

OEM MANUAL
SERIES 5000E BASIC
1/4-INCH STREAMING TAPE CARTRIDGE DRIVE

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1.0 SCOPE

This document describes the operational specifications, and interfacing requirements for the Wangtek Series 5000E 1/4-inch cartridge tape drive.

2.0 REFERENCE DOCUMENTS

1. ANSI X3.55 1977 1/4-inch wide tape cartridge
2. ANSI X3.54 1976 1/4-inch wide tape cartridge
3. 3M-DC 600 Cartridge specification
4. QIC-02 Intelligent Interface Standard(Proposed)
5. QIC-24 Data Interchange Standard(Proposed)
6. QIC-36 Basic Interface 1/4-inch Cartridge Tape Drive

3.0 GENERAL DESCRIPTION

3.1 Introduction

The Series 5000E streaming tape drive (Figure 1.0) is a family of innovative, low cost, highly reliable 1/4-inch wide cartridge tape drives.

When utilized in the "streaming" mode at 90 ips, and using a standard 450-foot-long tape cartridge (Figure 1.1) the drive can record 20, or 45 Mbytes of data, using the 4- or 9-track format, respectively.

Utilization of the 600-foot-long tape cartridge provides storage of either 26.7 or 60 Mbytes of data with the 4 or 9 track format, respectively.

The Series 5000E cartridge tape drive can be utilized for either Winchester disk backup or general data storage in the streaming start/stop or data distribution mode.

An optional intelligent formatter, available in either a half-high module or external to the drive, will record either the QIC-24 or Archive 8-inch QIC-11 data format using the QIC-02 defined intelligent interface.

3.2 Physical Description

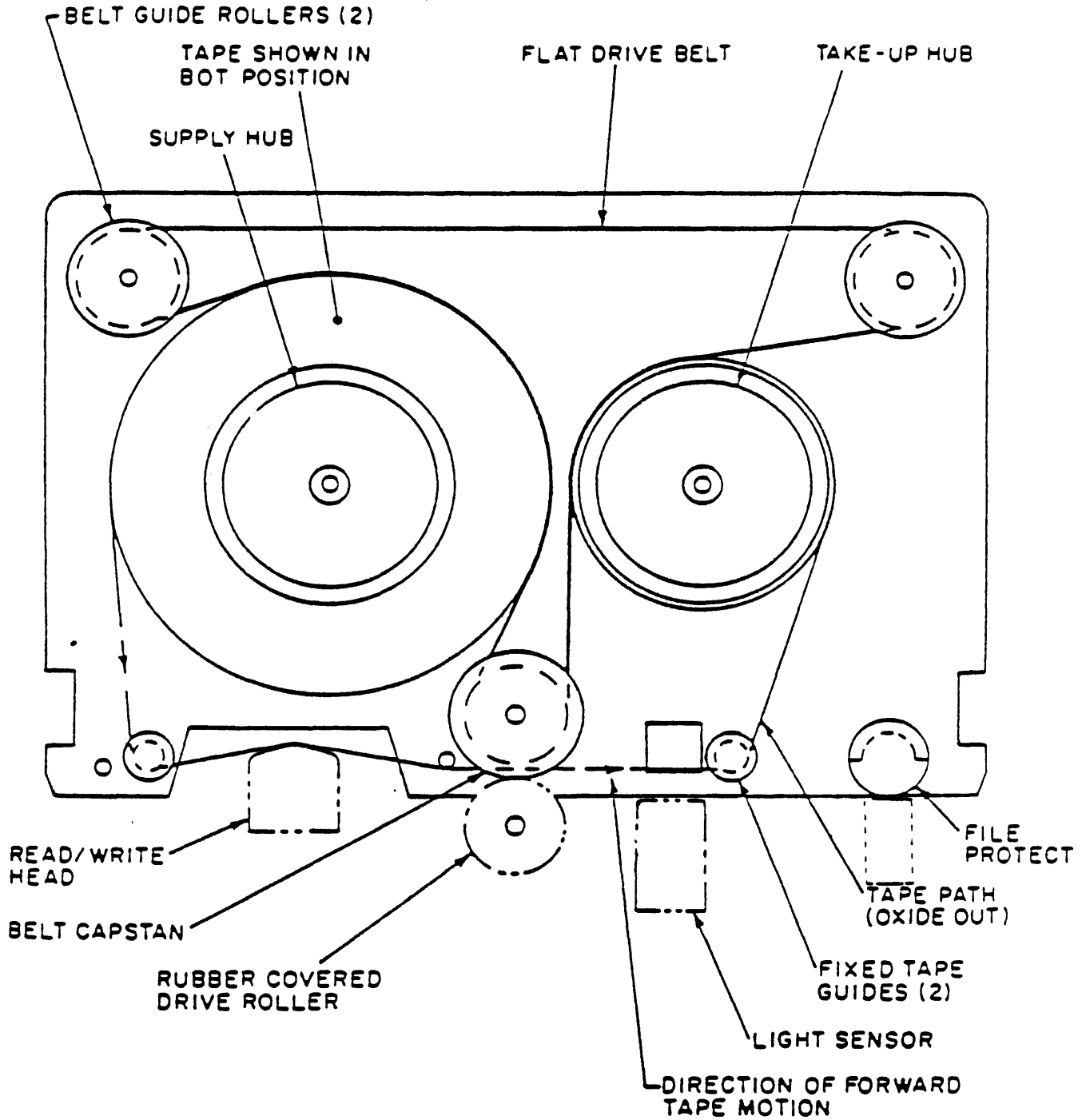
The drive consists of a die cast aluminum deck. The components mounted on the deck are as follows:

Head Carriage and Stepper Motor Assembly

Read/Write Head Assembly with integral tape cleaner

Capstan Motor

(ref. ANSI X3.55 - 1977)

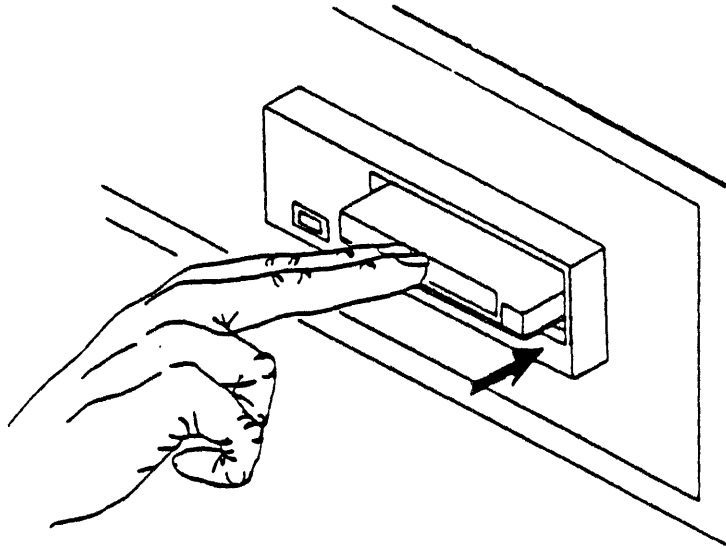


ANSI Tape Cartridge

Figure 1.1

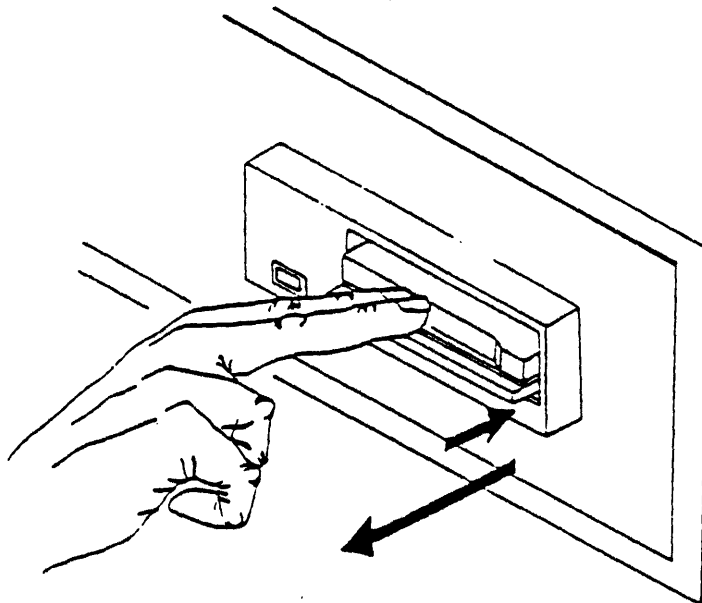
Cartridge Loading

Figure 2.0



Cartridge Unloading

Figure 2.1



Tape Hole Sensor Block Assembly

"Safe" and "Cartridge In" Switch Assembly

The Series 5000E is designed to have the same dimensional parameters as a 5 $\frac{1}{4}$ -inch Winchester or Floppy Disk drive.

The control electronics are mounted on the deck. The components are mounted on a 5.75-inch-wide, 1.6-inch-high, 8-inch-deep envelope (Basic Interface), and 5.75-inch-wide, 3.25-inch-high, 8-inch-deep envelope with the intelligent formatter included.

3.3 Functional Description

The Series 5000E can utilize either the 450-, or 600-foot tape cartridge.

The type of cartridge being used is transparent to the user, due to the drives automatic capability to select the proper write currents and read gains for the respective cartridge being utilized.

The Series 5000E also utilizes the QIC-24 track reference burst to automatically position the head to the center of the reference burst.

NOTE: This feature requires that the "Search" jumper be removed.

The above feature minimizes misalignment of the head when reading tapes generated by other drives utilizing the QIC-24 data format.

When the Series 5000E tape drive is in the WRITE mode, it will automatically position the Read/Write head assembly to the theoretical Track 0 position.

3.4 Drive Microprocessor

The microprocessor employed is the kernel for the device operation, and maintains control of the stepping mechanism, drive motor, and decodes all the commands from the formatter.

3.5 Capstan Motor System

The capstan motor assembly is controlled by the drive microprocessor. The speed is also monitored by the formatter, which uses a signal derived from a tachometer. Instantaneous speed variation is held within $\pm 7\%$, while long term speed variation is limited to $\pm 3\%$.

3.6 Head Carriage and Stepper Motor Assembly

Positioning of the head to the desired track is accomplished by a stepper motor lead screw positioning mechanism. The drive signal to the stepper motor is generated by the CPU on the formatter, and interpreted by the drive microprocessor.

3.7 Read/Write Head Assembly

Reading and writing on the tape in either a 4-, or 9-track format is performed by a two channel serpentine recording head, arranged with "read, after write" poles with a full tape erase bar.

3.8 Tape Hole Sensor Assembly

The system for detection of End of Tape (EOT), Beginning of Tape (BOT), Load Point (LP), and Early Warning (EW) holes utilizes optical sensor assemblies, the output of which are synchronously clocked into the formatter's CPU.

3.9 Daisy Chain Capability

The drive may be configured by the user to be constantly selected or selected by any one of four available discrete select lines. The selected (SLD) signal is sent to the formatter CPU and the activity LED.

3.10 Activity LED Indicator

The activity LED is illuminated when the drive is selected and busy. It is enabled by the select lines in conjunction with the user selectable DIP shunts.

4.0 OPERATIONAL SPECIFICATIONS

4.1 Storage Capability

Tape Length	450 foot		600 foot	
Formatted Capacity	20 Mb	45 Mb	26.7 Mb	60 Mb
Number of Tracks	4	9	4	9
Data Transfer Rate	86.7 Kbytes/Second			
Head Type	Read after write with separate erase bar and tape cleaner.			
Recording Format	4- or 9-Track Serpentine			
Recording Code	GCR (0.2 Run Length Limited).			

4.2 Data Reliability

4.2.1 Soft Error Read Rate 1×10^8

4.2.2 Hard Error Read Rate 1×10^{10}

4.3 Tape Motion

Speed (During Read/Write) 90IPS

Speed Variation
(During Read/Write)

Long Term $\pm 3\%$

Short Term $\pm 7\%$

Start/Stop Time 300 mSec Maximum

4.4 Power Requirements

DC VOLTAGE +12 Volts +5 Volts

Tolerance-Including
Ripple $\pm 5\%$ $\pm 5\%$

Ripple (maximum) 500 millivolts 100 millivolts

CURRENT

Basic Unit

Standby 200 mAmps nominal 1.0 Amps nominal

Operational 1.9 Amps nominal 1.0 Amps nominal

Start Up Surge 4.2 Amps max. for less
than 122 mSeconds.

Formatter QIC-02
(QIC-11/24)

Operational 500 mAmps 2.0 Amps

Time to Rated Voltage 100 mSec maximum 50 mSec maximum

Power Sequence Turn on both voltages simultaneously

Power Disipation

Basic Unit 16 watts nominal

Basic Unit w/QIC-02 Formatter 32 watts nominal

NOTE: To determine total current requirements, add the specified current of the basic drive, and the desired formatter.

4.5 DC Power Connector

Power for the Series 5000E is supplied through an AMP (PN 1-480426-0) connector. The mating connector is AMP (PN 1-40880424-0) using AMP (PN 60619-1) female contacts. The connector is configured as follows:

Pin	1	+12 VDC
	2	+12 VDC RETURN
	3	+ 5 VDC RETURN
	4	+ 5V VDC

The power connector configuration is the same for the Basic drive and formatters. The +12V and +5 V returns are tied together at the drive. However, it is recommended that the host system ties the returns together at the power supply. Also, the returns are tied to the chassis ground via a PCBA mounting screw.

5.0 PHYSICAL CHARACTERISTICS

5.1 Dimensions

Basic Unit (Half-Height)

Depth	8.5-inches max.	215.9-mm max.
Width	5.75-inches ± 0.05 in.	146.1-mm ± 1.3 -mm
Height	1.625-inches ± 0.05 in.	41.1-mm ± 1.3 -mm
Weight	2.2 lbs.	4.8 Kg.

Unit With Intelligent Formatter (Full Height)

Depth	8.5-inches max.	215.0-mm max.
Width	5.75-inches ± 0.05 in.	146.1-mm ± 1.3 -mm
Height	3.25-inches ± 0.05 in.	82.6-mm ± 1.3 -mm
Weight	4.25 lbs.	9.6 Kg.

5.2 Mounting

The Series 5000E is designed to utilize the same mounting holes, and dimensions as the industry standard 5 $\frac{1}{4}$ -inch Winchester and Floppy Disk drive.

5.3 Front Bezel

Bezels are available in a full or half-high configuration. Access to the power connector and interface is at the rear of the drive. Drives are available with the formatter separate from the half-high basic drive.

5.4 Cartridge Loading and Unloading

The cartridge can be loaded into the Series 5000E drive in one orientation only. This is accomplished by pushing the cartridge into the open slot until further travel is restricted and released. The cartridge can be unloaded, even during operation, by simply repeating the load procedure until the cartridge is released and free. (Figures 2.0, 2.1)

5.5 Mean Time between Failure (MTBF)

The design goal of the Series 5000E is for MTBF of greater than 8,000 P.O.H., inclusive of power on and operation time, but excluding any maintenance periods. It is assumed for this calculation that the drive will run at a 20% duty cycle.

5.6 Mean Time to Repair (MTTR)

The MTTR of the Series 5000E is 0.5 Hours.

5.7 Preventative Maintenance

NOTE: ALWAYS TURN POWER OFF.

After the insertion of a new tape cartridge, the recording head and tape cleaner should be cleaned after approximately two hours of use, and every 8 hours thereafter of actual use.

The recommended cleaning procedure is to use a lintless cotton swab soaked with Freon TF or IBM tape cleaner only.

NOTE: Isopropyl Alcohol will leave a residue on the head assembly, and should not be used whenever possible.

6.0 ENVIRONMENTAL CHARACTERISTICS

6.1 Temperature (°C)

Operational	+ 5 to + 45*
Non-Operational	- 30 to + 60

*Note: Assure that the base plate of the cartridge never exceeds 45°C.

6.2 Relative Humidity

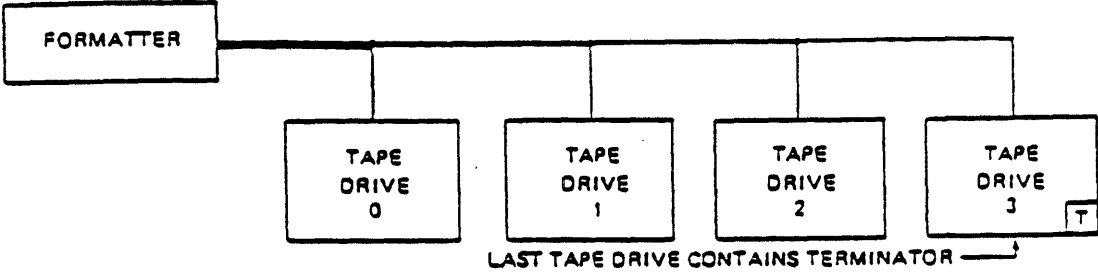
Operational	20 % to 80 % non-condensing
Non-Operational	0 % to 99 % non-condensing

6.3 Thermal Gradient

Operational	Not to exceed 1.0°C per minute.
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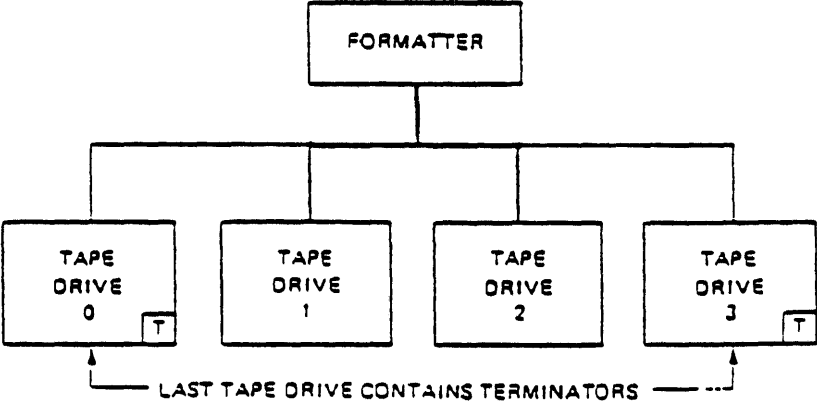
Daisy Chain Configuration

Figure 3.0



Daisy Chain Configuration

Figure 3.1



6.4 Altitude

Operational - 1000 to 15,000 feet
Non-Operational - 1000 to 50,000 feet

6.5 Shock

Operational 2.5g max., ½ sine wave, 11 mSec duration on any axis.
Non-Operational* 30g max., ½ sine wave, 11 mSec duration on any axis.

* Packaged in Wangtek NSTA specified container.

6.6 Vibration

Operational 0.005-inch max., peak to peak displacement 0 to 63 Hz; 1g max., acceleration 63 to 500 Hz.
Non-Operational 0.1-inch max., peak to peak displacement 0 to 17 Hz; 1.5g max., acceleration 17 to 500 Hz.

6.7 Acoustical Noise

The Series 5000E tape drive, without a cartridge inserted, will generate a maximum of 49 dB(A), weighted over a period of 60 seconds and measured 1 meter from the drive in all axis'.

CONF. VIA WITH CARTRIDGES INSERTED.

6.8 Safety

The Series 5000E is UL listed, and CSA approved.

6.9 Electromagnetic Compatibility

The Series 5000E is certified to conform to FCC Part 15, Class B regulations.

7.0 OPERATION

7.1 Unpacking the Drive

The drive is packaged in a protective container to minimize the possibility of damage during shipment. The following is the recommended procedure for unpacking the drive:

1. Place the shipping container on a flat surface.
2. Open the container and inspect the internal damage (if any).
3. Remove the drive from the container.
4. Check the contents of the container against the packaging slip.

5. Visually inspect the contents of the package for any physical damage.
6. Notify the carrier immediately if there is any damage.

7.2 Pre-Installation Checklist

Prior to applying power to the drive, the following procedure should be implemented:

1. Check to ensure that there are no loose components on the drive.
2. Check to ensure that when the tape cartridge is inserted, the head assembly loads properly.
3. Check the security of the front panel.
4. Check to see if the drive belt is in place.
5. Check the security of the printed circuit boards.
6. Check the security of all connectors, and ensure they are properly orientated, i.e. pin 1 to pin 1.

7.3 Mounting the Drive

The drive has been designed to be mounted either horizontally or vertically. If mounted vertically it is recommended that the cartridge door is physically located above the activity LED.

Four 6/32 tapped mounting holes are provided on the bottom of the drive. When installed in either plane, horizontal or vertical, only three mounting screws are required to securely fasten the drive in place.

Any mounting scheme in which the drive is part of the structural integrity of the enclosure is not permitted.

Mounting schemes should allow for adjustable brackets or the incorporation of resilient members to accommodate tolerances.

In addition, it is recommended that mounting schemes include no more than two mounting surfaces.

The drive is manufactured and tested with some internal alignments, which must be maintained. Therefore, it is important that mounting hardware does not introduce significant stress on the drive chassis.

7.3.1 Dust Cover

The design of an enclosure should incorporate a means of prevention from contamination, i.e. dust, lint, and other dust producing material, as the drive does not have a dust cover.

7.3.2 Cooling

Heat dissipation from a single drive is normally 16 watts, 54 BTU/hour (Basic Drive), under high load conditions. When the drive is mounted to allow free flow of air over the components, normal convection cooling will be sufficient to operate within the specified temperature range.

When the drive is mounted in a confined enclosure, air flow must be provided to maintain the specified temperature range.

When forced air is introduced, the flow must be directed outward from the drive through a filter to avoid the introduction of contaminants. Do not intake air through the drive, as it will cause contamination in critical areas.

7.4 Tape Cartridge

The tape cartridge used is a standard ¼-inch tape (Figure 1.1). The following are recommended 3M tape cartridges to be utilized with the Series 5000E tape drive:

DC 600A	600ft Data Cartridge
DC 300XL/P	450ft Data Cartridge
DC 300XL	450ft Data Cartridge

7.4.1 Cartridge Loading

The tape cartridge is loaded into the drive by pushing it into the front loading slot. The tape should be loaded towards the LED indicator side of the drive. The tape is loaded by pushing forward until the cartridge is latched. The head/carriage assembly is loaded, and the tape is ready for operation. (Figure 2.0)

7.4.2 Cartridge Unloading

The tape cartridge is unloaded by simply pushing it into the drive until it stops, thus releasing the cartridge and unloading the head/carriage assembly, allowing it to be ejected from the drive. (Figure 2.1)

7.4.3 Write Protect Feature

The data on the tape cartridge may be protected from being overwritten by turning the Write Protect indicator 180° to the SAFE position.

7.4.4 Handling and Storage

The tape cartridge must not be exposed to dirt, moisture, or extreme temperature.

The user should never open the tape access cover to expose the tape when the cartridge is not in use, and should never physically touch the tape. The oils and acids of the hand can contaminate the tape surface, and magnetic coating.

A properly handled tape cartridge will provide long, reliable service. Broken, chipped, or cracked cartridges should be discarded immediately.

NOTE: ANY ATTEMPT TO UTILIZE A DAMAGED CARTRIDGE MAY RESULT IN DAMAGE TO THE TAPE DRIVE!

Storage of tape cartridges should be in accordance with the manufactureres recommendations. Never place cartridges near a device which may generate a strong magnetic field.

8.0 INTERFACE DESCRIPTION (Basic Drive)

8.1 Interface Characteristics

There are 25 signal lines at the Basic Tape Drive Interface. Fifteen (17) lines are used for signals that are generated by the formatter CPU, and seven (7) lines are used for signals that are generated on the Basic Drive. One (1) line is reserved for future use.

The signals are transmitted via a conductor flat ribbon cable which must not exceed 3 meters in length.

8.2 Signal Levels

All voltage measurements are at the drive connector with the terminators installed.

Standard TTL are used on signal lines to the formatter as follows:

FALSE, logic 0 (High) = 2.4 to 5.25 VDC

TRUE, logic 1 (Low) = 0.0 to 0.55 VDC

Standard TTL levels are required on signal lines to the drive as follows:

FALSE, logic 0 (High) = 2.0 to 5.25 VDC

TRUE, logic 1 (Low) = 0.0 to 0.80 VDC

8.3 Signal Termination

The recommended termination is 220 ohms to +5 VDC, and 330 ohms to ground. The resistor network tolerance shall be $\pm 10\%$. In a standard daisy chain configuration, all lines to the formatter shall be

terminated at the formatter, while the signals at the last drive in the chain will also be terminated. (Figure 3.0) In the event that the formatter is in the middle of the daisy chain, all signal lines shall be terminated at the extreme ends of the bus. (Figure 3.1)

8.4 Signal Loading

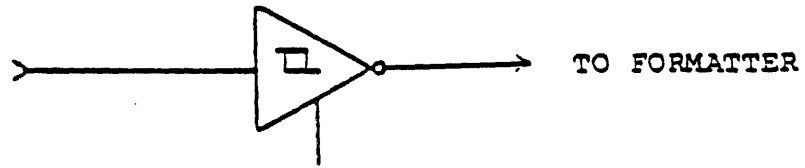
Signals transmitted from the drive are capable of driving two termination networks and a single TTL load. Signals received by the drive are loaded by only one TTL load at each drive plus the necessary termination network. It is recommended that the formatter not load the signal lines from the drive by more than one termination network and one TTL load. (Figure 3.2)

8.5 Interface Connector

The interface connector on the Series 5000E is a 50-conductor flat ribbon cable. The recommended mating connector is a 3M PN 3425 or equivalent.

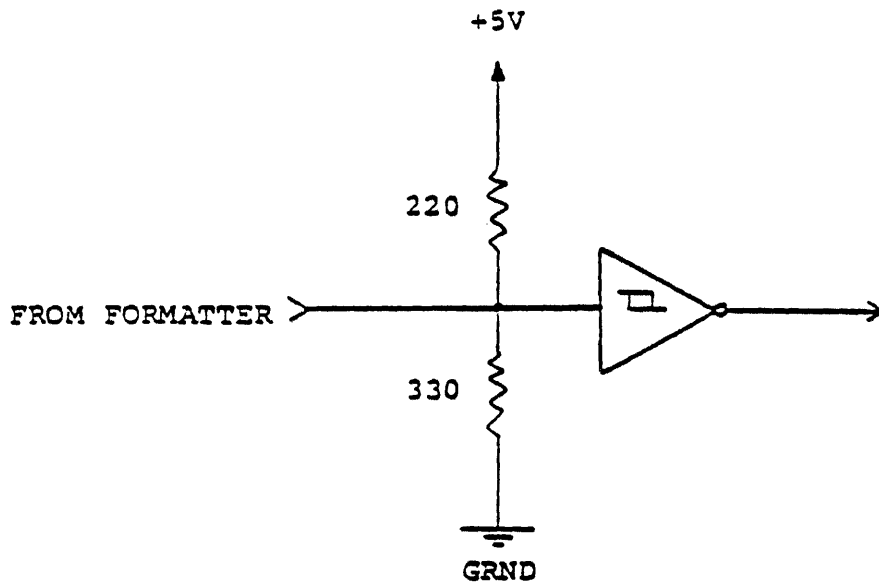
Interface Signals
Drivers and Receivers

Figure 3.2



TYPE 74LS240

DRIVER

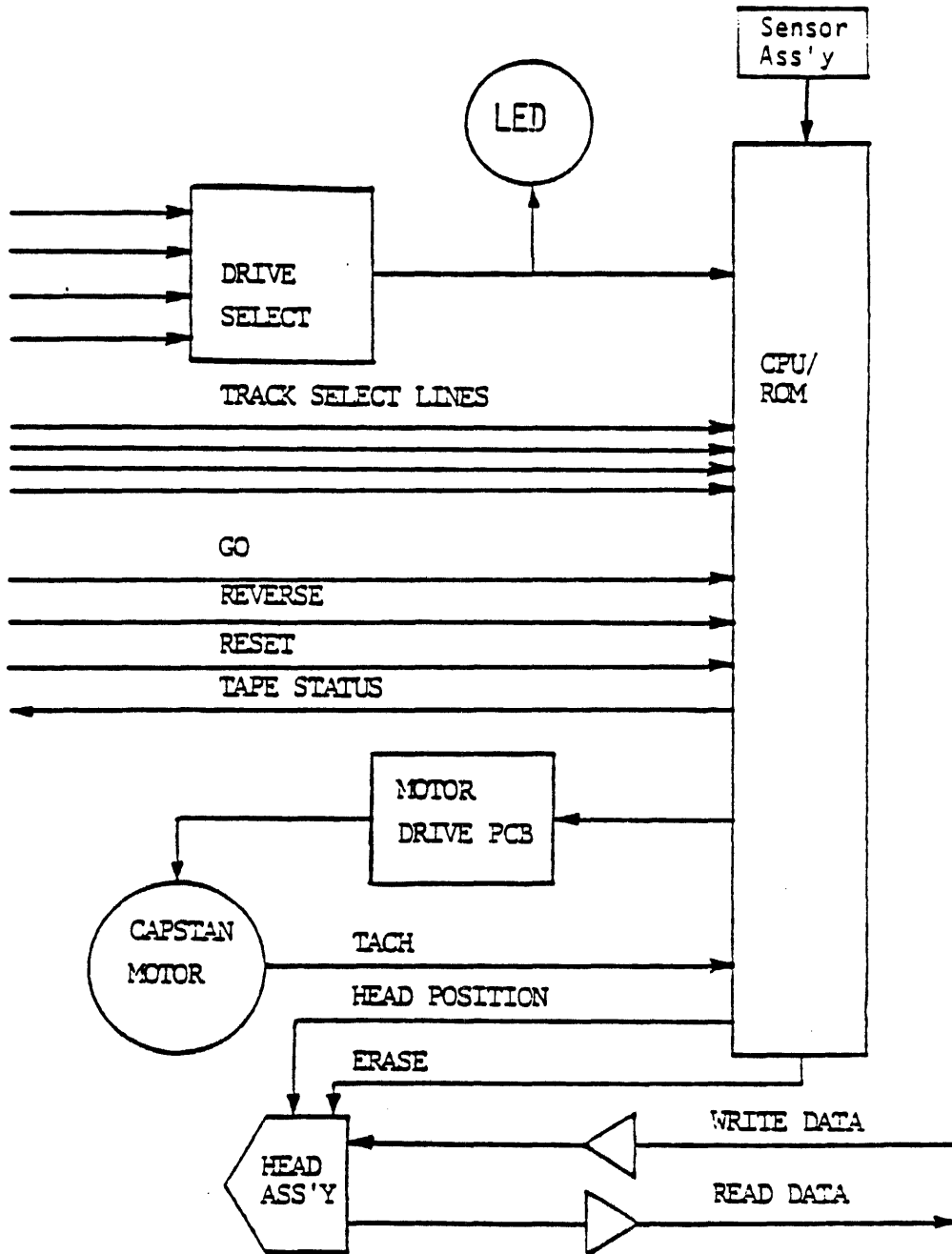


TYPE 74LS14

RECEIVER

Block Diagram

Figure 3.3



8.6 I/O Pin Assignments

<u>PIN#</u>	<u>MNEMONIC</u>	<u>TO</u>	<u>DESCRIPTION</u>
02	GO-	D	Go control for capstan motor
04	REV-	D	Direction control for capstan motor
06	TR3-	D	Track Select Bit #3
08	TR2-	D	Track Select Bit #2
10	TR1-	D	Track Select Bit #1
12	TR0-	D	Track Select Bit #0
14	RST-	D	Reset
16	DS3-	D	Drive Select #3 control
18	DS2-	D	Drive Select #2 control
20	DS1-	D	Drive Select #1 control
22	DS0-	D	Drive Select #0 control
24	HC-	D	Select Operation with type tape
26	RDP-	F	Read Pulse output
28	UTH-	F	Upper tape hole position code
30	LTH-	F	Lower tape hole position code
32	SLD-	F	Selected Response from drive
34	CIN-	F	Cartridge In place
36	USF-	F	Unsafe
38	TCH-	F	Tachometer Pules from capstan
40	WDA-	D	Write Data signal
42	WDA+	D	Write Data signal (inverse)
44	N/A		Reserved for future use
46	HSD-	D	High speed select control
48	WEN-	D	Write Enable control
50	EEN-	D	Erase Enable control

NOTE: All odd pins are signal returns which should be connected to the ground at both the drive (D) and formatter (F).

8.7 Detailed Signal Description

The block diagram in Figure 3.3 depicts the functional building blocks for the 1/4-inch streaming cartridge tape drive. (The CPU will execute a recalibration and initialization algorithm at power up, reset, or upon cartridge insertion that will last approximately three (3) seconds with no search feature (QIC-11) or eight (8) seconds with the QIC-24 search feature.

The CPU then begins to scan the Formatter/Controller signals to determine which drive control functions are to be performed. Scanned signals DS0-3, TR0-3, REV, GO, and HSD will initiate the control functions in the following priority:

1. Track Positioning
2. Tape Hole Responses
3. Motion Control

The scanning operation will be aborted while track positioning and tape start/stop operations are in progress.

8.7.1 Capstan Motor Control

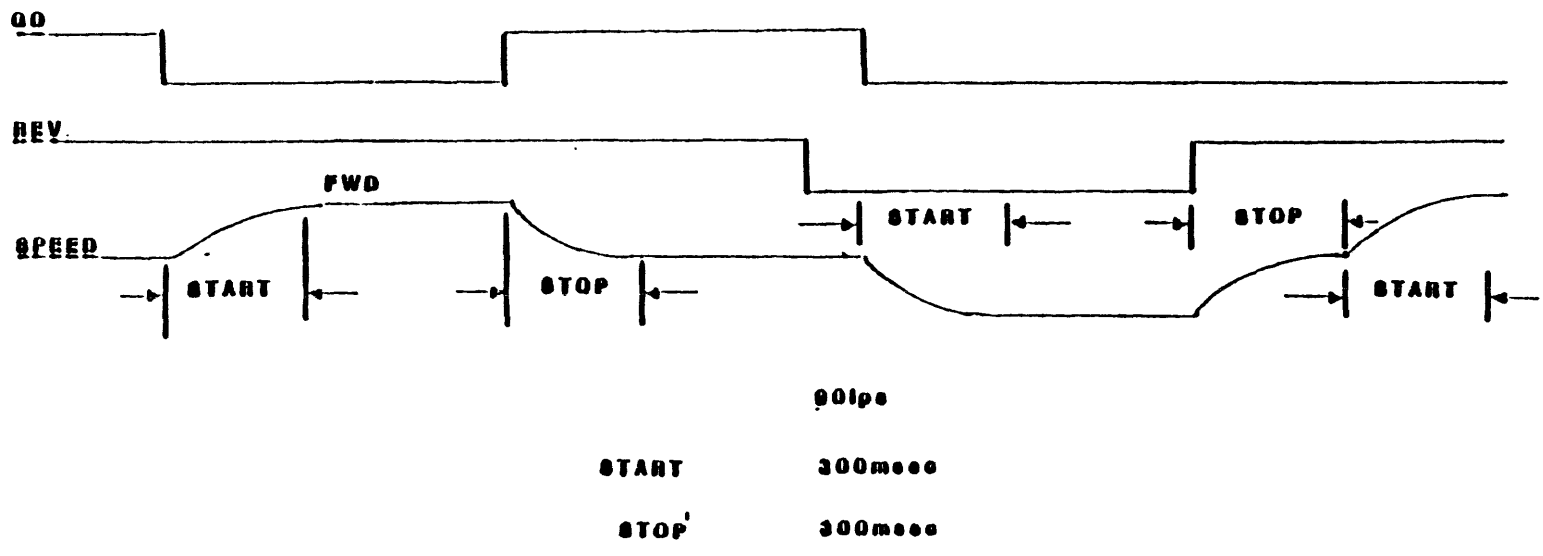
Two lines control the motion of the capstan motor. They are "GO Control" and "Direction Control". Typical tape motion control timing is detailed in Figure 3.4. The assertion of GO, when found by the scan, causes tape motion in the direction specified by the state of REV. When REV is HIGH, tape motion is in the forward direction, and when REV is LOW, tape will move in the reverse direction. When the tape is in motion, it is permissible to change the state of the track address (TR0-3), but it will be ignored until tape motion has stopped, or with the assertion of the REV signal, which causes a track positioning sequence to occur.

Changing the level of REV causes tape motion to stop and restart in the opposite direction. The removal of the cartridge causes the capstan motor to stop.

8.7.2 Tape Position Code Signals UTH, LTH

The tape position code signals are generated by the CPU, and are defined by the table below:

<u>UTH</u>	<u>LTH</u>	<u>Description</u>
1	1	Beginning of Tape (BOT)
0	1	End of Tape (EOT)
1	0	Early Warning (EW)
0	0	Data recording zone (lost during initial load)

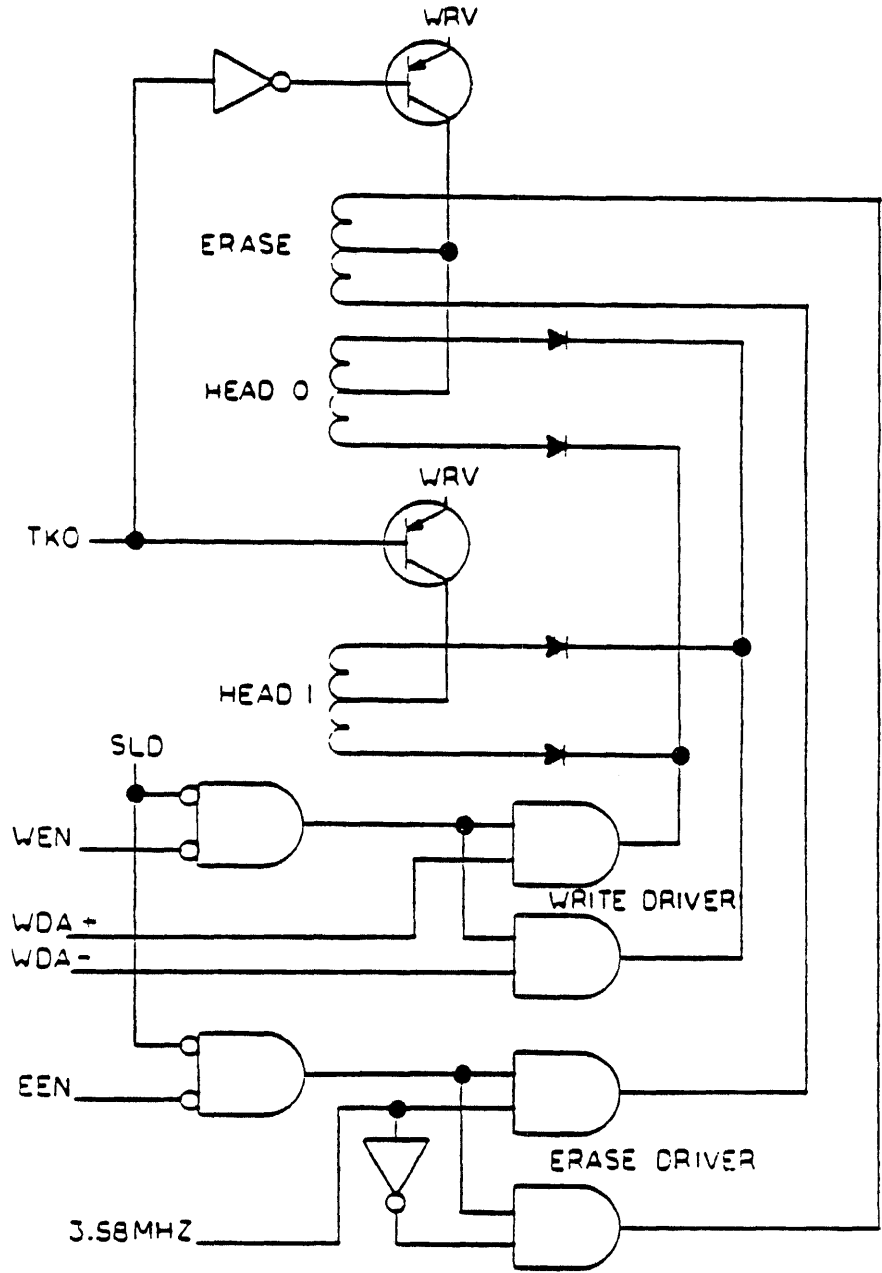


Motion Control Timing

Figure 3.4

Write and Erase Controls

Figure 3.5



When a new cartridge is inserted into the drive, the position of the tape within the cartridge is unknown. It is recommended that the Formatter/Controller move the tape to EOT or BOT to establish a reference point. With the use of the appropriate commands, the tape can be moved to BOT where "UTH", and "LTH" signals are asserted and initiate a stop sequence.

If the scanning operation does not detect any further motion commands, the tape is moved forward until BOT is sensed and is immediately stopped. Once tape motion is commenced, the Formatter/Controller will detect the LP, then the Data recording zone, followed by the EW and EOT, whereby a tape stop sequence is initiated. If REV and GO are asserted, the tape will be moved until EOT is sensed and immediately stopped. If REV and GO are subsequently asserted, reverse tape motion occurs and is analogous to the sequence in the forward direction described above.

8.7.3 Track and Head Selection

Selection of one of two heads is performed by the "TRK0" select bit. When false, head zero is selected; when true, head one is selected.

The assertion of a RESET signal causes the head assembly to initiate a recalibration routine, which takes approximately 8 seconds for Q-24, and approximately 2.7 seconds for the (search disabled) Q-11.

In either the 4- or 9-track models, track selection is accomplished by TRK1-3 select bit signal lines. Track positioning takes 500 mSec per track, nominal.

8.7.4 Cartridge In Place

Cartridge In (CIN) is a drive generated signal indicating that the tape cartridge is inserted into the drive correctly.

8.7.5 Reset

The Reset (RST) is a Formatter/Controller generated signal, which performs the same sequence as a power up routine when initiated, and lasts for approximately 300 uSec.

8.7.6 Unsafe

The Unsafe (USF) is a drive generated signal indicating that the inserted tape cartridge cannot be written on (Write Protected). The file protect tab is in the SAFE position.

8.7.7 Tachometer Pulses

The Tachometer (TCH) Pulses are generated by the drive, where each pulse equals 141 mils $\pm 3\%$ of tape movement.

8.7.8 Write and Erase Controls

The write and erase circuits are depicted in Figure 3.5. The interface signals which control the circuits are "Write Enable Control" (WEN), and "Erase Enable Control" (EEN).

The state of "Write Data Signal" (WDA+, WDA-) determines if positive or negative current flows through the selected head. Only the inverse states of the write data signal pair is allowed. The write drivers are disabled during a power up/down sequence and while the SAFE switch is enabled.

The erase function is enabled by "Erase Enable Control" (EEN), and is an internally generated AC signal which is used to drive the erase pole.

When writing is enabled, data transitions must occur with the following intervals:

1.11 uSec, 2.22 uSec, 3.33 uSec $\pm 1\%$

The recording code must comply with the above requirements.

8.7.9 Read Data

Data read from the tape is first amplified, passed through a differentiator and filter and circuit, amplified again before being passed through a comparator and limiter circuit. The signal is digitized prior to being output to the host on the signal line: "Read Data Output" (RDP). (Figure 3.6)

Peak shift data is as follows for recording areas where the signal amplitude is not less than 25% of nominal:

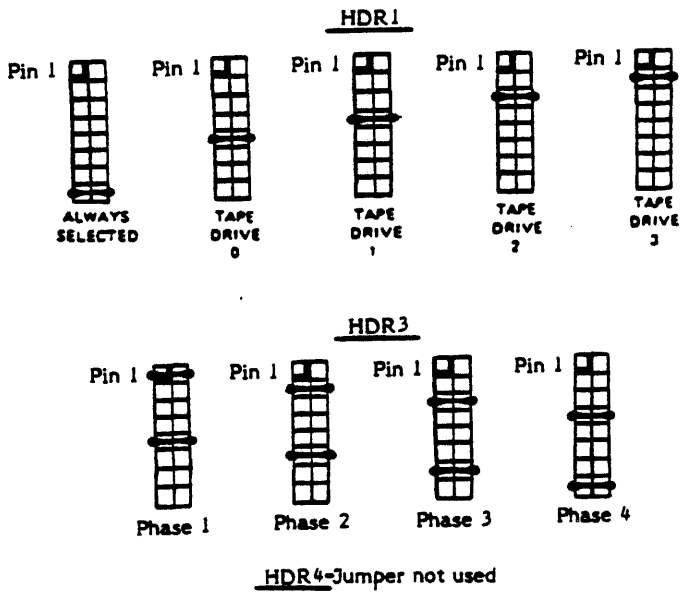
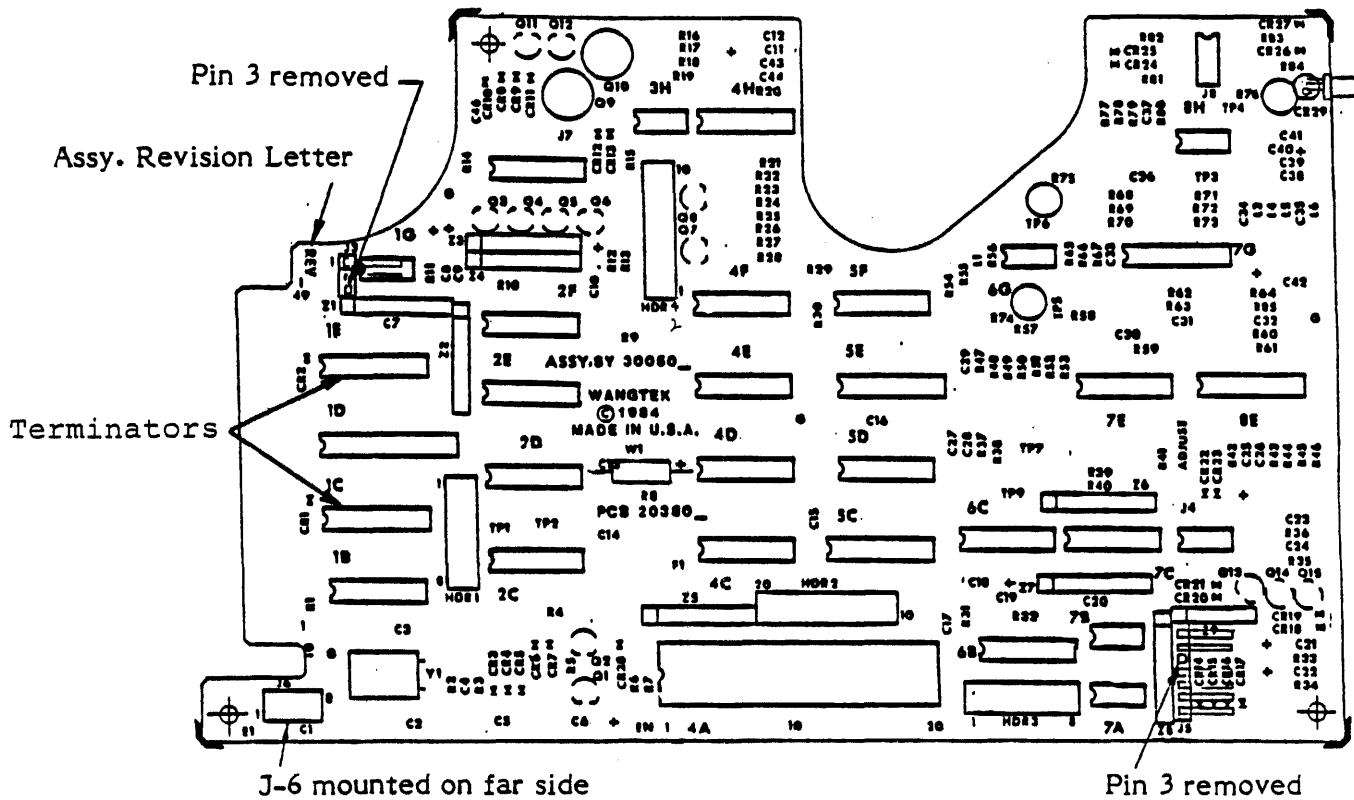
± 0.41 uSecs at 90 ips

In areas where the signal amplitude (measured at test points 5 & 6) is less than 25% of nominal, peak shift could possibly be up to $\pm \frac{1}{2}$ a data transition period.

8.7.10 Drive Select

The drive can be configured to be selected by any one of the select lines, or to be constantly selected. The select signal is sent to the activity LED and the CPU on the

Main Board



Main Board Layout and Jumper Configuration

Figure 3.7

drive board. At any time that the drive is not selected, the drive CPU will wait for a reset command when it is selected. (Figure 3.7)

8.7.11 Track Reference Burst Seek

The Track Reference Burst Seek sequence is initiated each time the drive receives a RST or CIN; either one of these two signals will initiate a rewind sequence until BOT is sensed.

This feature eliminates the alignment differences of tapes generated by other drives. The drive searches and positions the head to compensate for alignment differences of up to 9 mils.

The drive will also read Archive 8-inch format (QIC-11) without the QIC-24 reference burst, but will not correct for any misalignment.

To ensure interchangeability, the drive automatically defaults to theoretical Track 0, whenever a Write operation is initiated, and re-writes the track reference burst.

If a reference burst is not found in the Read Data mode, the drive automatically defaults to a mechanical Track 0 reference.

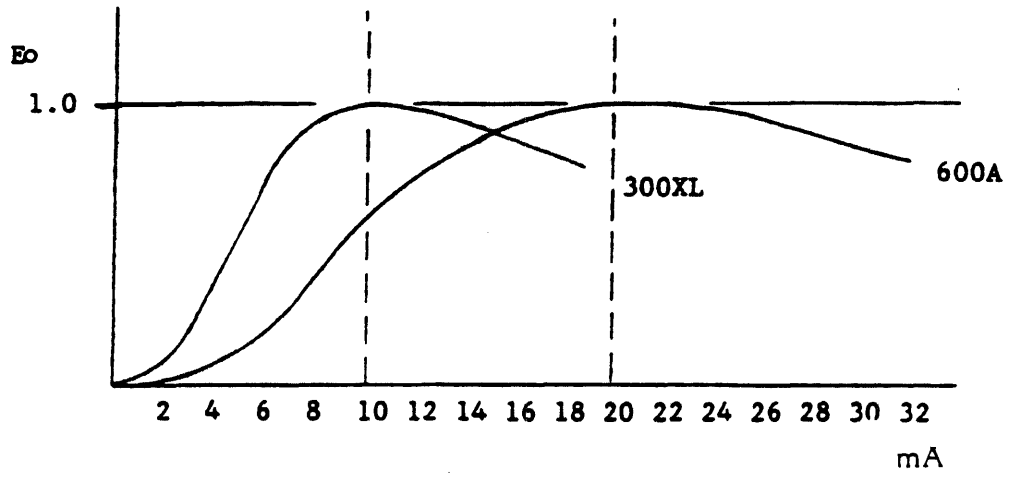
The following is the sequence of events which occur during a Track Seek:

1. Determine if cartridge is 450/600 ft. (measure the distance from BOT to LP).
2. Position the head assembly below a specified reference point, and then measure the number of steps required to reach the defined threshold level from the bottom and top to the pre-defined reference track.

Future track steps are referenced to the position defined in step # 2 above.

8.7.12 Saturation Recording

The Series 5000E cartridge tape drive automatically determines whether the inserted cartridge is a DC300XL or DC600A, thus making the type of tape being used transparent to the user.



Tape Coercivity vs Write Current
Figure 3.8

The 600A takes twice as much current to reach its maximum amplitude. Utilizing the ANSI criteria to determine the operating current, the current for the 300XL tape is 20 mAmps peak to peak and the 600A tape is 40 mAmps peak to peak.

Any compromise current will result in over saturating the 300XL tape causing a lose of resolution, and under saturating the 600A tape, making it vulnerable to extremes in amplitude modulation. Figure 3.8 depicts the respective saturation curves.

9.0 BASIC DRIVE - THEORY OF OPERATION

9.1 General Theory of Operation

This section provides a functional description of the cartridge tape drive.

Two primary sources of input signals are received by the cartridge drive:

1. Power Input
2. Command signals from the formatter/controller.

Through the use of the command signals the user can input data (Write) and receive data (Read), detect errors, etc..

The command signals, with the exception of read/write, are combined with internally generated signals to provide multiplexed data. Decoding is accomplished by the microprocessor (CPU), which performs five basic functions:

1. Decodes formatter/controller signals
2. Sends signals to the formatter/controller
3. Receives signals from the sensor assemblies
4. Sends signals to the drive motor
5. Sends signals to the stepper motor

A crystal oscillator and associated logic controls the CPU and systems timing. A 50-pin connector provides interface between the external formatter/controller and the cartridge tape drive. All internal and external system interface connectors and accompanying routing information are listed in Table 1.0.

Table 1.0. Interface Connectors

<u>Connector</u>	<u>Destination</u>
J1	To/From Formatter/Controller
J2	Capstan Motor
J3	Tachometer
J4	Sensor Assembly
J5	Stepper Motor
J6	Internal Board Connections
J7	Write/Erase Heads
J8	Read Heads

9.2 Subsystems

9.2.1 Cartridge

The cartridge tape drive uses an ANSI standard $\frac{1}{4}$ -inch tape cartridge. (Figure 1.1)

The cartridge tape has several distinct physical features designed for industry use and are listed below:

1. Three Reference Locators
2. Position Sense Holes
3. Mirror Mechanism
4. File Protect
5. Door
6. Capstan Wheel

The three reference points are positioned on the tape cartridge case to prevent improper insertion into the tape drive. A springloaded button on the cartridge drive tensions the tape cartridge against all reference points.

The in-position sensor is located on the front surface of the the tape cartridge. When positioned in the tape drive, a signal is routed to the drives CPU to indicate that the cartridge is in place and that the drive is ready to accept further commands.

The cartridge tape contains a rotatable plug which can be manually positioned by the user. This feature prevents accidental writing or erasing of the tape when it is in the SAFE position.

This signal is routed to the drive CPU when sensed, and inhibits the write/erase circuitry.

The mirror mechanism is located within the cartridge tape casing, and is utilized for tape position detection by deflecting light through the holes on the tape itself. This function is further explained in the Sensor Assembly subsection 9.2.2.

The cartridge door and capstan wheel do not generate any electrical signals, but are an intergral part of the tape cartridge.

The door, designed to protect the magnetic tape during storage and transport, swings open during the insertion of the tape cartridge into the drive to allow for proper positioning of the tape over the read/write heads.

The capstan wheel functions as a control for tape movement when driven by the cartridge tape drive capstan assembly. Further details are defined in Section 8.7.1 Capstan Motor Control.

9.2.2 Sensor Assembly

The Sensor Assembly is designed to detect tape hole positions (BOT, EOT, LP, EW) utilized by the tape drive for track positioning, tape status and position.

An infrared transmitter, located on the drive housing, emits a light to the mirror mechanism opposite the transmitter within the tape cartridge casing, creating a light field.

As the tape passes through this field, the holes are detected by two photo-transistors which are located within the drive housing, translated into signals, and routed to J4. From the J4 connector, the signals are sent to the drive CPU for processing.

Interface connector J4 also routes CIN and SAFE signals to the drive CPU.

9.2.3 Head Stepper Motor Assembly

The head stepper motor assembly physically positions the read/write heads to the specified track.

The stepper motor assembly is connected through connector J5 by six wires.

Electrical pulses from the drive CPU are converted into discrete mechanical movements refered to as steps. The steps are incremented/decremented in a logical sequence which acts on the internal mechanism of the stepper motor.

The head positioning mechanism is a lead screw type. The stepper motor is composed of a shaft connected to the motor. A screw is attached to the shaft, which is attached to a threaded sleeve. Attached to this sleeve is the magnetic head assembly.

The shaft and screw rotate while only the nut moves up or down. Depending on the sequence of inputs, the stepper motor will rotate the shaft in a clockwise or counter-clockwise direction. Twenty four (24) step pulses will rotate the shaft 360°. With this type of mechanism, precise positioning is accomplished with minimum effort.

9.2.4 Power Connector

The cartridge tape drive utilizes +12 VDC and +5 VDC which is connected through an AMP (PN 1-408426-0) connector and the mating connector, an AMP (PN 1-4080424-0), utilizing the following pin assignments:

Pin	1	+12.0 VDC
	2	+12.0 VDC Return
	3	+ 5.0 VDC Return
	4	+ 5.0 VDC

9.2.5 Power Requirements (Basic Drive)

DC Voltage	+12 VDC	+5.0 VDC
Tolerance Plus Ripple	$\pm 5\%$	$\pm 5\%$
Ripple (Max)	500 mV	100 mV
<u>Current</u>		
<u>Basic Drive Only</u>		
Standby	0.2 amps max	1.0 amps max.
Operational	1.9 amps max	1.0 amps max.
Start-up		
Surge	4.2 amps max. for less than 122 mSec.	
Power Sequence	Turn on both, drive and formatter, simultaneously.	

9.3 Magnetic Head

The magnetic head is designed to be compatible with either the QIC-11, or QIC-24 data format guidelines. It has two-track capability, due to the two read heads, two write heads, and a full tape width erase bar.

The head receives the write/erase commands from the formatter/controller, which are routed through interface connector J7 and directed to the appropriate write and erase driver circuitry.

Read commands are routed through interface connector J8 to the read amplifier/peak detector and time domain filter before being sent to the I/O connector J1. Refer to Section 8.6 for interface pin assignments.

The write and erase heads cannot be enabled simultaneously, with the exception of Track 0 where they are both activated.

The erase signal is AC driven, along with the clock signal generated by the crystal oscillator, and both signals are routed to the drives CPU.

The read function of the head is designed to detect flux transitions on the tape as it moves across the head.

"Read Pulse Output" (RDP) is formatter/controller signal input which is derived from signals received from the basic drive connector J8.

9.4 Drive Microprocessor

The CPU contains most of the cartridge tape drive control circuitry, including memory and I/O circuitry from the formatter/controller and drive subsystems.

The microprocessor functions are as follows:

Coordinate system activities and perform all addressing, data manipulation, and arithmetic functions.

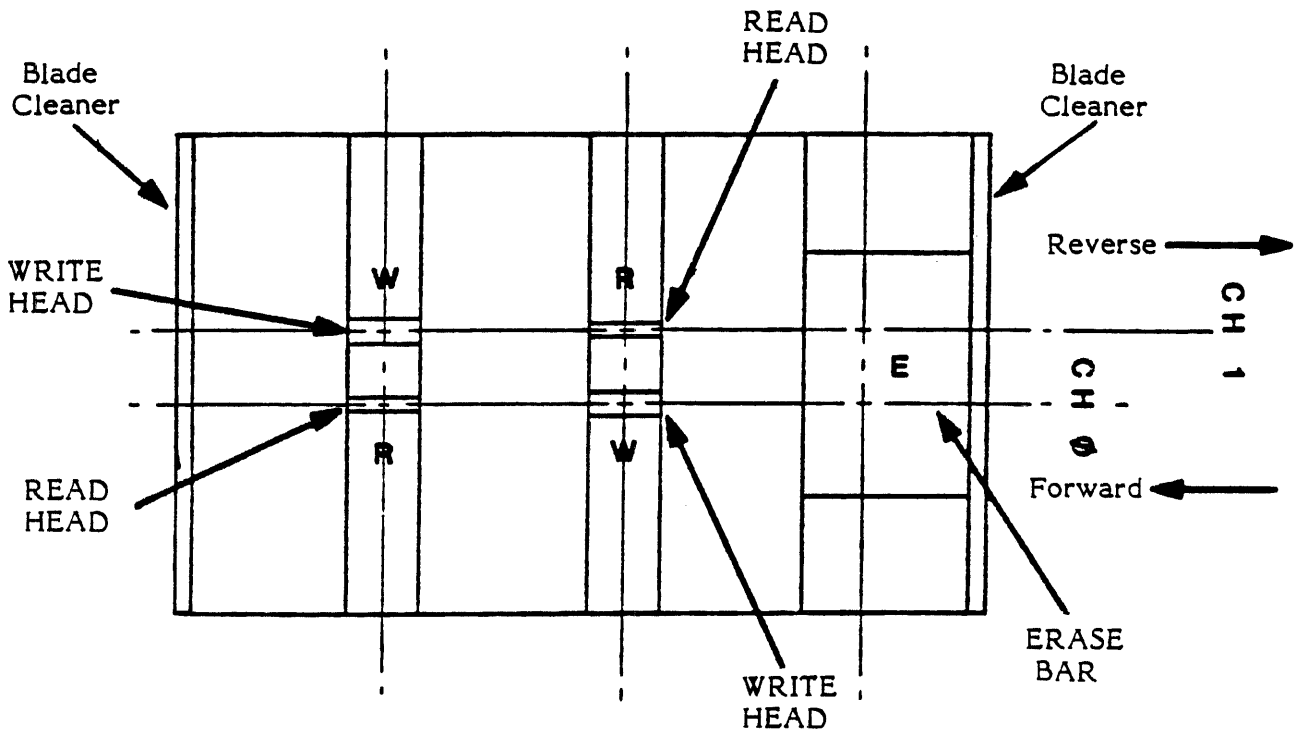
Storage through memory of data and software utilized by the microprocessor. Memory includes RAM and ROM.

The major features of the microprocessors are:

- o 8 bit bus
- o Clock on pins XTA connected to external crystal oscillator
- o RESET - active LOW which initiates the CPU on power-up
- o INT - active LOW interrupt signal that initiates an interrupt if enabled
- o ALE - Address Latch Enable
- o Ports 1 and 2 - read/write ports which control data
- o 1K X 8 Prom
- o 64 X 8 RAM
- o 27 I/O lines to control data commands

The CPU utilizes a control program to ensure correct sequencing and coordination of the cartridge tape drive functions.

The microcode firmware breaks down into two major sections which are the main and subsystem programs.



CH0: used during the forward direction only

CH1: used during the reverse direction only

Read/Write Head Assembly
with Erase Bar and Tape Cleaners
Figure 3.9

The following activities are included in the main program:

After reset:

- o initializes the CPU
- o initializes all ports
- o clears memory and regulator locations
- o absolute head positioning to Track 0
- o self test for normal operations
- o scanning for formatter/controller commands

The subsystem subroutines include the following:

- o absolute head positioning
- o capstan motor start/stop
- o magnetic head motion-up/down
- o track positioning
- o speed control for capstan motor
- o scanning for EOT/BOT

9.5 Detailed Theory of Operation

All commands are initiated through the formatter/controller, and directed to the basic drives CPU.

The initial command sent to the drive is RESET, on interface connector J1-pin 14 to CPU pin 4. Upon receipt of the RESET command, the CPU initiates an initialization routine which initializes two ports and clears memories and registers.

Upon completion of the initialization, the CPU begins scanning for signals on the 8-bit bus which enters from either the formatter/controller or the sensor assembly.

The first signal processed is Cartridge In Place (CIN-J4 pin 3); this signal indicates to the CPU that a cartridge is positioned correctly in the drive.

The CPU must assure that the read/write are positioned on Track 0 prior to the accepting any read/write commands. This is coordinated through the Sensor, Capstan Motor, and Stepper Motor assemblies under CPU control.

The formatter/controller initiates tape movement with GO (J1 pin 2) and REV (J1 pin 4). These commands are processed by the CPU and output from the main board to the drive board through connector J6 pin 1 and J6 pin 2 respectively.

The signals are then logically applied through IC's 7A and 7B, and move the Capstan Motor in either of the two directions. The current flow in a clockwise direction through J2 pin 2 (motor +), or counter-clockwise through J2 pin 1 (motor -). Refer to Table 2.0 for motion control logic.

TABLE 2.0 Capstan Motor Logic

<u>ON BUS</u>		<u>ON PORT</u>	
<u>REV</u>	<u>GO</u>	<u>FWD</u>	<u>REV</u>
0	0	0	0
1	0	0	0
0	1	1	0
1	1	0	1

After the tape is up to speed, the CPU scans for tapehole locators using signals clocked from the infrared Sensor Assembly.

Infrared light is emitted from the sensor and the UTH signal is routed through connector J4 pin 7, and the LTH through J4 pin 5. The signals are fed to two comparators and stored in a D flip flop.

The scanned signals are input to the CPU's 8-bit bus from IC 6C pin 9 and pin 5, respectively.

When the CPU senses BOT, tape motion is stopped and the CPU is ready to position the head.

The STEP ENABLE signal is generated from the CPU port 1, pin 34, as an active LOW.

The signal is inverted and logically nanded with the CPU - generated stepper control signals which are output to two places: stepper motor, connector J5 pins 7, 6, 5, and 4 combined with SAFE from connector J4 pin 1 to disable the write command.

The stepper motor receives these signals and initiates rotation of the shaft which mechanically positions the head to Track 0 on the tape.

Upon completion of the above steps, the tape is positioned at BOT and the head at Track 0.

At this point the drive is ready to begin the primary functions of read/write/erase, which are directed by signals directly inputted to/from the formatter/controller.

The controlling signals from the formatter/controller are: Write Enable Control (WEN J1 pin 48), Erase Enable Control (EEN J1 pin 50), and Write Data (WDA+ J1 pin 43 and WDA -J1 pin 40).

Writing to the tape is controlled by WEN and the two Write Data lines (WDA+, WDA-).

If the SAFE signal is not active, WEN will allow current to flow to the selected write head. WDA+ and WDA- define the data to be written.

The Erase function is enabled by EEN, and is routed through circuitry which outputs to connector J7 pin 7 and 8.

An internally generated AC signal energizes the erase pole only when the tape is at Track 0, through connector J7 pin 7, and if SAFE is Low(False) at connector J4 pin 1.

The Read signals are detected by the head as flux transitions, and transmitted to connector J8 pins 8 and 2 or 4 and 6, channel - and channel - respectively.

Data read from the head is first preamplified, then passed through a differentiator and filter circuitry.

The data is amplified again before passing through a comparator and limiter circuit.

Prior to being output to the formatter/controller, the data is passed through a time domain filter and output as Read Pulse Output - RDP (J1 pin 26).

As the drive brings the tape up to speed, and monitoring by the CPU is accomplished by the data received from the tachometer (J3 pins 1 and 3). The tachometer pulses are generated by the sensor on the Capstan Motor, and routed through a series of amplifiers, with inputs to the interrupt (INT- active LOW) input of the CPU, which will correct for the any variation in the speed.

10.0 MAINTENANCE CHECKS AND ADJUSTMENTS

This section contains the maintenance checks and adjustments that are performed during the normal life of the tape drive.

The following equipment is recommended for the checks and adjustments described:

1. Lint free cotton swabs
2. Freon TF or IBM tape head cleaner
3. Oscilloscope
4. Blank tape cartridge
5. Azimuth test tape cartridge
6. Alignment test tape cartridge
7. Tape drive exercisor
8. Wangtek head/azimuth adjustment tool (PN 200119-001).
9. 5/64-inch allen wrench (ball)
10. 3/32-inch allen wrench
11. .035-inch allen wrench
12. Small flat blade screwdriver
13. Cartridge tape power supply (+5 and +12 VDC)

10.1 Head Cleaning

NOTE: POWER MUST ALWAYS BE OFF.

The head cleaning procedure assures the user that the head is free of contamination to ensure proper head to tape compliance and prevention of data loss.

The head should be cleaned after 2 hours of use with a new cartridge, and every 8 hours thereafter of operation.

10.1.1 It may be necessary to dock the head in order to access the head for cleaning, due to some mounting schemes.

To dock the head, press the tape carriage plate to the rear of the drive. Stop pushing the plate when the travel is restricted and the latching mechanism releases. The carriage plate will automatically slide out (approximately 3/8-inches). At this point the head is docked.

10.1.2 Clean the head using the cotton swab and head cleaning solution. Clean the head only, never clean the capstan.

Return the head to the Ready (to load tape) position by pushing the carriage plate until its motion is restricted from any further travel.

10.2 Head/Track Alignment Check Procedure

The head alignment sets the position of the read/write tracks on the tape. For proper data interchange between cartridge tape drives, the head must be aligned properly.

10.2.1 Load a standard track alignment tape cartridge into a drive which is connected to a power supply.

10.2.2 Using an exercisor or test routine (Retension), run the tape from BOT to EOT (with Head 0 selected to read) and back.

10.2.3 Repeat step 10.2.2 with the oscilloscope connected to Test Point 5 to verify that there is output from the Read Head.

10.2.4 After 15% of the tape has been read (approximately 68 feet or 10 seconds), verify that Test Point 5 has very little or no output in the forward direction (BOT to EOT, physical) only. See Section 10.4 if the alignment is greater than 10% of the first 15% of the tape's signal.

10.3 Azimuth Check/Adjustment

The azimuth adjustment sets the lateral angle of the head to the path of the tape.

The head alignment check should be within the parameters stated above, prior to proceeding with this adjustment.

10.3.1 Load an Azimuth alignment tape into the drive, which should be connected to an exercisor or system and appropriate power supply.

10.3.2 Loosen the 2 head mounting screws $\frac{1}{4}$ turn (Figure 4.0).

10.3.3 Put the oscilloscope probe on Test Point 5.

10.3.4 Using an exercisor or test routing (Retension), run the tape from BOT to EOT (with Head selected to read) and back.

NOTE: NEVER adjust the drive in the reverse direction (EOT to BOT).

10.3.5 Repeat Section 10.3.4. During the portion of the tape that has the recorded signal on it, adjust the azimuth of the head with the Wangtek Head azimuth adjustment tool (PN 200119-001) so that the maximum signal is present.

10.3.6 Tighten the head mounting screws, and re-check to verify that the amplitude has not dropped.

10.3.7 Re-check the Head Alignment and adjust if necessary.

10.4 Head Alignment Procedure

NOTE: The following requires a tape alignment exercisor.

10.4.1 Load a standard track alignment tape cartridge into the drive.

10.4.2 Using the exercisor, step the stepper motor until the locking collar can be accessed. Loosen the locking collar on the head positioner. (Figure 4.1)

10.4.3 Using the tape exercisor, run the tape from BOT to EOT with Head 0 and Track 0 selected.

NOTE: NEVER adjust the drive in the reverse direction (EOT to BOT).

10.4.4 After approximately 10 seconds of running, step the head positioning motor to the position which provides the least signal amplitude peak to peak as monitored at Test Point 5.

10.4.5 Step the head down 121 Steps.

10.4.6 Rotate the locking collar to the right until it rests snug, and tighten the locking collar's set screw.

10.4.7 Step the head up 121 Steps.

- 10.4.8 Verify that the signal at Test Point 5 is still null as seen in step 10.4.4.
- 10.4.9 Recheck the track alignment and adjust if necessary. Should you encounter problems with either data interchangeability or excessive hard error rate, it is suggested that the alignment/check procedure be initiated to assure that the head assembly is in alignment as described in the above procedures.

11.0 REPLACEMENT PROCEDURE

NOTE: All power and the formatter/controller board should be disconnected prior to proceeding with any replacement of components on the drive.

11.1 Drive Belt

- 11.1.1 Without a cartridge being loaded and the base plate in the unloaded or in-position, gently grasp the spindle drive belt and remove it from the drive.
- 11.1.2 With the drive still in the unloaded position, gently install the new belt over the motor and the capstan drive pulleys. Rotate the capstan by hand to seat the drive belt.

11.2 Front Bezel

- 11.2.1 Remove the two screws at either side of the bezel (Figure 5.0).
- 11.2.2 Remove the front bezel.
- 11.2.3 Making sure that the flat connector cable is secured to the chassis, carefully re-install the front bezel.
- 11.2.4 Install the two screws that secure the front bezel to the chassis.
- 11.2.5 Check that the front bezel is correctly installed by loading a cartridge, and check for no interference between the front bezel and the cartridge base plate.

11.3 Left Rail

- 11.3.1 Remove the three screws that secure the left rail to the side of the chassis (Figure 5.1).
- 11.3.2 Remove the screw that secures the left rail to the top of the chassis. Save the spacer.
- 11.3.3 Lift the rail away from the drive.

CAUTION: The head assembly is now unprotected. Be careful not to bend the head flexures and the sensor housing the UTH/LTH flexure strips.

11.3.5 Install the left rail in the reverse order of the removal procedure. Take care to assure that the flat-pak connector cables are not pinched or crimped between the rail and chassis.

11.4 Right Rail

11.4.1 Remove the three screws that secure the rail to the chassis. (Figure 5.2)

11.4.2 Lift the rail from the chassis.

11.4.3 Re-install the rail by reversing the removal procedure.

11.5 Motor Driver Board

11.5.1 Remove the right rail. (Section 11.4)

11.5.2 Remove the connector to the capstan motor.

11.5.3 Remove the two screws that attach the motor driver board to the chassis. (Figure 5.3)

11.5.4 Lift the motor driver board away from the chassis.

11.5.5 Install the replacement motor driver board by reversing the removal procedure, taking care to assure that the connector to the motor is properly inserted.

11.5.6 Check to ensure that all spacers are in position and that the feed through connector between the board is seated correctly.

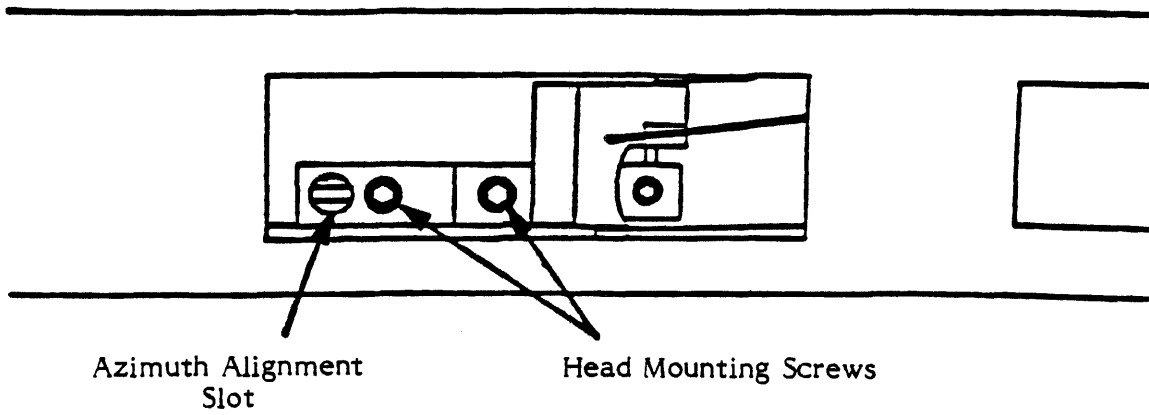
11.6 Main Board

11.6.1 Carefully remove the five (5) connectors from the main board.

CAUTION: Due to the flexure cables being extremely fragile, it is suggested that they be removed from the board by pulling them straight up from the board by the connector body only.

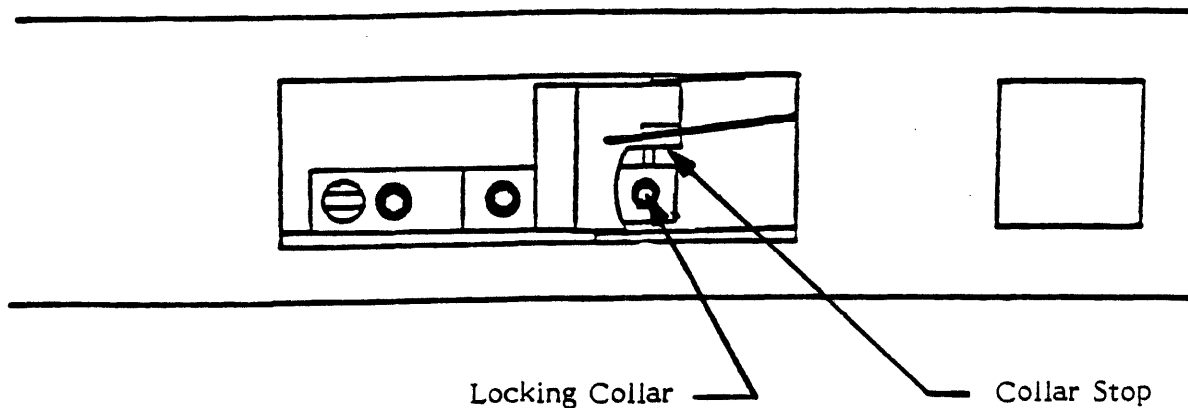
11.6.2 Remove the three screws that attach the main board to the chassis. (Figure 5.4)

11.6.3 Carefully lift the main board from the chassis.



Head Azimuth Adjustment Locations
Figure 4.0

Note: Head is shown in Recalibration position (121 steps down from track \emptyset position).



Set the track alignment by pushing the locking collar up into the collar stop and rotate the locking collar to the right until it stops. See Sec. 10.4

Head Tracking Adjustment Locations
Figure 4.1

11.6.4 To re-install the main board, reverse the removal procedure, checking to assure that the connectors are re-installed correctly and that all the jumper blocks are configured in the same way as removed from the board.

11.7 Drive Motor

11.7.1 Remove the drive belt. (Section 11.1)

11.7.2 Remove the left rail. (Section 11.3)

11.7.3 Unplug both of the connectors between the motor and the motor driver board. (Figure 5.5)

11.7.4 Remove the three screws that mount the drive motor to the chassis, saving the spacers and washers.

11.7.5 Carefully lift the drive motor away from the chassis.

11.7.6 Install the drive motor by reversing the removal procedures, being sure to re-install all spacers and washers prior to tightening all screws.

11.8 Formatter Chassis

11.8.1 Remove the front bezel. (Section 11.2)

11.8.2 Remove the connector from the formatter/controller to the basic drive.

11.8.3 Remove the two screws by the edge connect and power plug, and slide the formatter PCBA out.

11.8.4 Install the chassis in the reverse order of the removal procedure.

Ensure that all the spacers are properly replaced when installing the board (QIC-02/24 only).

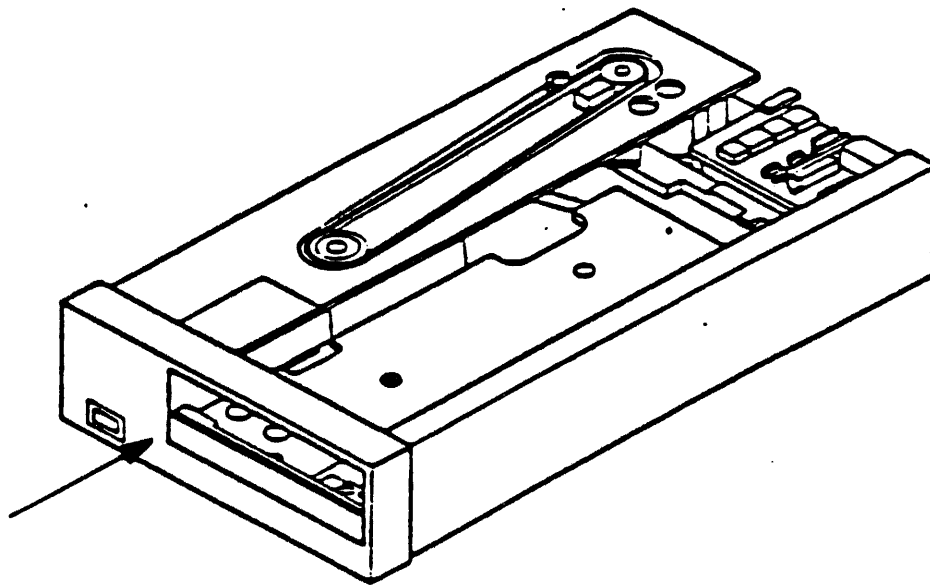
12.0 TROUBLESHOOTING GUIDE FOR BASIC DRIVE

12.1 Initial Checks

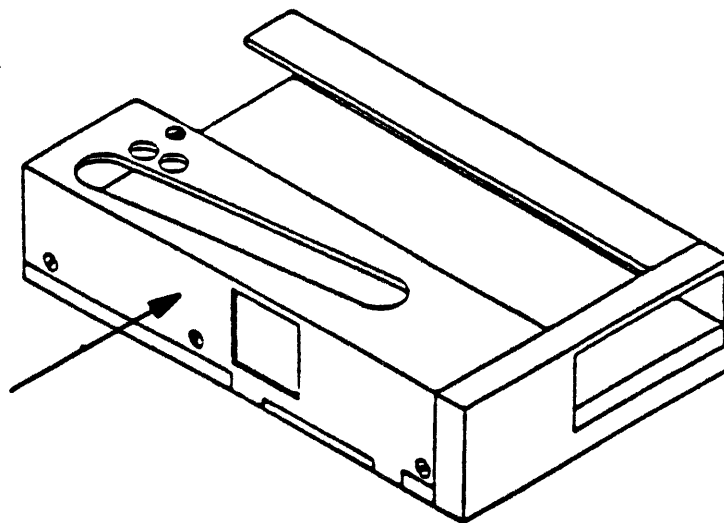
Prior to initiation of the troubleshooting procedure, check the drive and associated system components for any problems.

Always check cables, interface, host system, cartridge tape, and power tolerances.

Check connectors, jumpers, and terminators for proper location, and check that they are properly seated.



Front Bezel
Figure 5.0



Left Rail
Figure 5.1

12.2 Interchange

Interchange is defined as being able to read tapes generated on other drives.

Recommended Procedure:

1. Check Alignment
2. Check Azimuth adjustment, see Section 10.3 for adjustment procedure.

12.3 Data Reliability

Data reliability is defined as a drive exhibiting excessive (unrecoverable) read errors.

Recommended Procedure:

1. Verify that the tape cartridge is still good.
2. Clean the read/write head assembly.

NOTE: Always turn power off when cleaning head.

12.4 Non-Operation

Non-operation is defined as the drive not responding to any commands from the host, the lack of tape motion, or the inability to reset the head assembly.

Recommended Procedure:

1. Perform initial checks
2. Replace the main board.

12.5 Tape Inactive

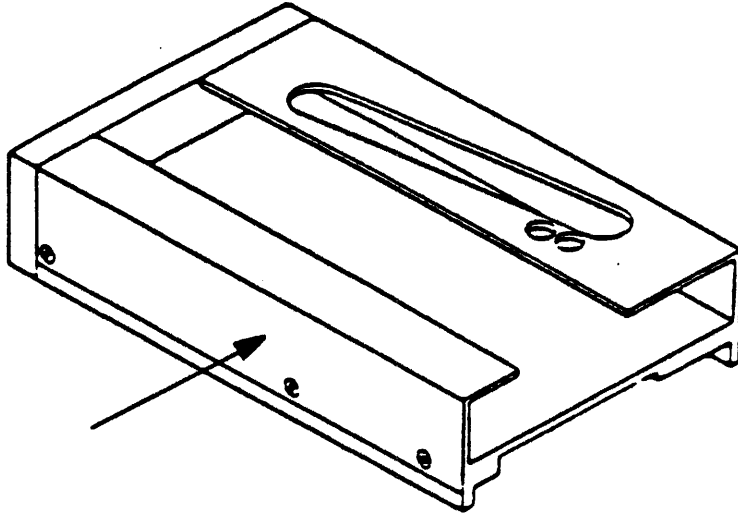
Tape inactive is defined as the head assembly being reset, but the drive does not respond to any motion commands.

Recommended Procedure:

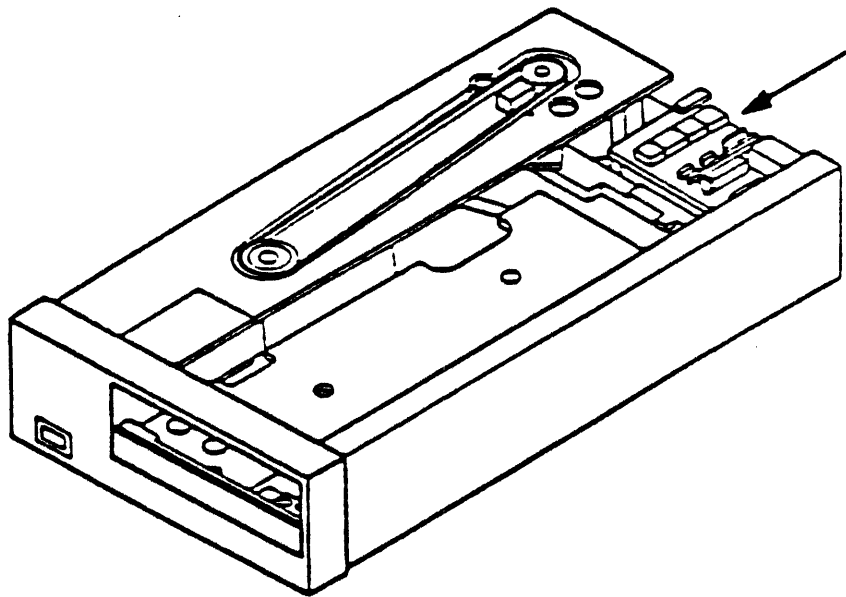
1. Replace the motor driver board.
2. Replace the main board.

12.6 Miscellaneous

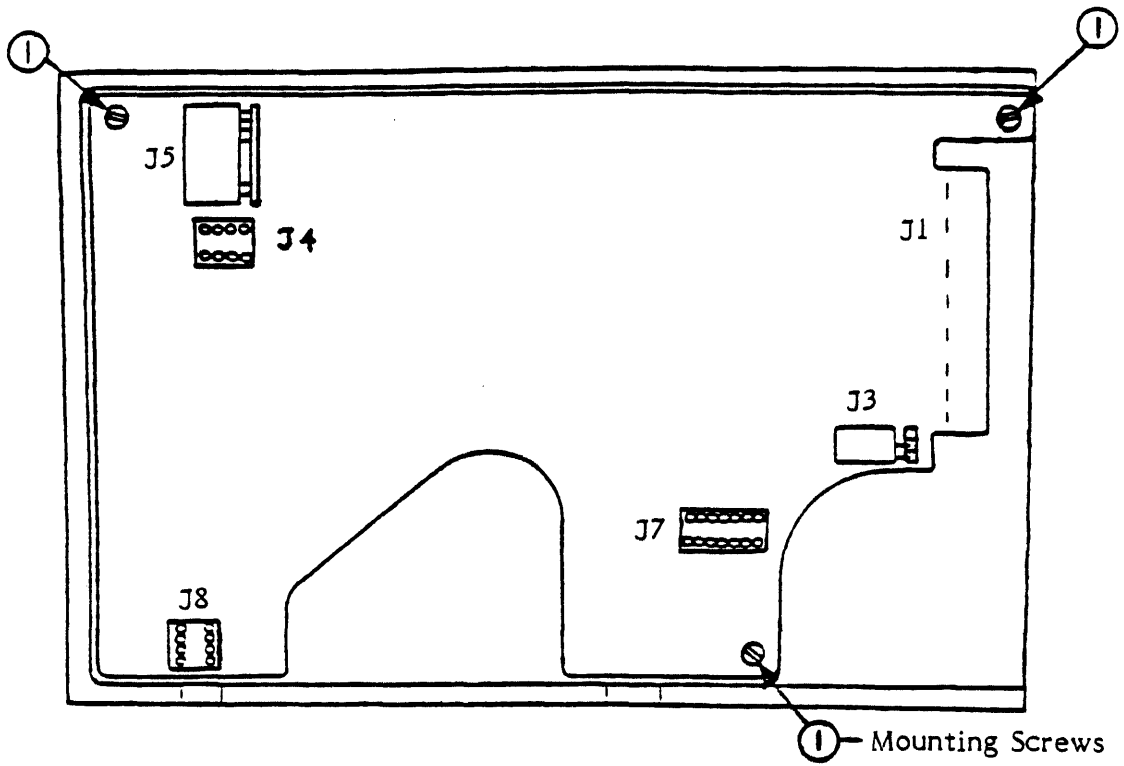
If none of the above procedures are successful, contact the nearest Wangtek Service Center for assistance and/or repair.



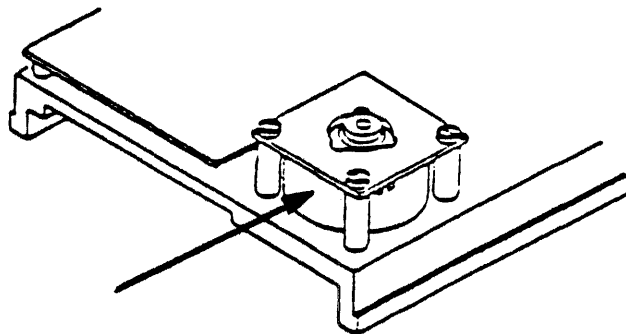
Right Rail
Figure 5.2



Motor Driver Board
Figure 5.3



Main Board
Figure 5.4



Drive Motor
Figure 5.5

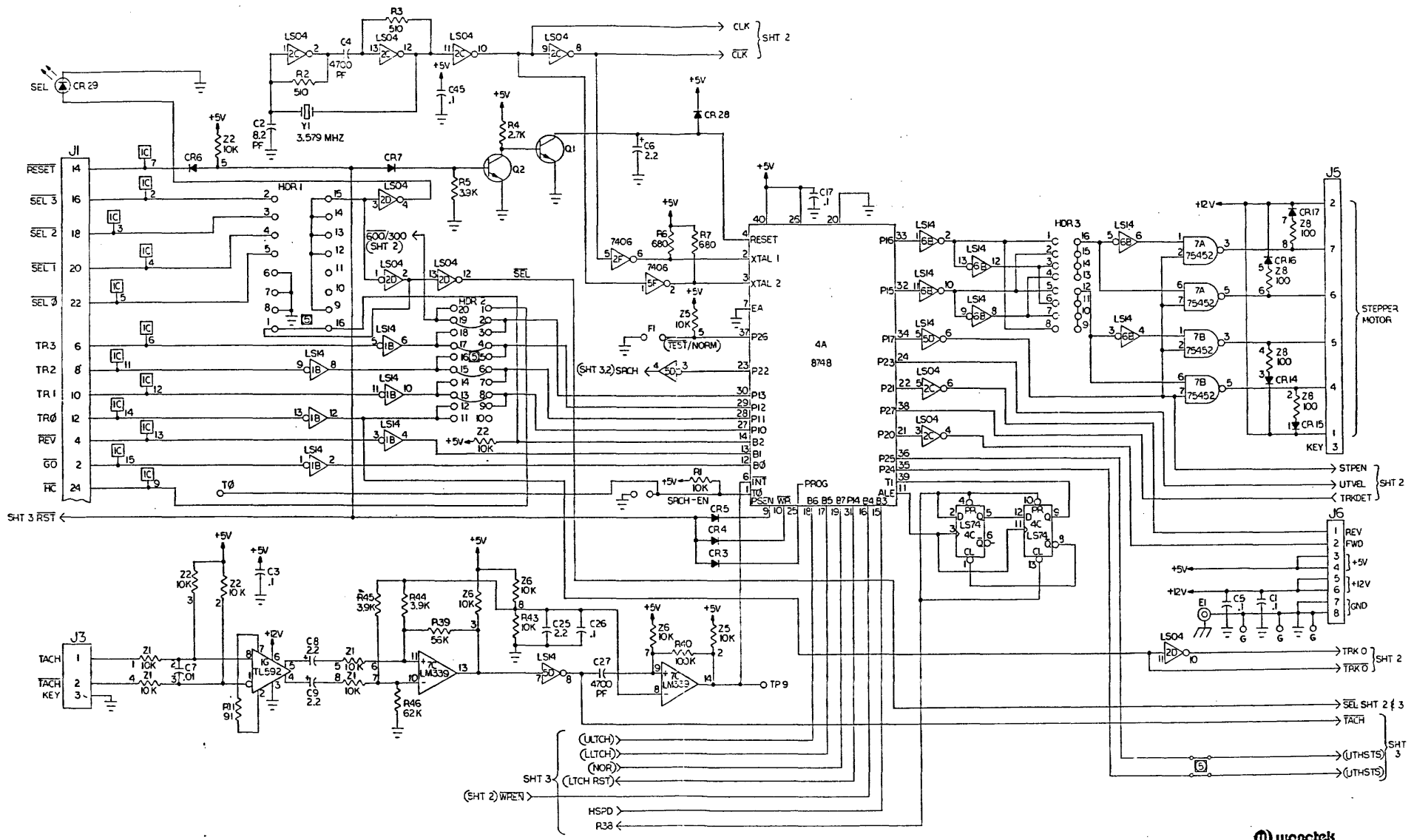
13.0 PARTS LIST

All assemblies listed are available for purchase as spare replacement parts.

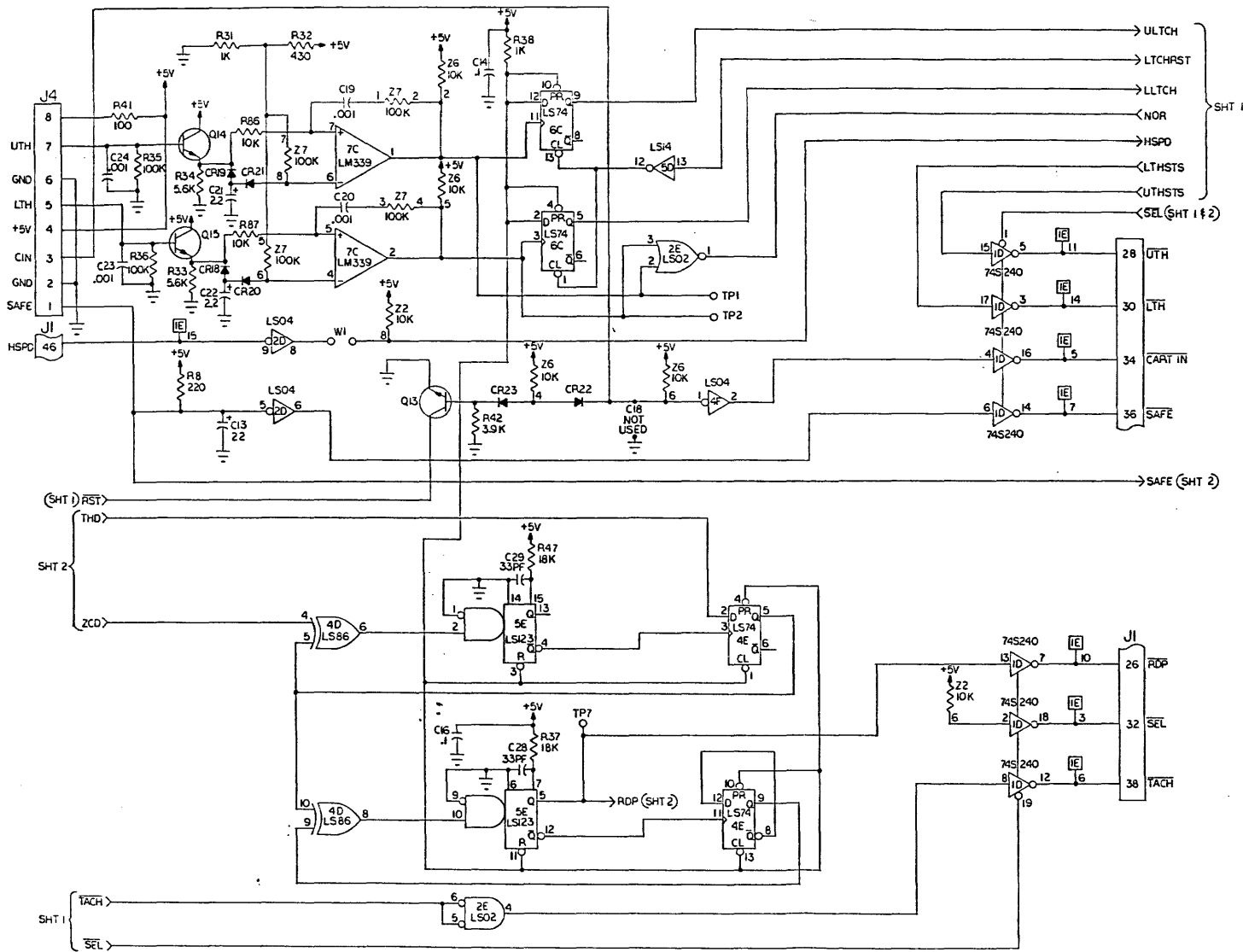
If an assembly has been determined to be defective and is not on the list, the drive must be returned to the manufacturer.

<u>DESCRIPTION</u>	<u>PART NUMBER</u>
Main Board- Q-24 (TK0 Burst)	30051-001
- Q-11	30051-003
- Q-24 (TK0 Burst)	30051-101
Separate Ground	
- Q-11 Separate Ground	30051-103
Motor Driver Board	30148
Drive Motor Assembly	200080-002
Drive Belt	200120-001
Front Bezel - 1/2 high, 3 flange	20451
- 1/2 high, 4 flange	20452
- 1/2 high, no flange	200301-001
- full high, 4 flange	200302-003
- full high, no flange	200302-001
Rail - Left	20213
- Right	20212
Formatter/Controller- Q24, 9TK (45 to 60 MB*)	30033-001
- Q11, 9TK (45 to 60 MB*)	30033-002
- Q11, 4TK (20 to 26.7 MB*)	30033-003
Formatter Chassis	20488
Wangtek Azimuth Adjustment Tool	200119-001
Wangtek Azimuth and Track Alignment Tape	300007-001

* See Section 4.1 for Storage Capability.



wangtek
SCHEMATIC, MAIN BOARD-
600/300

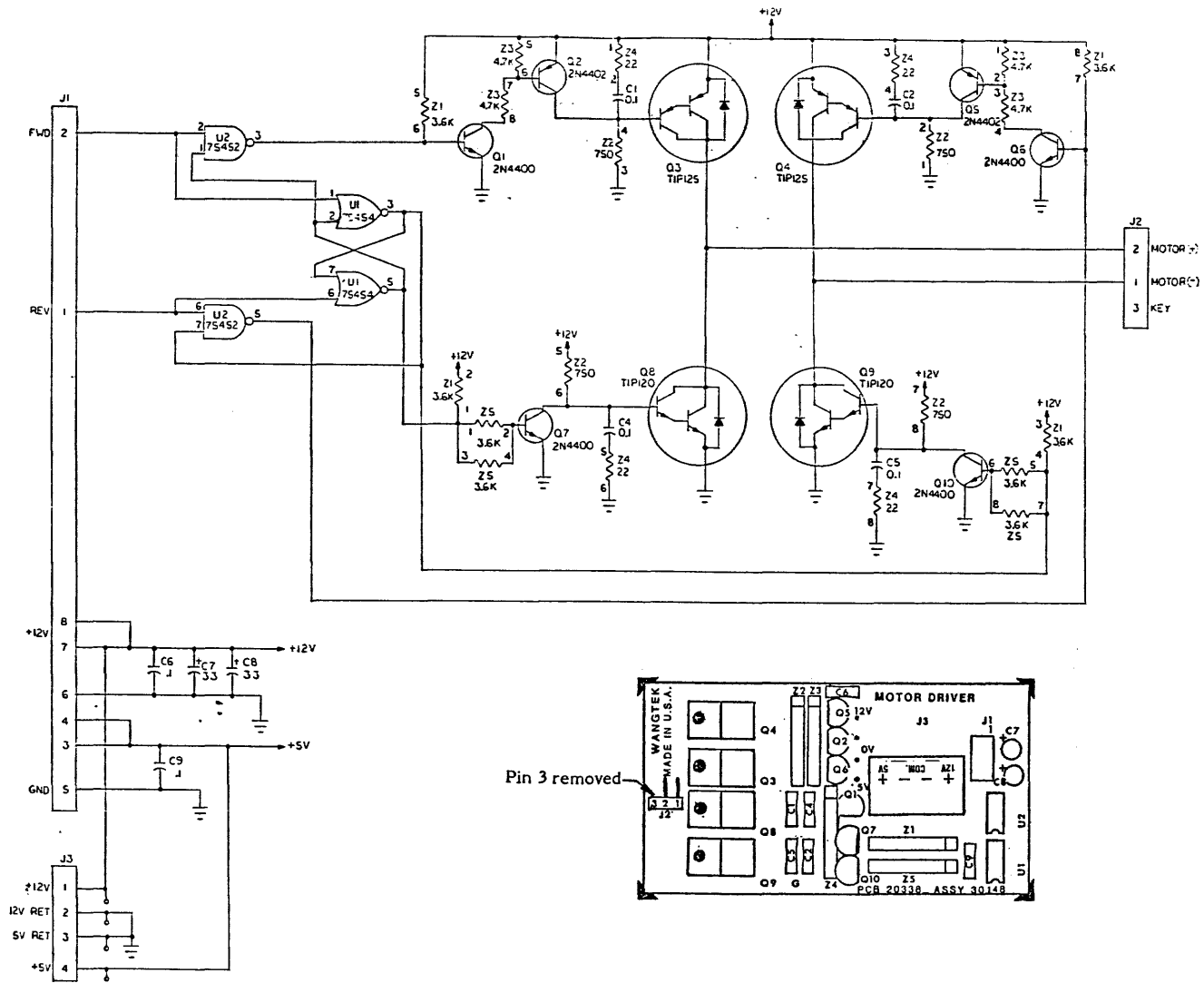


LC POWER CONNECTION

LOC.	TYPE	PWR	GND
1B, 5D, 6C	74LS14	14	7
1C, 1E	220/330 TERM	16	8
1D	74S240	20	10
2C, 2D, 4F	74LS04	14	7
4C, 4E, 6C	74LS74	14	7
1G, 6G, 8H	TL592	6	3
4A	8748	40	20
4H	74LS09	14	7
5E	74LS123	16	8
2F, 5F	7406	14	7
2E	74LS02	14	7
3H	76451	8	4
4D	74LS86	14	7
7A, 7B	75452	8	4
7C	LM339	3	12
7E	LM319	11	3
8E	74LS153	16	8
5C	74LS109	16	8
7G	4053 B	16	8



SCHEMATIC, MAIN BOARD -
600/300



MOTOR DRIVER BOARD
SCHEMATIC & LAYOUT