the read amplifiers to be dynamically adjusted for all tracks. A special ARA ID burst character follows the ARA burst and is used to identify the ARA burst when reading in reverse to BOT.

2.2.2 GCR Filemark

A filemark (also called tape mark) separates files and file labels on tape. It consists of 250 to 400 flux reversals, all ones in channels 7, 2, 6, 5, P, and 0, while channels 3, 1, and 4 are DC erased.

2.2.3 GCR Preamble and Subgroups

Each block of data is preceded by a preamble for synchronization purposes. The preamble consists of 80 characters, divided into sixteen control subgroups. Control subgroups are special subgroups of characters which have sets of identical control five-serial-bit values in the nine tracks, except for the subgroup containing the last character. They identify various GCR format items on tape. The preamble contains sixteen control subgroups: one *Term Control Subgroup*, one *Second Control Subgroup*, and 14 *Sync Control Subgroups*.

Term Control Subgroup - identifies the first or last subgroup of a block

Second Control Subgroup - the second subgroup and next to last subgroup of a block.

Sync Control Subgroup - indicates recorded frequency and phase which allows synchronization of the variable frequency clock in the read circuitry.

Mark 1 Control Subgroup - Follow the preamble and indicates that data will follow. At other locations on tape, this subgroup is used to demark Storage Groups from other Control Subgroups.

The actual data which has been encoded in the GCR format follows the Mark 1 Control Subgroup. Blocks are divided into Data Groups, the essential elements of group-code recording. The Data Group consists of seven sequential data characters, plus an error correction code (ECC) character. These eight characters are encoded into a Storage Group which is ten characters long before being written on tape. The encoding is done to ensure that no more than two zeros will be written consecutively on the tape.

Resync Burst - Occurs after each 158 data groups (1106 bytes). This is a set of control subgroups which identify format resynchronization points in a block. The read circuits resynchronize each time these bursts are sensed.

End Mark Control Subgroup - Used to indicate the end of a series of complete data groups, and the beginning of the Residual Group.

2.2.4 GCR Check Characters

The GCR format contains three types of check characters:

ACRC - A Auxiliary Cyclic Redundancy Check character is calculated by a polynomial and exclusive-OR operation on the data, including parity.

CRC - A Cyclic Redundancy Check character is a repeating character calculated in a way similar to the ACRC character.

ECC - An Error Correction Code character is generated for each seven bytes of data, excluding parity. It is calculated by a feedback-shift operation.

2.2.5 Residual Data Group

A Residual Data Group contains either the extra data characters leftover from the division of blocks into Data Groups, or it contains padding characters to fill up the group. It also contains an ACRC character and an ECC character which are used for error detection.

A CRC Group follows the Residual Data Group and contains CRC characters, a residual character and an ECC character. This group is present at the end of each block and is used for error detection.

A Mark 2 group follows the CRC Group or Storage Groups and indicates that a Control Group (such as Sync) will follow. If a Mark 2 is at the end of the block, a postamble will follow.

2.2.6 GCR Postamble

The postamble consists of 80 characters. The first 14 subgroups are all ones in all tracks, followed by *11110* and *1010L* in all tracks. *L* is the last character of a block, and will be followed by erasure. The postamble is recorded for the purpose of electronic synchronization when reading in reverse, and is the mirror image of the preamble.

2.2.7 GCR IBG Length

In addition to preambles and postambles, an IBG of 0.3 inch (0.28 inch minimum, 15 feet maximum) follows each block.

Theory of Operation 3

This chapter is divided into the following sections:

- A general overview of tape drive operations
- A brief summary of the functional parts of the tape drive

The first section provides background information which will assist the service technician in the understanding of other areas of the manual, while the second section provides a functional description of PCBA operations.

Detailed information about specific inoperative conditions is given in Chapter 9. Detailed information about the host commands and data transfer can be found in Product Specification 500180, and the Glossary in Appendix A will be helpful in understanding the tape drive terminology used in this manual. Schematic drawings and located in Appendix C.

3.1 Overview

This overview describes a historical perspective of tape drives, the distinctions between tape drive and host operations, and the principle functions of the drive.

3.1.1 Start-Stop Tape Drives

Early computers used magnetic tape not only to store, but also to manipulate data. The host could search the tape for a particular piece of data, read that data into its memory, update the information, and then overwrite the old data on the tape with the new data (a process known as *editing*).

To allow the selective reading and editing of data, nine track tape drives record data on magnetic tape in a series of blocks. Each block is separated from the others by a short, erased area (0.6 inch long) called an *interblock gap*, or IBG for short. Early tape drives were known as *start/stop* drives because they actually stopped and restarted the tape between each block of data. Due to the short length of the IBG, and because the tape had to be decelerated and accelerated within this distance, start/stop drives required several complicated and expensive subsystems:

- A precision motor/tachometer assembly to control tape acceleration, speed, direction, and deceleration (capstan motor);
- Large, powerful motors to overcome the inertia of the tape reels at the accelerations required (reel motors);
- A physical tape buffering system to match the rapid acceleration of the tape by the capstan to the relatively slow acceleration of the reels (i.e., tension arms or vacuum columns).

3.1.2 Advent of the Streaming Tape Drive

Whereas the time to access a particular block on magnetic tape could be several minutes, depending upon the speed of the tape and location of the block on the tape, the access time for any block of data on a disk averaged less than a second. Because disk operations were thousands of times faster than tape operations, more and more data manipulation was done using disk-based data. The role of the tape drive as a backup storage device for disk-based data grew, while the use of tape for data processing and online editing declined.

The increase in disk storage capacities from a few megabytes to over several hundred megabytes, the change in the role of tape drives from data manipulation to high speed disk backup, and the advent of the microprocessor gave rise to a new generation of tape drives. Because the high-speed start/stop ability was no longer required, tape motion could be controlled by the reel motors and the capstan motor could be eliminated. And because high tape accelerations were not longer required, the heavy reel motors could be replaced by lighter, less expensive motors.

Microprocessors were used to monitor tape speed, direction and tension several times a second and to provide continuous control over these factors by controlling the reel motors. Low tape acceleration requirements allowed complicated tape buffering systems to be replaced by simple tape tension and speed sensing devices.

Because these drives were used almost exclusively for disk backup purposes, systems were redesigned to keep the tape moving as much as possible and to send the data to the drive in a continuous stream (and hence the term *streaming*). Tape drives which were optimized for this mode of operations became known as *streamers*.

3.1.3 Host Control

Model 1260 tape drives employ read-while-write electronics which allow the immediate detection of data errors while writing. When errors are detected during writing, the host normally instructs the drive to backspace the tape across the bad block, erases that portion of tape, and then rewrites the block.

The host controls the data transfer to and from the tape drive via a series of commands and signals such as Write, Enable Formatter, Reverse, and Rewind. The tape drive interprets the signals, performs the requested operation, and returns status signals such as End-Of-Tape, Online, Data Busy, Rewinding, and Hard Error to the host.

The host transfers data to the tape drive by first sending the appropriate command to the drive, and then using nine write data lines to carry the data to be recorded, byte by byte, until the entire block has been transferred. The host transfers data from the drive in a similar manner, first sending the appropriate command and then using nine read data lines to transfer the data which was read from the tape, again byte by byte.

A simple writing operation may proceed as follows:

1. The operator loads a tape and places the drive online.
2. The host sends a write command to the drive to write and gives it data.

3. The tape drive accelerates the tape and writes data at the appropriate tape position.

4. The tape drive reports any errors to the host and signals when it is ready for more data.

5. If no more data is available, the drive stops the tape, repositions it, and waits for another command.

6. If the drive reports an error, the host instructs drive to rewrite that block.

7. When the drive detects the end of the tape, it informs the host.

8. The host instructs drive to rewind and unload the tape.

9. The operator removes the tape reel.

3.1.4 Functional Overview of the 1260 Tape Drive

The 1260 tape drive is made up of several functional units. These units are shown in Figure 3-1.

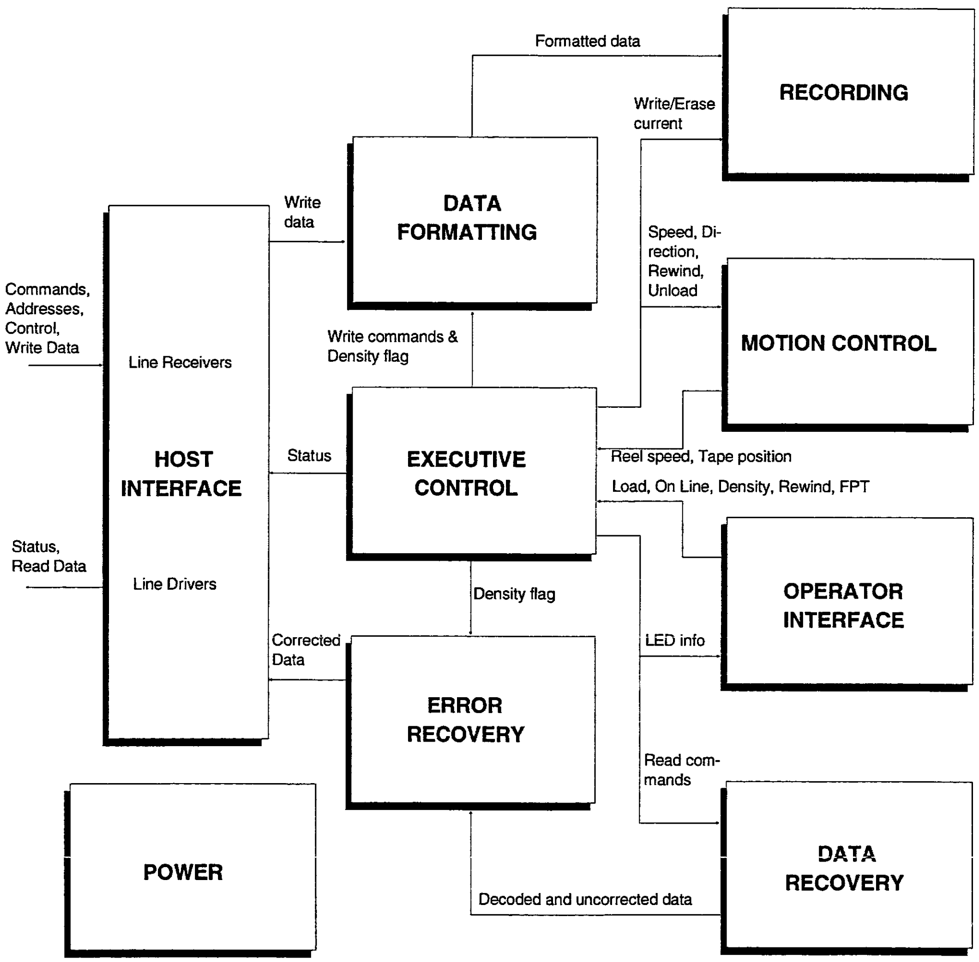


Figure 3-1 1260 Functional Overview Diagram

3.2 Functional Parts

The basic functional parts of the tape drive are the power supply, the tape controller (including logic and servo circuitry), the write formatter, the read analog amplifier, the read formatter, and the switch/indicator/sensor electronics. These basic functional parts are found on the Power Supply PCBA, the Read/Formatter PCBA, the

Write/Controller PCBA, the Preamplifier PCBA, the Switch PCBA, the Hall PCBA, and on the base itself. It will be helpful to refer to the functional block diagram in Figure 3-2 and to the Interconnect Diagram (DN 500242 in Appendix C) while reading this chapter.

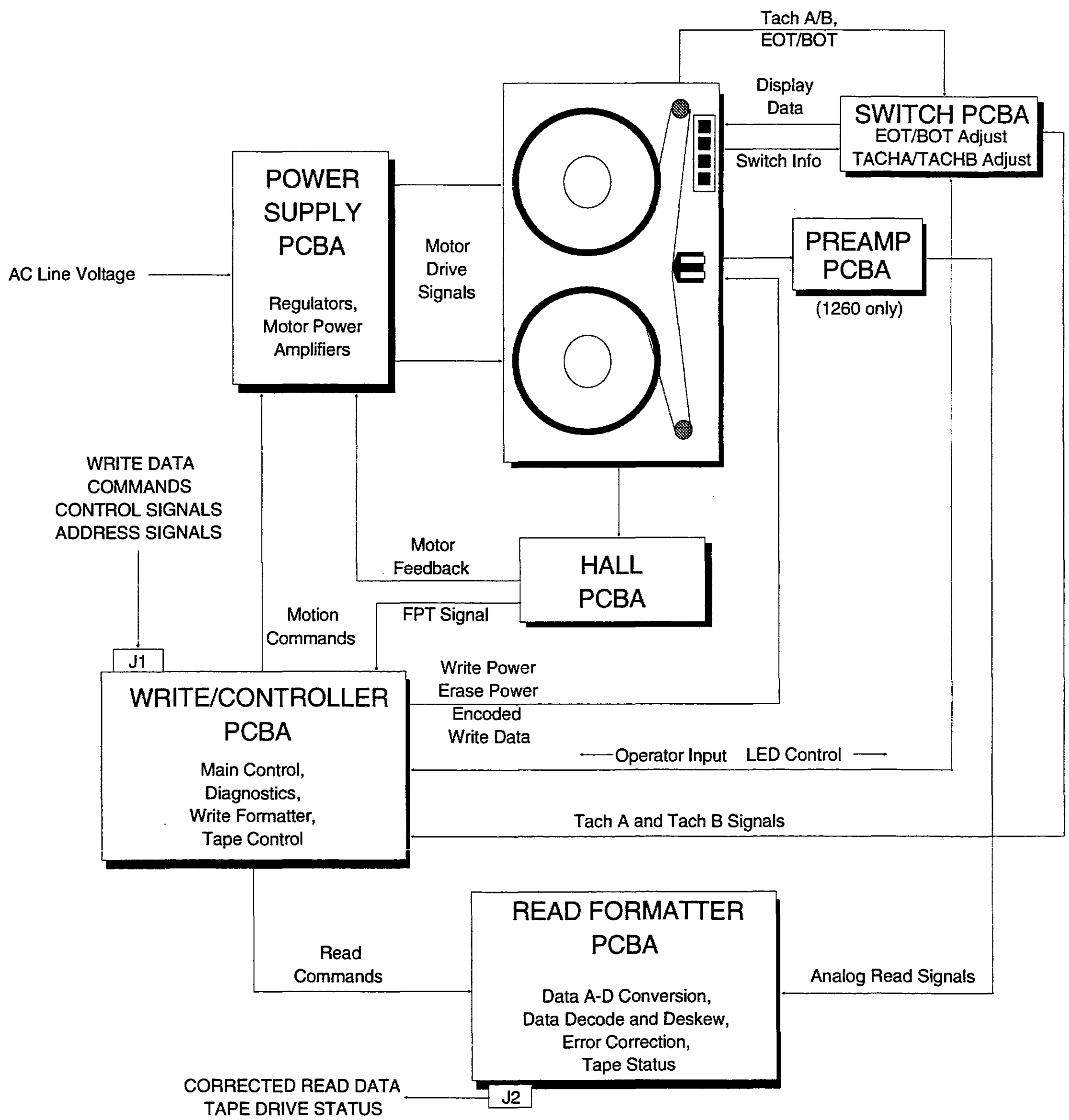


Figure 3-2 1260 Functional Block Diagram

3.2.1 Power Supply PCBA

The Power Supply PCBA includes the supply for the entire drive including the digital electronics (+5V and GND), the analog electronics (±15V and AGND) and the reel servos (+32V and +32V return).

3.2.2 Tape Control Electronics

The primary function of the tape control electronics, found mostly on the Write/Controller PCBA, is to move the tape, and to interpret various sensor information (EOT/BOT, tachometer, motor Hall sensors) and switch information (front panel, internal options and test settings). The tape control electronics also processes all host commands and oversees the read and write formatter operations. Although most of the reel servo electronics are physically located on the Power Supply PCBA, they control the reel motors and consequently tape speed and tension, and so are considered part of the tape control function.

3.2.3 Write Formatter

The write formatter on the Write/Controller PCBA encodes the data from the host into the proper tape format and sends it to the write head.

3.2.4 Read Analog Amplifier

The read analog amplifier amplifies the signals from the read head on the Preamplifier PCBA and sends them to the nine Read Channel PCBAs. There, the signals are differentiated and stored as raw read data in the deskew buffer. At this point, the raw data contains all the overhead characters (preamble, postamble, check, etc.) The output of the deskew buffer are sent to the read formatter for decoding and transmission to the host.

3.2.5 Read Formatter

The read formatter on the Read/Formatter PCBA deskews the data from the read channels, decodes the formatting information, corrects data errors (1 channel in PE and 2 channels in GCR), notifies the host of any errors, and transmits the data to the host.

3.2.6 Switch/Indicator/Sensor Electronics

The switch/indicator/sensor electronics receive signals from the EOT/BOT sensors, the tachometer and the front panel. These signals are conditioned before being sent to the tape controller. The controller also sends status information to the front panel indicators.

3.3 Operations at the PCBA Level

The following sections describe the operations of each PCBA. Inputs and outputs are detailed, as well as signals to be expected at test points and other important areas. These sections provide the background needed to understand the information in Chapter 9 and are not intended for component-level troubleshooting. Figure 6-1 on page 6-3 identifies most of the PCBAs. Instructions on opening and closing the drive are given in Chapter 6; schematics and assembly drawings can be found in Appendix C.

3.3.1 Write/Controller PCBA

With the chassis open, the Write/Controller PCBA is located at the right side of the drive, mounted over the Power Supply PCBA. It contains the option switch and jumpers to select drive options and diagnostic tests. Refer to drawings 500217 and 500218 in Appendix C.

The microprocessor's crystal frequency is 6.144 MHz, requiring version 2.0 or higher firmware in the PROM at U12. Jumper W10 MUST be present between W10 pins 1 and 2 (2764 position).

The Write/Controller PCBA performs four primary functions:

- Oversees tape drive operations
- Calculates reel motor signals to maintain correct tape speed and tension
- Formats write data prior to recording
- Writes the data on tape

Signals are transferred to and from the Read/Formatter PCBA, the Switch PCBA, the write head, the Power Supply PCBA and the host interface. Command signals from the interface are strobed into a command latch by the IGO signal. Refer to product specification 500180 for details about read, write and erase operations.

3.3.1.1 Write/Controller Tape Control Operation

The primary function of the tape control circuitry is to maintain proper tape tension, position, and velocity. During load operations, the Write/Controller PCBA tensions the tape by slowly turning the take up reel until the tachometer senses tape motion. During tape motion, the Write/Controller PCBA microprocessor maintains correct tape tension by calculating the required torque for each motor.

1. First, the number of tach pulses between Hall effect pulses from each motor are counted.
2. From this, the microprocessor determines the amount of tape present on each reel.
3. Since there are no tension arms, PROM tables are used to determine the amount of torque required on each motor to maintain tension for various speeds, reel sizes and the amount of tape pack on each reel.
4. The digital numbers are translated to analog levels (by the DACs at U15 and U16) and sent to the reel servos.
5. The tach pulse rate is then compared to a constant value for that speed and the difference between the two is used to make corrections to the speed.

6. The correction is accomplished by changing the take up motor current.

Testpoint Signals:

TACHA, TACHB - Tachometer signals from the Switch PCBA. During tape motion, TACHA and TACHB are square waves.

TFWD - Derived from TACHA and TACHB, TFWD is high whenever the tape motion is forward.

FBY, DBY - Formatter Busy and Data Busy are generated on the Write/Controller PCBA. FBY and DBY are status signals which are sent to the host via the Read/Formatter PCBA. FBY indicates that the command has been received, and DBY indicates that the required function is being performed. FBY goes false after DBY goes false. DBY is a good signal to trigger an oscilloscope during write and read tests.

SPMC, TUMC - Supply and Take up Motor Commands. Active whenever tape is tensioned. These analog level signals are sent to the Power Supply PCBA to set the motor currents. SPMC controls tape tension and TUMC controls tape speed. Both signals will be a sawtooth waveform during a diagnostic ramp linearity test. At a constant speed, SPMC is a DC level which changes about every 100 feet of tape, and TUMC is a slightly varying DC level. These waveforms are illustrated in Figure 3-5 on page 3-15. The DC level varies according to the take up reel diameter, tape speed, and direction of tape travel. The variations from the DC level are corrections to maintain the desired speed.

RAMPRESET - A 15 KHz synchronizing pulse sent to the Power Supply for pulsewidth modulation control of the motors. See Figure 3-7 on page 3-16.

RST7.5 - Restart 7.5 is an interrupt to the microprocessor which occurs every other tach pulse. It causes a counter to be read for speed information.

RST6.5, RST5.5 - Interrupts for the calculation of the supply and take up reel diameters, respectively.

3.3.1.2 Write/Controller Write Formatting Operation

The write formatter performs all formatting and encoding of data blocks, including preambles, check characters, postambles, and filemarks. When writing from BOT, the write formatter generates an ID burst. In GCR, it encodes the data into Storage Groups and generates the error checking characters, the parity bits, and the control, sync and mark groups. In PE, it generates the parity bits. More information about data formats is given in Chapter 2.

The write formatter microprocessor operates at 30 times the write data rate. It generates the Write Strobe signal (IWSTR) and synchronizes the transfer of data from the host to the formatter. The host data is encoded and combined with check characters by a high speed digital signal processor (U60) which executes the instructions and looks up data in tables found in the PROMS at U58 and U59.

The Last Word (ILWD) signal from the host indicates the normal end of write data. In the case of a formatter-enable abort, or if the drive is forced offline during a write operation, the Write/Controller PCBA microprocessor generates the Last Word signal which terminates the write operation with a normal postamble.

Testpoint Signals:

IWSTR - A pulse which occurs at a nominal 12.5 microsecond rate. Generated by the write formatter, it clocks the data and last word signals into the Write/Formatter PCBA.

WRON - Write On is true during the entire writing of a block, including the preamble and postamble. This enables the write formatter.

DGRP - Data Group is true only during the data portion of a block. Details on data formats are given in Chapter 2.

PCLK - A clock with a frequency of 3.39 MHz (which is ¼ the digital signal processor's frequency). It is used to clock the data to the write drivers.

FCLK - Active for ¼ of the PCLK period. Together with PCLK, this signal causes the write current at the head to be stepped at the start of each flux reversal.

3.3.1.3 Write/Controller Write Drivers

This functional portion of the Write/Controller PCBA includes the write and erase power circuitry and nine channels of data drivers for the head.

Each driver channel has two complementary pairs of paralleled drivers. Only one side of the head is driven at a time. A flux reversal occurs on tape whenever the drive current is switched to the opposite side. Each side consists of two drivers which turn on whenever a change occurs. After ¼ cell time has elapsed, the lower current driver (820 ohms) turns off, creating a stepped signal at the head. This is illustrated in Figure 3-6 at the end of this chapter.

Testpoint Signals:

WRPWR - While writing in PE, WRPWR is between +7.5 and +12.5 volts, depending upon the head manufacturer. WRPWR is present whenever WRITEPWR/ at U68 pin 1 is low. There is about a one millisecond ramp time associated with the voltage rise and fall.

ERPWR - Erase Power should be about +4.0 to +4.5 volts during write or erase.

3.3.2 Read Preamplifier PCBA

The Read Preamplifier PCBA is the small PCBA mounted to the cabinet at the left side of the drive. It receives differential signals from the read head and provides a differential output with a gain of about 80. After amplifying the read signals from the head, it sends them to the Read Channel PCBAs via the Read/Formatter PCBA. It receives its power from the Read/Formatter PCBA. There are no testpoints on the Read Preamplifier PCBA. Refer to drawings 500167 and 500168 in Appendix C.

3.3.3 Read Channel PCBAs

Also called *daughter cards,* these nine identical PCBAs are plugged into the Read/Formatter PCBA (also called the *motherboard*) at the left side of the drive. They translate the analog data signals from the Read Preamplifier PCBA into digital levels and return them to the Read/Formatter PCBA. Each PCBA has its own deskew buffer consisting of a FIFO at U16. Data flows into each buffer asynchronously, but the outputs of the buffers are read synchronously into the Read/Formatter PCBA. Refer to drawings 500157 and 500158 in Appendix C.

Note: *Beginning with revision F, the 3200 cpi circuit has been replaced by a new GCR automatic gain adjust circuit which eliminates the need to manually adjust the GCR read gains.The new PCBAs are backwards-compatible with the earlier drives provided updated firmware is also installed in the Read/Formatter PCBA and in the Write/Controller PCBA.*

TESTPOINT SIGNALS (found on P3 along the edge of the PCBAs):

AMP (P3 pin 3) - This is the Amplified analog signal from the Read Preamplifier PCBA. When data is present (a written tape is moving), there will be about a four volt peak-to-peak signal here during the preamble. This is illustrated in Figure 3-4 at the end of this chapter.

DIF (P3 pin 2) - When data is present, an amplified differentiated read signal is present here the amplitude of which will be greater than that of the preamble, and which will vary with the data.

ENV (P3 pin 6) - This Envelope signal is high whenever data is present (except during the first eight bits of a block).

DLYDATA (P3 pin 5) - The Delayed Data signal is a negative pulse occurring about half a data celltime after the peak of the analog read signal. The delay is about 4.4 microseconds in GCR and about 3.5 microseconds in PE.

STRB (P3 pin 8) - Read Strobe is a positive pulse which occurs in a definite phase relationship to the delayed data. There will always be a strobe, regardless if the data is a one or a zero. STRB is used to clock data into the deskew buffer.

DIN (P3 pin 9) - Data In is a digital signal which is put into the deskew buffer which is controlled by the formatter.

FIFORDY (P3 pin 4) - This indicates that the FIFO is input is ready to accept data.

VCO (P3 pin 7) - The Voltage-Controlled Oscillator signal clocks delayed data into the phase error detection circuitry. Its frequency is nominally 3.6 MHz in GCR, and 5.12 MHz in PE. The valid window for data to appear in is $\pm^{13}/_{32}$ of a celltime from its center.

ORDY (P3 pin 13) - Output Ready indicates the presence of data. It is or'ed with all the other channels on the Read/Formatter and contributes to the DRDY (data ready) signal on the Read/Formatter PCBA.

DOUT (P3 pin 14) - Data Out is sent to the Read/Formatter for decoding and error correcting.

ERR1 (P3 pin 15) - Error 1 indicates that one bit of insufficient amplitude has been detected, but that the envelope did not drop. The formatter will decide whether or not to correct this channel. Valid only during GCR operations.

ERR2 (P3 pin 16) - Error 2 indicates that a data transition did not occur within the valid cell time window. Valid only during GCR operations.

3.3.4 Read/Formatter PCBA

The Read/Formatter PCBA performs the following functions:

- Aligns the data from the read channels
- Decodes the formatted data
- Corrects data errors (single-track in PE, two-tracks in GCR)
- Notifies the host of errors
- Sends drive status and read data to the host

Refer to drawings 500197 and 500198 in Appendix C.

Because there are no check characters in the PE format, error detection and correction is limited to checks against parity. In GCR, however, several checks on the data can be and are performed. Two sets of circuitry (EDAC and EMAP) are employed for checking and correction.

The EDAC circuitry (Error Detection and Correction) is designed to check and correct data at the incoming data rate, whereas the EMAP circuitry (Error Mapping) identifies which channels are potentially bad and instructs the EDAC circuitry to correct them.

In GCR at 12.5 ips, the data transfer rate is about 80K per second. The Error Detection and Correction (EDAC) circuitry operates at a rate of about one byte every 900 nanoseconds, or about 12 times the data rate.

The digital to analog converter at U18 is controlled by the EMAP processor and provides the threshold voltages +VREF and -VREF for the read channels. The threshold voltages during read/write and gap/data are given in Table 3-1 on page 3-12.

Status signals indicating hard error, corrected error, and a detected filemark are output at U49.

Testpoint Signals:

RGATE/ - Read Gate enables the deskew buffers on the Read Channel PCBAs and remains true (low) during the entire block.

	DATA TIME		GAP TIME	
	+Vref	**-Vref**	**+Vrev**	**-Vref**
WRITE	+1.45	-1.45	+1.45	-1.45
READ	+0.5	-0.5	+0.76	-0.7

Table 3-1 Read Threshold Voltage Levels

DAVAIL/ - Data Available is used by the Write/Controller microprocessor. It goes true (low) when valid data is found, and goes false at the end of the block.

OSTB - Outstrobe is used for reading the output buffer FIFOs.

WDCD2 - Write Decode 2 is the write decode 2 strobe and it initiates hardware-generated Read Strobes.

WAKEUP - Interrupt from the EMAP processor to the EDAC processor. It is used to pass messages from the EMAP to the EDAC. See Figure 3-3 on page 3-14.

3.3.5 Switch Interconnect PCBA

This PCBA receives signals from the tachometer, EOT/BOT sensor and front panel switches and sends them to the Write/Controller PCBA. It receives status signals from the Write/Controller PCBA and lights the front panel indicators. Refer to drawings 500187 and 500188 in Appendix C.

Testpoint Signals:

TACHA and **TACHB** - Digital tachometer signals whose duty cycle can be adjusted by R3 and R2, respectively. See Chapter 7 for details.

EOT/ and **BOT/** - Digital signals from the EOT/BOT sensor assembly. The balance between the two signals is adjusted by R1. See Chapter 7 for details.

3.3.6 Power Supply PCBA

The Power Supply PCBA includes power supplies for the entire drive in addition to the reel servo electronics. The rest of the power supply (transformer, e.g.) is shown on the interconnect drawing 500242 in Appendix C. Refer also to drawings 500207 and 500208.

3.3.6.1 Power Supply

The power supply includes the transformer (mounted on the chassis), rectifiers, filters and regulators. There are six power supplies:

- Motor supply (+32V)
- +15V (A and B)
- -15V (A and B)
- +5V supply

The power transformer has two secondary windings, one for ±15V and the other for +32V and +5V. The analog and digital grounds are tied together by a 15 ohm, ½ watt resistor for test purposes. They are directly connected together on the Read Channel PCBAs. All power supplies are shown on sheet 1 of Schematic 500208 in Appendix C.

The +5V supply is a switching regulator type of supply which runs off the +32V supply. The +5V load is split between the Read/Formatter PCBA and the Write/Controller PCBA. If the +5V regulator should fail, the output voltages could become dangerously high. An overvoltage protection circuit (crowbar) shorts the regulator output to protect the integrated circuits on the PCBAs. The normal output of the regulator before the inductor is shown in Figures 3-11 and 3-12 at the end of this chapter.

3.3.6.2 Reel Servos

This functional portion of the Power Supply PCBA includes two nearly identical circuits. They drive the brushless DC motors based on commands from the Write/Controller PCBA and signals from the three Hall sensors (which change state every 15 degrees of motor rotation). The Hall sensor signals (at J12) are square waves when the motors turn. Each motor has four pairs of north-south magnets and the sensors react to the south magnets. During 90 degrees of motor rotation each Hall sensor makes a complete cycle.

The Write/Controller PCBA firmware contains the *servo intelligence* section which controls the speed. It continually calculates the pack diameter on both reels by counting the number of tachometer pulses per Hall-Effect cycle. This number, interpreted via a lookup table in the PROMs, determines the required motor current to provide acceleration torques and tape tension. The digital numbers for each reel are translated to an analog level by the Write/Controller DACs (U15 and U16), and then are sent to the motor drivers. The tach pulses are then compared to a calculation of what they should be and the error, if any, is used to make speed corrections to the motors.

Testpoint Signals:

The motor current can be seen at testpoints **ISPM** and **ITUM**. These signals follow the values from the DAC, are opposite in polarity, and represent -3.33 volts per ampere of drive. This is illustrated in Figures 3-8, 3-9, and 3-10 at the end of this chapter.

The signals at **SPCM** and **TUCM** should be at levels equal to ISPM and ITUM, respectively, but of opposite polarities.

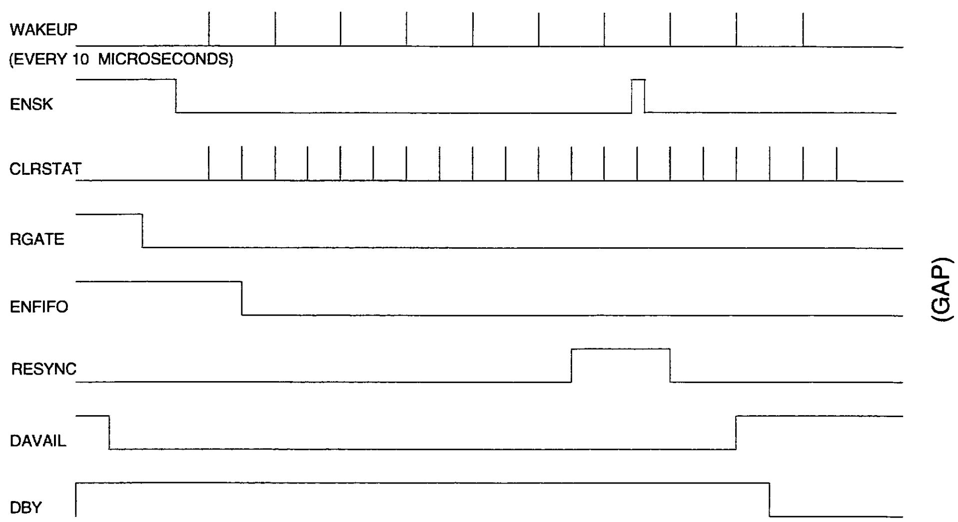


Figure 3-3 Relative Read Timing Diagram

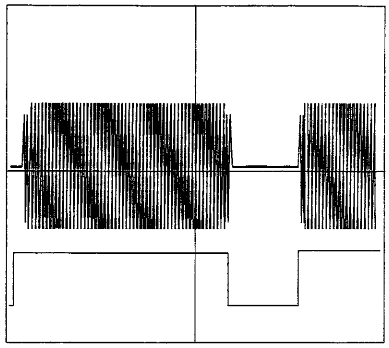


Figure 3-4 Read Analog and Envelope Waveforms

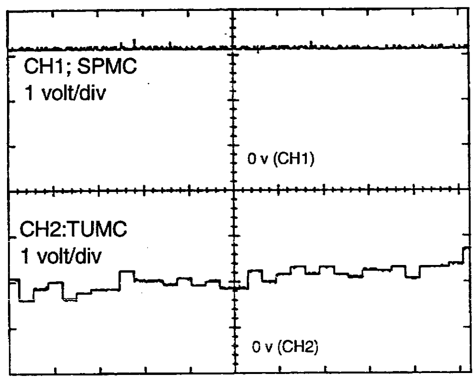


Figure 3-5 Supply and Take Up Motor Waveforms

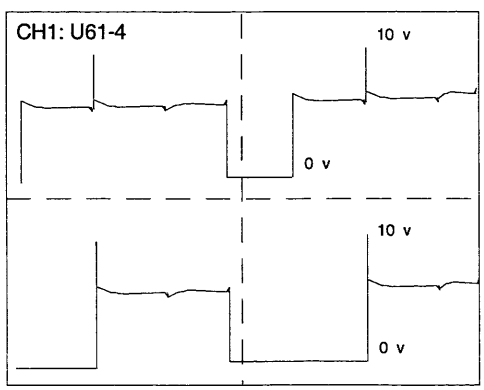


Figure 3-6 Write Head Driver Waveforms

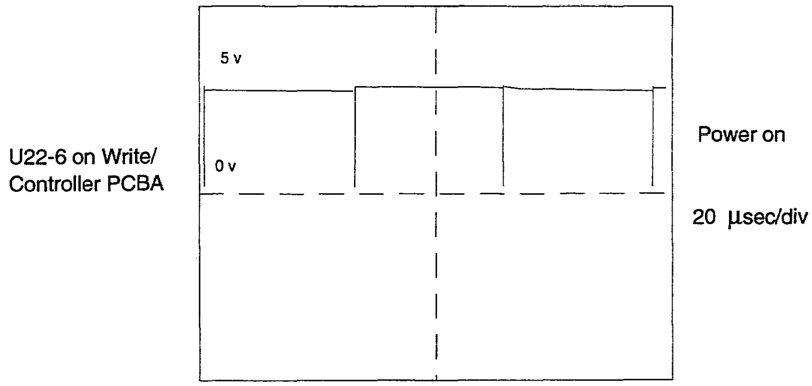


Figure 3-7 Ramp Reset Pulse

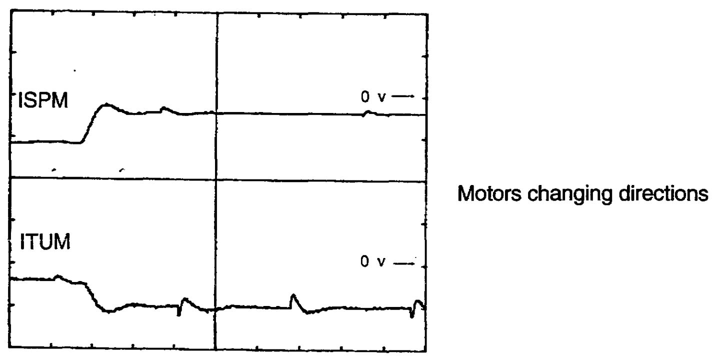


Figure 3-8 Servo Waveform A

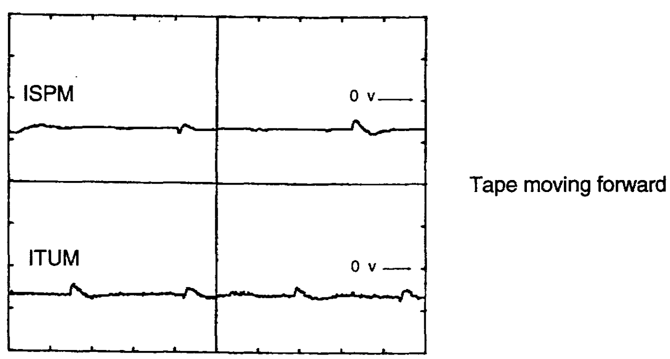


Figure 3-9 Servo Waveform B

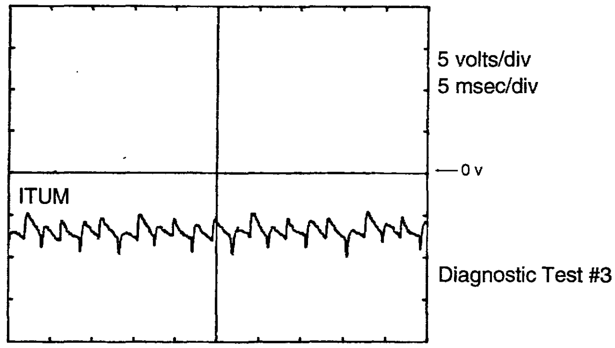


Figure 3-10 Servo Waveform C

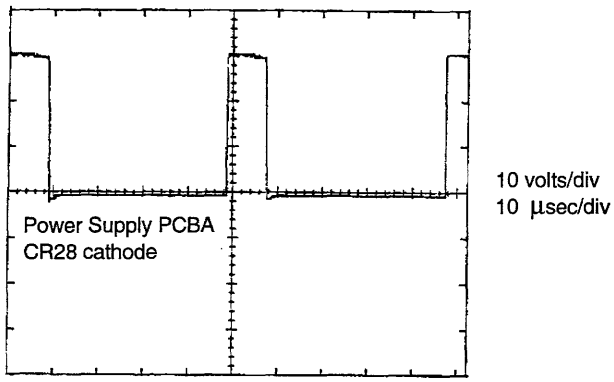


Figure 3-11 +5 Volt Regulator with Load

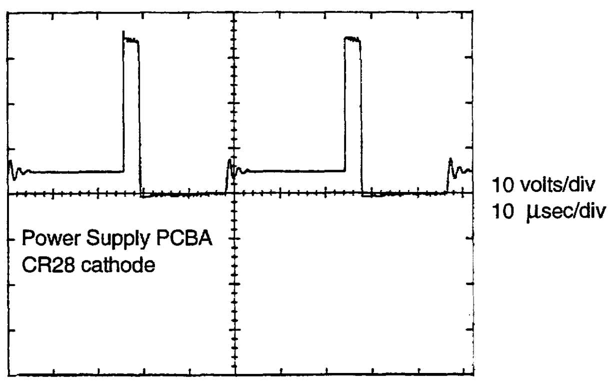


Figure 3-12 +5 Volt Regulator without Load

Diagnostics 4

The tape drive can be placed into a diagnostic mode to diagnose certain error conditions and to perform most of the adjustments. This chapter describes the tests which are available in the diagnostic mode and how to use them.

The tables at the end of this chapter summarize the front panel switch functions in the diagnostic mode, and the switch settings for each test.

4.1 Entering and Exiting the Diagnostic Mode

The diagnostic mode is controlled by S1 on the Write/Controller PCBA. All you need to do to place the drive in the diagnostic mode is to power the drive off, set S1 ON, and power the drive on again. When the drive is powered up, the microprocessor on the Write/Controller PCBA reads the position of S1. If S1 is on, the drive is placed in the diagnostic mode; if S1 is off, the drive is placed in the normal mode.

To exit the diagnostic mode, stop the tape and set S1 off. The drive will then be placed in the normal mode of operation. To re-enter the diagnostic mode, you must switch the power off and set S1 ON before reapplying power.

Once in the diagnostic mode, you can select a particular test by setting S2, S3, S4 and S5 on or off as required. In the diagnostic mode, the front panel switches and indicators behave differently than they do in the normal mode. Their diagnostic functions are summarized in Table 4-2. In the diagnostic mode, the following tests are available:

- **Tests 0 and 1** - Read Test (moves tape)
- **Test 2** - Motor Calibration (done with no tape mounted)
- **Test 3** - Motor Amplifier Linearity Ramp (done with no tape mounted)
- **Test 4** - Write Blocks (moves tape)
- **Test 5** - Write Filemarks (moves tape)
- **Tests 6 and 7** - Write/Erase Switching (does not move tape)
- **Test 8** - Shoe-Shine

The following sections describe the available tests. Note that during any given test, the front panel switch functions are unique to that test.

4.1.1 Test 0 - Read

Test 0 allows you to read tapes in both the forward and reverse directions. The formatter toggles IDBY as each block and filemark are read, and generates all output signals and read strobes in both directions and in all densities except 6250 reverse.

MODE	TEST	SWITCH POSITIONS				
		S1	S2	S3	S4	S5
NORMAL		OFF				
Test 0	Read	ON				
Test 1	Read	ON			ON	
Test 2	Motor Calibration	ON		ON		
Test 3	Motor Amplifier Linearity Ramp	ON		ON	ON	
Test 4	Write Blocks	ON	ON			
Test 5	Write Filemarks	ON	ON		ON	
Test 6	Write/Erase	ON	ON	ON		
Test 7	Write/Erase	ON	ON	ON	ON	
Test 8	Shoe-Shine	ON				ON

Table 4-1 Diagnostic Test Switch Assignments

To run Test 0:

1. Power the drive off, set S1 ON, and S2 through S5 off.
2. Power the drive on again.
3. Manually remove the slack from the tape and then press LOAD. The drive will tension the tape and move it forward.
4. *After* the BOT marker passes the sensor, press FPT to stop the tape and enable the test.
   a. To read forward, press ONLINE. If the tape reaches EOT or BOT, the drive will automatically switch tape directions.
   b. To stop the tape, press FPT.
   c. To read reverse, press 6250 while the tape is stopped. You cannot change directions while the tape is moving.
   d. To change density, press FPT while the tape is stopped. You cannot change density while the tape is moving.
   e. To rewind the tape, press LOAD while the tape is stopped.
   f. To unload the tape, stop the tape, set S1 off and then press LOAD.

4.1.2 Test 1 - Read

Select Test 1 by setting S1 and S4 ON and S2, S3 and S5 off. Test 1 is identical to Test 0, except that the Load switch will not rewind the tape.

4.1.3 Test 2 - Motor Calibration

Caution! ***EQUIPMENT DAMAGE OR DATA LOSS may result if Test 2 or Test 3 is run when a tape is mounted on the drive. Unload and remove the tape before running these tests.***

To run Test 2:

1. Power the drive off and remove all tape from the drive.
2. Set S1 and S3 ON, and S2, S4 and S5 off.
3. Power the drive on again and then press LOAD to enable the test.
4. The motors can be driven using the ONLINE, FPT, and 6250 switches.
   a. Pressing ON LINE turns the take up motor counter-clockwise, using one ampere of current.
   b. Pressing FPT deactivates both motors.
   c. Pressing 6250 turns the supply motor counter-clockwise, using one ampere of current.

If the supply hub locking levers are in the unlocked position, you may hear a loud snap as centrifugal force forces them to the locked position.

4.1.4 Test 3 - Motor Amplifier Linearity Ramp

Test 3 activates a positive-going sawtooth waveform (i.e., a ramp) which can be seen at testpoints SPMC and TUMC on the Write/Controller PCBA. The ramp can then be applied to either the supply or the take up amplifier (not both at the same time), causing the reel motor to turn.

To run Test 3:

1. Power the drive off and remove the tape from the drive.
2. Set S1, S3 and S4 ON, and S2 and S5 off.
3. Power the drive on again and then press LOAD to enable the test.
4. The motors can be driven using the ONLINE, FPT and 6250 switches.
   a. Pressing ONLINE applies the ramp to the take up motor.
   b. Pressing FPT removes the ramp from both motors.

c. Pressing 6250 applies the ramp to the supply motor.

4.1.5 Test 4 - Write Blocks

Test 4 is used to write data blocks and to perform certain adjustments. The block length is 2000 bytes at 1600 cpi, 4000 bytes at 3200 cpi (1260T only), and 8000 bytes at 6250 cpi. In order for these block lengths to be written, you must remove any connector from interface connector J1 on the Write/Controller PCBA.

To run Test 4:

1. Power the drive off and set S1 and S2 ON, and S3, S4, and S5 off.
2. Power the drive back on again.
3. Manually remove the slack from the tape and then press LOAD. The drive will tension the tape and move it forward.
4. *After* the BOT marker passes the sensor, press FPT to stop the tape and enable the test.
   a. To begin writing, press ONLINE. If the tape reaches EOT, the drive will automatically switch to read reverse. If the tape then reaches BOT, the drive will automatically switch back to write forward.
   b. To stop the tape, press FPT.
   c. To read the tape in reverse, press 6250 while the tape is stopped. You cannot change directions while the tape is moving.
   d. To change density, press FPT while the tape is stopped. You cannot change density while the tape is moving.
   e. To rewind the tape, press LOAD while the tape is stopped.
   f. To unload the tape, stop the tape, set S1 off and then press LOAD.

4.1.6 Test 5 - Write Filemarks

Test 5 is identical to Test 4 except that the tape drive writes filemarks instead of data blocks. Select Test 5 by setting S1, S2, and S4 ON, and S3 and S5 off.

4.1.7 Test 6 - Write/Erase

When the tape is tensioned, selecting Test 6 alternately applies write and erase power to the head. Test 6 is used to verify write/erase ramp timing, and no tape motion occurs. The write and erase power signals may be seen at Write/Controller PCBA test points WRPWR and ERPWR.

To run Test 6:

1. Power the drive off and set S1, S2 and S3 ON, and S4 and S5 off.

MODE>	STANDBY	TESTING	READY: READ/WRITE	READY: MOTOR TESTS
LOAD	Tensions tape	No effect	Rewinds tape	No effect
ONLINE	No effect	No effect	Starts test fwd	Take up on
FPT	No effect	Stops the tape	Selects density	Off
6250	Selects density	No effect	Reverse read	Supply on
Standby - Tape is threaded but not tensioned, switch S1 is on and no test is in progress. **Testing** - Switch S1 is on, test is in progress. **Ready** - Tape is tensioned, switch S1 is on, No test in progress.				

Table 4-2 Front Panel Switch Assignments during Diagnostics

2. Power the drive back on again.

3. To change the density, press 6250.

4.1.8 Test 7 - Write/Erase

Test 7 is identical to Test 6, and can be selected by setting S1 through S4 ON, and S5 off.

4.1.9 Test 8 - Shoe-Shine

Test 8 shuttles the tape towards EOT. When the tape reaches EOT, the drive automatically switches to reverse until BOT is detected, at which point it resumes the shoe-shine.

To run Test 8:

1. Power the drive off and set S1 and S5 ON, and S2, S3 and S4 off.

2. Power the drive back on again.

3. Manually remove the slack from the tape and then press LOAD. The drive will tension the tape and move it forward.

4. *After* the BOT marker passes the sensor, press FPT to stop the tape and enable the test.

   a. To start the shuttle, press ONLINE.

   b. To stop the shuttle, press FPT.

   c. To change the tape speed, press FPT while the tape is stopped. You cannot change the speed while the tape is moving.

d. Pressing 6250 while the tape is stopped switches the drive into a read reverse mode. When the tape reaches BOT, the drive automatically switches into read forward.

e. To rewind the tape, press LOAD while the tape is stopped.

f. To unload the tape, stop the tape, set S1 off and then press LOAD.

Preventive Maintenance 5

5.1 Preventive Maintenance Schedule

Table 5-1 lists the periodic maintenance required in a normal environment to achieve the anticipated life of the tape drive and to maximize data reliability. A "normal" environment is considered to be an office environment free of smoke, dirt and excessive dust.

INTERVAL	ITEM
DAILY	Clean head
	Clean reference guides (2)
	Clean tape cleaner
WEEKLY	Clean tachometer roller
	Clean fixed roller
18 MONTHS	Perform all adjustments

Table 5-1 Preventive Maintenance Schedule

5.1.1 Why Preventive Maintenance Is Necessary

As magnetic tape ages, tiny oxide particles on the coated side of the tape loosen and flake away. While most of these loose oxide particles will be caught by the tape cleaner, some will be deposited on the head. If allowed to accumulate, the data reliability of the tape drive will be adversely affected. This is usually first noticed by infrequent recoverable data errors progressing to the point where tapes simply cannot be read. Because the tape cleaner removes the larger particles of dirt and dust, it must be periodically cleaned along with the oxide build-up on the head if maximum data reliability is to be achieved.

If allowed to build up on the write head gaps, the oxide can act much like a keeper across a magnet and reduce the magnetic saturation of the flux reversals on the tape. A similar buildup on the read head gaps can cause a reduction in the induced signal from the tape. In severe cases, the build-up can actually lift the tape away from the head surface, further reducing signal strength.

Dirt, dust and oxide particles can also accumulate on the tape guide surfaces and flanges. If allowed to accumulate, they can be transferred to the recording side of the tape when it packs onto the supply and take up reels. In extreme situations, heavy accumulations on the guide surfaces can induce a skew effect resulting in data errors most noticeable when reading tapes generated on other drives.

5.1.2 Frequency of Preventive Maintenance

In addition to the "normal" environment assumed by the preceding preventive maintenance schedule, several other factors, if present, will require more frequent tape cleaning:

- Age and condition of the tape. As previously stated, oxide particles tend to flake off older tapes more readily than off newer ones. The more that older tapes are used, the more frequently the tape path will have to be cleaned.
- General cleanliness of the operating environment. Tape drives which are operated in dusty, smokey, or high humidity environments, or in machine shops or heavy manufacturing or industrial areas will require more frequent cleaning than those which are operated in office environments or in computer rooms.
- Tape handling and storage. The use of improperly handled and/or stored tapes will require more frequent tape path cleaning. Tapes which are left on work benches will accumulate dust on the reel flanges which will eventually work its way into the tape path. Tapes which have been partially unwound onto the floor or which have finger prints will pick up dirt and transfer it directly to the tape cleaner, which then requires more frequent cleaning.
- Amount of tape which has run through the tape path. Tape drives which process several thousand feet of tape each day will require more frequent cleaning than tape drives which are used only a few minutes a day.

5.2 Tape Path Cleaning Procedure

Dirt shows up as dark brown or black smudges on the face of the head and is often difficult to see. A strong light and a small inspection mirror can be used to see the head more clearly. Refer to Figure 5-1.

When cleaning the head and tape path, do not use abrasive materials, detergents, or general purpose cleaning solutions. These can cause permanent damage to the head surface and roller bearings. Use only 91% isopropyl alcohol and nonabrasive applicators such as TexPads®.

1. Remove the head cover by pulling straight out from the base.
2. Clean the entire surface of the head, including the erase head. Rub firmly until all deposits are removed.
3. Clean the tape cleaner blade and the area behind it.
4. Clean the tape contact surface of the reference guides. Be especially alert to deposits under the caps on the reference guides and make sure these areas are clean.
5. Clean the tape contact surfaces of the two black roller guides located near the corners of the drive. Clean the areas between the roller surfaces and their flanges. To prevent deterioration of the lubricant in the roller guide bearings, do not allow any solution to seep into the bearings.

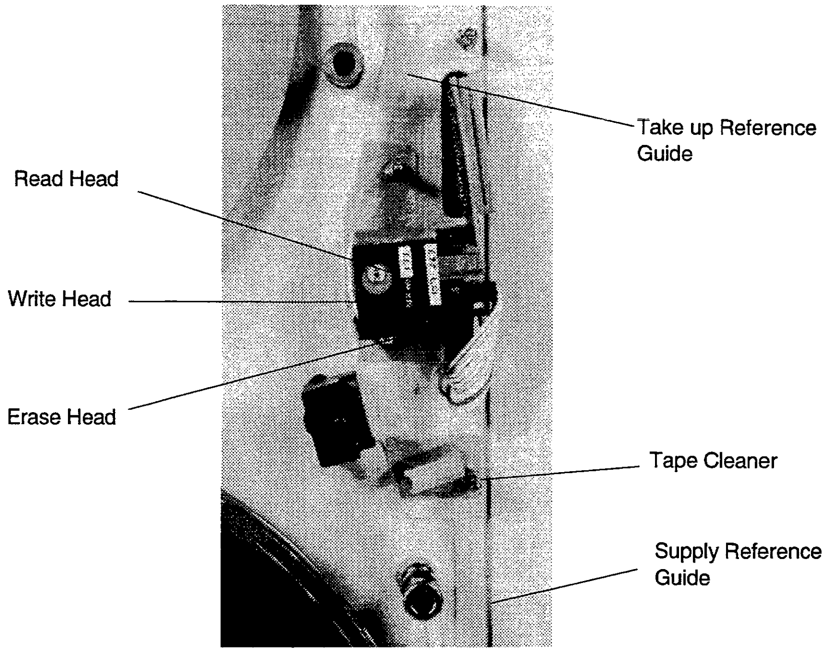


Figure 5-1 Head Area Components

6. Reinstall the head cover.

TexPads® are individually sealed pads premoistened with 91% isopropyl alcohol and are ideal for head and tape path cleaning. They can be obtained from Qualstar or directly from The Texwipe Company by calling (800) 284-5577.

Subassembly Replacement 6

6.1 Introduction

This chapter describes the procedures for replacement of the printed circuit board assemblies (PCBAs), sensor assemblies, and the read/write head. Adjustments are described in Chapter 7, while Chapter 8 describes the procedure for replacing motor and tape guide bearings.

A list of Field Replaceable Units (FRU) parts is given in Appendix B, and schematic and assembly drawings can be found in Appendix C.

Table 6-1 lists the replacement procedures described in this chapter.

FOR REPLACEMENT INSTRUCTIONS COVERING THESE PARTS,	REFER TO:
Write/Controller PCBA	Section 6.5.1
Power Supply PCBA	Section 6.5.2
Read Channel PCBA	Section 6.5.3
Read/Formatter PCBA	Section 6.5.4
Read Preamplifier PCBA	Section 6.5.5
Switch PCBA	Section 6.5.6
Hall PCBA	Section 6.5.7
Reel Motors	Section 6.6
Tachometer Sensors	Section 6.7.1
EOT/BOT Sensor	Section 6.7.2
FPT Sensor	Section 6.7.3
Read/Write Head	Section 6.8

Table 6-1 Field Replaceable Subassemblies

6.2 Required Tools and Supplies

6.2.1 Standard Tools

#2 Phillips screwdriver
$3/32$ inch hex ball driver (Xcelite P/N LN-23BP)
$1/4$ inch nut driver (Xcelite P/N 8)
$7/64$ inch hex driver (Xcelite P/N 99-764)

Needle-nose pliers
Diagonal cutters

6.2.2 Special Tools and Supplies

Skew adapter cable (Qualstar P/N 500260-02-1).
Cable ties, 3-¼ inch long (Qualstar P/N 669-1001-9)

6.3 Opening and Closing the Drive

DANGER ! **PERSONAL INJURY OR DAMAGE TO THE DRIVE MAY RESULT IF THE DRIVE IS DISMANTLED OR REASSEMBLED WHILE POWER IS ON. ALWAYS TURN OFF THE POWER AND DISCONNECT THE POWER CORD BEFORE ATTEMPTING TO DISCONNECT OR RECONNECT CABLES, AND BEFORE REMOVING OR INSTALLING ANY SUBASSEMBLY OR PCBA.**

6.3.1 Opening the Drive

1. Stand the drive up with the push buttons at the top.
2. Remove the six large Phillips screws from the outside edges of the rear panel. Refer to Figure 6-1 for cover screw locations.
3. Swing the chassis open and observe the Read/Formatter PCBA at the left and the Write/Controller PCBA at the right.

6.3.2 Closing the Drive

1. Before closing up the drive and returning it to service, ensure that S1 on the Write/Controller PCBA is off, and that the other switches are set to their original positions (refer to Section 6.3.4).
2. Verify that all cables are reconnected and that the PCBAs are secured by their mounting screws.
3. Close the rear panel, making sure that the large ribbon cable between the Read/Formatter PCBA and the Write/Controller PCBA is not pinched.
4. Reinstall the six Phillips screws in the rear.

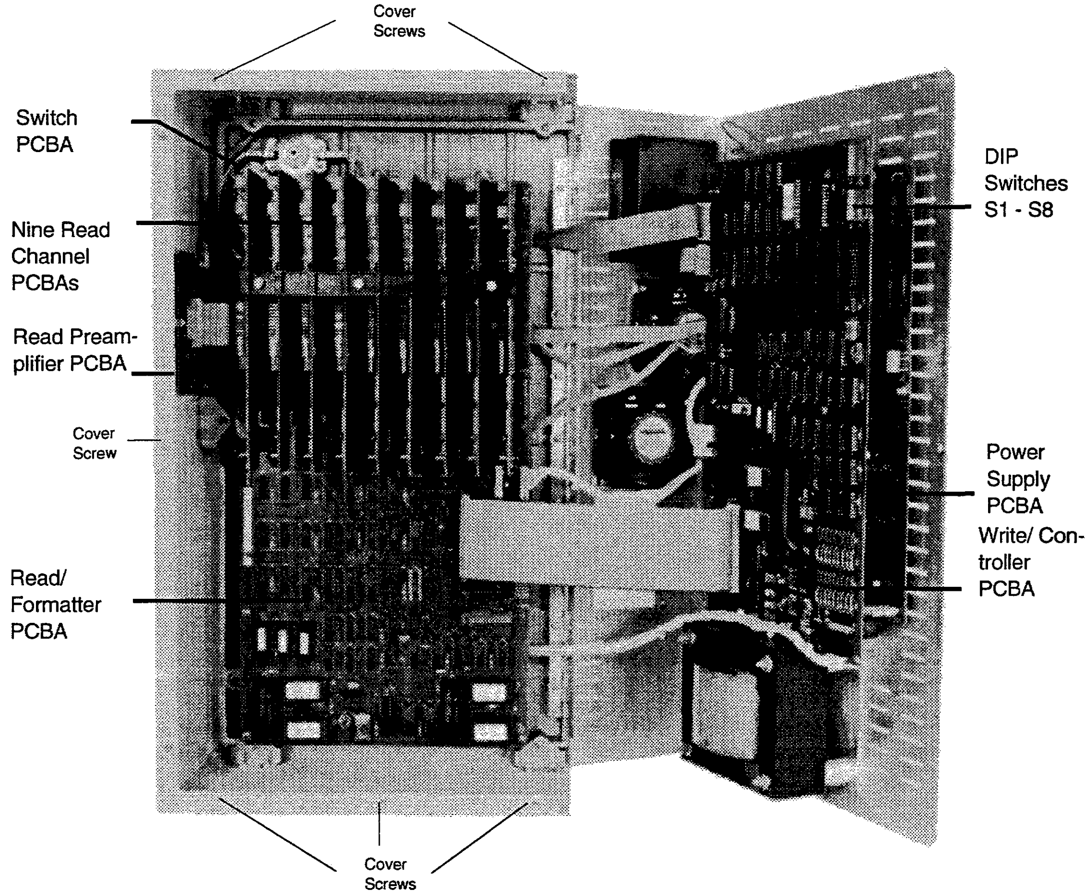


Figure 6-1 Printed Circuit Board Identification

6.3.3 Option Switch Positions

Refer to the 1260 User's Guide (500250) for complete explanations of these options.

SWITCH 3		PERTEC®/CIPHER® COMPATIBILITY	
On		Pertec® Mode	
Off		Cipher® Mode	
SWITCH 4		**FILEMARK GAP SIZE**	
On		0.4" GCR and 0.6" PE gaps (minimum)	
Off		3.5" gaps (standard)	
SWITCHES 5 AND 6		**INTERBLOCK GAP SIZE**	
S5	**S6**	**IBG (PE)**	**IBG (GCR)**
Off	Off	0.6 inch	0.4 inch
Off	On	1.8 inch	1.6 inch
On	Off	5.4 inch	5.2 inch
On	On	16.2 inch	16.0 inch
SWITCH 7		**DEFAULT DENSITY**	
On		6250 cpi	
Off		1600 cpi	
SWITCH 8		**AUTOMATIC DENSITY SELECTION**	
On		Manual Density Selection	
Off		Automatic Density Selection (read only)	

Table 6-2 Field-Selectable Options

6.3.4 Factory Default Jumper Option Positions

JUMPER	FACTORY DEFAULT
W0 - W7	W0
W8	REQ
W9	FSEL
W10	Dependent upon microprocessor
W11	LO (nearest circle)
W12	Don't care
W13	Omitted

Table 6-3 Factory Default Jumper Positions

6.4 Primary Power

DANGER! **HAZARDOUS VOLTAGES ARE PRESENT IN THE POWER SUPPLY. DISCONNECT THE PRIMARY AC LINE CORD BEFORE OPENING THE TAPE DRIVE AND REMOVING THE SWITCH SAFETY COVER.**

The primary power connections to the power supply are shown in Table 6-4. Nominal line voltages of 100V, 120V, 220V and 240V at 50 or 60 Hz can be used as a primary input power. Drives can be reconfigured in the field by changing the line fuse and the transformer connections at the terminal block located on the power supply chassis. If the line voltage is changed, a tag indicating the new line voltage, line current and line fuse must be added next to the nameplate.

VOLTS	JUMPERS	POWER	FUSE RATING
100VAC	1-4, 3-5	2&5	2.5A Slow Blow
120VAC	1-4, 3-5	1&5	2.5A Slow Blow
220VAC	3-4	2&5	1.25A Slow Blow
240VAC	3-4	1&5	1.25A Slow Blow

Table 6-4 Primary Power Connections

6.4.1 AC Line Fuse

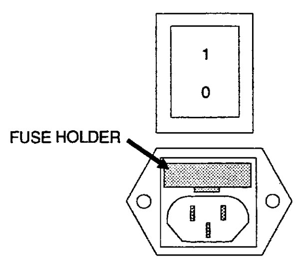


Figure 6-2 AC Plug and Fuse Holder

The AC line fuse is located in the power plug receptacle as shown in Figure 6-2.

- To remove the fuse, first remove the power cord from the tape drive. Then using a small flat blade screwdriver, carefully pop the rectangular fuse holder out of the receptacle.
- To replace the fuse holder, insert it into the receptacle and press it in until it snaps into place.

FUSE RATING	QUALSTAR P/N	LITTLEFUSE P/N	BUSSMAN P/N
2.5A	626-0012-7	2180.25	GDC 2.5
1.25A	626-0011-9	2181.25	GDC 1.25

Table 6-5 Primary (Line) Fuse for Model 1260

6.5 PCBA Replacement

This section describes the removal and installation of the PCBAs. Refer to Chapter 3 for theory of operation, and to Figure 6-1 on page 6-3 for PCBA identification.

6.5.1 Write/Controller PCBA (Assembly 500217-01-3)

The Write/Controller PCBA is the second largest PCBA in the drive and controls the motion of the tape and the writing of data on the tape. Viewed from the rear of an open drive, it is located on the right side and is mounted on the Power Supply PCBA. Refer to Figure 6-3.

6.5.1.1 Required Tools

#2 Phillips screwdriver
Diagonal cutters

6.5.1.2 Required Adjustments

If the Write/Controller PCBA is replaced, the Write Current adjustments described in Chapter 7 must be performed.

6.5.1.3 Removing the Write/Controller PCBA

1. Note the positions of jumpers W0 through W13 if the PCBA is to be replaced.
2. Remove the ribbon cables attached to J1, J3, J4, J5, J6 and J8.
3. Cut away the two cable ties holding the write head cable to the bottom of the PCBA.

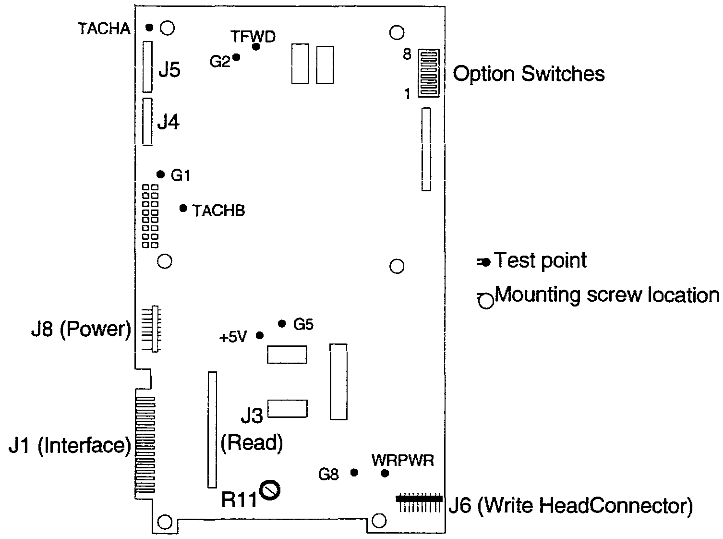


Figure 6-3 Write/Controller Layout

4. Remove the six Phillips screws holding the PCBA to standoffs and remove the PCBA.

6.5.1.4 Reinstalling the Write/Controller PCBA

If the PCBA is being replaced, verify that jumpers W0 through W13 are positioned as on the old PCBA. Most tape drives are set at the factory with the options shown in Section 6.3.4. The PROM located at U12 must contain the latest version of firmware. Use the PROM with latest (highest) version number from either the old or the new PCBA. "V2.03" is an example of a version number. PROMs with a version of 2 or greater require a crystal (at Y1) of 6.144 MHz, while versions 1.xx require a 5.12MHz crystal.

1. Set S1 off.
2. Position the PCBA over the standoffs on the Power Supply PCBA and secure it using six Phillips screws.
3. Connect the ribbon cables to J3, J4, J5, J6 and J8.
4. Secure the power cable from J8 to the bottom of the PCBA using two cable ties.

6.5.2 Power Supply PCBA (Assembly 500207-01-4)

The Power Supply PCBA is located on the hinged chassis beneath the Write/Controller PCBA. The Power Supply PCBA provides power for all of the electrical assemblies and for the motors.

6.5.2.1 Required Tools

#2 Phillips screwdriver
¼ inch nut driver
Small pliers

6.5.2.2 Required Adjustments

After replacing the Power Supply PCBA, the +5 volt adjustment described in Chapter 7 must be performed.

6.5.2.3 Power Supply PCBA Removal

1. Remove the Write/Controller PCBA as described in Section 6.5.1.

Caution! ***Use a suitable pair of pliers to disconnect the slide-on connectors from the PCBA. Do not remove the connectors by pulling on the wire.***

2. Disconnect the wires from E10 through E13 at the top of the PCBA.
3. Disconnect the wires from E1 through E7 on the left edge of the PCBA.
4. Unplug J4B, J9, J12, and J19 along the left edge of the PCBA.
5. Disconnect the wires from E14 through E19 at the bottom of the PCBA.
6. Remove the six mounting Phillips screws from the outside of the chassis. This may require holding the four standoffs mounted on the PCBA so that they don't turn. Hold the hex nuts near the bottom of the PCBA with a ¼ inch nut driver while unscrewing the screws on the outside of the chassis.
7. Remove the Power Supply PCBA from the drive.

Table 6-6 lists the power supply wiring for reference.

6.5.2.4 Power Supply Installation

1. Install the PCBA with the six screws, four standoffs at the top and middle, and two hex nuts near the bottom. The two hinged standoffs must be installed at the left of the PCBA so that they pivot to the left and right.

Caution! ***Do not pinch the primary power leads from the power transformer.***

2. Reconnect the wires at E14 through E19 at the bottom of the PCBA.
3. Reconnect the wires to E1 through E7 at the left edge of the PCBA.
4. Reconnect J4B, J9, J12, and J19.
5. Reconnect E10 through E13 at the top of the PCBA.

CONNECTOR	WIRE COLOR	DESTINATION
E1	Orange	Supply Motor
E2	Brown	
E3	Red	
E4	Blue	Fans
E5	Red	
E6	Blue	
E7	Red	
E8	Red	Auxilliary fans (optional)
E9	Blue	
E10	Green with stripe	Chassis ground
E11	Orange	Take up Motor
E12	Brown	
E13	Red	
E14	Orange	Transformer
E15	Red	
E16	Black	
E17	Yellow	
E18	White	
E19	violet	
J9	White Cable	Read/Formatter power
J19	White Cable	Write/Control power

Table 6-6 Power Supply Wiring

DANGER! **THE GREEN WIRE CONNECTS TO E10 ONLY. IF THE TERMINAL IS CONNECTED TO TEST POINT "ITUM" WHICH IS ADJACENT TO E10, SEVERE DAMAGE CAN RESULT IF POWER IS APPLIED.**

6. Replace the Write/Controller PCBA.

6.5.3 Read Channel PCBAs (Assembly 500157-01-1)

Nine identical Read Channel PCBAs are plugged into the Read/Formatter PCBA at the left side of the drive. These PCBAs amplify and convert analog read signals from the Read Preamplifier into digital read signals which are further processed on the Read/Formatter PCBA.

6.5.3.1 Required Tools

#2 Phillips screwdriver.

6.5.3.2 Required Adjustments

If the Read Channel PCBAs are replaced or if they are reinstalled out of their original order, the read gain adjustment described in Chapter 7 must be performed.

6.5.3.3 Read Channel PCBA Removal

1. Loosen the three slotted screws which hold the Read Channel PCBA retaining clamp and remove the clamp.
2. Grasp the Read Channel PCBA firmly at the top and bottom and gently pull the PCBA straight out such that both connectors unplug at the same time.
3. To facilitate replacing the PCBAs into their original slots, mark them by channel number.

6.5.3.4 Read Channel PCBA Installation

Caution! ***The Read Channel PCBAs may be destroyed if not properly aligned before installation. There are no keys on the connectors and no card guides.***

Note: *All Read Channel PCBAs must be of the same revision letter and number, all nine "ENV" ICs must be of the same revision, and all nine "RNGDCD" ICs must be of the same revision.*

1. Align the connector pins with the sockets in the Read/Formatter PCBA and gently press the PCBA into the connectors such that both connectors seat at the same time.
2. Reinstall the retaining clamp.

6.5.4 Read/Formatter PCBA (Assembly 500197-01-7)

The Read/Formatter PCBA is the large PCBA mounted on the rear of the base casting as shown in Figure 6-1 on page 6-3.

6.5.4.1 Required Tools

#2 Phillips screwdriver.

6.5.4.2 Required Adjustments

None.

6.5.4.3 Read/Formatter PCBA Removal

1. Note the locations of each Read Channel PCBA and then remove them. Refer to Section 6.5.3 for the removal procedure.
2. Disconnect J3, J9, and J10. Pull only on the connector— do not pull on the cable.

3. Remove the eight Phillips head screws which secure the PCBA to the base casting. There are four screws along each side.

4. Remove the three hex standoffs and their insulators.

5. Remove the Read/Formatter PCBA.

Notes: *If the Read/Formatter PCBA has been replaced, be sure that the PROMS located at U57, U58, U64 and U65 are of the latest revision.*

U57 and U58 comprise a set of EDAC PROMS and must be of the same revision number and date.

U64 and U65 comprise a set of EMAP PROMS and must also be of the same revision number and date. The EDAC PROM labeled HI must be installed in the upper socket U57 and the one labeled LO must be installed in location U58. The EMAP PROM labeled HI must be installed in the upper socket U64 and the one marked LO must be installed in U65.

Common problems during installation are bending a pin bent under the IC, or installing the IC with pin 1 in the wrong location. If this occurs, the drive will not read.

6.5.4.4 Read/Formatter PCBA Installation.

1. Place the PCBA on the shield standoffs and reinstall the eight Phillips screws.

2. Install the three hex standoffs and their insulators onto the PCBA.

3. Reconnect J3, J9, and J10.

4. Install the Read Channel PCBAs. If the Read Channel PCBAs are returned to their original locations, no adjustments are required.

5. Reinstall the Read Channel PCBA retaining clamp.

6.5.5 Read Preamplifier PCBA (Assembly 500167-01-1)

The Read Preamplifier is the small PCBA at the left side of the drive mounted to the cabinet as shown in Figure 6-1 on page 6-3. The purpose of the Read Preamplifier PCBA is to amplify the read signals as close to the head as possible, thus maintaining a high signal-to-noise ratio. The output of the Read Preamplifier PCBA goes to the Read Channel PCBAs via the Read/Formatter PCBA.

6.5.5.1 Required Tools

¼ inch nut driver.

6.5.5.2 Required Adjustments

If the Read Preamplifier PCBA is replaced, the read gain adjustment described in Chapter 7 must be performed.

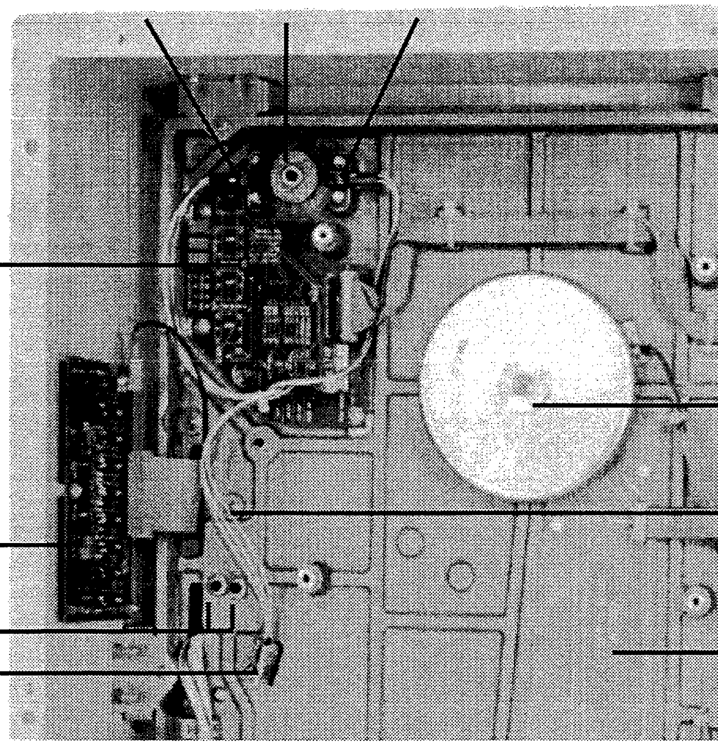


Figure 6-4 Open Drive with Mechanical Parts Identified

6.5.5.3 Read Preamplifier Removal

1. To gain access to the Read Preamplifier PCBA, first remove several of the Read Channel PCBAs on the left. Refer to Section 6.5.3 for instructions.
2. Unplug ribbon cables P2 (connects to the Read/Formatter) and P1 (connects to the head).
3. Unplug the ground wire at G1.
4. Remove the three hex nuts from the cabinet mounting screws, and then remove the PCBA.

6.5.5.4 Read Preamplifier Installation

1. Place the PCBA on the mounting screws and reinstall the three hex nuts.
2. Plug the ground wire into G1, the head ribbon cable into P1 and the Read/ Formatter ribbon cable into P2.
3. Re-install the Read Channel PCBAs in their original locations.

4. Reinstall the retaining clamp.

6.5.6 Switch PCBA (Assembly 500187-02-6)

This small PCBA mounted to the base casting near the top left side of the drive supplies power to and receives signals from the tachometer, EOT/BOT sensors and front panel switches. It also sends status signals to the Write/Controller PCBA and controls the front panel indicators.

6.5.6.1 Required Tools

¼ inch nut driver.

6.5.6.2 Required Adjustments

If the Switch PCBA is replaced, the EOT/BOT and the tachometer adjustments described in Chapter 7 must be performed.

6.5.6.3 Switch PCBA Removal

1. Remove the Read/Formatter PCBA as described in Section 6.5.4.
2. Remove the six Phillips screws holding the shield in place (the shield may drop as the last screw is removed.)
3. Disconnect the two cables from the Switch PCBA.
4. Remove the three mounting Phillips screws, being careful not to let the PCBA drop as the last screw is removed.

6.5.6.4 Switch PCBA Installation

1. Position the PCBA under the sensor wire cables and install the three Phillips screws.
2. If P16 cable connector is longer than the header on the PCBA, position the cable connector so that it aligns at the left end of P16 and plug it in.
3. Reconnect the cable at P5.
4. Reinstall the shield and the Read/Formatter PCBA. The colored wire from the right hand tach sensor should connect to pin 1.

6.5.7 Hall PCBA (Assembly 500107-02-4)

The Hall PCBA is attached to the base casting and contains six Hall sensors which sense the passing of the magnets attached to the inside of the motor rotors. An additional Hall sensor on the other side of the PCBA protrudes through the front of the base casting and detects the passing of a small magnet on the underside of the supply hub. Installing a write ring causes the magnet to be positioned such that the sensor will detect its presence once per revolution. If no write ring is installed, the magnet will not be positioned close enough for the sensor to detect its passing, thus providing FPT sensing.

6.5.7.1 Required Tools

#2 Phillips screwdriver.

¼ inch nut driver.

6.5.7.2 Required Adjustments

None.

6.5.7.3 Hall PCBA Removal

1. Remove the Read/Formatter PCBA as described in Section 6.5.4.

2. Remove the shield (held on by six Phillips screws) from the base casting.

3. Partially disassemble the supply motor by grasping the supply hub with one hand, the supply rotor with the other, and turning the rotor counter-clockwise. Once the rotor is broken loose, remove the screw and washer, and carefully pull the rotor away from the stator. It is not necessary to remove the supply hub.

Note: *Do not lose the motor flange washer which fits between the bearing and the rotor. A complete description of motor disassembly can be found in Chapter 8.*

4. Partially disassemble the take up motor in like manner as the supply motor. Do not remove the take up reel.

5. Remove the three Phillips screws from the right side of the Write/Controller PCBA, swing the PCBA away from the Power Supply PCBA and disconnect Hall PCBA connector P2 from the Power Supply PCBA.

6. Remove the two Phillips screws which hold the supply stator to the base casting and move the stator away from the casting.

7. Remove the four screws which hold the Hall PCBA to the base casting and remove the PCBA, taking care not to bend the sensors out of alignment.

Caution! ***Do not bend or misalign the six Hall sensors or the FPT sensor on the front of the PCBA. Their position is crucial to the proper operation of the motors.***

6.5.7.4 Hall PCBA Installation

1. Inspect the Hall sensors to verify they are not misaligned. If they are, the Hall PCBA should be returned to the factory for adjustment.

2. Position the Hall PCBA against its mounting bosses and install the four hex screws.

3. Reassemble the reel motors according to the procedures in Section 6.6.

4. Reconnect J2 to the Power Supply PCBA and secure the Write/Controller PCBA.

5. Reinstall the shield and the Read/Formatter PCBA.

6.6 Reel Motors

The two reel motors are brushless DC motors consisting of a magnetic rotor and an electrically commutated stator as shown in Figure 6-5. As the stator windings are energized, the magnets attached to the rotor move to align themselves with the magnet fields and in doing so, turn the reel.

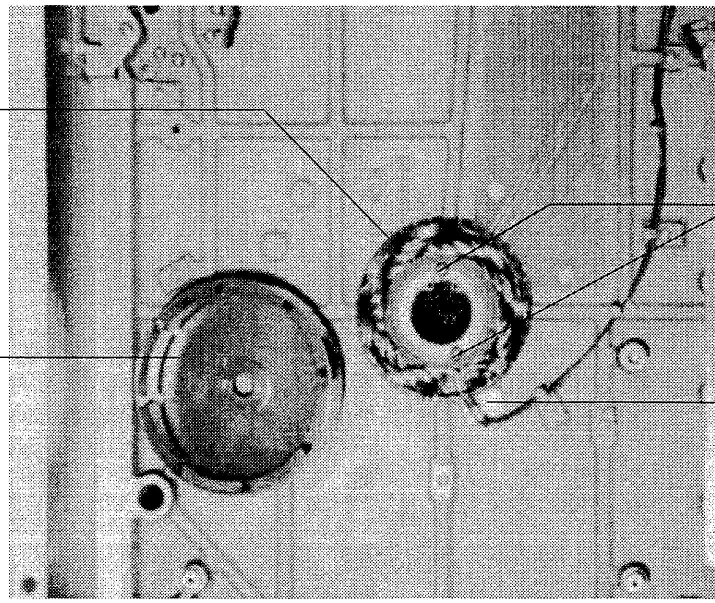


Figure 6-5 Motor Rotor and Stator

6.6.1 Rotor and Stator Removal

1. Remove the Read/Formatter PCBA and the shield beneath it as described in Section 6.5.4.
2. Grasp the hub with one hand and turn its rotor counter-clockwise to loosen it.
3. Once the rotor is broken loose, remove the screw and washer, and carefully pull the rotor away from the stator.

Note: *Do not lose the motor flange washer which fits between the bearing and the rotor. A complete description of motor disassembly can be found in Chapter 8.*

4. Inspect the rotor magnets for chips. If the magnets are chipped, the rotor should be replaced.
5. To remove the stator, first remove the three Phillips screws on the right side of the Write/Controller PCBA so that it will swing open.
6. Unplug the motor wires at the Power Supply PCBA.
7. Remove the ¼ inch hex screw which secures the stator cable clamp near the stator, and remove the clamp.
8. Cut the cable ties which secure the stator cable.
9. Untwist and remove the spiral cable covering. When removing the take up stator, leave the green chassis ground wire inside the shielding intact.
10. Remove the two Phillips screws which secure the stator to the reel hub and remove the stator.

6.6.2 Rotor and Stator Installation

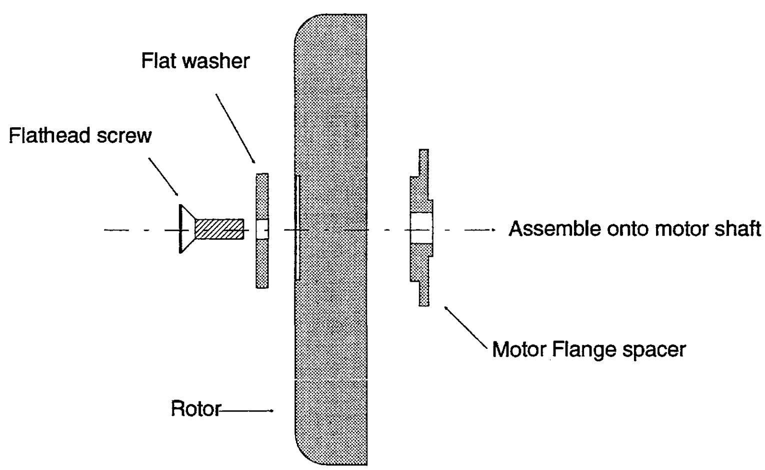


Figure 6-6 Rotor Assembly

1. Place the new stator over the reel hub with the wires toward the base casting and secure with two Phillips screws.
2. Secure the wires with the hex nut and clamp, cable, and spiral shielding. Include the green chassis ground wire with the take up motor wires.
3. Connect the motor wires into the Power Supply PCBA the take up stator orange wire connects to E11, its brown wire to E12, and its red wire to E13.

The supply stator orange wire connects to E1, its brown wire to E2, and its red wire to E3.

4. Make sure the hub shaft is fully seated, then position the motor flange washer on the end of the shaft such that the wider shoulder faces outward as shown in Figure 6-6.

Caution! ***If a screw, nut, etc., is dropped near the motor, it may be attracted to the inside of the rotor by the rotor magnets, and damage the motor. Insure that no lost metal parts are stuck to the rotor magnets before continuing.***

5. Position the rotor on the end of the shaft and motor flange so that the hole in the rotor is flush with the motor flange washer. The magnetism of the rotor will offer resistance while seating the rotor.
6. While holding the hub with one hand, install the washer and shaft screw. Do not tighten it at this time.
7. First tighten the Phillips screw manually by holding the rotor and turning the hub clockwise, working it back and forth until the motor flange seats into the hole in the rotor. Then tighten the screw with the Phillips screwdriver.
8. After tightening, turn the hub by hand and verify there is no rubbing, scraping, or rough spots. If the hub or the rotor wobbles, or if there is any interference when moving the hub, reinstall the rotor.

6.7 Sensor Replacement

Figure 6-4 on page 6-12 identifies most of the mechanical parts included in this section.

6.7.1 Tachometer Sensors

The infrared LED tachometer sensors are mounted on two bosses between the tachometer disk and the base casting behind the tachometer roller. The tachometer disk is attached to the tachometer tape guide shaft. As the disk turns due to tape motion across the tachometer tape guide, infrared light alternately passes through, then is blocked by the slots. The Switch PCBA translates the off-on light activity into square waves.

6.7.1.1 Required Tools

3/32 inch hex ball driver.

6.7.1.2 Required Adjustments

If the tachometer sensors are moved or replaced, the tachometer phasing adjustments described in Chapter 7 must be performed.

6.7.1.3 Tachometer Sensor Removal

1. Unplug the connector from the optical sensor to be replaced.

2. Remove the two sensor mounting screws using the 3/32 inch hex ball driver. Be careful not to dent or bend the delicate tachometer disk when sliding the sensor out.

6.7.1.4 Tachometer Sensor Installation

1. Replace the sensor and install the two screws and washers, tightening them until they are just snug enough to allow some movement during the adjustment.

2. Install the connector with the red wire nearest the base casting.

6.7.2 EOT/BOT Sensor (Assembly 500039-01-1)

The EOT/BOT sensor assembly, located in the tape path before the head, senses the presence of an End-Of-Tape (EOT) or Beginning- Of-Tape (BOT) reflective marker on the tape. See Figure 6-7 for the location of the EOT/BOT sensor assembly.

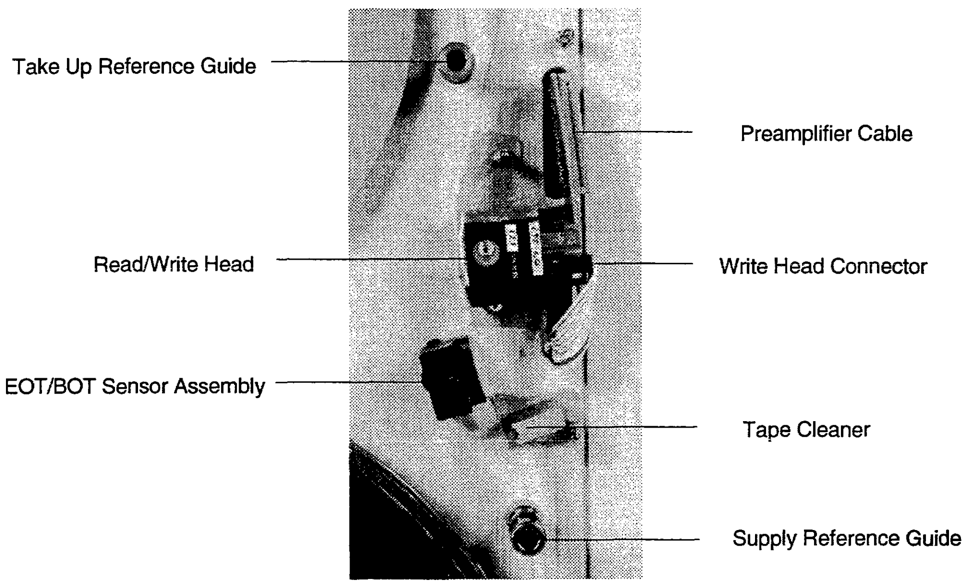


Figure 6-7 Head Area Components

6.7.2.1 Required Tools

#2 Phillips screwdriver.

6.7.2.2 Required Adjustments

If the EOT/BOT sensor is replaced, the EOT/BOT adjustment described in Chapter 7 must be performed.

6.7.2.3 EOT/BOT Sensor Removal

1. Remove the Read/Formatter PCBA as described in Section 6.5.4.
2. Remove the six Phillips screws holding the shield in place. The shield may drop as the last screw is removed.
3. Unplug the connector from the EOT/BOT assembly inside the drive.
4. Remove the two Phillips screws from the rear of the base casting and lift the sensor assembly out from the front of the drive.

6.7.2.4 EOT/BOT Sensor Installation

1. Install the sensor assembly using the two Phillips screws.
2. Plug the connector into the assembly with the red wire nearest the casting.

6.7.3 File Protect Sensor

The file protect (FPT) sensor is part of the Hall PCBA and cannot be replaced individually. If the FPT sensor is defective, replace the Hall PCBA.

6.8 Read/Write Head Replacement

The read/write/erase head is located in the tape path between the EOT/BOT sensor assembly and the upper tape fixed guide and is concealed by the head cover. See Figure 6-7 for parts identification.

Note: *Be sure the head needs replacement or alignment. First rule out other possibilities (such as a bad cable) before loosening the screws. The head alignment is critical and the alignment procedure (which is REQUIRED after the head is moved) is difficult, requiring a special skew cable and skew tape.*

6.8.1 Required Tools

3/32 inch hex driver

6.8.2 Required Adjustments

If the head is replaced, the write current, read gain, and write deskew adjustments described in Chapter 7 must be performed.

6.8.3 Head Removal Procedure

1. Remove the head cover and disconnect the connectors and wires at the rear of the head.

Caution! ***Note the orientation of the Erase connector before removing it. If it is reconnected upside down, data reliability will be adversely affected.***

2. Remove the Read/Formatter PCBA and underlying shield as described in Section 6.5.4.

3. While holding the head with one hand, use a 3/32 inch hex driver to loosen the two head retaining screws inside the drive. The two screws have attached insulators and washers that need not be separated. See Figure 6-8 on page 6-20.

4. Carefully remove the head and save the head insulator for reinstallation.

Note: *The head insulator is a special .005 inch mylar shim used to electrically isolate and properly space the head above the casting surface. Do not use any other spacer under the head. The insulating bushings and washers on the head screws are also required for electrical isolation.*

6.8.4 Head Installation Procedure

1. Use only the Qualstar P/N 645-0001-0 head; others will not function properly.

2. Assemble the screw/washer/insulator subassemblies as shown in Figure 6-8.

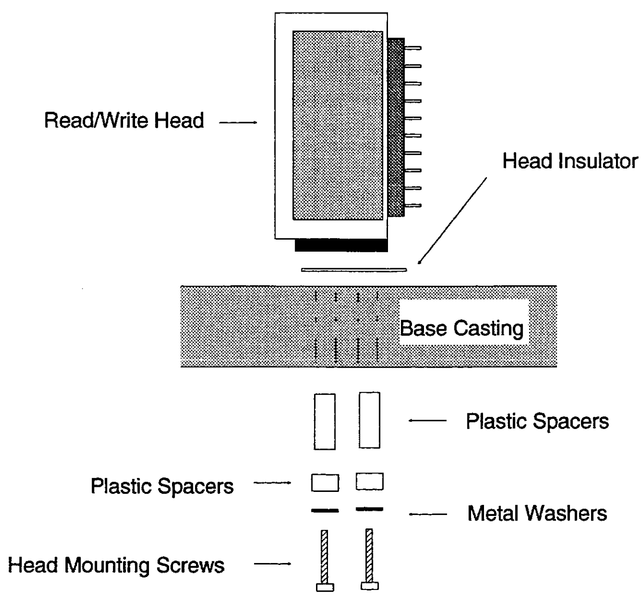


Figure 6-8 Head Mounting Hardware

3. Place the head insulator between the head and the casting and hold the head in place while installing the screw subassemblies inside the drive. Do not fully tighten them at this point.

4. Position the head in the approximate center of its rotational range.

5. Carefully tighten the mounting screws. *Do not over-tighten or the insulators will be damaged.*

6. Use an ohmmeter to verify that the head is isolated from the chassis.

7. Reinstall the connectors and head cover.

Adjustment Procedures 7

This chapter describes the check and adjustment procedures required after replacing certain PCBAs and other subassemblies. The actual replacement procedures can be found in Chapters 6 and 8. This chapter contains the checks and adjustments listed in Table 7-1:

TO ADJUST THE FOLLOWING ITEMS,	REFER TO:
+5 Volt Regulator	Section 7.2
Motor Test	Section 7.3
Read Reference Voltage	Section 7.4
EOT/BOT Sensor	Section 7.5
Tachometer Sensor	Section 7.6
Write Current	Section 7.7
Read Amplifier Gain	Section 7.9
Write Deskew	Section 7.10

Table 7-1 List of Adjustments

7.1 Test Equipment

The following test equipment is required to carry out the adjustments described in this chapter:

- DVM (VOM), 3-½ digits
- Oscilloscope, Dual Channel, 100MHz (Tektronix 465 or equivalent)
- Master Output Tape, Qualstar P/N 646-0005-9 (for read gain adjustment)
- Head Alignment (Skew) Tape, Qualstar P/N 646-0004-2 (for deskew adjustment)
- Skew Adapter Cable (Qualstar P/N 500260-02-1)
- Head Alignment Tool (Qualstar P/N 600131-01)

Note: *Some of the adjustments require special option switch (S1 through S8) settings. Before beginning the adjustment, note the original positions of the switches. Return the switches to their original settings before returning the drive to service.*

SWITCH FUNCTIONS IN DIAGNOSTIC MODE

The drive must first be placed into the diagnostic mode to perform various adjustments. To place the drive in the diagnostic mode, switch S1 on the Write/Controller PCBA ON with the tape NOT tensioned. Then thread the tape and tension it by pressing LOAD. When the tape is tensioned, the drive will begin reading forward until EOT is detected.

To place the drive into the write mode, press FPT after the BOT marker has passed the head. Then set S2 on, and press ON LINE. If nothing is connected to J1 on the Write/Controller PCBA, the drive will write 2K byte blocks on the tape until EOT is detected.

Upon detecting EOT, the drive will read the tape in reverse until BOT is detected. It will then resume writing forward. To read forward, press FPT, turn S2 off, and press ON LINE.

Pressing FPT stops tape motion.

ACTION	RESULT
Pressing ON LINE when the tape is stopped>	starts writing or reading forward.
Pressing FPT while the tape is moving>	stops the tape.
Pressing 6250 when the tape is stopped>	starts reading in reverse.
Pressing FPT when the tape is stopped>	changes the density.
Pressing LOAD when the tape is stopped>	rewinds the tape to BOT.
Setting S2 on>	writes 2K byte blocks to EOT.

7.2 +5 Volt Regulator Adjustment

7.2.1 General Information

This adjustment controls the +5 volts which is used to power the integrated circuits on all PCBAs.

When Required: After replacing or repairing the Power Supply PCBA.

Equipment Required: DVM

Drive setup: Set option switches S1 through S6 off, and S7, S8 ON.

7.2.2 +5 Volt Regulator Adjustment Procedure

1. Connect the positive lead of a DVM to testpoint +5V and the negative lead to testpoint G5 near power connector J8 on the Write/Controller PCBA.

2. Apply power.

3. Adjust R101 on the Power Supply PCBA for a reading of +5.0 (+0.1, -0.0) volts.

7.3 Motor Test

When required: After changing motor components, Power Supply or Hall PCBA.

Equipment required: None

Drive setup: Set options switches S2, S4, S5 and S6 off, and S1, S3, S7 and S8 ON.

7.3.1 Motor Test Procedure

1. Apply power.
2. While preventing the take up reel from turning by holding it with one hand, press LOAD, then ON LINE to turn the motor driver on.
3. Turn the reel at least one revolution against its torque, and verify that no rough motion or missing phases are present.

Note: *Each motor is driven by three signals which are 120° phase-shifted from each other. If you feel loose spots or loss of torque in a motor while turning it, it indicates a problem with one of the phases or with the Hall sensors located on the Hall PCBA beneath the Read/Formatter PCBA.*

4. Stop the motor by pressing FPT.
5. Perform the same test on the supply motor, pressing 6250 to turn it on and FPT to turn it off.
6. Allow each motor to free-run and verify there are no unusual noises.
7. Turn S3 off.

7.4 Read Reference Voltage Check

7.4.1 General Information

The Read Reference Voltage is a precision reference which is used in the analog to digital data converters. There is no adjustment. If the voltage is not as specified in the procedure, the cause must be determined and eliminated for maximum data reliability.

When required: After replacing the Read/Formatter PCBA.

Equipment required: DVM.

Drive setup: Set option switches S1 through S6 off, and S7, S8 ON.

7.4.2 Read Reference Voltage Adjustment Procedure

1. Connect the positive lead of a DVM to testpoint +VR and the negative lead to testpoint AG1 on the Read/Formatter PCBA. These testpoints are at the upper right corner of the PCBA.

2. Apply power and verify that +VR is between +1.4 and +1.5 volts. If the reading is 0.8 volts, verify that S7 is ON.

3. Move the positive lead of the DVM to testpoint -VR and verify that -VR is between -1.4 and -1.5 volts.

7.5 EOT/BOT Sensor Adjustment

7.5.1 General Information

The EOT/BOT Sensor adjustment sets the sensitivity of the EOT/BOT sensors. It should be performed with the head cover in place, and under normal lighting conditions.

When required: After replacing EOT/BOT sensor.

Equipment Required: Oscilloscope or DVM; A tape with an EOT marker tab one to two inches ahead of the BOT marker tab.

Drive setup: Thread the tape and remove the slack; set option switches S1 through S6 off, and S7, S8 ON.

7.5.2 EOT/BOT Sensor Adjustment Procedure

1. Connect the positive lead of a DVM to TP1 and the negative lead to TP8 (ground) on the Switch PCBA. Refer to Figure 7-1 for testpoint location.

2. Apply power and with no marker strip under sensor, adjust R1 (top pot) on the Switch PCBA for +2.5 ±0.2 volts. The FPT indicator must be on.

3. Move the BOT tab under the sensor; verify that TP1 is greater than +4.0 volts, and that the LOAD indicator is flashing.

4. Move the EOT tab under the sensor and verify that TP1 is less than +1.0 volt, and that the FPT indicator is flashing.

7.6 Tachometer Sensor Adjustment

7.6.1 General Information

The tachometer is located behind the upper tape guide. It is made up of a slotted metal disk and two infrared LED sensor assemblies which straddle the disk. When the tape moves it turns the guide, causing the disk to interrupt the infrared light beam in the sensors. The Switch PCBA translates the off-on light activity into square waves which can be seen at testpoints 5 and 4 (TACHA and TACHB) on the Switch PCBA, and also at the TACHA and TACHB testpoints on the Write/Controller PCBA.

The frequency of TACHA and TACHB is directly proportional to tape speed and is 5KHz at 50 ips. The duty cycle of each signal (the percentage of time the signal is high) can be controlled by a pot. The sensor nearest the pots on the Switch PCBA generates TACHB, and the other sensor generates TACHA.

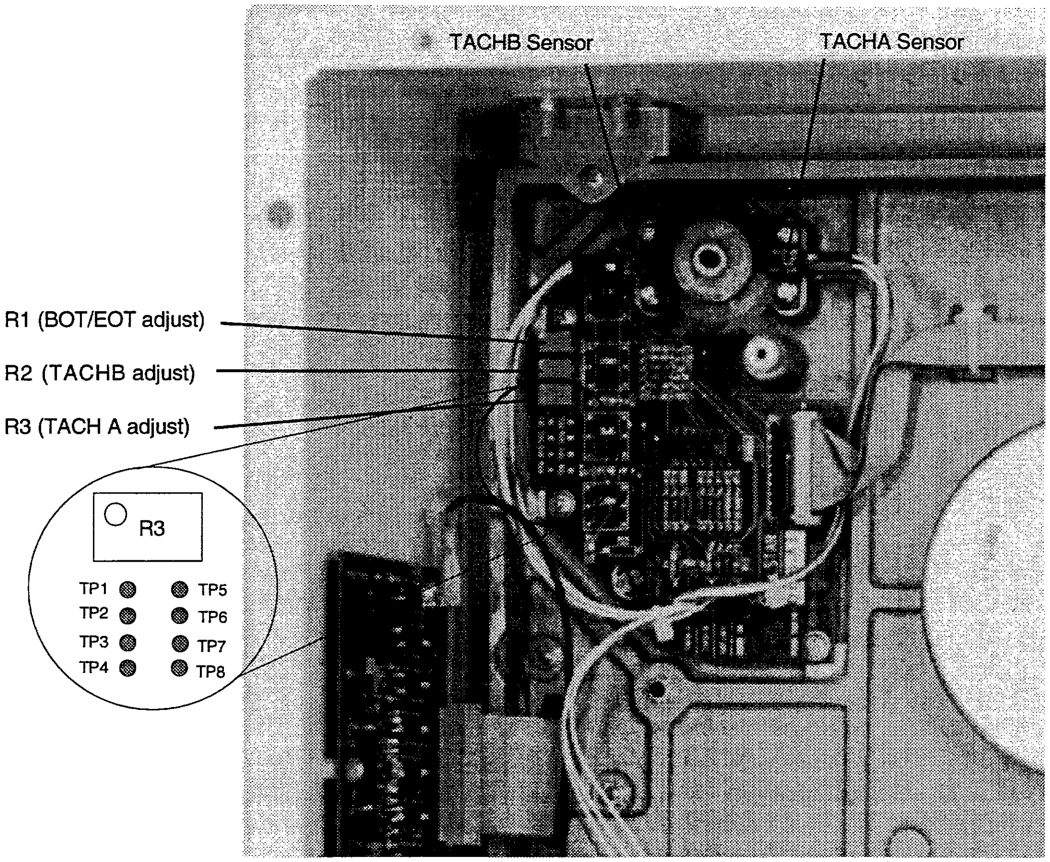


Figure 7-1 Switch PCBA and Tachometer Sensor Locations

The adjustment consists of adjusting the positive duration of each tach signal so it equals the negative duration (i.e., a *50% duty cycle*) and then adjusting the position of the TACHA sensor until TACHB occurs 90 degrees ahead of TACHA. This allows the microprocessor to determine the direction of tape travel.

The adjustments are first performed statically, during which you move the tape guide. This is called the *static* adjustment. When the static adjustment is correct, the drive will be able to load and move the tape, and you can then use the tape drive to move the tape at an even speed while you fine tune the adjustments. This part of the adjustment is called the *dynamic* adjustment.

When required: After replacing tach bearing, tach disk, upper tape guide or tach sensors.

Equipment required: Oscilloscope, work tape.

7.6.2 Static Tachometer Adjustment

1. Turn power off and thread a tape.
2. Loosen the TACHA and TACHB sensor screws, center the sensors vertically and retighten the screws. See Figure 7-1 for sensor locations.
3. Connect scope channel 1 to TACHA in the upper left corner of the Write/Controller PCBA, and its ground lead to G1 or G2.
4. Set the scope to measure 2 volts/division and 1 millisecond/division, auto-trigger.
5. Turn power on.
6. Manually turn take up reel clockwise and adjust R3 (bottom pot) on the Switch PCBA until the positive and negative durations of TACHA are approximately equal (i.e., a 50% duty cycle). Fine tuning will be done later. See Figure 7-2.

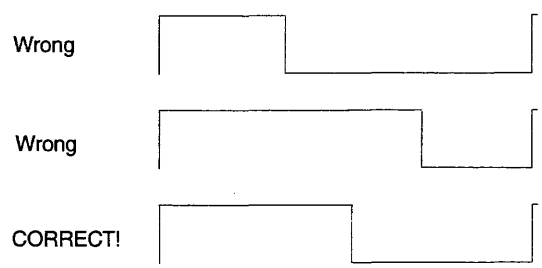


Figure 7-2 Tachometer 50% Duty Cycle Adjustment

7. Move the scope probe from TACHA to TACHB (four inches below).
8. Manually turn take up reel clockwise and adjust R2 (center pot) on the Switch PCBA until the positive and negative durations of TACHB are approximately equal (fine tuning will be done later).
9. Move scope probe from TACHB to TFWD (upper center of PCBA).
10. Loosen TACHA sensor screws slightly.
11. While turning the tachometer tape guide, adjust the TACHA sensor up or down slightly such that TFWD is high when the tape guide is turned counterclockwise (i.e., in the *forward* tape direction), and low when the guide is turned clockwise (i.e., in the *reverse* tape direction).
12. Tighten TACHA sensor screws.
13. Check that the position of TACHA sensor did not change when you tightened the screws by verifying TFWD is high when the tape guide is turned counterclockwise, and low when turned clockwise.

7.6.3 Dynamic Tachometer Adjustment

The steps in this procedure require that the static tachometer adjustment be correct.

1. Select the diagnostic mode by setting option switch S1 on.
2. Connect scope channel 1 to TACHA and scope channel 2 to TACHB on the Write/Controller PCBA.
3. Press LOAD to tension the tape and move it forward.

Note: *If the tape does not load, recheck the tachometer sensor static adjustment. TFWD must go high when the tachometer is turned in the forward tape direction.*

4. When the BOT marker is past the head, stop the tape by pressing FPT. (To stop the tape, press FPT; to move tape in reverse, press 6250; to move tape forward, press ON LINE; to change speeds, press FPT while the tape is stopped).
5. Select high speed (1600) and press ON LINE to start the tape moving *forward*. The 6250 indicator must be off.
6. Set the scope for 20 microseconds/division and trigger negative on channel 1 (TACHA).
7. While the tape is moving, fine tune R2 (TACHB) and R3 (TACHA) for 50% ±5% duty cycles. See Figure 7-2.

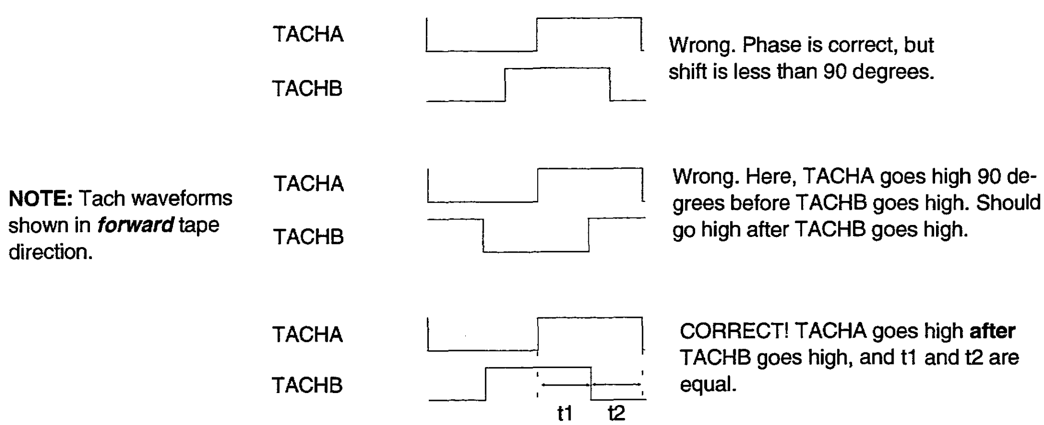


Figure 7-3 Tachometer Phase Adjustment

8. Carefully readjust the position of the TACH A sensor up or down so that TACHA goes high 90 degrees after TACHB goes high *in the forward tape direction* as shown in Figure 7-3.

Notes: *If TACHA or TACHB jitters by more than one centimeter on the scope, do not try to adjust it. If the signal remains high less than 80 microseconds or greater than 120 microseconds, either the tape guide is bent, the tach disk is defective, or the runout is excessive.*

If either scope channel is inverted, if the testpoints are reversed, or if the tape is not moving in the proper direction, the adjustment will appear to be correct but the phasing will be incorrect and lead to tape motion problems.

9. Tighten the mounting screws and verify that the rising edge of channel 1 still occurs 90±10 degrees (5.6 microseconds at 50 ips) after the rising edge of channel 2. If necessary, repeat the adjustment until the phasing is within the tolerance.

10. Verify that the phase angle is correct by observing a steady high logic signal TFWD during forward tape motion, and a steady low signal during reverse tape motion.

Note: *The two tach sensors should be in line with each other and with the center of the tachometer disk, and the signals should be clean both the forward and reverse directions. Excessive jitter indicates defective mechanical components or excessive runout.*

11. Press FPT to stop the tape. Disconnect the scope probes.

7.7 Write Current Adjustment (All except 1260T)

7.7.1 General Information

The write current adjustment sets the amount of write current which flows through the write head coils, and thus directly affects the magnetic saturation of the tape. Too little write current can cause a weak read signal, while too much write current will cause tape saturation and consequent read signal distortion. Both conditions can lead to data reliability problems.

Each density requires a different write current. The PE write current is fixed and requires no adjustment, while the GCR write current requires adjustment. There is an additional write current adjustment for DPE on the 1260T drives.

When required: After replacing the head or the Write/Controller PCBA.

Equipment required: Oscilloscope, DVM, Master Output Tape (if one is not available, use a tape in excellent condition and of the same brand and type which is most used at the site in question.)

7.7.2 Drive Setup

1. With power off, thread the master output tape.
2. Place the drive in the write diagnostic mode by setting S1 and S2 on.
3. Apply power and press LOAD to tension the tape.
4. After the BOT marker has past the sensor, press FPT to stop the tape.
5. Press FPT until the 6250 indicator is on.

7.7.3 Test Equipment Setup

1. P3 is the row of pins at the edge of each Read Channel PCBA. Connect scope channel 1 to pin 3 of P3 (amplified read signal) on *any* Read Channel PCBA and the ground lead to the AGND testpoint of the *same* Read Channel PCBA.
2. Connect scope channel 2 to testpoint ENVSUM on the Read/Formatter PCBA.
3. Set channel 1 gain to measure 1 volt/division, scope channel 2 gain to measure 2 volts/division, and the timebase to 2 milliseconds/division.
4. Set the scope to trigger positive on channel 2.
5. Connect the positive lead of the DVM to the WRPWR testpoint near the bottom of the Write/Controller PCBA and the negative lead to G8 (next to WRPWR).

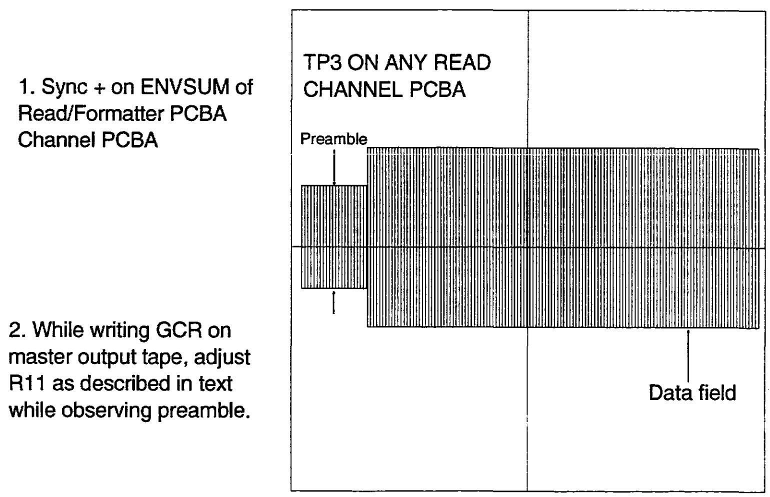


Figure 7-4 GCR Write Current Adjustment Waveform

7.7.4 Write Current Adjustment Procedure

1. Press ON LINE to begin writing (refer to Figure 3-6). The tape should move at 12.5 ips.
2. Check the head part number on the label on the side of the read/write head.
   a. If the part number is 645-0001-0, the DVM should read between 3.5 and 4.5 volts.
   b. If the part number is 645-0002-8, the reading should be about 7.5 volts. You may need to adjust R11 (labeled GCR) on the Write/Controller PCBA to get the correct voltage at the WRPWR testpoint.

Note: *If the changes in signal amplitude do not seem to correspond with the turning of R11, the drive is probably in a read mode.* **This adjustment must be made while writing forward.**

If the tape reaches EOT, it will stop writing and go into a read reverse mode, and turning R11 will not change the read signal. Also, the DVM will not read 4 volts. If this is the case, rewind the tape by first pressing FPT (to stop the tape) and then LOAD to start the rewind. When the tape stops at BOT, press ON LINE to start writing forward again.

3. Verify the 6250 indicator is on.
4. Sync the scope positive on channel 2 and observe the start of the read signal on channel 1. Obtaining the start of the waveform may require careful scope level adjustment.
   a. Turn R11 on the Write/Controller PCBA until the preamble at the start of channel 1 read signal reaches its maximum amplitude.
   b. Turn R11 on the Write/Controller PCBA counter-clockwise until the signal just begins to decrease. Do not turn the pot any further.

Note: *The adjustment pots on Revision A Write/Controller PCBAs (older drives only) have reversed operation. On these PCBAs, turn the pot CCW until the preamble has just reached its maximum amplitude.*

7.8 3200 Write Current Adjustment (1260T only)

Note: *1260T (the T stands for tri-density) tape drives can be identified by the green LED next to the 6250 indicator on the front panel.*

Repeat the preceding write current adjustment procedure with the drive configured for 3200 cpi but adjust R10 (labeled DPE) on the Write/Controller PCBA. The DVM reading should be about +5.65 volts.

7.9 Read Gain Adjustment

7.9.1 General Information

The purpose of the read gain adjustment is to match the read electronics to the read head characteristics. The read amplitudes usually decrease with time as the head wears due to normal usage. Performing the read gain adjustment may then bring the amplitudes back within specification.

Drives containing Read Channel PCBAs revision E and earlier have two read gain adjustment pots: One for 1600 cpi (PE) and one for 6250 cpi (GCR). Because the PE gain adjustment affects the GCR gains, always adjust the PE gains on these drives first. The GCR gain adjustment does not affect the PE gains. The 3200 cpi (DPE) gains (on model 1260T are based upon the PE adjustments and do not require adjustment.

Drives containing Read Channel PCBAs revision F and later feature an automatic GCR read gain adjustment and have a read gain adjustment pot only for 1600 cpi.

All read gain adjustments are made while writing on a master output tape, and only after the write current adjustment has been performed. If a master output tape is not available, a new tape of the same brand and type most used at the site in question should be used.

The nine read channels are identified on the Read/Formatter PCBA. Each Read Channel PCBA has its own testpoints on P3 at the outer edge of the PCBA. The analog ground testpoint AGND is located above P3.

7.9.2 When Required

After replacing the head or a Read Channel PCBA.

7.9.3 Equipment Required

Oscilloscope, master output tape.

7.9.4 Procedure for 1600 Cpi (PE)

1. ***IMPORTANT:** Verify nothing is connected to J1 and J2 interface connectors.*
2. Turn power off, thread the master output tape, and set S1 and S2 on.
3. Turn power on and press LOAD to tension the tape.
4. After the BOT marker has past the sensor, press FPT to stop the tape.
5. Connect scope channel 1 to pin 3 of P3 (read signal) on the fifth Read Channel PCBA from the right and scope channel 2 to testpoint ENVSUM on the Read/Formatter PCBA.
6. Select 1600 cpi by pressing FPT until the 6250 indicator goes out.
7. Press ON LINE to begin writing.

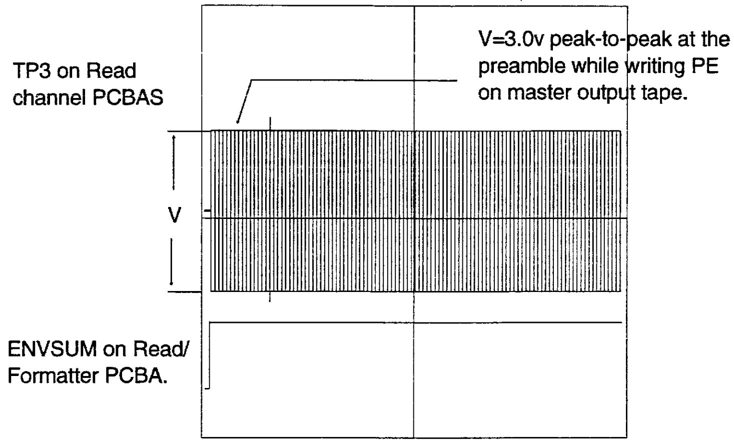


Figure 7-5 Read and ENVSUM Waveforms

8. Sync the scope positive on scope channel 2 and adjust the timebase to obtain a signal similar to that shown in Figure 7-5.
9. Adjust R3 (R5 on revisions D and E) on the selected Read Channel PCBA until the preamble is 3.0 volts peak-to-peak at pin 3 as shown in Figure 7-5.
10. **Head Alignment** - If the head was moved or replaced for some reason, the tape wrap angle across the head must be adjusted. If the head position was not disturbed, skip to the next step.

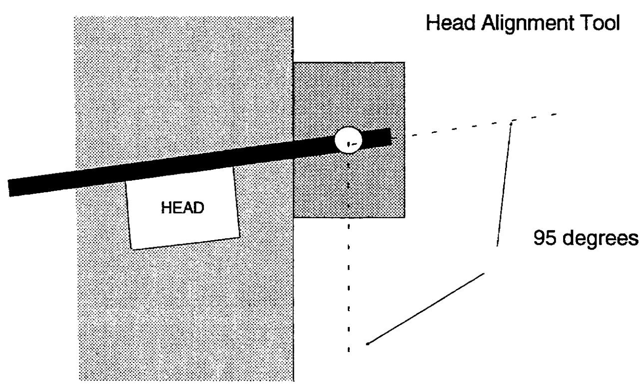


Figure 7-6 Head Alignment Angle

a. With the tape stopped, press FPT to select 6250 cpi. The 6250 LED must be on.

b. Press ON LINE to write forward.

c. Barely loosen the head mounting screws and see if there is any change in the amplitude of the preamble while rotating the head. It may help to increase the vertical gain of the oscilloscope and observe only the positive peaks of the waveform to see the difference in amplitude.

d. If the preamble amplitude changes while rotating the head, rotate the head to a position of maximum preamble amplitude and retighten the mounting screws.

e. If the preamble amplitude does not change, stop the tape by pressing FPT and use the head alignment tool to position the head to 95 degrees as shown in Figure 7-6. Retighten the mounting screws.

f. Press FPT to select 1600 cpi. The 6250 LED must be off.

g. Press ON LINE to resume writing and readjust R3 (R5 on revisions D and E) on the Read Channel PCBA until the preamble is 3.0 volts peak-to-peak.

11. Move scope channel 1 probe to pin 3 of P3 of the first Read Channel PCBA and adjust R3 on that PCBA for a peak-to-peak amplitude of 3.0 volts at the preamble.

Note: *There should be no more than 0.25 volt of amplitude modulation on the read envelopes. Excessive modulation can be caused by a worn tape, a dirty or defective head, poor tape tracking, or excessive tape guide runout.*

12. In like manner, adjust the remaining seven circuits.

13. Stop the tape by pressing FPT.

7.9.5 6250 Read Gain Check Procedure (GCR)

If the Read Channel PCBAs are revision F2 or higher, check the read amplifiers at 6250 cpi as follows (there is no adjustment):

1. Select 6250 by pressing FPT (6250 indicator on).
2. Press ON LINE and monitor each of the read gain testpoints. The amplitudes should all be about the same. Small differences among them are allowed. *Do not readjust the gain pots.*
3. Press FPT to stop the tape, and set S1 and S2 off.

7.9.6 GCR Read Gain Adjustment Procedure

This adjustment procedure applies to Read Channel PCBAs revision E5 and lower ONLY. These PCBAs can be easily identified by their two gain adjust pots. Revision F2 and later PCBAs feature automatic gain control in the GCR mode, eliminating the GCR read gain adjustment and its pot.

The adjustment procedure is identical to the 1600 gain adjustment, except that 6250 must be selected, and the adjustment pot is R11 on each Read Channel PCBA. Note that the 6250 indicator must be on. After adjusting the 6250 cpi gains, it is not necessary to recheck the 1600 cpi gains.

7.10 Write Deskew Adjustment

7.10.1 General Information

Each character on the tape consists of nine bits which are recorded in a line from one edge of the tape to the other. This is illustrated in Figure 2-1 on page 2-2. If these bits d are not lined up vertically with each other, the character is said to be *skewed*. Skew can result when the read or write gaps in the head are not lined up exactly with each other, when the head is tilted with respect to the deck, or when some mechanical condition prevents the tape from crossing the head at right angles. Ideally, there will be no skew, and each bit of a character will be detected simultaneously with the other eight bits of that character.

Due to the buildup of mechanical tolerances, a small amount of skew is sometimes unavoidable. If the amount is not excessive, the read circuitry can compensate for it. A tape written with an excessive amount of skew cannot be read by other tape drives, and often cannot be read by the drive which wrote it. In such cases, the tape's path across the head must be physically adjusted to bring the skew within acceptable limits. This process is called *deskewing*.

Because the PE data recovery circuits can compensate for skewed data and the write circuits cannot, mechanical skew is adjusted while using the write head to view the skew waveform. This is done by connecting the write head to the read amplifier circuits with a special adapter cable and observing the analog read signals from a Master Head Alignment (skew) tape as seen through the write head. The time difference between each pair of all tracks is measured until the track pair with the greatest time difference is found. Shims are then inserted or removed from under the reference guides to bring this time difference within specification. This method insures that tapes will be written with the minimum amount of skew.

In most cases, the two tracks with the greatest time difference will be tracks 4 and 5, the two outside tracks. In a few cases, however, another track pair may exhibit the greatest time difference, making it necessary to check all track pairs.

Inserting shims under the reference guides will raise or lower the tape position with respect to the base and sometimes will cause the tape to ride against the tachometer tape guide flanges hard enough to curl the tape. Edge curl will damage tape edges and is not acceptable. Therefore, while measuring the skew, you will need to periodically check tape tracking around the tachometer tape guide. When deskewing the tape path, tape curl will influence how you add or subtract shims.

When required: After replacing the head or changing any tape path components.

Equipment required: Skew tape; skew cable adapter; oscilloscope.

7.10.2 Oscilloscope setup

1. Connect scope channel 1 to pin 3 of P3 on the Read Channel PCBA for track 4 (the PCBA furthest to the right), and connect the ground lead to AGND on that PCBA. This will be the initial reference track.
2. Connect scope channel 2 to pin 3 of P3 on the Read Channel PCBA for track 5 (fourth from the left), and connect the ground lead to AGND on that PCBA.
3. Set both channels for 0.5 volt/division, DC coupling, and set the zero-volt reference point of both traces to the center graticule on the display.

Note: *It is important that the zero-volt level of both traces be set to the same point on the display. If one trace is offset from the other, an error in skew measurement will occur.*

4. Set the timebase to 1 microsecond/division and trigger AC positive on channel 1.

7.10.3 Drive Setup

1. Turn the power off and thread the skew tape.
2. Remove the head cover and note the polarity of the erase head connector.
3. Disconnect the write and erase connectors from the head.
4. Temporarily remove the two Read Channel PCBAs nearest the Preamplifier PCBA.
5. Remove the ribbon cable which connects the Read/Formatter PCBA to the Preamplifier PCBA.
6. Remove the ribbon cable which connects the read head to the Preamplifier PCBA by pulling it out from the front of the drive.
7. Working from the rear of the drive, feed the smaller connector of the cable adapter through the slot in the base and connect it to the write head. The red wire goes towards the base.
8. Connect the other end of the cable adapter to P1 read input connector on the Preamplifier PCBA. Pin 1 (colored wire) goes up.
9. Reinstall the cable between the Preamplifier and the Read/Formatter PCBAs.

10. Replace the Read Channel PCBAs.
11. Turn S1, S7 and S8 on, and S2 through S6 off.

7.10.4 Skew Measurement Procedure

Skew is measured by looking at the time difference between scope channel 1 and 2 where the waveforms cross the zero-volt reference (i.e., the center graticule of the display) as shown in Figure 7-7. Channel 2 scope probe is then moved to pin 3 of P3 on each Read Channel PCBA in succession to determine the track pair with the greatest time difference.

The skew is minimized by installing or removing shims from beneath the reference guides as shown in Figure 7-8 on page 7-19.

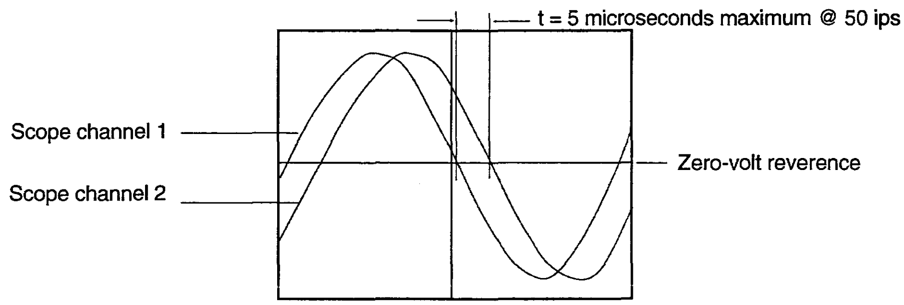


Figure 7-7 Skew Adjustment Waveform

Notes: *As skew tapes wear out, the apparent skew becomes erratic and excessive. To extend the useful life of a skew tape as long as possible, do not rewind skew tapes. When the tape reaches EOT, the drive will automatically move it in reverse. When the tape reaches BOT, the drive will automatically move it forward again. The skew may be checked with the tape moving in either direction.*

The skew shims come in thicknesses of .001 inch and .004 inch. Each guidepost must be shimmed at least .002 inch, but not more than .006 inch. All shims are placed between the reference guide posts and the base casting.

1. Apply power and press LOAD to tension the tape.
2. After the BOT marker has passed the sensor, press FPT to stop the tape.
3. Select the 1600 cpi mode (i.e., 50 ips) using the FPT switch. The 6250 indicator should be off.
4. Press ON LINE to move the tape forward.
5. Adjust the scope to obtain two sine-like waveforms as shown in Figure 7-7.

6. Measure the time difference where the falling edges of the waveforms cross the zero-volt reference (i.e., the center graticule) on the display. (You may want to increase the vertical sensitivity of the scope to 200 millivolts/division. If you do, be sure to recheck the zero-volt reference of both traces before continuing.

7. If the zero-crossings ("t" in Figure 7-7) occur within five microseconds of each other, the top and bottom tracks on the head are within tolerance.

   a. Move channel 2 scope probe to the pin3/P3 testpoints on each Read Channel PCBA in succession. Leave the probe at the testpoint which shows the greatest time difference.

   b. Move channel 1 scope probe to the pin3/P3 testpoints on each Read Channel PCBA in succession. Leave the probe at the testpoint which shows the greatest time difference.

8. Verify that each waveform crosses the zero reference on the scope within five microseconds of each other as shown in Figure 7-7.

9. If there is more than a five microsecond time difference, observe the skew waveforms while lightly pressing the side of the erase head up.

   a. If the time between the zero-crossings decreases (i.e., if the skew improves), stop the tape by pressing FPT and remove shims one at a time from under the supply reference guide. Note that there must be at least 0.002 inch shims under each guide, so if removing a shim results in less than this, you will have to add a shim under the take up reference guide instead. Use the procedure in Section 7.10.5.

   b. If the time increases (i.e., skew becomes worse), stop the tape by pressing FPT and remove a shim from under the take up reference guide (or add a shim under the supply reference guide). Use the procedure in Section 7.10.5.

10. Check the effect of the shim change on tape tracking as follows:

    a. Alternately press ON LINE and 6250 and look at the tape as it moves forward and reverse around the tachometer tape guide.

    b. If the tape is curling up against either flange as it enters or leaves the guide, the upper fixed guide should be shimmed so as to move the tape away from the edge being contacted. Each time you add or subtract shims, check the effect the change has upon tape curl.

11. Recheck the skew waveforms and repeat the preceding steps until the skew is less than five microseconds in both directions, and there is no sign of tape curl at the tachometer tape guide.

12. If the allowable shim content does not provide proper tachometer tape guide contact and skew less than five microseconds, the head should be replaced. If the head replacement fails to solve the problem, the tachometer tape guide should be replaced. As a last result, the reference guides should be replaced,

one at a time. If the skew is still out of specification, the tape drive must be returned to the factory for repair.

13. Avoid rewinding skew tapes. Unload the tape as follows:

    a. Press 6250 to move the tape reverse.

    b. When the tape reaches BOT, stop the tape by pressing FPT.

    c. Turn power off and manually wind the tape onto the supply reel.

14. Return the other switches to the correct option settings.

15. Remove the skew cable adapter and reinstall the original head cables and wires. The colored wires plug in closest to the base.

16. Replace the head cover.

17. If this skew adjustment was performed due to the installation of a new head, the read amplifier gains will also require adjustment. The procedure is described in Section 7.9 beginning on page 7-11.

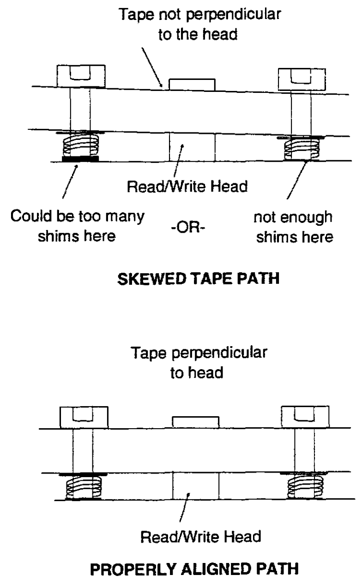
7.10.5 Skew Shim Installation Procedure

1. Remove the reference guide to be shimmed by removing the Allen screw from the front of the tape drive. Be sure not to drop the guide or guide spring.

Note: *Very early tape drives had nuts on the inside of the drive holding the reference guide Allen screws. If you are working on one of these tape drives, be careful not to allow the nut to fall inside the drive, as it may be attracted to and stick to one of the motor magnets.*

Remove or add a shim and replace the spring and guide. Shims should be added or removed one at a time and the effect upon skew and tape tracking checked.

The addition or removal of shims changes the perpendicularity of the tape path with respect to the write head. Although there is no standard number of shims for each reference guide, each guide must be shimmed at least .002 inch, and not more than .006 inch. Shims are inserted between the reference guides and the base casting.



CAUTION: Do not overtighten the reference guide screws.If the reference guide screws are overtightened, damage will occur to the shims or to the surface of the base casting.

Removing shims from one reference guide lowers that guide relative to the other. The effective height of one reference guide can be decreased by removing one of the shims beneath it, or by adding a shim underneath the other guide as illustrated above.

Figure 7-8 Reference Guide Shimming

Bearing Replacement Procedures 8

The bearings used in the Qualstar tape drives are high quality and are designed to last the life of the tape drive. This chapter describes the correct procedures for replacing motor and guide bearings in the remote possibility that one should fail.

Each motor and guide shaft is supported by two roller bearings. Because it is difficult to determine which bearing of a pair is defective, always replace both bearings. Due to the precision required when checking and adjusting the tape guide runout, it is not recommended that tape guide bearings be replaced in the field.

8.1 When to Replace a Bearing

A bearing set should be replaced when:

- The motor or tape guide feels rough when turned by hand;
- Clicking or whirring noises are heard during tape motion, most obvious during rewind operations;
- The tape tends to loop or leave the tape guide at the moment tape motion is reversed. This is most obvious during slow speed operation.

8.2 Special Tools

The following special tools are required to properly carry out the procedures in this chapter:

- Small scraper, such as an X-Acto knife, for cleaning bearing bores
- Flat tipped nailset and plastic or soft metal hammer to tap out old bearings
- Bearing mount adhesive (Loctite 609 or equivalent)
- Adhesive primer (Loctite Type T, N, or equivalent)
- Tape Guide Runout Measurement Kit, Qualstar P/N 600138-01-0. This kit is illustrated in Figure 8-4 on page 8-12.

8.3 Bearing Replacement Procedures Common to All Assemblies

This section contains important information common to all assemblies which should be read and understood before attempting to replace any bearing assembly. The following sections provide information which is unique to each individual assembly.

The following guidelines must be adhered to when replacing bearings:

- Always use bearings supplied by Qualstar. While other bearings may fit, Qualstar cannot guarantee their reliability.
- Only use bearings which are known to be in new condition.

- Always replace both bearings in a given assembly.
- Never reuse a bearing which has been removed from a drive.
- Do not use bearings which have been dropped onto a hard surface such as a surface plate or a concrete floor.
- Roller bearings must be properly installed with the correct axial preload. To accomplish this, the machined surface which contacts the bearing outer diameter must be clean and smooth enough to allow a new bearing to slip easily into and out of the bores in the casting. Check that these conditions are met and correct if necessary.

Caution! ***When tapping out old bearings, tap them out evenly all around and do not allow them to cock in the bore. The steel bearing housings are much harder than the aluminum base casting and may damage the bore if incorrectly removed.***

If the bore is nicked or gouged, the fit of the bearing may be too loose or too tight. If the fit is too loose, then the bearing may seat off-center and cause excessive runout. If the fit is too tight, the friction between the bearing and the bore will not overcome the force applied by the preload spring, causing incorrect bearing preload and early failure. When the bore surface has been properly prepared, a new bearing will just slide in and out of the bore under the force of the preload spring.

- Always clean the bores and the outer diameter of the new bearings with adhesive primer.
- Do not allow any adhesive primer to seep into the bearing.
- Always allow five minutes for adhesive primer to dry before applying bearing mount adhesive.
- Always apply a thin coat of bearing mount adhesive to the inside of the bores in the casting rather than to the outer diameter of the bearing.

Caution! ***Never force new bearings into position. Find and eliminate the cause of any binding before seating bearings.***

8.4 Motor Bearings

The position of the front motor bearing is determined by a C-ring inside the bore. The position of the rear motor bearing is determined by a shaft spacer which sets the distance between the front and rear bearing inner races. Preload is established by a set of four spring washers (Belleville type) which are installed between a second C-ring inside the bore and the outer race of the rear bearing. These components are illustrated in Figure 8-1 on page 8-4.

8.4.1 Motor Disassembly

1. Remove the Write/Controller PCBA and the shield, following the procedure in Chapter 6.
2. Gripping the supply hub (take up reel) with one hand and the rotor with the other, loosen the rotor by turning it counter-clockwise. Once the rotor is loose, the screw can be removed.
3. Carefully pull the rotor away from the stator and retrieve the motor flange washer which will come loose inside the rotor.
4. Remove the supply hub (take up reel) from the front of the drive.

8.4.2 Motor Bearing Removal

1. Insert a nailset through the rear bearing and using a plastic or soft metal hammer, tap at several locations around the inner race of the front bearing until the bearing is dislodged.

Caution! ***Do not allow the bearings to cock in the bore. The steel bearing housings are much harder than the aluminum base casting and may damage the inside diameter of the bored hole.***

2. Insert the nailset through the front bearing and tap out the rear bearing, taking care not to cock it in the bore of the casting.
3. Remove the four Belleville springs and the shaft spacer from the bore and set them aside.
4. Clean the bores and new bearings as described in Section 8.3.

Note: *When the bore surface has been properly cleaned, a new bearing will slide easily in and out of the bore.*

8.4.3 Motor Reassembly

To install motor bearings and reassemble the motor components, follow the instructions in Figure 8-1 on page 8-4.

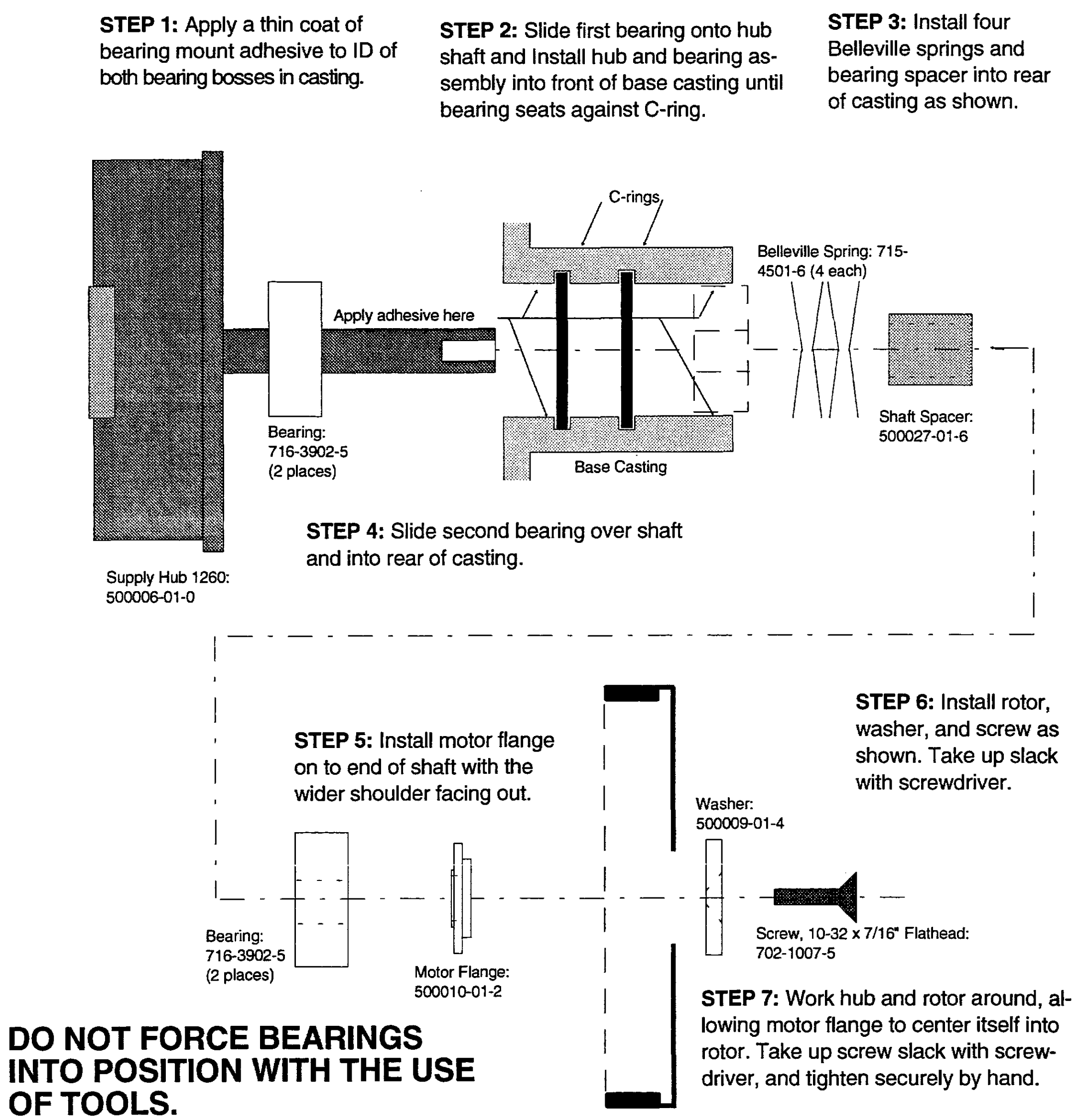


Figure 8-1 Motor Bearing and Component Assembly

8.4.4 Checks and Adjustments

The supply hub (take up reel) should turn freely by hand with no clicking, scraping, or roughness.

8.5 Tachometer Bearings

The tachometer tape guide assembly consists of a one-piece tape guide and shaft which is supported in the base casting by two ball bearings. The distance between the bearing inner races is determined by a bearing spacer, while the distance between the bearing outer races, and hence the preload, is determined by a spring-loaded spacer. Both bearings are fixed in place by bearing mount adhesive.

The bearing replacement procedure consists of disassembling the components, removing the bearings, cleaning the mounting surfaces of the base casting, reinstalling new bearings, reassembling the guide components and adjusting the guide runout to less than 0.0005 inch.

Note: *The tachometer tape guide is precisely centered in its bearings at the factory for minimum radial runout, and the screw on the back of the tachometer tape guide is securely locked after the runout is adjusted. Once the locking screw has been loosened, mechanical adjustment will be required to restore the radial runout to 0.0005 inch maximum. Do not attempt to service the tachometer bearings without the proper tools for measuring runout.*

A full set of replacement parts should be available before disassembly. The parts required for the tachometer assembly are listed in Figure 8-2.

8.5.1 Special Tools Required

Tachometer Runout Measurement Kit, Qualstar P/N 600138-01-0.

8.5.2 Tachometer Tape Guide Disassembly

1. Remove the Read/Formatter PCBA and shield as described in Chapter 6.
2. While holding the tachometer tape guide with one hand, remove the Allen screw from the rear of the tape guide shaft using a 3⁄32 inch hex driver.
3. Remove the flat washer, slotted disk and spacer and set them aside.
4. Remove the tachometer tape guide and shaft from the front of the drive.

8.5.3 Tachometer Tape Guide Bearing Removal

1. Insert a small nailset through one of the bearings and using a plastic or soft metal hammer, tap out the opposite bearing. Tap evenly all around the inner bearing race to prevent the bearing from becoming cocked in the bore.

Caution! ***Do not allow the bearings to cock in the bore. The steel bearing housings are much harder than the aluminum base casting and may damage the inside diameter of the bored hole.***

Note: *When the bearing comes out, an internal spring and one or both of the internal spacers may fall out onto the work area and roll out of sight.*

2. Set the spring and the internal spacers aside.
3. Using the nailset, tap out the remaining bearing. Do not allow the bearing to cock in the bore.
4. Clean the bores and the new bearings as described in Section 8.3.

Note: *When the bore surface has been properly prepared, a new bearing will slide easily into and out of the bore.*

8.5.4 Tachometer Tape Guide Reassembly

The instructions for installing the tachometer tape guide bearings and reinstalling the tachometer tape guide are given in Figure 8-2.

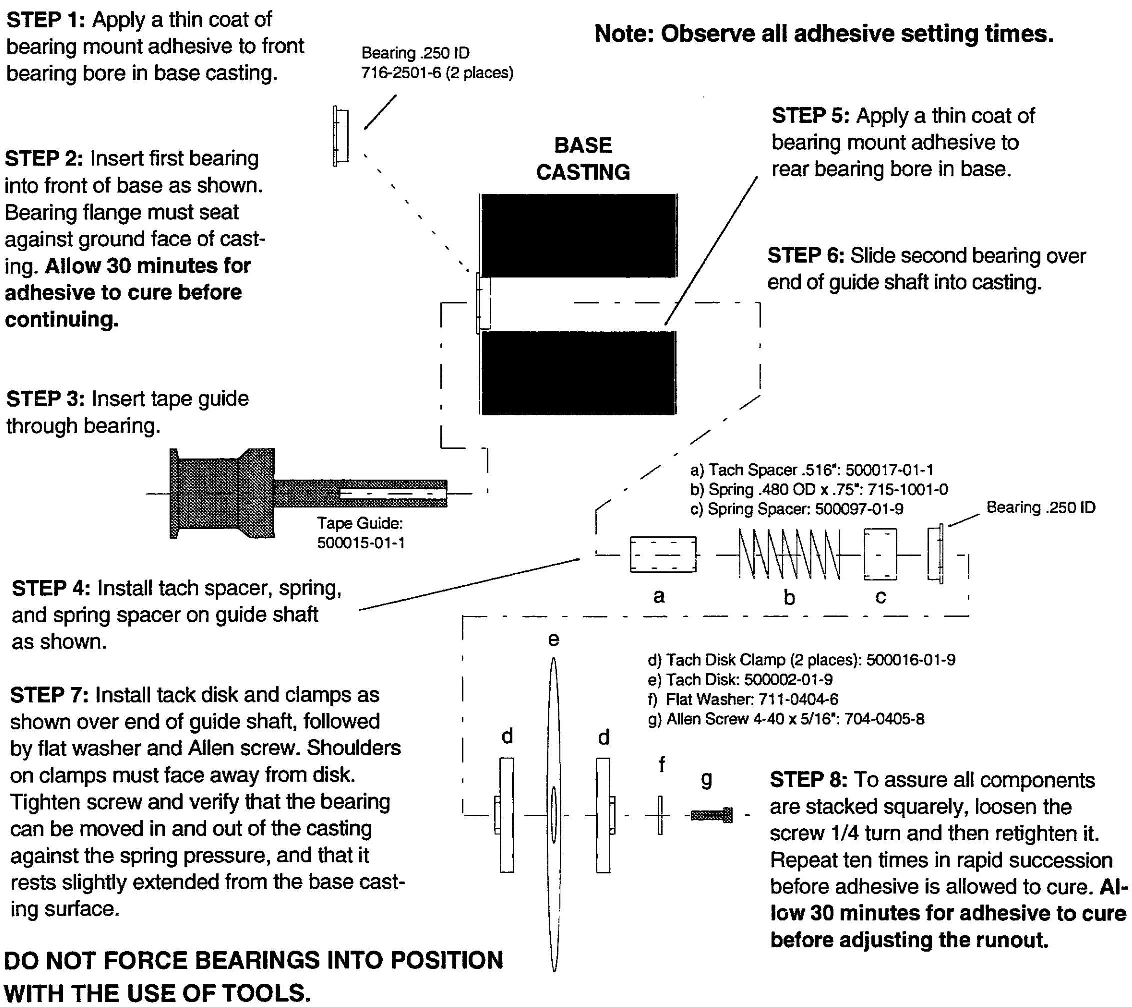


Figure 8-2 Tachometer Tape Guide Assembly

Before installing new bearings, insure all adhesive residue has been removed from the bearing bores. Clean the bearing bores and the bearing ODs with adhesive primer and allow five minutes for the primer to dry. Failure to clean mounting surfaces may result in improper bearing seating and early bearing failure.

When installing the front bearing, use finger pressure to insert it squarely into the bore until it is flush with the outside surface of the base casting. The final position of the rear bearing will be determined by the preload spring pressure.

8.5.5 Adjustments

Check the runout as described in Section 8.7 beginning on page 8-9.

8.6 Fixed Tape Guide Bearings

The fixed tape guide assembly consists of a one-piece tape guide and shaft which is supported in the base casting by two ball bearings. The distance between the bearing inner races is determined by a bearing spacer, while the distance between the bearing outer races, and hence the preload, is determined by a spring-loaded spacer. Both bearings are fixed in place by bearing mount adhesive.

The bearing replacement procedure consists of disassembling the components, removing the bearings, cleaning the mounting surfaces of the base casting, reinstalling new bearings, reassembling the guide components and adjusting the guide runout to less than 0.0005 inch.

Note: *The fixed tape guide is precisely centered in its bearings at the factory for minimum radial runout, and the screw on the back of the fixed tape guide is securely locked after the runout is adjusted. Once the locking screw has been loosened, mechanical adjustment will be required to restore the radial runout to 0.0005 inch maximum. Do not attempt to service the fixed tape guide bearings without the proper tools for measuring runout.*

A full set of replacement parts should be available before disassembly. The parts required for the fixed guide assembly are listed in Figure 8-3.

8.6.1 Special Tools Required

Tachometer Runout Measurement Kit, Qualstar P/N 600138-01-0

8.6.2 Fixed Tape Guide Disassembly

1. Remove the Read/Formatter PCBA and shield as described in Chapter 6.
2. While holding the fixed tape guide with one hand, remove the Allen screw from the rear of the tape guide shaft using a $3/32$ inch hex driver.
3. Remove the flat washer and spacer and set them aside.
4. Remove the fixed tape guide and shaft from the front of the drive.

8.6.3 Fixed Tape Guide Bearing Removal

1. Insert a small nailset through one of the bearings and using a plastic or soft metal hammer, tap out the opposite bearing. Tap evenly all around the inner bearing race to prevent the bearing from becoming cocked in the bore.

Caution! ***Do not allow the bearings to cock in the bore. The steel bearing housings are much harder than the aluminum base casting and may damage the inside diameter of the bored hole.***

Note: *When the bearing comes out, an internal spring and one or both of the internal spacers may fall out onto the work area and roll out of sight.*

2. Set the spring and the two internal spacers aside.
3. Using the nailset, tap out the remaining bearing.
4. Clean the bores and new bearings as described in Section 8.3.

Note: *When the bore surface has been properly prepared, a new bearing will slide easily into and out of the bore.*

8.6.4 Fixed Tape Guide Reassembly

The instructions for installing the tape guide bearings and reinstalling the fixed tape guide are given in Figure 8-3.

Before installing new bearings, insure all adhesive residue has been removed from the bearing bores. Clean the bearing bores and the bearing ODs with adhesive primer and allow five minutes for the primer to dry. Failure to clean the mounting surfaces may result in improper bearing seating and early bearing failure.

When installing the front bearing, use finger pressure to insert it squarely into the bore until it is flush with the outside surface of the base casting. The final position of the rear bearing will be determined by the preload spring pressure.

8.6.5 Adjustments

Check the runout as described in Section 8.7.

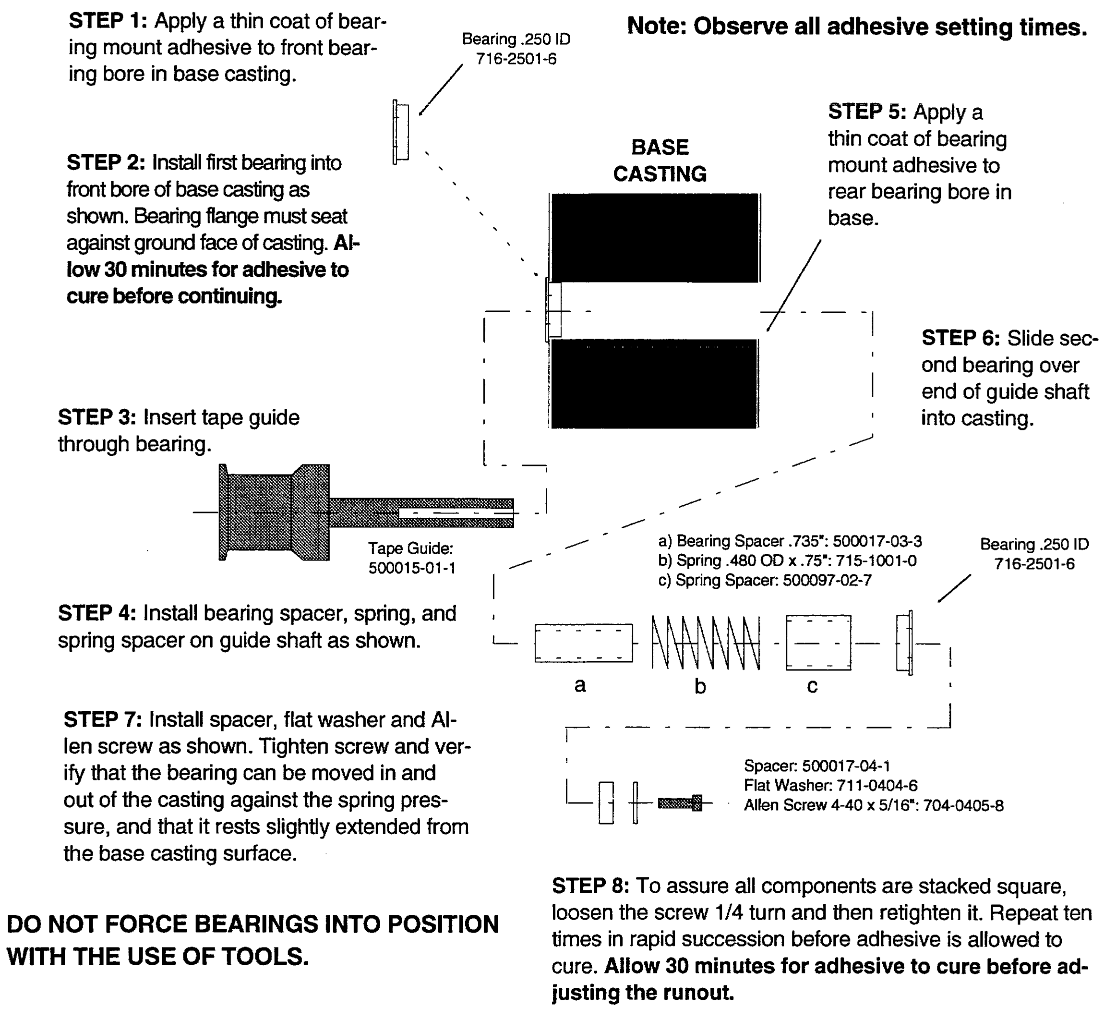


Figure 8-3 Fixed Tape Guide Assembly

8.7 Tape Guide Runout Adjustment

Whenever a tape guide is reinstalled or replaced, the guide runout must be adjusted. Excessive runout will result in guide wobble (too small to be seen with your eye) which causes tape speed variations. In severe cases, the tape can actually leave the guide at the instant it changes direction from forward to reverse. This effect can cause data errors and can sometimes be seen, and heard as a light “snap,” at the moment of direction reversal. Use the procedure in this section to measure and adjust guide runout.

8.7.1 Setting Up the Fixture

1. Assemble the fixture as shown in Figure 8-4 on page 8-12.

2. Place the fixture on the drive:

a. If measuring the tachometer guide, simply place the fixture on top of the drive as shown in Figure 8-5 on page 8-13.

b. If measuring the fixed guide, first open the drive chassis and attach the support bracket between the chassis and the cover using one of the cover screws and the screw which came with the support bracket. Then rest the drive on the chassis as shown in Figure 8-7 on page 8-14.

3. Adjust the position of the indicator as follows:

   a. Slowly lower the tip onto the guide surface while watching the dial pointer. Allow the pointer to move between one and two full turns before the tip comes to a complete rest on the guide.

   b. Check that the tip is over the center of the guide, centered between the guide flanges, and that it is perpendicular to the guide. See Figure 8-5.

   c. Tighten the knobs on the fixture.

4. If you want, you can loosen the small black knob on the side of the indicator and turn the bezel (the ring around the outside of the indicator) to line up the "0" on the dial face with the pointer. If you do, be sure to retighten the black knob before continuing.

8.7.2 Measuring the Runout

1. While rotating the tape guide with one finger, observe the pointer. Use only enough pressure to turn the tape guide, because excessive finger pressure may result in incorrect readings. Refer to Figure 8-5.

2. If the pointer moves one division or less on the dial during one full turn of the guide, the runout is acceptable and no adjustment is required (i.e., the total runout is 0.0005 inch or less).

3. If the pointer moves *more* than one division during one full turn of the guide, the runout is ***not*** acceptable and will have to be adjusted as described in the following section.

8.7.3 Adjusting the Runout

This adjustment normally takes one or more iteration of the following steps.

1. While holding the tape guide with one hand, alternately loosen the Allen screw at the other end of the guide and retighten it several times. This will act to seat the guide in the bearings.

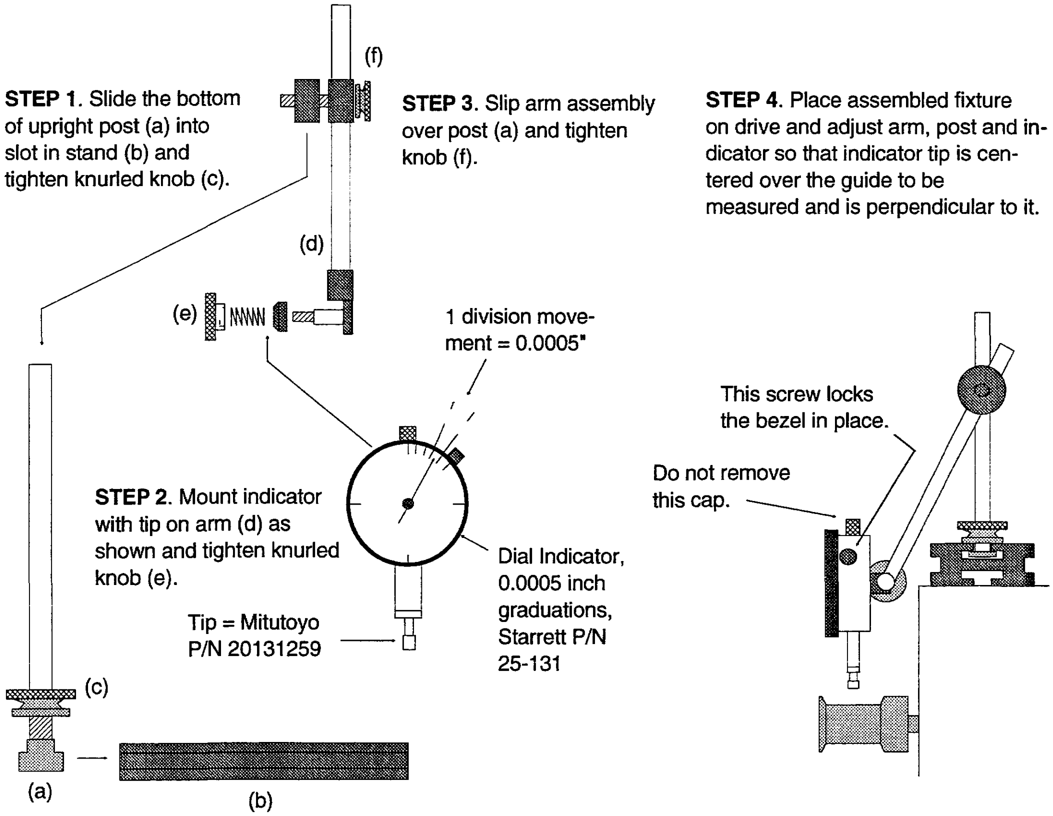
2. Measure the runout again. If it is within tolerance, the adjustment is finished.

3. If it is out of tolerance, loosen the Allen screw slightly, but not so much as to introduce slack in the assembly.

4. Rotate the guide until the highest runout is obtained.

5. Apply a small amount of hand pressure downwards (towards the workbench) and then tighten the Allen screw.
6. Measure the runout again.
7. If it is not in tolerance, again loosen the Allen screw slightly.
8. Turn the guide to obtain the maximum reading, then rotate it 1/4 turn (either direction).
9. Again, apply a small amount of hand pressure downwards (towards the workbench) and then tighten the Allen screw.
10. Repeat this process of looseing, turning, pressing and tightening until the total runout is less than 0.0005 inch.
11. If all attempts fail, remove the tape guide completely from the tape drive, rotate it 90° relative to the bearings and reinstall it. Then repeat the adjustment procedure. If repeated attempts fail to bring the desired results, the tape guide or one of the bearings may be defective or incorrectly installed.

Runout of more than 0.0005 inch will result in a loss of tape handling performance.



Note: *The tip of the indicator should be flat to provide a line of contact with the tape guide. A round tip will provide a point of contact which may scratch the finish on the tape guide and cause future tape damage. Always use a flat tip, such as Mitutoyo P/N 20131259 or equivalent.*

The kit shown in this figure can be purchased from Qualstar (P/N 600138-01-0). The kit includes the dial indicator, flat tip, indicator stand, post, arm, and two support brackets (not shown here) which are required when adjusting the fixed tape guide.

Figure 8-4 Setting Up Runout Fixture

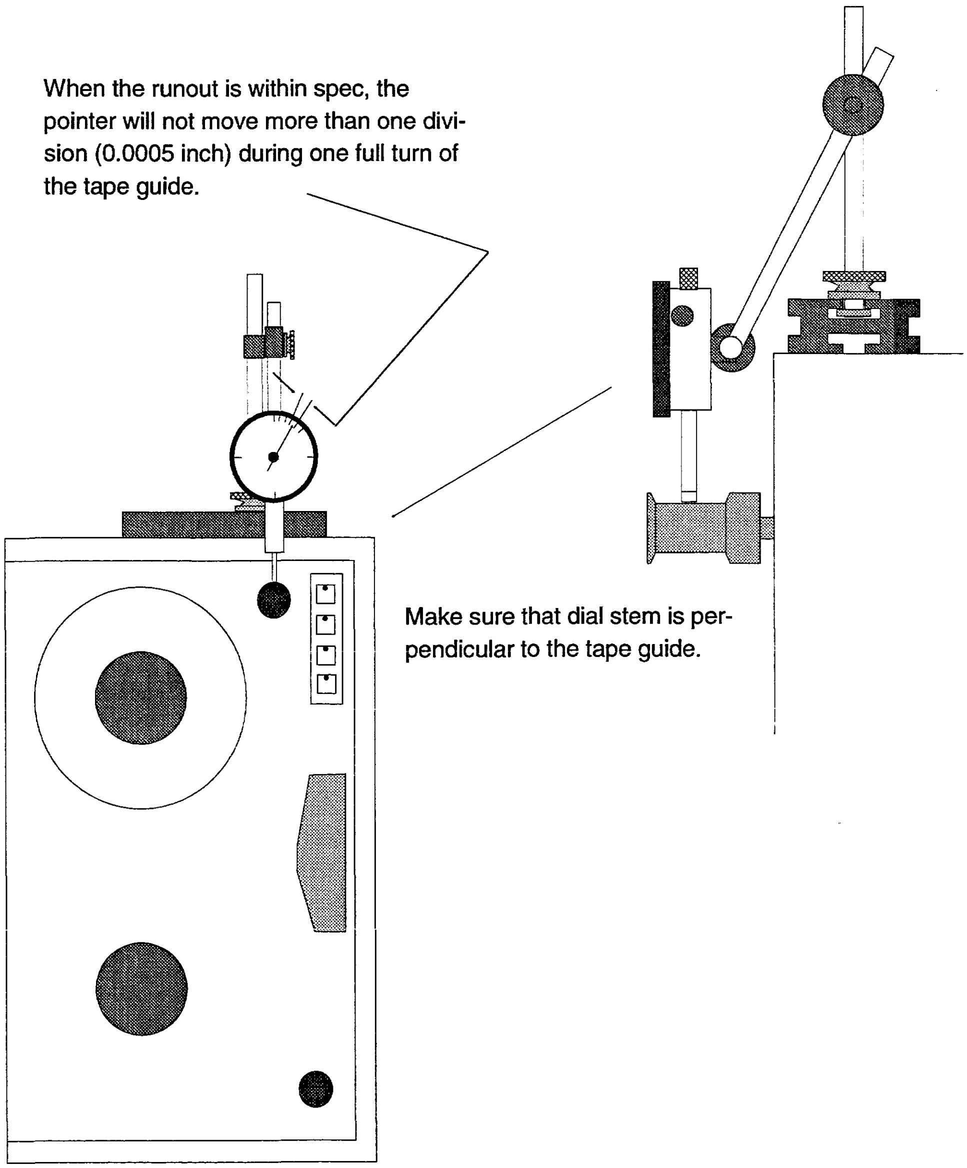


Figure 8-5 Measuring Tachometer Tape Guide Runout

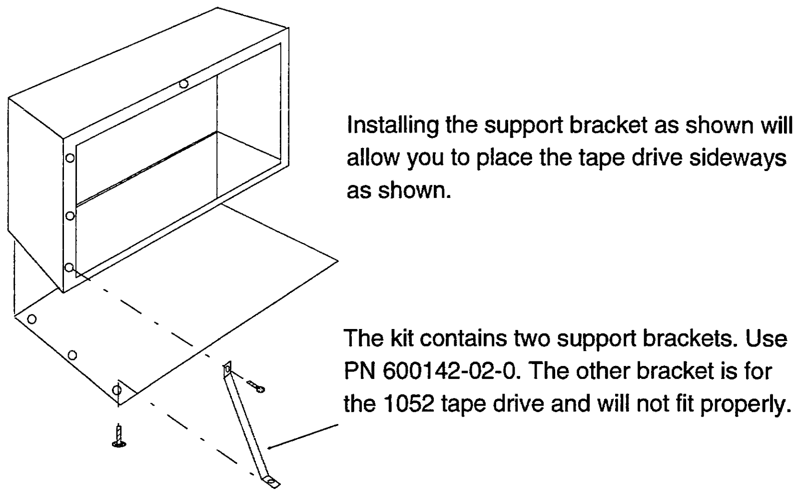


Figure 8-6 Support Bracket Installation

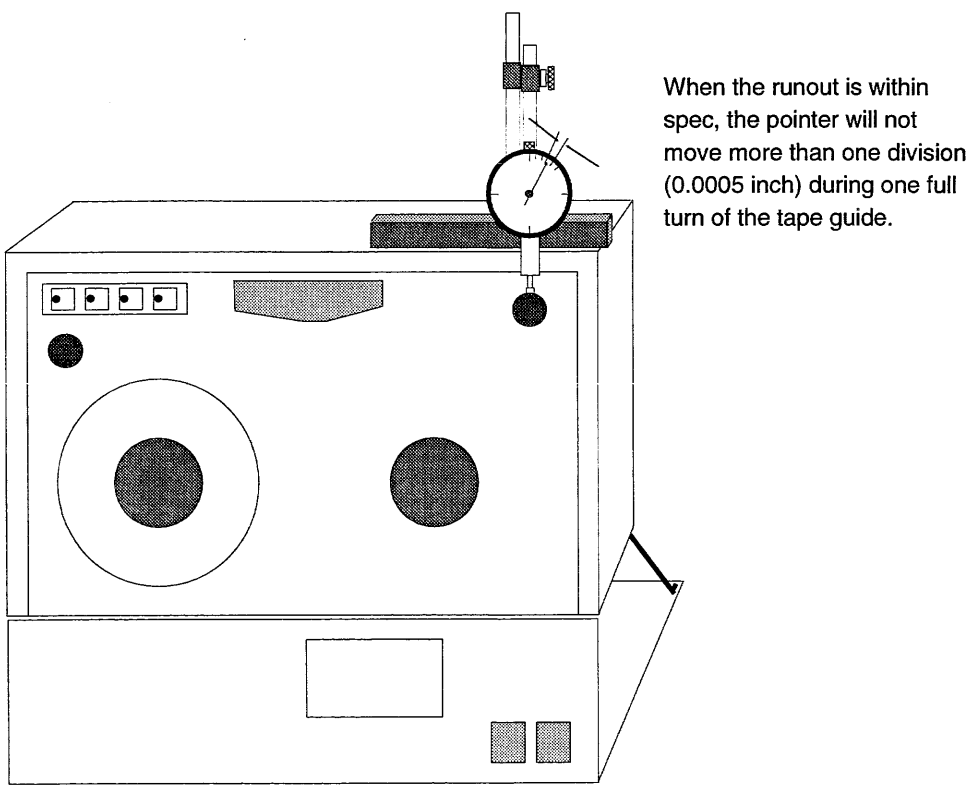


Figure 8-7 Measuring Fixed Tape Guide Runout

Troubleshooting 9

9.1 Introduction

This chapter will help determine which field-replaceable-unit (FRU) needs adjustment or replacement. A list of FRU parts can be found in Appendix B. Schematic and assembly drawings are in Appendix C. This chapter does NOT cover component level troubleshooting.

A simple troubleshooting chart is presented first. The *Diagnosis* column contains very brief lists of items to check. Each checklist item is referenced to a paragraph number so that details can be easily found in the numbered paragraphs following the chart. For technicians who are familiar with the Qualstar Model 1260 tape drive, the chart alone may suffice.

Following the chart is a *Troubleshooting Notes* section which describes each checklist item and suggests troubleshooting techniques. Reference is made to the Theory, Operations, Diagnostic and Replacement/Adjustments chapters as needed.

9.2 Troubleshooting Chart

PROBLEMS	POSSIBLE CAUSES	DIAGNOSES
Loading Problems:		
Attempts to load, but loses tension.	Loose connector;	Check all PCBA connections.
	Improperly threaded;	Check tape threading (1).
	Faulty tachometer;	Adjust or replace tach (2).
	Irregular motor torque;	Hall sensors (3), or motor resistance (4).
	Defective tape guide bearing;	Tape guide (5).
	Defective Power Supply PCBA;	Power supplies (6), or motor servos (7).
	Defective Write/Controller PCBA.	Motor control (8).
Loads and moves tape forward, but won't stop.	Drive is in diagnostic mode.	Write/Controller PCBA S1 is on (see Chapter 4).
Loads tape, then is unpredictable.	Wrong voltage supplied to drive;	A 220/240 volt drive is plugged into 110/120 volt outlet.
	Low +32 volt supply.	Power supply (6).
Loads, then unloads tape.	Cabling error;	J1 and J2 reversed or upside down.
	Logic malfunction.	Unload (9).
Doesn't even try to load.	Defective power supply;	Power supplies (10).
	Defective Load switch.	Front panel switch or PCBA (11).
Unusual Noises:		
Continuous high frequency noise.	Defective power supply;	Power supplies (10).
	Defective +5V regulator	Power supply (6).
Grinding when tape moves.	Defective tape guide bearing.	Tape guide (5).
Loud chirping noise when the tape repositions.	Tape sticking to tape path.	Dirty tape path (12), or replace worn or dirty tape.
Intermittent high frequency noise when tape moves.	Tape guides.	Dirty tape path (12), or damaged tape guides (17).
Tape Motion Problems:		
Tape flutters.	Bent roller;	Roller guide (5).
	Tachometer;	Tach disk or sensor dirty (clean it), or tach out of adjustment (2).
	Incorrect Hall signal.	Hall sensors (3), or Write/Controller PCBA (18).
Tape spills.	Defective motor servo;	Power Supply PCBA (7).
	Poor tape control;	Write/Controller PCBA (8).
	Defective roller;	Roller guide (5).
	Defective motor;	Motor resistance (4).
	Incorrect Hall signal;	Hall sensors (3), or Write/Controller PCBA(18).
	Defective tachometer.	Tach disk or sensor dirty (clean it), or tach out of adjustment (2).

PROBLEMS	POSSIBLE CAUSES	DIAGNOSES
After rewind, tape jitters or creeps.	Defective tachometer.	Tach disk or sensor dirty (clean it), or tach out of adjustment (2).
Tape runs off end of the reel.	Missing EOT tab;	Replace EOT tab.
	Tape control;	EOT sensor malfunction (19), or Write/Controller PCBA problem.
	Host software.	Read near and past EOT, check IEOT on Read/Formatter PCBA to host. If IEOT is sent out, problem is host.
Power Problems:		
Fans do not turn, or fuse blows;	Power supply;	Power Supply PCBA (10).
No indicators lit.	Fuses;	Check fuse, see Table 6-4 on page 6-5.
	No +5 volts.	Power supply (6).
Miscellaneous:		
Drive operates well for a limited amount of time, then fails;	Overheating;	Inoperative or dirty fan, or Power Supply PCBA (10).
Writes SHORT blocks (in diagnostics);	J1 (ILWD) held true;	Unplug J1.
All indicators lit when power applied.	Inoperative microprocessor.	Make sure that all ICs are firmly seated in their sockets and that no pins are bent under, or replace Write/Controller PCBA.
Read Problems:		
Continuous CER (not fatal).	Loss of one read signal;	Reseat Read Channel PCBAs.
	Dirty head;	Clean tape path (12).
	Low gain adjustment;	Adjust or replace Read Channel PCBA (13).
	Poor signal from tape;	Verify that the tape is good; try writing and reading new tape.
	Defective roller;	Roller guide (5).
	Worn out head.	Replace head (14).
Intermittent correctable and/or hard errors (occasional fatal errors).	Dirty head;	Clean tape path (12).
	Poor signal from tape;	Verify that the tape is good; try writing and reading new tape.
	Low gain adjustment;	Adjust or replace Read Channel PCBA (13).
	Defective tape guide;	Tape guide (5).
	Tape motion problems.	See preceding descriptions.
Continuous HER, excessive repositioning (100% fatal).	Loss of 2 or more read signals;	Check Read Channel PCBAs, Read Preamplifier PCBA and head (15).
	Read errors;	Check Read/Formatter PCBA (16).
	Tape motion problems.	See preceding descriptions.
Write Problems:	**Note:** Errors while writing may be caused by problems with reading. Eliminate that possibility by reading a known good tape before checking the write circuitry.)	
Continuous CER.	Dirty head;	Clean tape path (12).
	Improper write voltage;	Write/Controller PCBA (20).
	Write drivers;	Write/Controller PCBA (21).
	Tape motion problems;	See preceding descriptions.
	Low amplitude signals.	Replace head (4).

PROBLEMS	POSSIBLE CAUSES	DIAGNOSES
Error Conditions:		
Flashing LOAD indicator.	Load error;	Lock hub, eliminate slack, press load twice; if it still fails, check motors (4), tach (2) and power (7).
Flashing FPT indicator.	File Protect error;	Press FPT, check write ring, observe light, check Write/Controller PCBA signals; may be host program error.
Flashing ONLINE indicator.	See User's Guide (500250);	Note flashing error code, press ONLINE to clear error.
Code 22 (Failed to stop from rewind).	Missing BOT tab;	Inspect tape.
	Tape control;	BOT sensor malfunction (19), or Write/Controller (23).
Code 31-36 (Failed to reach full speed in time).	Insufficient motor torque;	Defective motor (4) or servo supply (6).
	Excessive friction;	Motor bearings (should spin freely and quietly), or roller guides (5).
Code 37 (Lost normal speed control).	Defective motor servo;	Power Supply board (7).
	Poor tape control;	Write/Controller (8).
	Defective tape guide;	Tape guide (5).
	Defective motor;	Motor resistance (4).
	Defective Hall signal;	Hall sensors (3), or Write/Controller (18).
	Defective tachometer;	Dirty disk or sensor (clean it), or adjust or replace tach (2).
Code 38 (Lost rewind speed control).	Same as above.	Same as above.
Code 39 (Write or erase power stuck on).	Write/Controller PCBA.	Write/Controller PCBA (22).
Code 40 (BOT sensor stuck on or malfunctioning).	Tape control.	Defective BOT sensor (19), or check sensor; check Write/Controller PCBA (23)
Code 41 (BOT not found).	Missing BOT tab;	Inspect tape.
	Tape control.	BOT sensor malfunction (19).
Code 51 - 54 (Write at load point positioning error).	BOT sensor.	BOT sensor malfunction (19).
Code 61 (Write/erase power error, won't come on).	Write/Controller PCBA.	Write/Controller PCBA (22).
Code 62 (Positioning error).	Tape slipping on tachometer.	Tachometer tape guide (5).
Code 63 (Read while write failure, no evidence of read signals while writing).	Loose Read Channel PCBAs;	Reseat PCBAs.
	Write power;	See read problems section above, also see write problems above.
	Head;	
	Incorrect threading.	
	Read or write formatter.	
Code 71-73 (Tape positioning errors).	Same as Code 61.	Write/Controller PCBA (22).

9.3 Troubleshooting Notes

This section describes the *Diagnoses* items in the preceding troubleshooting chart. The numbered paragraphs below refer to the numbers found in the chart.

1. Make sure that tape is properly threaded and there is no slack when the LOAD switch is pressed.

2. An impaired or misadjusted tachometer sensor can cause periodic loss of tach pulses, making accurate speed and tension control impossible. Spin the upper roller guide counter-clockwise and look for squarewaves at testpoints TACHA and TACHB on the Write/Controller PCBA, and for a high at TFWD. If these signals appear correct, check the adjustment of the tachometer sensors following the procedure in Chapter 7.

3. An impaired Hall sensor will cause the motor to turn unevenly. This irregular torque can be felt by slowing turning the hub during Diagnostic Test 2. Motors and sensors should turn smoothly and with an even force all around.

   a. If the torque isn't even, take the drive out of diagnostics mode. While turning the motor by hand, monitor Power Supply PCBA U8 pins 10, 11, and 12 (supply servo) or U9 pins 10, 11, and 12 (take up servo) for squarewaves.

   b. If these signals are good, the motor (see paragraph 4) or motor driver circuitry (see paragraph 7) may be defective.

   c. If the signals are not squarewaves, check the cabling to the Hall PCBA. Hall sensors cannot be checked directly, so an incorrect signal at the Hall PCBA indicates that the entire PCBA should be replaced.

DANGER! **DO NOT TOUCH THE HUB WHILE IT IS SPINNING. STOP THE DIAGNOSTIC TEST, HOLD THE HUB, THEN START THE TEST. REFER TO CHAPTER 4 FOR THE PROCEDURE.**

4. A defective motor also will fail the torque test described in paragraph 3. Ohm out all possible combinations of three wires to the motor. They should all be about 7.5 to 8.5 ohms. If the resistances are not within this range, replace the motor. Check the motor for worn out bearings by spinning the motor when not in a diagnostic test. It should be quiet and turn smoothly. Noisy bearings should be replaced at the factory.

5. A tape guide is defective when it is bent or when the bearings are sticky or dry.

   a. A bent tape guide can usually be seen to wobble during tape motion. It causes the tape to flutter, and often produces read or write errors.

b. Defective bearings are usually noisy, and a defective bearing in the tachometer tape guide will not allow the tachometer to spin freely, causing poor speed control.

c. Another possibility is excessive runout due to incorrect assembly or worn bearings. Instructions for replacing tape guide bearings and checking runout are given in Chapter 8. While it is possible to effective repairs of this kind in the field, a drive with a impaired tape guide should be returned the factory for repair.

6. With no load present, the power supply should still have proper voltages present at its outputs. Disconnect J9, J19, J20 and E4 thru E9 (some of these are options and may not be present). Look for approximately +5 volts on J19-3, +15 volts on J19-8, -15 volts on J19-9, and for +32 volts on the cathode of CR27 (located above and to the left of J20).

    a. If any of these voltages are missing, replace the Power Supply PCBA. If the voltages are okay, reconnect the outputs and check them again.

    b. If +5V on the Write/Controller PCBA is not between +5.0 and +5.1 volts, adjust R101 on the Power Supply PCBA.

    c. If there is greater than a 0.2 volt drop on any voltage, disconnect the plugs which carry that voltage and reconnect them one a time.

    d. If only one particular output causes the drop, it indicates that the power supply is good and that the load on that output is excessive.

    e. If a drop occurs no matter which output is plugged in, the Power Supply PCBA is defective.

7. If the motor servos on the Power Supply PCBA are defective, the drive will not move tape properly. Run Diagnostic Test 3 and verify that first one motor speeds up then slows down, followed by the other motor doing likewise.

    a. While holding the motors stalled (during Test 3), a sawtooth waveform should appear at testpoints ISPM and ITUM. The two should look similar during Test 3.

    b. If not, the Write/Controller PCBA could be defective (see paragraph 8).

    c. If the supply servo is suspected, plug the take motor onto the supply servo (E1, E2, and E3 on the Power Supply PCBA) and repeat Diagnostic Test 3.

8. Loss of motor control may be caused by a defective Write/Controller PCBA. Run Diagnostic Test 3 and look for sawtooth waveforms at test SPMC and TUMC. If the waveforms are missing or incorrect, replace the Write/Controller PCBA.

9. The interface unload signal (IRWU) may be true. Unplug J2 and try loading the tape again. If it then loads, the host was sending an unload signal.

Otherwise, check to see that U66 pin 5 on the Read/Formatter PCBA is low (NOT rewind-unload). If it is high, replace the Read/Formatter PCBA. If it is low, then trace the signal to U1-9 on the Write/Controller PCBA.

10. The fans should turn as soon as power is applied. If they do not, check the AC power plug connection and the AC fuse. If the AC fuse has blown, replace it and try again. Sometimes fuses just wear out.

    a. If it blows a second time, disconnect all Power Supply PCBA outputs, replace the fuse and try again.

    b. If it blows a third time, the Power Supply PCBA is probably defective.

    c. If the fuse doesn't blow, refer to paragraph 6.

    d. A continuous high frequency noise may indicate a defective +5 volt switching regulator.

11. If pressing a front panel switch does not cause the proper action, look for a low-true signal while pressing the switch. Look at U8 on the Write/Controller PCBA for Load at pin 15, Online on pin 13, File Protect on pin 11, and 6250 on pin 8. If the signals are correct, replace the Write/Controller PCBA. If the signals are incorrect or missing, check the cabling from the Switch PCBA. If the cabling is okay, replace the Switch PCBA.

12. A dirty tape path (head, tape cleaner and tape guides) can cause data errors and chirping noises if the tape sticks. Refer to the chapter on preventive maintenance in this manual for the cleaning procedure.

13. Misadjusted read gains can cause data errors. Perform the read gain adjustment described in Chapter 7. Look for DRDY on the formatter while reading a known good tape. A DRDY signal which never goes high may indicate a faulty Read Channel PCBA (i.e., the PCBA never sends a Data Ready signal). DRDY is an or'ed signal and its inputs (the Read Channel OR signals) will float high when the Read Channel PCBAs are removed. If DRDY never goes high, remove the Read Channel PCBAs one at a time. When the faulty PCBA is removed, DRDY will go high.

    a. On a good Read Channel PCBA, the Delayed Data (P3-5) and the Strobe (P3-8) can be added together on the oscilloscope and the phases will be locked (no walking of signals).

    b. If a Read Channel PCBA continuously has a true ERR1 signal, swap the PCBA with another to see if the error stays with the PCBA or is associated with a particular channel. If it stays with the channel rather than the PCBA, check the Preamplifier PCBA and the head. When a Read Channel PCBA is replaced, all nine PCBAs must be the same revision letter and number. Also, all nine *ENV* ICs must be the same revision number, and all nine RNGDCD ICs must be the same revision number.

14. Replace the head only as a last resort. Be sure all the adjustments (read gain, write current, write power, write skew) have been performed using a known good tape before replacing a head. Usually a defective head will have an open winding, or the read signals will be low in amplitude and vary a lot. Refer to the head pinout table on page 9-10 for head pinouts and resistances. To replace a head, follow the procedure in Chapter 6 and then perform the write deskew, write current and read gain adjustment procedures described in Chapter 7. As this is very time consuming, be sure head really needs replacement before starting to remove it.

15. If two or more Read Channel PCBAs are not operating properly in PE (or three in GCR), the drive cannot correct errors. Put the drive in Diagnostic Test #0 (read) and load a tape with known good data. Look for any kind of read signals on all of the Read Channel PCBAs at P3-3 and adjust according to the procedure in Chapter 7.

    a. If the signals are incorrect, check the Read Preamplifier PCBA for the presence of output signals at pins 4 and 5 of the ICs. If those signals are missing, check the cabling to the head.

    b. As a last resort, replace the head (see paragraph 14). If the read signals appear correct (P3-3), look for changing data at the outputs, P3-14. If the signals are present, the Read/Formatter PCBA may be defective (see paragraph 16). If the signals are missing, replace that Read Channel PCBA.

16. While reading a known good tape, DRDY should be active. FBY goes true (high) when the formatter has received a command from the Write/Controller PCBA, and DBY goes true (high) to indicate that the required function is being performed. FBY goes false after DBY goes false. When data is found, the formatter responds with a low DAVAIL/ signal. At the end of the block, DAVAIL/ goes high. Refer to Figure 3-3 on page 3-14 for relative timing. If the read threshold generator (U18) does not supply proper voltages (see Table 3-1), CERs and HERs will be common.

17. Bent or scored reference guides can cause data errors. One or the other of the outer tracks (channel 4 or 5) will have a fluctuating amplitude.

18. Poor tape control (fluttering or spilling) may be caused by a defective Write/Controller PCBA. Reload the tape and perform the same operation again to see if it recurs. If it does, check the motor control signals as shown at the end of Chapter 3.

19. The EOT/BOT sensors can be quickly checked by looking at the front panel. The LOAD indicator is illuminated when the tape is tensioned and at the load point (about two feet before the BOT marker). When tape is not tensioned, the LOAD indicator will flash rapidly whenever a BOT reflector is sensed, and the FPT indicator will flash rapidly whenever an EOT reflector is sensed. An adjustment should be performed if they do not flash in the presence of reflector a tab.

a. If a proper adjustment cannot be made, look for a changing signal on test-point 1 of the Switch PCBA as a reflector passes by the sensor.

b. If the signal switches at that point but BOT or EOT will not adjust, replace the Switch PCBA.

c. If the signal does not switch, check the cable. As a last resort, replace the sensor assembly.

20. If the write voltage is incorrect, follow the write current adjustment procedure given in Chapter 7.

21. Place the drive in Diagnostic Test 4 and observe the write head drive signals at the write head connector (J6 pins 16,17, etc.) on the Write/Controller PCBA. While writing, the outputs should change on all channels. A zero volt level indicates a probable open in the cable or the head. Some other steady DC level indicates a defective Write/Controller PCBA.

22. Place the drive in Diagnostic Test 6 and observe the WRPWR and ERASEPWR signals per Chapter 4. WRPWR can be adjusted as previously described.

23. Check for low-true input signals on the Write/Controller PCBA at U18 pin 15 (EOT) and pin 17 (BOT), using the method described in paragraph 19. If the signals are present, the Write/Controller PCBA may be defective.

ANSI TRACK	IBM CHANNEL	READ HEAD PINS	WRITE HEAD PINS
1	5	20, 17	19, 18
2	7	18, 15	17, 16
3	3	16, 13	15, 14
4	P	14, 11	13, 12
5	2	12, 9	11, 10
6	1	10, 7	9, 8
7	0	8, 5	7, 6
8	6	6, 3	5, 4
9	4	4, 1	3, 2
	Head Ground	19, 2	
	Center Tap		20, 1

Read Coil Resistance: 7.5 KOhms
Write Coil Resistance (each leg): 10 KOhms
Erase Coil Resistance: 80 KOhms

Table 9-1 Head Pinouts

Nine Track Tape Terminology — Appendix A

Block: A group of contiguous data characters transferred as a unit to and from the magnetic tape. The block includes any check or formatting characters (CRC, preamble, sync byte, etc.) required by the density format at which the tape is recorded. The number of characters per block, or block length, is determined by the host.

BOT: Beginning Of Tape is a photoreflective marker placed near the beginning of the recording area on the tape. It is positioned along the upper edge of the tape (nearest the reel label), 16 ±2 feet from the actual beginning of tape on the tape's uncoated side. See also *loadpoint*.

BPI: Data density in bits per inch (bpi). This term originally referred to the density of 1 channel along tape. In today's common usage, bpi refers to the density of all channels across tape, and so is commonly interchanged with *cpi*. According to ANSI specification, the densities of PE and GCR are 1600 and 6250 cpi, not bpi.

Byte: A byte is a group of eight bits at the tape drive interface and is the smallest unit of data transfer to and from a nine-track tape drive.

Channel: The path along tape that a particular bit follows, referenced by its logical position in the data byte. See also *Track*.

Character: Nine bits (bits 0 through 7, plus parity) written in parallel on the tape. Each character consists of an eight bit data byte plus an odd-parity bit.

Control Characters: A special set of characters in GCR blocks which demark data from other *overhead* characters needed for synchronization, error detection, etc.

Coupler: A piece of hardware (usually a board installed in the host) that allows a host computer to communicate with a peripheral device. The coupler is (somewhat incorrectly) referred to as a controller; actually the formatter more closely approximates a controller.

Controller: A hardware device that controls operation of another device (usually electro-mechanical). Commonly interchanged with "coupler".

CPI: Data density in characters per inch (cpi). This term is commonly (and sometimes incorrectly) interchanged with bpi, and refers to the effective density of interface (raw) data after it is recorded on the tape. Depending upon the recording format, the actual recorded density may include check characters and thus be higher.

CRC: cyclic redundancy check. A group of characters at the end of each block of GCR data which is used for error detection. In NRZI recording, the CRC character follows the last data character of each block.

DPE: Double Phase Encoded. This format is identical to PE but is recorded at twice the density (3200 cpi).

ECC: An Error Correction Character at the end of residual groups, CRC groups and data groups in the GCR recording format.

EOT: End Of Tape. This is a photoreflective marker placed near the end of the recording area on the tape. It is positioned along the lower edge of the tape, 25 feet from the actual end of tape, on the tape's uncoated side.

FIFO: First-In-First-Out buffer. Data is stored and read out in the same order as it was input.

File: A group of one or more data blocks concluding with a filemark. The user determines the number of blocks in a file. A tape may contain one or more files.

Filemark: A special control block which is uniquely distinguished from any possible data block. A filemark (sometimes referred to as *tapemark*) divides blocks of data on the tape into groups, or *files*, which belong together. Two or more consecutive filemarks are frequently used to indicate the logical end of tape.

Flux Reversal: A change in the alignment of magnetically polarized oxide particles on the surface of the tape. The data is written by a magnetic head which polarizes the magnetic particles on the tape in one direction or another. The read head senses flux reversals.

Formatter: A functional portion of the tape drive electronics which provides data synchronization, error detection and correction, preambles and postambles. The formatter also generates and detects parity, IBGs, ID bursts and filemarks. it accepts commands from and provides drive status to the coupler.

GCR: Group Coded Recording, usually at 6250 cpi, the *effective* recording density. The actual recording density, including *overhead*, is 9042 cpi. The recording efficiency of the GCR format is 70%. It is similar to NRZI in that a flux reversal represents a one-bit, but different in that the formatter encodes the data prior to recording in such a way that no more than two zeros will occur consecutively on the tape. The encoding also provides self-clocking, error detection and correction.

Interblock Gap: The IBG is a DC-erased portion of tape between two blocks. Start/stop drives require the presence of IBGs on tape; streaming drives implement the IBGs to maintain tape compatibility.

Interphase Transition: The non-data flux reversals in PE that are required between two sequential bits of the same value (two one-bits or two zero-bits). This allows each bit to be represented by a flux reversal in the required direction. If the interphase transitions were not present, consecutive one-bits would be written with the same direction of magnetization and there would be no flux reversals on the tape until the next zero character.

Last Word: This is the last write data character of a block to be transferred from the host. Also, ILWD (Interface Last Word) is an interface signal that indicates the last character of the block is being presented to the formatter.

Loadpoint: At or near the BOT marker. In Qualstar tape drives, loadpoint is about two feet ahead of the BOT marker.

Loaded Tape: The tape is threaded and wrapped onto the take up reel. It may or may not be tensioned. Loading tape is the process of placing a supply reel on the hub and threading tape through the tape path and onto the take reel.

Mark Groups: Special groups of characters in GCR blocks used to demark data from control characters and residual groups.

NRZI: Non-Return to Zero Inverted. The oldest commonly used format for nine track tape recording. The density is 800 cpi. It is not self-clocking and there are no inter-phase transitions. A one-bit is recorded as a flux reversal on tape; no change is interpreted as a zero-bit.

Overhead: Those bytes, characters, and byte-groups on tape which are necessary as part of the recording format, but which do not contain the actual recorded data. Examples are sync bytes, preambles, resync bursts, check characters, etc.

PCBA: Printed Circuit Board Assembly.

PE: Phase Encoded. The most widely used data format for nine track tape. It is recorded at 1600 cpi (3200 in Double PE) and the recording efficiency is 50%. Sequential bits of the same value are separated by an interphase transition, and the bit values are determined by the direction of a flux reversal on tape.

Postamble: A group of special signals recorded at the end of each block for synchronization in the reverse tape direction.

Preamble: A group of special signals recorded at the beginning of each block for synchronization in the forward tape direction.

Record: A group of data bytes and associated check characters as recorded on magnetic disk. Often interchanged (incorrectly) with *block*, which refers to the same unit on magnetic tape.

Reference Edge: The edge of tape nearest the labeled side of the tape reel (the upper edge of tape), and furthest from the base casting on Qualstar tape drives.

Residual Group: These GCR characters are written on the tape after the data block and end mark group. The group consists of residual data, an auxiliary CRC character and an ECC character.

Skew: The deviation of bits within a tape character from the intended or ideal placement, which is perpendicular to the tape reference edge.

Streaming: In the context of tape drives, the reading and writing of data with continuous (non-start/stop) tape motion. This generally requires data buffering somewhere else in the system.

Tensioned Tape: The tape is loaded and tensioned (without slack). It may or may not be moving.

Track: The path along tape that a particular bit follows referenced by its physical position relative to the reference edge of tape. There are nine tracks on the tape.

Unloaded Tape: A supply reel is present, but tape has not been threaded. Unloading tape is the process of winding all the tape onto the supply reel.

ORDER NO.	FIELD REPLACEABLE UNIT	QUANTITY (IF MORE THAN ONE)	REMARKS
500002-01-9	Tach Disk		
500015-01-1	Tape Guide	2	
500039-01-1	EOT/BOT Sensor Assembly		
500071-03-0	Cable Assembly, Read GCR		
500073-16-8	Cable Assembly, Mass Term		Preamp to Read PCBA
500107-02-4	Hall Switch PCBA		
500214-02-8	Supply Reel Hub Assembly, GCR		
500214-04-4	Take Up Hub Assembly, GCR		
500316-02-1	Tape Cleaner		
600-0022-1	Motor	2	
604-0010-8	Fan, 21 CFM, DC		
613-0001-8	Switch, **LOAD**		
613-0002-6	Switch, **FPT**		
613-0005-9	Switch, **ONLINE**		
613-0006-7	Switch, **6250**		
626-0007-7	Fuse, 2.5 Amp Slo Blo, 250V		Non-VDE 100/120V
626-0008-5	Fuse, 1.25 Amp Slo Blo, 250V		Non-VDE 220/240V
626-0011-9	Fuse, 2.5 Amp, 3AG, Slo-Blo, 5 x 20mm		VDE 100/120V
626-0012-7	Fuse, 1.25 Amp, 3AG, Slo-Blo, 5 x 20mm		VDE 220/240V
630-0013-7	Transformer, 1260		
632-0835-9	Optical Switch	2	TachA and TachB
633-0003-2	Filter, Line, 3 Amp		VDE with switch
645-0001-0	Head, nine-track		
712-1410-0	Shim, .001 Thick, .147 ID, .380 OD	As required	Skew adjust
712-1411-8	Shim, .004 Thick, .148 ID, .375 OD	As required	Skew adjust
716-2501-6	Bearing, .250 ID	4	
PCB157-01-1	GCR Read Channel PCBA	9	All 9 must be same revision
PCB167-01-0	GCR Preamplifier Board		
PCB187-01-8	Switch Interconnect PCBA		All except 1260T
PCB197-01-7	Read/Formatter PCBA		
PCB207-01-4	GCR Power Supply PCBA		
PCB217-01-3	GCR Write/Controller PCBA		
PCB507-01-7	SCSI-2 PCBA		1260S only

1260 Field Replaceable Unit Parts List

PCBA Drawings and Schematics — Appendix C

This appendix contains the following schematics and assembly drawings:

Note: *When replacing components on PCBAs, always use genuine Qualstar parts. Many of the discrete parts used on Qualstar products are screened to meet Qualstar specifications; generic parts purchased "off the shelf" which do not meet Qualstar specifications may not work reliably in a given application.*

DRAWING NUMBER	TITLE
500157	Assembly Drawing, GCR Read Channel PCBA
500158	Schematic Diagram, GCR Read Channel PCBA
500167	Assembly Drawing, GCR Preamp PCBA
500168	Schematic Diagram, GCR Preamplifier PCBA
500187	Assembly Drawing, Switch Interconnect PCBA 1260
500188	Schematic Diagram, Switch Interconnect — Model 1260
500197	Assembly Drawing, Read Formatter PCBA
500198	Schematic Diagram, GCR/PE Read Formatter
500207	Assembly Drawing, GCR Power Supply PCBA
500208	Schematic Diagram, Power Board — Model 1260
500217	Assembly Drawing, GCR Write/Controller PCBA
500218	GCR Write/Controller Board
500242	System Interconnect Diagram — Model 1260
500507	Assembly Drawing, SCSI-2 PCBA
500508	Schematic Diagram, SCSI-2 PCBA