

Blank lined area at the top of the page.

OEM MANUAL
SERIES 5099EQ/5125EQ/5150EQ QIC-02 INTERFACE
STREAMING 1/4 INCH TAPE CARTRIDGE DRIVE

Blank lined area at the bottom of the page.



OEM MANUAL
SERIES 5099EQ/5125EQ/5150EQ QIC-02 INTERFACE
STREAMING 1/4 INCH TAPE CARTRIDGE DRIVE



OPERATING AND SERVICE MANUAL NO. 63046-001

Rev. A

FORWARD

This manual provides operating and service information for the Streaming 1/4 Inch Tape Cartridge Drive, Model 5125EQ / 5150EQ, Manufactured by Wangtek Incorporated, 41 Moreland Road, Simi Valley, California.

The content includes a detailed product description, specifications, installation and operation instructions. Also included are theory of operation, maintenance, troubleshooting, and parts removal and replacement instructions.

TECHNICAL SUPPORT

If for any reason you require product technical support, please contact the OEM or Distributor where you first purchased your equipment. If they cannot help you or at their direction, Wangtek Technical Support can be reached at:

WANGTEK Incorporated
41 Moreland Road
Simi Valley, CA. 93065

(805) 583-5255
Telex 650450
TWX (910) 494-1925
FAX (805) 522-1576

WANGTEK-Europe
Unit 1A, Apollo House
Calleva Industrial Park
Aldermaston, Reading
RG7 4QW England
44-7356-77746
Telex 851-848135
FAX 44-7356-6076

WARNING

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for Class B computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial or residential environment.

PROPRIETARY NOTICE

This document contains information proprietary to Wangtek Incorporated. No reproduction, in whole or in part, or use of the information contained within is authorized except as Wangtek may agree to in writing.

COPYRIGHT NOTICE

This document and the information contained within is copyright by Wangtek Incorporated and may not be duplicated in full or in part by any person without prior written approval of Wangtek. While every effort has been made to keep the information contained within current and accurate as of the date of publication, no guarantee is given or implied that the document is error-free or that it is accurate with regard to any specification. Wangtek reserves the right to make changes, for the purpose of product improvement, at any time.

Table of Contents

Section 1 - PRODUCT DESCRIPTION	Page
1.1 Introduction	1-1
1.1.1 Model Identification	1-1
1.2 Purpose of Equipment	1-1
1.2.1 Features	1-1
1.3 Functional Description of Equipment	1-2
1.4 Mechanical and Electrical Specifications	1-3
1.5 Reference Documents	1-4
 Section 2 - INSTALLATION AND OPERATION	
2.1 Physical Description	2-1
2.1.1 Mechanical Dimensions	2-1
2.1.2 Weight Characteristics	2-1
2.2 Mounting Requirements	2-1
2.3 Cartridge Loading And Unloading	2-4
2.4 Tape Cartridge Characteristics	2-5
2.4.1 Write Protect Feature	2-5
2.4.2 Handling And Storage	2-5
2.5 Jumper Configuration	2-6
2.5.1 E2 Clock Frequency	2-6
2.5.2 E3 - E4 Last Track Status	2-6
2.5.3 E5 Write Precomp	2-6
2.5.4 E8 - E9 2Kbyte RAM	2-7
2.5.5 E7 - E10 8Kbyte RAM	2-7
2.5.6 E11 Chassis Ground	2-7
2.5.7 E12-E14 Default Data Format	2-7
2.5.8 HDR1 Pins 1,4 & 5 Test Mode	2-7
2.5.9 HDR1 Pins 2 & 3 Stepper Phase Alignment.	2-7
 Section 3 - GENERAL RECORDING FORMAT	
3.1 Introduction	3-1
3.2 Recording Method	3-1
3.2.1 Recording Code	3-1
3.3 QIC Recorded Block Format	3-2
3.3.1 Preamble	3-2
3.3.2 Data Block Marker	3-2
3.3.3 Data Block	3-2
3.3.4 Block Address	3-2
3.3.5 Cyclical Redundancy Check	3-3
3.3.6 Postamble	3-3
3.4 QIC-24 Recording Format	3-4
3.4.1 Track Center Line Locations	3-4

Table of Contents (continued)

	Page
3.4.2 Tape Position Holes And Track Locations	3-4
3.5 QIC-120 Recording Format	3-5
3.5.1 QIC-120 Track Center Line Locations	3-5
3.5.2 Tape Position Holes And Track Locations	3-5
3.6 QIC-150 Recording Format	3-7
3.6.1 QIC-150 Track Center Line Locations	3-7
3.6.2 Tape Position Holes And Track Locations	3-8
 Section 4 - INTERFACE	
4.1 Introduction	4-1
4.2 Power Connector And Contacts	4-1
4.3 Host Interface Connector	4-1
4.4 Interface Signal Levels	4-2
4.5 Signal Loading	4-2
4.6 Control Lines	4-4
4.6.1 Reset	4-4
4.6.2 Exception	4-4
4.6.3 Online	4-4
4.6.4 Request	4-4
4.6.5 Ready	4-4
4.6.6 Transfer	4-4
4.6.7 Acknowledge	4-5
4.6.8 Direction	4-5
4.7 Command Descriptions	4-5
4.7.1 SELECT DRIVE Command (01H)	4-5
4.7.2 SELECT QIC-24 FORMAT Command (27H)	4-5
4.7.3 SELECT QIC-120 FORMAT Command (28H)	4-5
4.7.4 SELECT QIC-150 FORMAT Command (29H)	4-5
4.7.5 WRITE DATA Command (40H)	4-6
4.7.6 WRITE WITHOUT UNDERRUNS Command (41H)	4-7
4.7.7 WRITE FILE MARK Command (60H)	4-7
4.7.8 WRITE FILE MARK/WRITE Command (62H)	4-7
4.7.9 WRITE FILE MARK/WRITE WITHOUT UNDERRUNS Command (63H)	4-7
4.7.10 READ DATA Command (80H)	4-8
4.7.11 READ CONTINUOUS Command (82H)	4-8
4.7.12 READ BLOCK N Command (8AH)	4-8
4.7.13 SPACE FORWARD Command (81H)	4-8
4.7.14 SPACE REVERSE Command (89H)	4-9
4.7.15 SEARCH TO END OF RECORDED MEDIA Command (A3H)	4-9
4.7.16 READ FILE MARK Command (A0H)	4-9
4.7.17 READ N FILE MARKS Command (B1H - BFH)	4-9
4.7.18 READ STATUS Command (C0)	4-9

Table of Contents (continued)

	Page
4.7.19 ERASE TAPE Command (22H)	4-10
4.7.20 INITIALIZATION (Retention) Command (24H)	4-10
4.7.21 REWIND To BOT Command (21H)	4-10
4.7.22 RUN SELF-TEST 1 Command (C2H)	4-10
4.7.23 RUN SELF-TEST 2 Command (CAH)	4-10
4.7.24 RUN SELF-TEST 3 Command (CBH)	4-11
4.7.25 READ FIRMWARE IDENTIFICATION Command (CFH)	4-11
4.7.26 Power-On/Reset	4-12
4.8 Status Description	4-12
4.8.1 Status Byte Descriptions	4-12
4.9 Exception Status Summary	4-14
4.9.1 Exception Status Description	4-14
4.10 Interface Timing	4-15
4.10.1 Reset Timing	4-16
4.10.2 Read Status Timing	4-16
4.10.3 Select Command Timing	4-16
4.10.4 Position Command Timing	4-16
4.10.5 Write Data Timing	4-16
4.10.6 Read Data Timing	4-16
4.10.7 Write File Mark Command Timing	4-16
4.10.8 Read File Mark Command Timing	4-16
 Section 5 - THEORY OF OPERATION	
5.1 Introduction	5-1
5.2 General Information	5-1
5.3 Capstan Motor Control	5-1
5.4 Write And Erase Controls	5-3
5.5 Read Data	5-3
5.6 Track Calibration Routines	5-3
5.6.1 Writing Track 0 Reference Burst	5-3
5.6.2 Track Zero Burst Detection	5-4
5.7 Major Component Functions	5-4
5.7.1 Cartridge	5-4
5.7.2 Sensor Assembly	5-5
5.7.3 Head Stepper Motor Assembly	5-6
5.7.4 Magnetic Head	5-6
5.8 Electro-static Discharge Specification	5-7
5.8.1 Definitions Of Effects	5-7
5.8.2 Test Criteria	5-7
5.8.3 Test Procedures	5-7

Table of Contents (continued)

Section 6 - MAINTENANCE	Page
6.1 Introduction	6-1
6.2 Product Reliability And Failure Definitions	6-1
6.2.1 Critical Failure	6-1
6.2.2 Infant Mortality Failure	6-1
6.3 Duty Cycle	6-1
6.4 Mean Time Between Failure	6-1
6.5 Mean Time To Repair	6-1
6.6 Data Reliability	6-2
6.7 Preventive Maintenance	6-2
6.7.1 Read/Write Head Cleaning Procedure	6-2
6.7.2 Capstan Cleaning Procedure	6-2
6.8 Troubleshooting Guide	6-3
6.8.1 Initial Checks	6-3
6.9 Power Malfunction	6-3
6.9.1 No +5 VDC and/or +12 VDC	6-3
6.10 Tape Motion Malfunction	6-3
6.10.1 Drive will not run in any mode.	6-3
6.10.2 Motor "runs away" (into very high speed).	6-3
6.10.3 Motor turns but does not drive cartridge.	6-3
6.10.4 Motor starts to drive cartridge but stops immediately.	6-3
6.10.5 Motion causes excessive noise.	6-3
6.11 Status Malfunction	6-3
6.11.1 No UTH or LTH signals.	6-3
6.11.2 UTH and/or LTH present at all times.	6-3
6.11.3 SAFE signal not functioning.	6-4
6.11.4 CIN signal not functioning.	6-4
6.11.5 L.E.D. not lighting.	6-4
6.11.6 L.E.D. always lit.	6-4
6.12 Data Malfunction	6-4
6.12.1 Drive will not read or write.	6-4
6.12.2 Drive will not read all tracks.	6-4
6.12.3 Drive will not read on one track.	6-4
6.12.4 Drive will not write but will read previously written tape.	6-4
6.12.5 Drive will not erase previously written information.	6-4
6.12.6 Excessive errors in read while write mode but not in read only mode.	6-5
6.12.7 Excessive errors in read only but not in read after write mode.	6-5
6.12.8 Excessive data errors in all modes.	6-5
6.12.9 The drive is non-operational. No tape movement, QIC-02 interface inoperative. ...	6-5
6.12.10 Tape drive does not respond to commands.	6-5
6.12.11 Cannot Write Tape	6-5
6.12.12 Cannot Read Tape.	6-5

Table of Contents (continued)

	Page
6.12.13 Cannot read tape beyond a predefined track	6-6
6.13 Parts Removal & Replacement Procedures	6-6
6.13.1 Drive Belt	6-6
6.13.2 Front Bezel	6-6
6.13.3 Left Side Rail Assembly	6-6
6.13.4 Main Board	6-8
6.13.5 Chassis Option	6-9
6.14 Adjustment Procedures	6-9
6.15 Read Amplifier Gain Adjustment	6-9
 Section 7 - PARTS LISTS, APPENDIX AND SCHEMATICS	
7.1 Introduction	7-1
7.2 Illustrated Parts Breakdown	7-1
7.3 Appendix A - Glossary of Terms	7-4
7.4 Appendix B - Schematics	7-7

List of Illustrations

	Page
Figure 1-1 Model Number Breakdown	1-1
Figure 1-2 Functional Block Diagram	1-2
Figure 2-1 Basic Drive Mounting Dimensions	2-2
Figure 2-2 Full Height Drive Mounting Dimensions	2-3
Figure 2-3 Cartridge Loading	2-4
Figure 2-4 Cartridge Unloading	2-4
Figure 2-5 Data Cartridge Write Protection	2-5
Figure 2-6 Jumper Locations	2-6
Figure 3-1 Data Block Format	3-2
Figure 3-2 QIC-24 Track Centerline Locations	3-4
Figure 3-3 QIC-24 Tape Position Holes and Track Locations	3-5
Figure 3-4 QIC-120 Track Center Line Locations	3-6
Figure 3-5 QIC-120 Tape Position Holes and Track Locations	3-7
Figure 3-6 QIC-150 Track Center Line Locations	3-8
Figure 3-7 QIC-150 Tape Position Holes and Track Locations	3-9
Figure 4-1 Interface Connector Dimensions	4-2
Figure 4-2 Interface Signal Terminations	4-3
Figure 4-3 Reset Timing	4-17
Figure 4-4 Read Status Command Timing	4-18
Figure 4-5 Select Command Timing	4-19
Figure 4-6 BOT, Retension or Erase Command Timing	4-20
Figure 4-7 Write Data Command Timing	4-21
Figure 4-8 Read Data Command Timing	4-22
Figure 4-9 Write File Mark Command Timing	4-23
Figure 4-10 Read File Mark Command Timing	4-24
Figure 5-1 Functional Block Diagram	5-2
Figure 5-2 Capstan Motor Control	5-2
Figure 5-3 Write And Erase Circuits	5-3
Figure 5-4 Tape Cartridge	5-5
Figure 5-5 Read / Write Head	5-6
Figure 6-1 Front Bezel Removal	6-7
Figure 6-2 Left Side Rail Removal	6-7
Figure 6-3 Main Board Removal	6-8
Figure 7-1 Illustrated Parts Breakdown	7-2

List of Tables

	Page
Table 1-1 Electrical and Mechanical Specifications	1-3
Table 1-1 Electrical and Mechanical Specifications	1-4
Table 3-1 Data To GCR (4 to 5) Translation	3-1
Table 3-1 Data Block Marker	3-2
Table 3-2 Block Address Bit Definations	3-3
Table 3-3 Control Nibble Bit Definations	3-3
Table 4-1 J2 Power Connector Pin Assignments Current Requirements	4-1
Table 4-2 Input Power Requirements	4-2
Table 4-3 Interface Connerctor Pin Assignments	4-3
Table 4-4 QIC-02 Standard & Optional Command Sets	4-6
Table 4-5 Definition Of Self-Test Error Bytes	4-11
Table 4-6 Status Bytes	4-12
Table 4-7 Exception Status Summary	4-15
Table 5-1 Maximum Permissible Occurence Rates	5-8
Table 6-1 Recommended Preventive Maintenance Schedule	6-2
Table 6-2 "K" Factor Adjustment Values	6-10
Table 7-1 Illustrated Parts List	7-3

Section 1

PRODUCT DESCRIPTION

1.1 Introduction

This section contains information about the purpose of the equipment, the physical and functional descriptions, and the mechanical and electrical specifications of the Wangtek model 5099EQ/5125EQ/5150EQ Streaming Cartridge Tape Drive, also referred to as the drive.

1.1.1 Model Identification

The basic drive model designator is the 5XXX-EQ series. This model number can be found on the drive identification label located on the left side of the drive. The complete model number breakdown is provided in Figure 1-1.

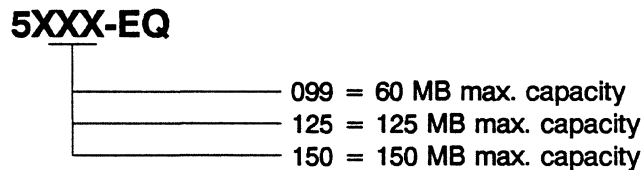


Figure 1-1
Model Number Breakdown

Also included on the identification label is the drive assembly number, also referred to as the drive part number. This number reflects the exact unit configuration and should be referred to in any communication with Wangtek.

1.2 Purpose of Equipment

The 5XXX-EQ, manufactured by Wangtek Incorporated, is designed to write and recover data on 1/4 inch magnetic tape cartridges conforming to ANSI standards. The data format written on tape conforms to the QIC-60, QIC-120 or QIC-150 specifications, depending on model selected, providing 60, 125 or 150 megabytes of formatted storage capacity depending on the type of tape cartridge used. The 5099EQ drive can also write and read data conforming to the QIC-11 specification. The 5125EQ & 5150EQ drives also have provisions for reading cartridges that have been recorded in the QIC-24 data format to allow for greater data interchangeability. The drive interfaces to the host computer through the embedded industry standard QIC-02 intelligent interface. The 5XXX-EQ is used primarily as a backup storage device to prevent the loss of valuable data due to accidental erasure or destruction caused by storage device failure. The removable data cartridge and the QIC standard recording formats also allow the drive to be used for data interchange and distribution.

1.2.1 Features

- Supports standard QIC-02 command set.
- Supports ANSI defined optional command set.
- Standard 8K byte data buffer.
- Single digital PLL chip with selectable (5%, 10%, or 15%) write precompensation.
- Low power D.C. brushless motor.
- Recording burst reference detection.

- Off track seek error retry algorithm.
- Integrated write/read analogue chip.

1.3 Functional Description of Equipment

The operation of the drive can be divided into six (6) major functional blocks as outlined in Figure 1-2. The drive is designed to utilize the 550 Oersted (DC 600A, DC 600 XTD or equivalent) tape cartridges when writing. In the read mode of operation, the drive is compatible with either the 310 Oersted (DC 300XL/P or equivalent) or 550 Oersted tape cartridges, therefore it is backward compatible with the QIC-24 data format. In the read mode, the drive will first determine tape type, search for the applicable reference burst, then read the tape. The 5099EQ is capable of writing and reading QIC-11 or QIC-24 formats. The 5125EQ is capable of writing and reading QIC-120 and reading QIC-24 formats. The 5150EQ is capable of writing and reading QIC-150 or QIC-120 and reading QIC-24 formats.

The drive utilizes the QIC-24, QIC-120 or QIC-150 track reference burst to automatically position the head to the center of Track 0 when reading a tape. This feature minimizes misalignment of the head when reading tapes generated by other drives utilizing the QIC-24, QIC-120 or QIC-150 data format.

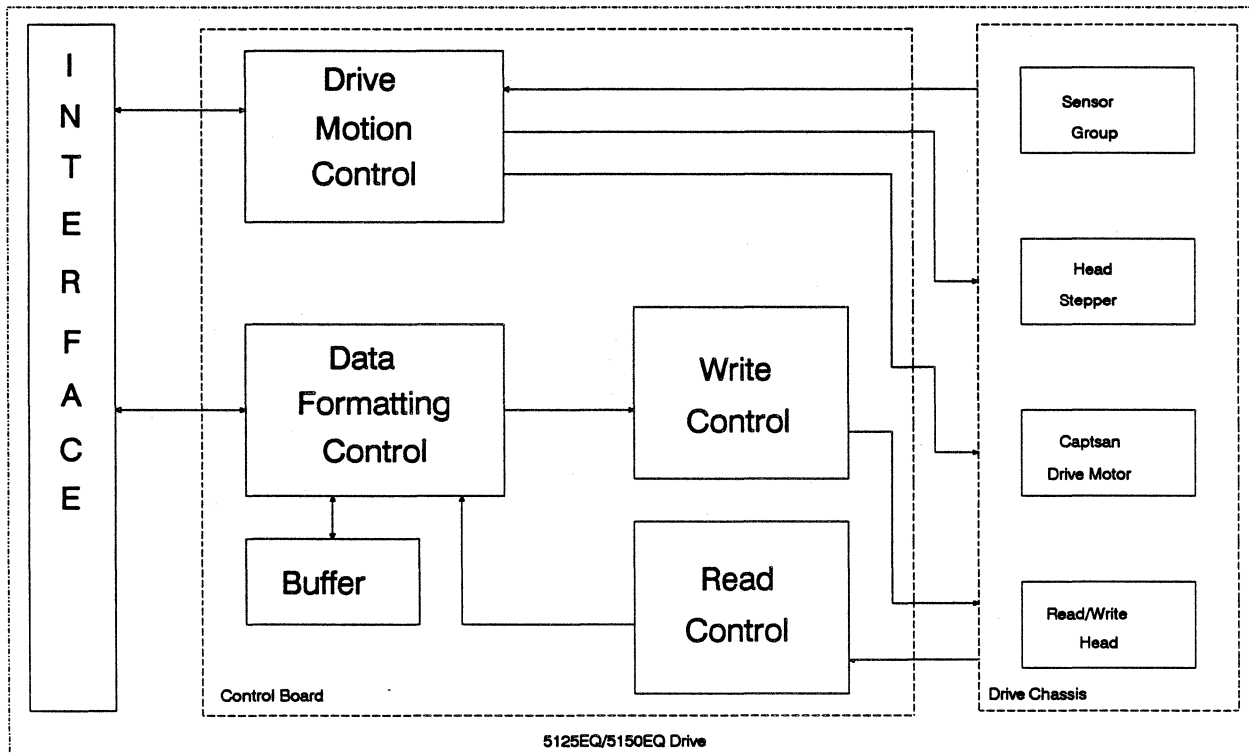


Figure 1-2
Functional Block Diagram

1.4 Mechanical and Electrical Specifications

Refer to Table 1-1 for the electrical and mechanical specifications of the 5XXX-EQ tape drive.

Table 1-1
Electrical and Mechanical Specifications

Tape Cartridge Type	DC 300XL/P, DC 600A, DC 600XTD or equivalent
Formatted Capacity	
5099EQ	60 megabytes with DC 600A
5125EQ	125 megabytes with DC 600XTD or DC 600A
5150EQ	150 megabytes with DC 600XTD
Recording Format	
5099EQ	QIC-11 or QIC-24
5125EQ	QIC-120
5150EQ	QIC-150
Recording Code	GCR (4,5) / RLL (0,2)
Recording Density	12,500 FTPI
Number of Tracks	
5099EQ	9 (serpentine)
5125-EQ	15 (serpentine)
5150-EQ	18 (serpentine)
Tape Speed	72 IPS Read/Write
	90 IPS search or rewind
Long Term Speed Variation	± 7%
Instantaneous Speed Variation	± 3%
Start/Stop Time	≤ 300 milliseconds
Voltage Requirements	+ 12 volts ± 5%, 100mVp-p max. ripple
	+ 5 volts ± 5%, 100mVp-p max. ripple
Current Requirements	
+ 12V Acceleration Surge maximum	2.5 Amps (max.) 1.0 Amp (nom.)
+ 5V	1.0 Amp (max.)
Acoustic Noise	
90 ips	50dBA with cartridge
Power Dissipation	
Standby	5.69 watts (nom.)
Operational	15.25 watts (nom.)
Temperature	
Operating	5°C to 45°C (40°F to 115°F) on the base plate of the cartridge.
Storage and Shipping	-30°C to 60°C (-22°F to 140°F)
Wet bulb	26°C (78°F) maximum
Humidity	20% to 80% non-condensing
Shock and Vibration	
Non-operational Shock	30 G's, 11mS pulse, 1/2 sine wave
Non-operational Vibration	0 to 17 Hz-.1 inch displacement amplitude (peak to peak)
	17 to 500 Hz -1.5 G's
Operational Shock	2.5 G's, 11 mS pulse, 1/2 sine wave
Operational Vibration	0 to 63 Hz-.05 in. displacement amplitude (peak to peak)
	63 to 500 Hz-1.0 G's
Altitude	
Operational	-1,000 - 15,000 feet
Non-operational	-1,000 - 50,000 feet
MTBF	> 15,000 power on hours at 15% tape motion
MTRR	30 minutes average
Soft Errors (read mode)	≤ 1 in 10 ⁸ bits
Hard Errors (read mode)	≤ 1 in 10 ¹¹ bits

**Table 1-1 (continued)
Electrical and Mechanical Specifications**

Dimensions (half height version)	
Height	1.625 inches (41.275 mm)
Width	5.750 inches (146.05 mm)
Depth	8.500 inches (210.82 mm), including signal and power connectors, and the front bezel.
Weight (unit)	2.4 pounds (1.1 Kgrams)
Weight (shipping)	3.75 pounds (1.7 Kgrams)
Mounting	Standard bottom or side mount for 1/2 height 5 1/4" form factor
Dimensions (full height version)	
Height	3.25 inches (82.55 mm)
Width	5.750 inches (146.05 mm)
Depth	8.500 inches (210.82 mm), including signal and power connectors, and the front bezel.
Weight (unit)	3.6 pounds (1.6 Kgrams)
Weight (shipping)	5.0 pounds (2.3 Kgrams)
Mounting	Standard bottom or side mount for full height 5 1/4" form factor
Safety Compliance	UL, CSA, VDE, TUV, FCC Class B

1.5 Reference Documents

- ANSI X3B5/85-138 Unrecorded Magnetic Tape Cartridge Specification, 5th Draft (DC 600A)
- ANSI X3.55-1982 Unrecorded Magnetic Tape Cartridge Specification (DC 300XL/P)
- ANSI X3B5/85-127A Unrecorded Magnetic Tape Cartridge Specification, 11th Draft
- 3M DC600A Cartridge Specification
- 3M DC300XL Cartridge Specification
- 3M DC300XL/P Cartridge Specification
- 3M DC615A Cartridge Specification
- 3M DC600XTD Cartridge Specification
- 3M DC615XTD Cartridge Specification
- DEI Series II Gold Cartridge Specification
- QIC-02 Intelligent Interface Standard, Rev. D
- QIC-24 Information Interchange Standard, Rev. D
- QIC-120 Information Interchange Standard, Rev. D
- QIC-150 Information Interchange Standard, Rev. I

Section 2 **INSTALLATION AND OPERATION**

2.1 **Physical Description**

The model 5099EQ/5125EQ/5150EQ consists of an aluminum casting which is the primary support for the internal elements of the drive, and also provides the mechanical support for mounting. The primary elements of the drive are the magnetic read/write/erase head, the head carriage and stepper motor assembly, the drive control board, and the basic mechanical assembly to which all of the above is mounted.

The drive is available in two physical configurations, half height 5 1/4 inch form factor and full height 5 1/4 inch form factor.

2.1.1 **Mechanical Dimensions**

The mechanical dimensions for the half height drive are as follows:

Width: 5.75 in. (146.05 mm)
 Height: 1.625 in. (41.275 mm)
 Depth: 8.50 in. (210.82 mm), including signal and power connectors.

The mechanical dimensions for the full height drive are as follows:

Width: 5.75 in. (146.05 mm)
 Height: 3.25 in. (82.55 mm)
 Depth: 8.50 in. (210.82 mm), including signal and power connectors.

2.1.2 **Weight Characteristics**

The weight characteristics for the half height drive are as follows:

Unit Weight: 2.4 pounds (1.1 Kilograms)
 Shipping Weight: 3.75 pounds (1.7 Kilograms)

The weight characteristics for the full height drive are as follows:

Unit Weight: 3.6 pounds (1.6 Kilograms)
 Shipping Weight: 5.0 pounds (2.3 Kilograms)

2.2 **Mounting Requirements**

The drive is designed to utilize the same mounting holes as the industry standard half-height 5.25" Winchester or floppy disk drives. The drive can be mounted in any orientation with the exception of upside down, i.e. where the PWB is located at the top of the drive when mounted. Eight 6-32 mounting holes are provided on the bottom of the drive, in addition to four mounting holes on the drive side rails. The drive half height mounting hole dimensions are shown in Figure 2-1. The drive may be mounted in the full height configuration by adding an optional chassis assembly. The full height drive mounting dimensions are shown in Figure 2-2.

The drive is manufactured and tested with several critical internal alignments, which must be maintained to guarantee data reliability. Therefore, it is necessary that the mounting hardware does not introduce significant stress to the drive chassis.

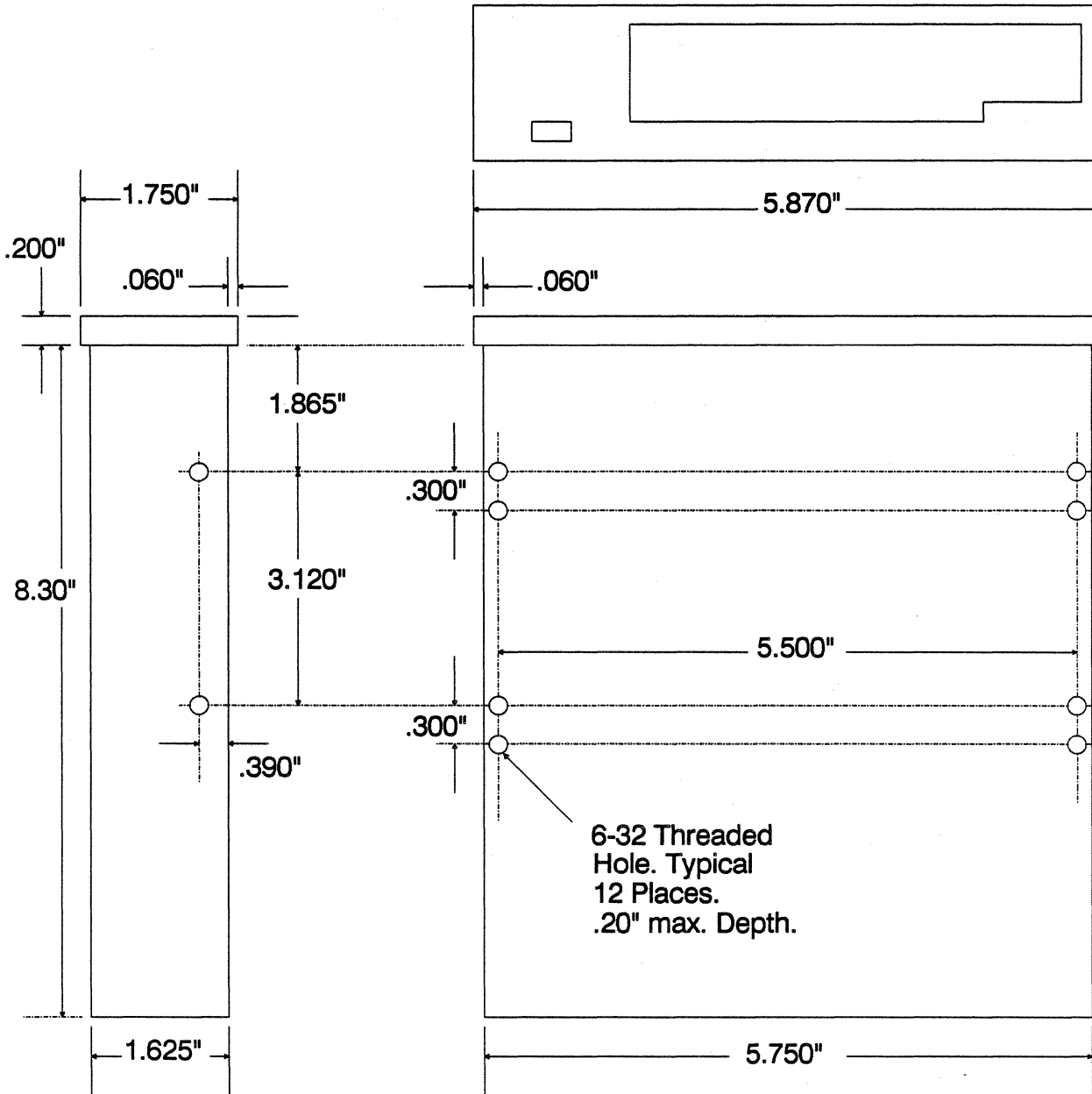


Figure 2-1
Basic Drive Mounting Dimensions

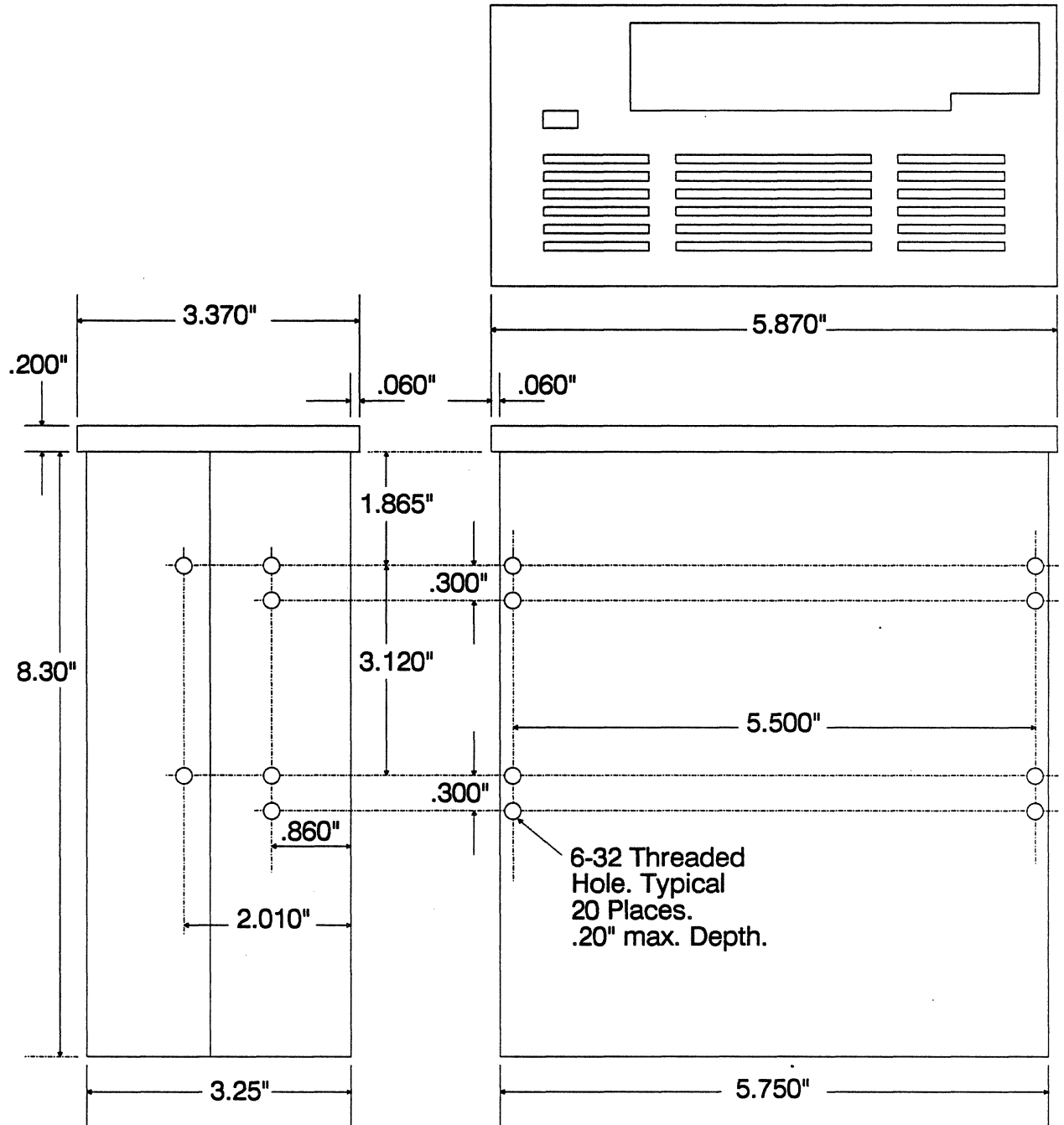


Figure 2-2
Full Height Drive Mounting Dimensions

2.3 Cartridge Loading And Unloading

The cartridge is loaded in the drive by placing the cartridge into the front loading slot with the tape door opening facing the left of the drive as viewed from the front. The tape is then loaded by pushing the cartridge into the drive until resistance is met and the cartridge will slide inward no further. At this point, release the cartridge and it will eject slightly outside the confines of the front bezel and the head assembly will swing outward to meet the tape surface. At this time, the cartridge is properly loaded into the drive. This is shown in Figure 2-3.

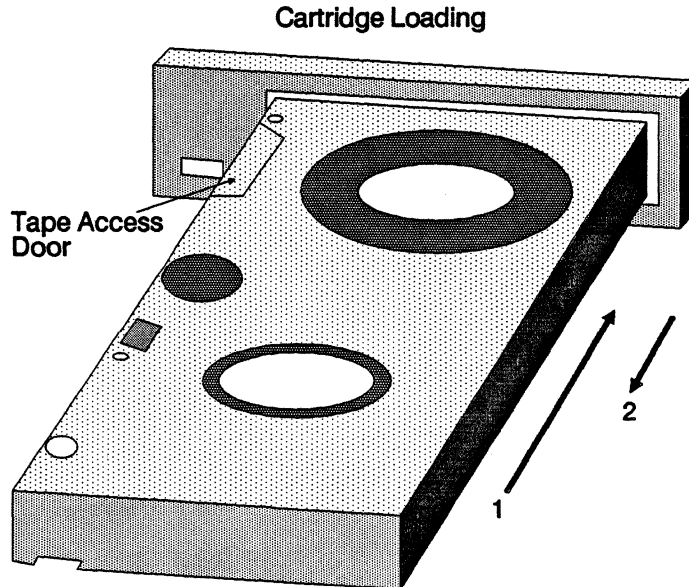


Figure 2-3
Cartridge Loading

The cartridge is unloaded from the drive in the same manner. To release the cartridge, push the cartridge into the tape drive until resistance is felt and the latch releases. This is signified by an audible "click". At this time, release the cartridge and it will be ejected partially out of the drive assembly. The cartridge unloading is shown in Figure 2-4.

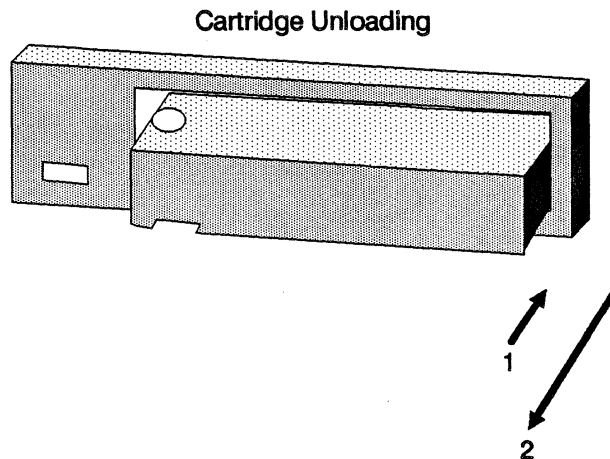


Figure 2-4
Cartridge Unloading

2.4 Tape Cartridge Characteristics

The tape cartridges designed for use in this product are the DC 300XL/P, DC 600A or DC 600XTD manufactured by 3M, or the DEI Series II Silver, Series II Gold or Series II Gold Plus High Coercivity tape cartridges. The acceptable cartridge types for each model are listed below:

- Model 5099EQ - DC300XL/P, DC 600A, Series II Silver, Series II Gold or Equivalent
- Model 5125EQ - DC 600A, DC 600XTD, Series II Gold, Series II Gold Plus or equivalent
- Model 5150EQ - DC 600XTD, Series II Gold Plus or equivalent

2.4.1 Write Protect Feature

The data on the tape cartridge may be protected from erasure by turning the write protect indicator to the SAFE position. This prevents the tape cartridge from being erased or from appending files (overwriting). Refer to Figure 2-5.

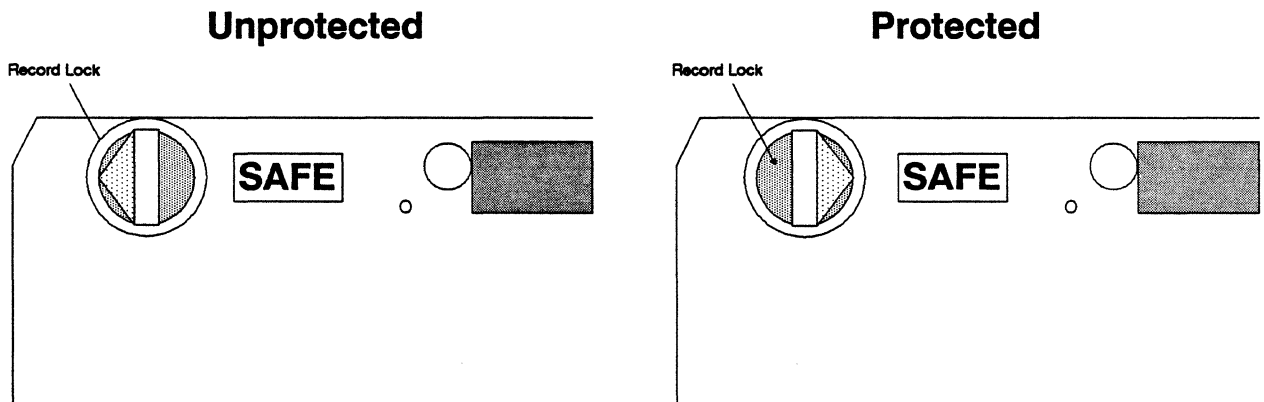


Figure 2-5
Data Cartridge Write Protection

2.4.2 Handling And Storage

The tape cartridge must not be exposed to dirt, moisture, or temperature extremes. 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 surface. The oils and acids of the hand can contaminate the tape surface and the magnetic coating.

A properly handled tape cartridge will provide long reliable service. Broken, chipped, or damaged tape cartridges should be replaced immediately. Any attempt to utilize a damaged cartridge may result in damage to the tape drive. Storage of the tape cartridge shall be in accordance with the manufacturers recommendations. Never place the cartridge near any device which may generate a strong magnetic field, as data integrity may be compromised.

Data Cartridge Do's

- Do store the cartridge in it's protective case.
- Do rewind the tape to BOT before removing the cartridge for storage.
- Do store the cartridge at temperatures between 5°C to 45°C (40°F to 115°F)
- Do allow the cartridge to stabilize after moving from one temperature extreme to another before using.

- Do keep magnetic sources (ie. magnets, motors...) away from the cartridge.
- Do replace damaged or contaminated cartridges.

Data Cartridge Don'ts

- Don't drop the cartridge.
- Don't expose the cartridge to moisture or high humidity.
- Don't place the cartridge in direct sunlight.
- Don't touch the tape at the head access door or cartridge capstan.
- Don't use excessive force while inserting or removing the cartridge from the drive.

2.5 Jumper Configuration

The following paragraphs describe the functions of the various jumpers on the embedded QIC-02 tape drive. For jumper locations, refer to Figure 2-6.

2.5.1 E2 Clock Frequency

When installed, provides the 18Mhz clock frequency to the controller. Normally installed.

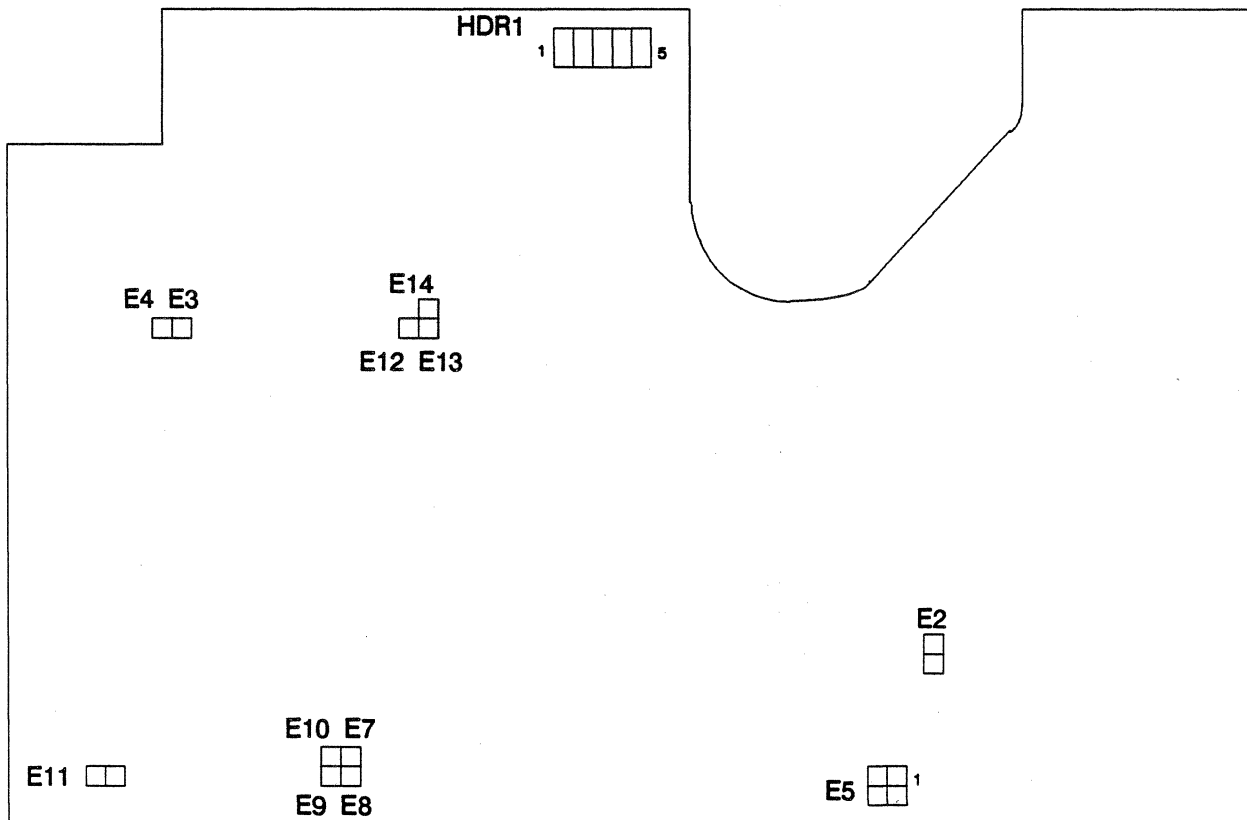


Figure 2-6
Jumper Locations

2.5.2 E3 - E4 Last Track Status

When installed, provides optional Last Track Status at the QIC-02 interface. This is a customer option.

2.5.3 E5 Write Precomp

These jumpers select a percentage of write precompensation which is matched with head resolution as an input to the custom PLL chip. **DO NOT CHANGE OR REMOVE THESE JUMPERS.**

2.5.4 E8 - E9 2Kbyte RAM

When installed, selects optional 2Kbyte RAM. This is a customer option.

2.5.5 E7 - E10 8Kbyte RAM

When installed, selects standard 8Kbytes RAM.

2.5.6 E11 Chassis Ground

When installed, this jumper provides a logic ground to chassis ground connection. When not installed, The logic ground is isolated from the chassis ground through a .47 microfarad capacitor. This is a customer option.

2.5.7 E12-E14 Default Data Format

These jumpers select the default data format mode after power up. With no jumpers installed, QIC-24 format is selected. With jumper E12 to E13 installed, QIC-150 format is selected. With jumper E13 to E14 installed, QIC-120 format is selected.

2.5.8 HDR1 Pins 1,4 & 5 Test Mode

These jumpers select several factory test modes and are for factory use only. No jumpers should be installed.

2.5.9 HDR1 Pins 2 & 3 Stepper Phase Alignment.

Installed to establish the proper stepper motor phasing at the recalibration position. **DO NOT CHANGE OR REMOVE THESE JUMPERS.**

Section 3

GENERAL RECORDING FORMAT

3.1 Introduction

This section contains information about the QIC-24, QIC-120, and QIC-150 recording formats used by the 5XXEQ drive.

3.2 Recording Method

The method of recording shall be "non-return to zero, change on one" (NRZI) where a ONE is represented by a flux transition occurring in the bit cell and a ZERO is represented by the absence of a flux transition in the bit cell.

3.2.1 Recording Code

Each 8 bit data byte is separated into two 4 bit groups (nibbles). Each 4 bit data nibble is encoded into a 5-bit GCR nibble for recording on the magnetic tape. The most significant nibble is recorded first. The encoded data has the property that no more than two consecutive zeros shall occur. The translation table for data nibbles (D3, D2, D1, and D0) and GCR nibbles (G4, G3, G2, G1, and G0) is shown in Table 3-1.

Table 3-1
Data To GCR (4 to 5) Translation

DATA NIBBLE					GCR NIBBLE					
Hex	D3	D2	D1	D0	G4	G3	G2	G1	G0	Hex
0	0	0	0	0	1	1	0	0	1	19
1	0	0	0	1	1	1	0	1	1	1B
2	0	0	1	0	1	0	0	1	0	12
3	0	0	1	1	1	0	0	1	1	13
4	0	1	0	0	1	1	1	0	1	1D
5	0	1	0	1	1	0	1	0	1	15
6	0	1	1	0	1	0	1	1	0	16
7	0	1	1	1	1	0	1	1	1	17
8	1	0	0	0	1	1	0	1	0	1A
9	1	0	0	1	0	1	0	0	1	09
A	1	0	1	0	0	1	0	1	0	0A
B	1	0	1	1	0	1	0	1	1	0B
C	1	1	0	0	1	1	1	1	0	1E
D	1	1	0	1	0	1	1	0	1	0D
E	1	1	1	0	0	1	1	1	0	0E
F	1	1	1	1	0	1	1	1	1	0F

Note: GCR bit G4 is recorded first.

3.3 QIC Recorded Block Format

The recorded data block format is shown in Figure 3-1

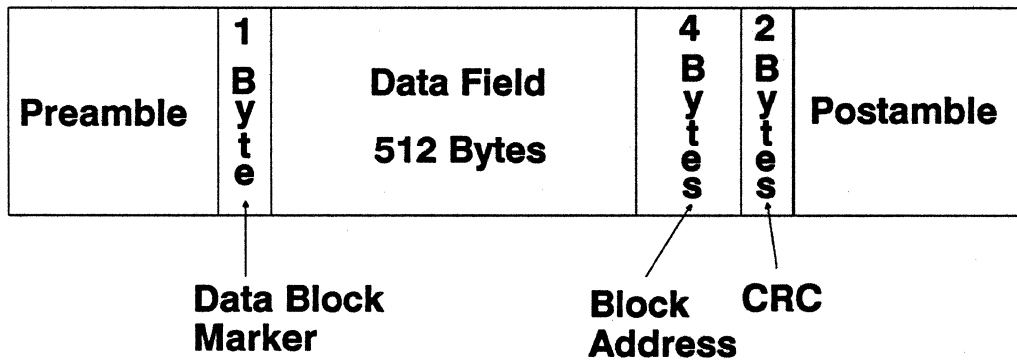


Figure 3-1
Data Block Format

3.3.1 Preamble

The preamble is used to synchronize the phase locked loop in the read electronics to the data frequency and to measure the average signal amplitude. A normal preamble consists of a minimum of 160 and a maximum of 300 (120 min. and 300 max. for QIC-24) flux transitions recorded at the maximum normal recording density of 12,500 ftpi (10,000 ftpi for QIC-24). An elongated preamble consists of a minimum of 5,500 and a maximum of 8,500 (3,500 min. and 7,000 max. for QIC-24) flux transitions and shall precede the first data block recorded after an underrun. A long preamble consists of a minimum of 15,000 and a maximum of 30,000 flux transitions and shall precede the first data block for interchange recorded at the beginning of a track.

3.3.2 Data Block Marker

The data block marker identifies the start of data and consists of the unique GCR data pattern found in Table 3-2.

Table 3-1
Data Block Marker

MS nibble					LS nibble				
G4	G3	G2	G1	G0	G4	G3	G2	G1	G0
1	1	1	1	1	0	0	1	1	1

3.3.3 Data Block

The data block contains 512 bytes of data encoded into GCR bytes.

3.3.4 Block Address

The block address consists of 4 data bytes encoded into 5 GCR bytes which uniquely identify a block recorded on tape. The bit definitions for each byte are described in Table 3-3.

**Table 3-2
Block Address Bit Definitions**

Byte	Bits	Defination
0	0-7	Track Number Bits 0-7
1	4-7	Control Nibble Bits 0-3
2	0-3	Block Number Bits 16-19
3	0-7	Block Number Bits 8-15
		Block Number Bits 0-7

The Control Nibble bits are defined in Table 3-4.

**Table 3-3
Control Nibble Bit Definitions**

Bits 3210	Value Hex	Defination
0000	00	The current block contains user data of file mark.
0001	01	The current block contains control information (QIC-24 or QIC120 only)
0010	02	The current block contains control information (QIC-150 only)
0011-1111	03-FF	Reserved

For more complete information about the QIC-24 format, refer to the Wangtek Application Note, QIC-24 Data Interchange Specification, drawing number 63047-001. For more complete information about the QIC-120 format, refer to the Wangtek Application Note, QIC-120 Data Interchange Specification, drawing number 63048-001. For more complete information about the QIC-150 format, refer to the Wangtek Application Note, QIC-150 Data Interchange Specification, drawing number 63049-001.

3.3.5 Cyclical Redundancy Check

The cyclical redundancy check (CRC) consists of two bytes calculated over the 512 bytes of interchange data and the 4 byte block address starting with all ones CRC initial value and using the CRC generating polynomial:

$$X^{16} + X^{12} + X^5 + 1$$

3.3.6 Postamble

A normal postamble consists of a minimum of 5 and a maximum of 20 flux transitions recorded at the maximum nominal flux density and shall be recorded following the CRC as a guard band. An elongated

postamble consists of a minimum of 5,500 and a maximum of 8,500 (3,500 min. and 7,000 max. for QIC-24) flux transitions, shall be recorded following an underrun sequence.

3.4 QIC-24 Recording Format

The following information is taken from the QIC-24 Data Interchange Specification Rev. D. The track layout, data format and tape position holes are explained in the following paragraphs. For more complete information about the QIC-24 format, refer to the Wangtek Application Note, QIC-24 Data Interchange Specification, drawing number 63047-001.

3.4.1 Track Center Line Locations

Track center lines are located as indicated in Figure 3-2

3.4.2 Tape Position Holes And Track Locations

The tape position holes and track locations are shown in Figure 3-3. Also shown are the dimensions for data recording zones.

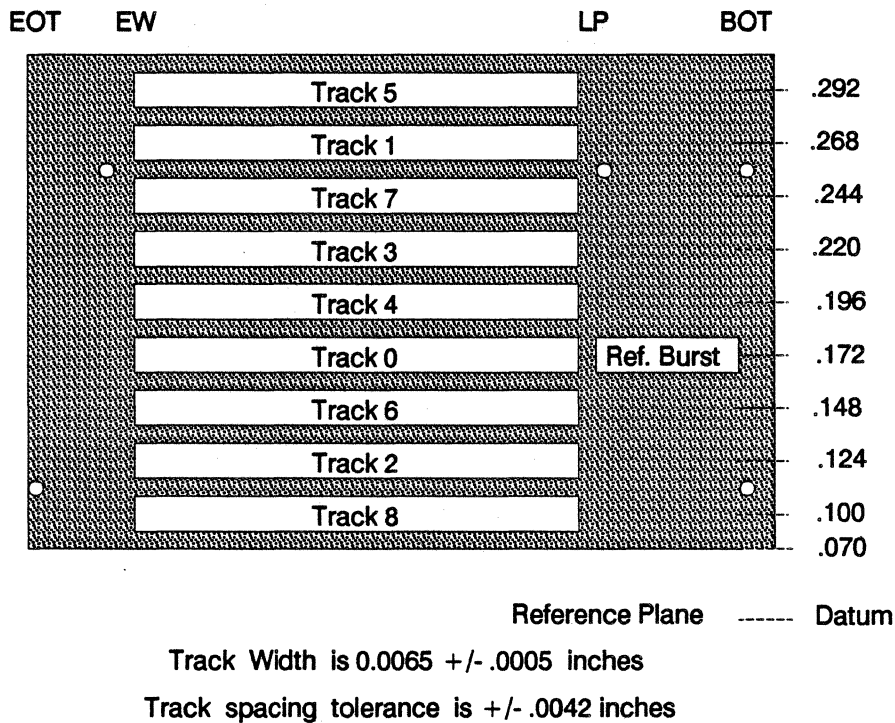
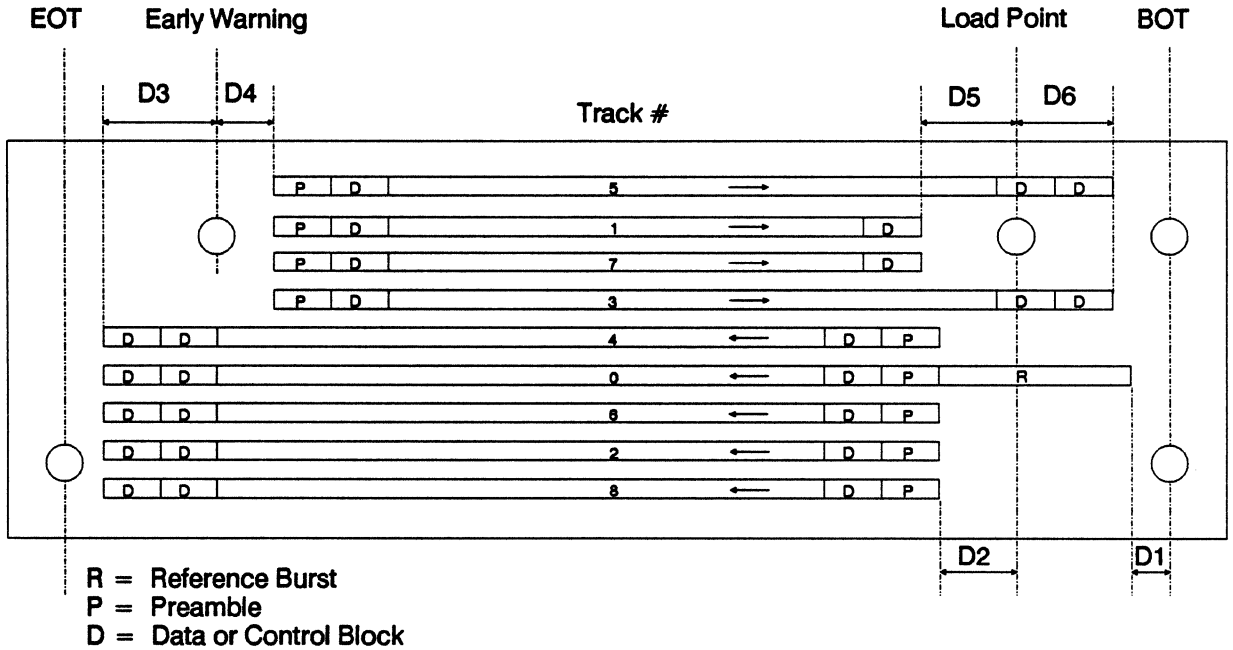


Figure 3-2
QIC-24 Track Centerline Locations



Dimension	Minimum	Maximum	Description
D1	0	15	BOT to Start of track reference burst Load Point to end of reference burst & start of preamble on even tracks
D2	3	4	
D3	-	36	Early warning to end of data on even tracks
D4	1	2	Early warning to start of preamble on odd tracks
D5	0.1	4	End of data to load point on tracks 1 and 7
D6	-	27	Load point to end of data on tracks 3 and 5

NOTE: All dimensions are in inches.

Figure 3-3
QIC-24 Tape Position Holes and Track Locations

3.5 QIC-120 Recording Format

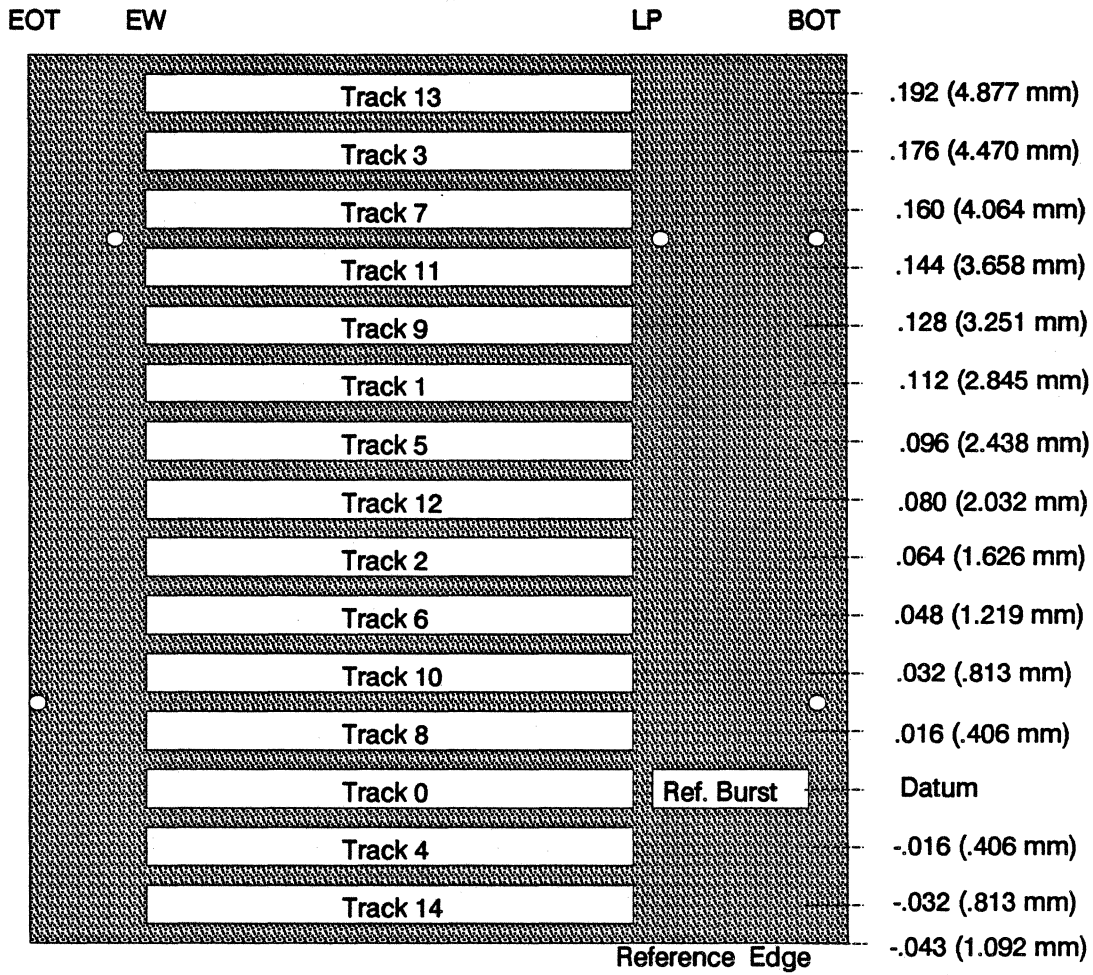
The following information is taken from the QIC-120 Data Interchange Specification Rev. D. The track layout, data format and tape position holes are explained in the following paragraphs. For more complete information about the QIC-120 format, refer to the Wangtek Application Note, QIC-120 Data Interchange Specification, drawing number 63048-001.

3.5.1 QIC-120 Track Center Line Locations

The track center lines shall be as indicated in Figure 3-4.

3.5.2 Tape Position Holes And Track Locations

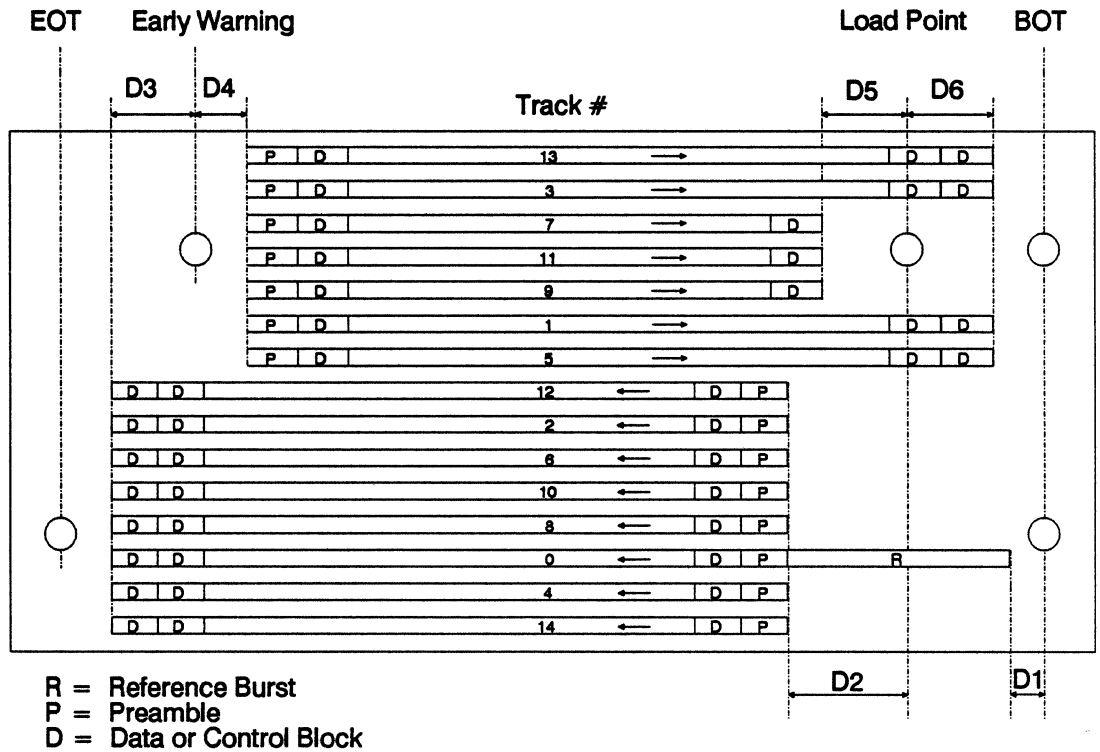
The tape position holes and track locations are shown in Figure 3-5. Also shown are the dimensions for data recording zones.



Track Width is 0.0065 +/- .0005 inches (0.19 +/- .01 mm)

Track spacing tolerance is +/- .002 inches (+/- .051mm)

Figure 3-4
QIC-120 Track Center Line Locations



Dimension	Minimum	Maximum	Description
D1	0	15	BOT to Start of track reference burst
D2	3	4	Load Point to end of reference burst & start of preamble on even tracks
D3	-	36	Early warning to end of data on even tracks
D4	1	2	Early warning to start of preamble on odd tracks
D5	0.1	4	End of data to load point on tracks 7, 9 and 11
D6	-	27	Load point to end of data on tracks 1, 3, 5 and 13

NOTE: All dimensions are in inches.

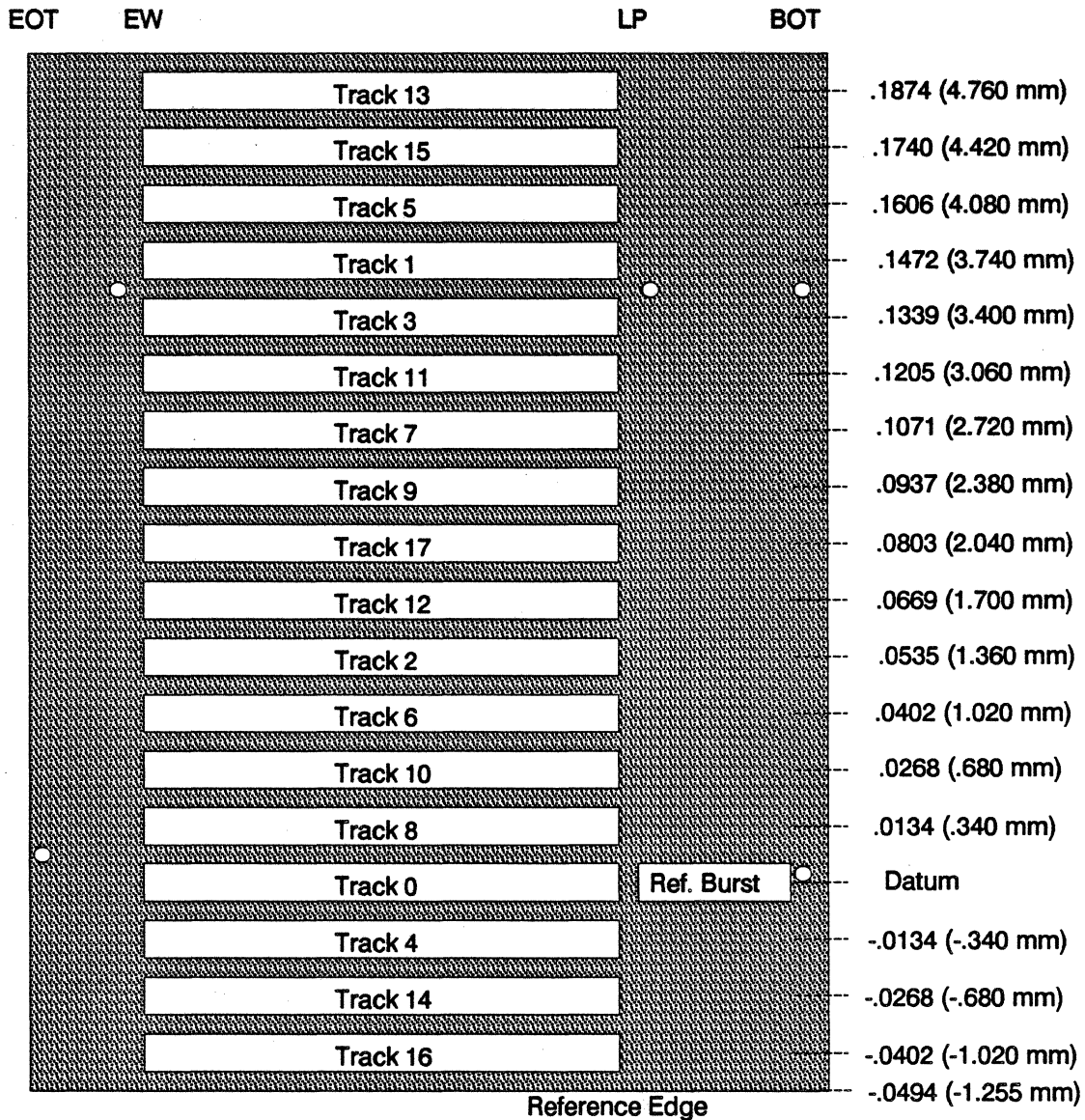
Figure 3-5
QIC-120 Tape Position Holes and Track Locations

3.6 QIC-150 Recording Format

The following information is taken from the QIC-150 Data Interchange Specification Rev. I. The track layout, data format and tape position holes are explained in the following paragraphs. For more complete information about the QIC-150 format, refer to the Wangtek Application Note, QIC-150 Data Interchange Specification, drawing number 63049-001.

3.6.1 QIC-150 Track Center Line Locations

The track center lines shall be as indicated in Figure 3-6.



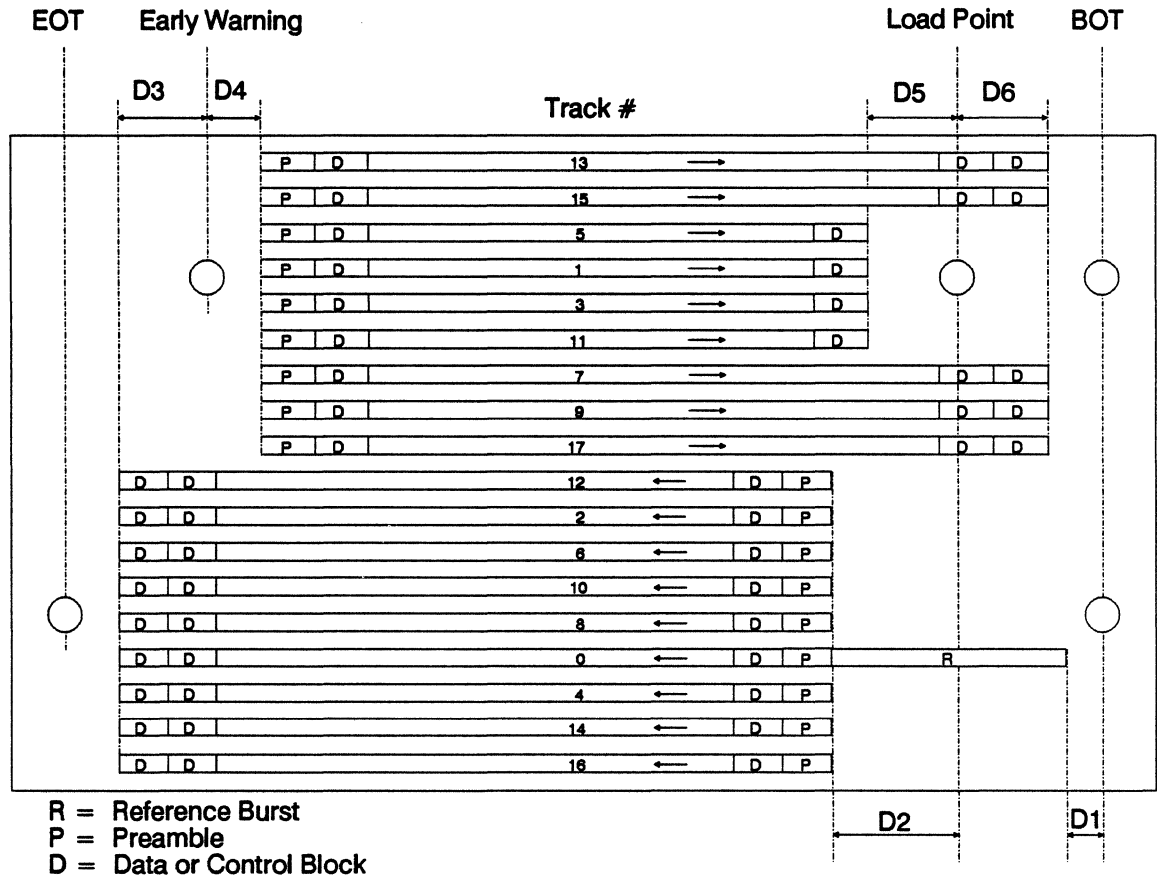
Track Width is 0.0065 +/- .0005 inches (0.19 +/- .01 mm)

Track spacing tolerance is +/- .002 inches (+/- .051mm)

Figure 3-6
QIC-150 Track Center Line Locations

3.6.2 Tape Position Holes And Track Locations

The tape position holes and track locations are shown in Figure 3-7. Also shown are the dimensions for data recording zones.



Dimension	Minimum	Maximum	Description
D1	0	15	BOT to Start of track reference burst
D2	3	4	Load Point to end of reference burst & start of preamble on even tracks
D3	-	36	Early warning to end of data on even tracks
D4	1	2	Early warning to start of preamble on odd tracks
D5	0.1	4	End of data to load point on tracks 1, 3, 5, and 11
D6	-	27	Load point to end of data on tracks 7, 9, 13, 15 and 17

NOTE: All dimensions are in inches.

Figure 3-7
QIC-150 Tape Position Holes and Track Locations

Section 4

INTERFACE

4.1 Introduction

This section contains information about the drive power connections, interface specifications and interface timing.

4.2 Power Connector And Contacts

The recommended power connector for the Wangtek Series 5099EQ/5125EQ/5150EQ drive is an AMP P/N 1-480424-0 or equivalent. This connector is keyed to avoid improper insertion. The contacts used with this connector are female pins, AMP P/N 60619-1 or equivalent. The recommended wire size is #18 AWG or larger. The +12 and +5 Volt Returns are tied together at the drive. Therefore, it is recommended that the host system also tie the returns together at the power supply. The J2 voltage, current and pin assignments are outlined in Table 4-1.

Table 4-1
J2 Power Connector Pin Assignments Current Requirements

VOLTS $\pm 5\%$	PIN	OPERATION MODE	CURRENT
+12V	1	Standby Operational Max. Surge	114 mA
+12V			1.0 Amp
+12V			2.5 Amp
+12V Return	2		
+5V Return	3	Standby Operational Max. Surge	1.0 Amp
+5V	4		1.0 Amp
+5V			1.0 Amp
+5V			1.0 Amp

The minimum supply voltage rise time, as measured from 0 Volts to 95% of rated voltages, shall be as follows:

+12V input (0 to 11.4 V)	5mS minimum
+5V input (0 to 4.75 V)	5mS minimum

The power supply voltages shall be applied simultaneously. Maximum Surge Current at +12 is measured for a maximum period of 150 milliseconds.

The power consumption of the drive is shown in Table 4-2.

4.3 Host Interface Connector

The 5099EQ/5125EQ/5150EQ interfaces with the Host via J1 using the QIC-02 interface standard. The signal connector on the drive is a fifty conductor edge connector. Refer to Figure 4-1. The recommended connector is a 3M type 3415-001 or equivalent. The signal cable shall be a fifty conductor, flat ribbon cable. This interface supports a total cable length of three meters or ten feet maximum using a cable of 100 ohms characteristic impedance $\pm 10\%$. All host/drive interface signals must be terminated by 220 ohms to +5 VDC and 330 ohms to ground. Refer to Figure 4-2. The interface signal connector pin assignments are listed in Table 4-3. Data and commands are transferred to and from the drive on an

Table 4-2
Input Power Requirements

VOLTS	OPERATION MODE	POWER
+12V	Standby	1.37 Watts
+12V	Operational	10.72 Watts
+5V	Standby	4.32 Watts
+5V	Operational	4.53 Watts
Total	Standby	5.69 Watts
Total	Operational	15.25 Watts

eight bit bi-directional data bus using asynchronous handshaking techniques to eliminate rigorous timing constraints.

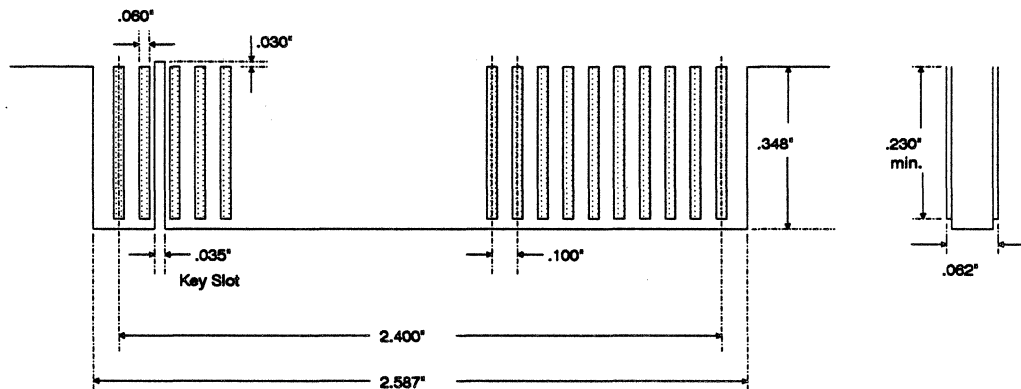


Figure 4-1
Interface Connector Dimensions

4.4 Interface Signal Levels

All signals to the host from the drive are standard TTL levels as follows:

- False, (Logic 0) = High = 2.4 to 5.25 VDC
- True, (Logic 1) = Low = 0.0 to 0.55 VDC

All signals to the drive should be standard TTL levels as follows:

- False, (Logic 0) = High = 2.0 to 5.25 VDC
- True (Logic 1) = Low = 0 to 0.8 VDC

Voltages should be measured at the drive Connector J1.

4.5 Signal Loading

Signals from the host to the drive should be loaded on the interface by no more than 2.0 mA plus the required terminations.

Signals from the drive to the host are loaded on the interface by no more than 2.0 mA plus the required terminations.

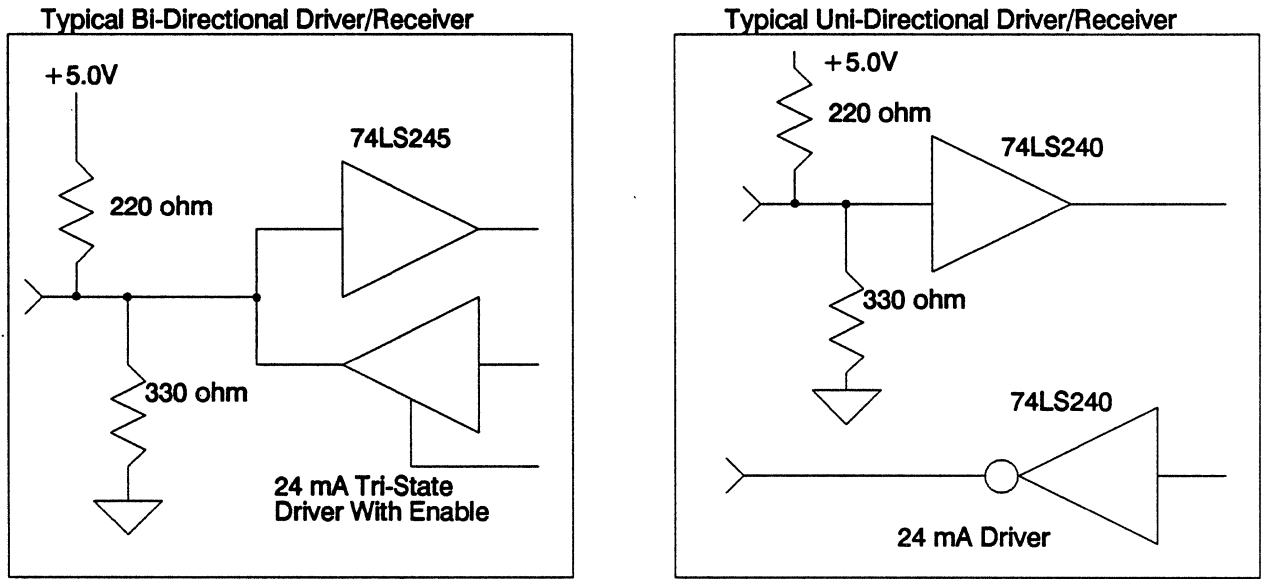


Figure 4-2
Interface Signal Terminations

Table 4-3
Interface Connector Pin Assignments

Pin#	Mnemonic	To	Description
02-10			Reserved for future use.
12	HB7-	B	Host Bus Bit #7, MSB
14	HB6-	B	Host Bus Bit #6
16	HB5-	B	Host Bus Bit #5
18	HB4-	B	Host Bus Bit #4
20	HB3-	B	Host Bus Bit #3
22	HB2-	B	Host Bus Bit #2
24	HB1-	B	Host Bus Bit #1
26	HB0-	B	Host Bus Bit #0, LSB
28	ONL-	D	Online
30	REQ-	D	Request
32	RSTC-	D	Reset Controller
34	XFR-	D	Transfer
36	ACK-	H	Acknowledge
38	RDY-	H	Ready
40	EXC-	H	Exception
42	DIR-	H	Direction
44-50			Reserved for future use.

NOTE: All odd pins are signal returns, which should be connected to ground at both the drive and the host. B = Bi-directional, D = Drive, H = Host.

4.6 Control Lines

4.6.1 Reset

This signal is generated by the host. The drive is reset and operating parameters are initialized. After RESET, the drive will assert EXCEPTION.

4.6.2 Exception

This signal is generated by the drive to indicate that it has information for the host. After a RESET, EXCEPTION is always asserted. EXCEPTION may be asserted during an operation and should be treated with priority. After EXCEPTION, the only legal command that shall be transmitted to the drive is Read Status.

4.6.3 Online

This signal is generated by the host and is true when the drive is either writing, reading or searching. In all other operations, the state of this signal is not relevant. Deasserting the ONLINE signal terminates a write or read operation and rewinds the tape to BOT. During deselection and selection of the drive, while at position, care must be taken to avoid unwanted rewinds as a result of the ONLINE signal. Following a write or read operation, the drive does not perform rewind when deselected with ONLINE asserted. When re-selected the drive will sample the state of ONLINE. A rewind does not occur if selection is made with ONLINE asserted or deasserted. However, the host must assert ONLINE prior to any subsequent read or write operations.

4.6.4 Request

This signal is generated by the host to initiate and execute command transfers. REQUEST is also used to handshake with READY when transferring status information from the drive to the host. This signal should be asserted only when an EXCEPTION or READY is asserted.

4.6.5 Ready

This signal is generated by the drive to indicate one of the following conditions:

- The drive is available to receive and execute a new command.
- A new block is ready for transfer during a read operation.
- The drive is ready to receive a new block during write operation.
- The drive is ready to transfer status information to the host when REQUEST is asserted.

4.6.6 Transfer

This signal is generated by the host to indicate that data is being placed on the data bus in write mode or that data has been taken from the bus in read mode. TRANSFER is used in conjunction with ACKNOWLEDGE to move data between the drive and host.

4.6.7 Acknowledge

This signal is generated by the drive to indicate that data has been accepted from the data bus in write mode or that data is being placed on the bus in read mode. ACKNOWLEDGE is used in conjunction with TRANSFER to move data between the drive and host.

4.6.8 Direction

This signal is generated by the drive to indicate the direction of the bus. The asserted state of DIRECTION indicates that transfers are from the drive to the host.

4.7 Command Descriptions

The drives implementation of all QIC-02 standard and optional commands are listed in Table 4-4, including the corresponding 8-bit OP Codes. A description of each command is provided in the following paragraphs. All reserved or unassigned commands will return an illegal command status from the drive.

4.7.1 SELECT DRIVE Command (01H)

The SELECT DRIVE command selects the drive for online operation. The drive remains selected until changed by either a RESET or another SELECT command. Before the drive is selected, the drive's tape must be rewound to BOT, otherwise the drive will return an illegal command status to the host.

4.7.2 SELECT QIC-24 FORMAT Command (27H)

The SELECT QIC-24 FORMAT command is used to instruct the drive to read a 9-track QIC-24 format tape. This command must be issued only when the selected drive is READY and the inserted cartridge is at BOT or before the first tape motion command. The drive will accept the command if a cartridge is not inserted; however it will then assert EXCEPTION, informing the host of no cartridge in place. If the command is given during a READ or WRITE operation, the drive will reject it as an illegal command, and the tape will be rewound to BOT.

4.7.3 SELECT QIC-120 FORMAT Command (28H)

The SELECT QIC-120 FORMAT command is used to instruct the drive to write in the 15-track QIC-120 format. This command must be issued only when the selected drive is READY and the inserted cartridge is at BOT or before the first tape motion command. The drive will accept the command if a cartridge is not inserted; however it will then assert EXCEPTION, informing the host of no cartridge in place. If the command is given during a READ or WRITE operation, the drive will reject it as an illegal command, and the tape will be rewound to BOT. If the first tape motion command is a read operation, the drive will determine the recorded format by searching for the QIC-120/QIC-150 control block or the QIC-24 reference burst. If the tape is blank, the drive will default to the QIC-120 or QIC-150 format dependent upon the firmware default version.

4.7.4 SELECT QIC-150 FORMAT Command (29H)

The SELECT QIC-150 FORMAT command is used to instruct the drive to write in the 18-track QIC-150 format. This command must be issued only when the selected drive is READY and the inserted cartridge

Table 4-4
QIC-02 Standard & Optional Command Sets

Command	Op Code Bits 7654 3210	Hex Value	Standard or Optional
Select Drive	0000 0001	01	S
Select QIC-24 Format	0010 0111	27	S
Select QIC-120 Format	0010 1000	28	S
Select QIC-150 Format	0010 1001	29	S
Write Data	0100 0000	40	S
Write Without Underruns	0100 0001	41	O
Write File Mark	0110 0000	60	S
Write File Mark / Write	0110 0010	62	O
Write File Mark / Write w/o Underruns	0110 0011	63	O
Read Data	1000 0000	80	S
Read Continuous	1000 0010	82	O
Read Block N	1000 1010	8A	O
Space Forward	1000 0001	81	O
Space Reverse	1000 1001	89	O
Search To End Of Recorded Media	1010 0011	A3	O
Read File Mark	1010 0000	A0	S
Read N Filemarks	1011 NNNN	B1-BF	O
Read Status	1100 0000	C0	S
Erase Tape	0010 0010	22	S
Initialize (retension) Tape	0010 0100	24	S
Rewind to BOT	0010 0001	21	S
Run Self-Test 1	1100 0010	C2	O
Run Self-Test 2	1100 1010	CA	O
Run Self-Test 3	1100 1011	CB	O
Read Firmware ID	1100 1111	CF	O
NNNN = Value can range from 0001 to 1111.			

is at BOT or before the first tape motion command. The drive will accept the command if a cartridge is not inserted; however it will then assert EXCEPTION, informing the host of no cartridge in place. If the command is given during a READ or WRITE operation, the drive will reject it as an illegal command, and the tape will be rewound to BOT. If the first tape motion command is a read operation, the drive will determine the recorded format by searching for the QIC-120/QIC-150 control block or the QIC-24 reference burst. If the tape is blank, the drive will default to the QIC-120 or QIC-150 format dependent upon the firmware default version.

4.7.5 WRITE DATA Command (40H)

The WRITE command causes data to be written on the tape in the drive. The host must assert ONLINE before issuing the WRITE command. Then, the drive transfers data. The READY line is asserted when the drive is ready for a data block transfer. When the READY line is asserted, the host can terminate

transfer of write data by alternatively issuing a WRITE FILE MARK command or deactivating ONLINE. Deactivating ONLINE causes a file mark to be written (if not preceded by a WRITE FILE MARK command) and the tape is rewound to BOT.

A WRITE command following cartridge insertion, RESET, or any command which positions the tape at BOT will commence recording at BOM. Otherwise, recording will commence at the current tape position. If, between blocks, the host starts data transfer by asserting TRANSFER before the drive asserts READY, then the behavior of the READY signal is drive dependent. The drive will, regardless of the way READY is handled, continue the TRANSFER and ACKNOWLEDGE handshaking correctly so that no data is lost.

When Early Warning is detected while recording on the last track, the drive ceases to transfer additional data blocks from the host. The drive completes writing the current write block in progress, terminates the WRITE command, and reports EOM by means of an EXCEPTION and READ STATUS. The drive allows the transfer of additional blocks of data with WRITE commands after the receipt of EOM. However, EXCEPTION is asserted for each block transferred. The drive will also accept the READ STATUS and WRITE FILE MARK command after detection of EOM.

4.7.6 WRITE WITHOUT UNDERRUNS Command (41H)

The Write Without Underruns (WU) command shall instruct the drive to perform all functions of a WRITE command and shall continue tape movement when an underrun occurs. Tape movement shall stop when the end of track is reached, or at the completion of a normal write command.

This command is used if the host cannot provide another block within 6 mS after the READY that request the next block. By not meeting this time requirement, the drive will underrun. WU command continues to write by rewriting the last block until end of track or another write command is issued.

4.7.7 WRITE FILE MARK Command (60H)

The WRITE FILE MARK Command causes a FILE MARK to be written on the tape in the drive. A WRITE FILE MARK command following cartridge insertion, RESET, or any command which positions the tape at BOT commences recording from BOM. Otherwise, recording commences from the current tape position. The normal completion of this command causes READY to be asserted. Deasserting ONLINE causes the tape to rewind to BOT.

4.7.8 WRITE FILE MARK/WRITE Command (62H)

The Write File Mark/Write command instructs the drive to combine the Write File Mark command with a Write command to achieve streaming operation when writing file marks. When executing this command, the drive shall first complete the writing of the remaining data block in the buffer, if applicable. It shall then write a file mark and, thereafter, the drive shall proceed with a normal write operation. To maintain streaming operation, the host must transfer a complete data block prior to the drive committing to an underrun.

4.7.9 WRITE FILE MARK/WRITE WITHOUT UNDERRUNS Command (63H)

The Write File Mark/Write Without Underruns Command instructs the drive to combine the Write File Mark Command and a Write Without Underruns command to achieve streaming operation when writing file marks. When executing this command, the drive shall first complete the writing of the remaining data

blocks in the buffer, if applicable. It shall then write a file mark and, thereafter, the drive shall with a normal Write Without Underruns command stopping when the end of track is reached, or at the completion of a normal write command. Refer to the Write Without Underruns command.

4.7.10 READ DATA Command (80H)

The READ command causes data to be read from the tape in the drive. The host must assert ONLINE before issuing the READ command. Then, drive transfers data. The READY line is activated when the drive is ready for a data block transfer. The READ command is terminated by the drive if a file mark is detected. The host is informed of file mark detection by means of an EXCEPTION and read status sequence. When READY is asserted, the host may terminate the READ command by either:

- Deactivating ONLINE, which causes the tape to rewind to BOT
- Issuing another command.

A READ command following cartridge insertion, RESET, or any command which positions the tape at BOT commences reading at BOM. Otherwise, the READ command commences from the current tape position. If the host starts a data transfer between blocks, before READY is asserted READY may not occur.

4.7.11 READ CONTINUOUS Command (82H)

This command shall instruct the drive to begin (or continue) a read operation. During the execution of the standard Read command, it is permissible to stop tape motion when a file mark is encountered. However, during execution of the Read Continuous Command, tape motion shall not stop when a file mark is encountered. The drive shall continue reading the following blocks, while simultaneously alerting the host by asserting the Exception signal. To maintain streaming, the host shall complete the Read Status sequence and issue a new Read or Read Continuous command prior to the drive committing to an underrun.

4.7.12 READ BLOCK N Command (8AH)

The Read Block N (RBN) command allows the host to read any given block by addressing the block via it's block number. The drive will automatically calculate the track and block position, then search for the block. The data block transferred will be the requested block.

This command has a total of 5 bytes transferred. The command byte is transmitted as is any other command. Next the parameter bytes are moved as a four byte DMA transfer. The value of the parameter bytes is as follows:

- byte 0 - track number, ignored by drive
- byte 1 - block address, MSB lower 4 bits only
- byte 2 - block address, middle byte
- byte 3 - block address, LSB

4.7.13 SPACE FORWARD Command (81H)

The Space Forward Command shall instruct the drive to logically move the tape forward over the subsequent data block or file mark. No data shall be transferred. The normal completion of this command

shall cause Ready to be activated. If the command is issued at End of Recorded Media or spacing over a file mark occurs, Exception shall result.

4.7.14 SPACE REVERSE Command (89H)

The Space Reverse Command shall instruct the drive to logically move the tape in reverse over the previous data block or file mark. No data shall be transferred. The normal completion of this command shall cause Ready to be asserted. If the command is issued at Beginning of Media or spacing over a file mark occurs, Exception shall be activated and Beginning of Media status set.

4.7.15 SEARCH TO END OF RECORDED MEDIA Command (A3H)

The Search For End of Data Command shall instruct the drive to search for the end of recorded media. The normal completion of this command shall cause Exception to be asserted with ERM (Byte 1, Bit 1) set. New data may then be recorded following the existing recording by issuing a Write command. Should there be no data on the tape, then normal completion shall cause Exception to be asserted with the NDD (Byte 1, Bit 5) set.

The drive shall search the even tracks (0, 2, 4, 6, 8, A, C, E in this order) until it finds a track without data. It then returns to the previous track and positions itself to the end of recorded media on that track or the next odd track. Exception is asserted with the RM bit set. In the case of NDD on track zero (0), Exception is activated with the NDD bit set. Track 14 (OEH) cannot step to the next even track, thus the drive starts reading immediately.

This command is necessary to reduce the positioning time in an append operation. Thus within six minutes on a 600 foot cartridge the tape could be positioned at the end of track 15. If this was accomplished by streaming (approximately two minutes per track with 15 tracks) it would require almost thirty minutes.

4.7.16 READ FILE MARK Command (A0H)

The READ FILE MARK command causes the tape in the drive to move to the EOM side of the next file mark. No data is transferred to the host. A READ FILE MARK command following cartridge insertion, RESET, or any command which positions the tape at BOT commences reading from BOM. Otherwise, reading commences from the current tape position. The normal completion of this command causes EXCEPTION to be asserted with FMD set.

4.7.17 READ N FILE MARKS Command (B1H - BFH)

The Read N Filemarks Command shall be identical in function to the Read File Mark Command except that the number of file marks read shall be equal to the binary value of NNNN. For example 1011 00001 shall cause one file mark to be read and 1011 0010 shall cause two file marks to be read. In the case where NNNN is zero (0011 0000), the drive shall return illegal command status.

4.7.18 READ STATUS Command (C0)

The READ STATUS command causes the drive to transfer to the host information about itself. The drive transfers six bytes of status information. The normal completion of this command causes READY to be

asserted. The READ STATUS command must be issued in response to an EXCEPTION condition. Any other command will be rejected by the drive if an EXCEPTION conditions exists.

4.7.19 ERASE TAPE Command (22H)

The ERASE command completely erases the tape in the drive. The command moves the tape to BOT, activates the erase head and moves to EOT, deactivates the erase head and moves the tape back to BOT. In addition, this command performs all the functions of the INITIALIZATION command. The normal completion of this command causes READY to be asserted.

4.7.20 INITIALIZATION (Retention) Command (24H)

The INITIALIZATION command conditions the tape in the drive according to the recommendations of the media manufacturer. The command moves the tape in the selected drive to BOT, then to EOT and then back to BOT. The normal completion of this command causes READY to be asserted.

4.7.21 REWIND To BOT Command (21H)

The REWIND command positions the tape in the drive at BOT. The normal completion of this command causes READY to be asserted.

4.7.22 RUN SELF-TEST 1 Command (C2H)

The Run Self-Test 1 Command shall instruct the drive to perform the self-test operations. This command shall not allow writing on the media. Following transfer of the command byte, the drive will deassert Ready and commence with the self-test. At the completion of the self-test, Ready shall be activated indicating that response information using the Request/Ready handshake protocol. The first two bytes of response information shall conform to the Standard Status Description. Information bytes 2, 3 4 and 5 are described in Table 4-5. The normal completion of this command shall cause Ready to be activated.

This test checks the following: Tape Holes, Tape Speed (72 and 90 ips), and the 8k RAM test.

The running time is dependent upon tape length. This test requires four minutes with a 600 foot tape. Subtract one minute of time for each decrease in length of 150 feet.

4.7.23 RUN SELF-TEST 2 Command (CAH)

The Run Self-Test 2 Command shall instruct the drive to perform vendor unique self-test operations. This command allows reading and writing on the media. This command may destroy user data if executed on a drive with media containing user data installed. Following transfer of the command byte, the drive shall deactivate Ready and commence with the self-test. At the completion of self-test, Ready shall be activated indicating that status information using the Request/Ready handshake protocol. The first two bytes of response information shall conform to the standard status description. Information bytes 2, 3 4 and 5 are described in Table 4-5. The normal completion of this command shall cause Ready to be asserted.

This test checks the following: Write Operation, Read Operation, Erase and the drive stepper motor.

**Table 4-5
Definition Of Self-Test Error Bytes**

Byte #	Data Bits 7654 3210	Description
0, 1, 2, & 5		Not Used
3	0000 0000	Test not performed
	0001 0001	Test performed, no failures
	0010 0100	Test failed, see byte 4
4	XXXX XX00	No hole sensor failure
	XXXX XX01	LTH hole sensor failure
	XXXX XX10	UTH hole sensor failure
	XXXX XX11	Both hole sensors failed
	XXXX X1XX	Drive speed error
	XXXX 1XXX	Head stepper motor error
	XX00 XXXX	No read/write failure
	XX01 XXXX	Write failure
	XX10 XXXX	Read failure
	XX11 XXXX	CRC failure
	X1XX XXXX	Erase failure
	1XXX XXXX	RAM failure

The running time is dependent upon tape length. This test requires 5 to 15 minutes with a 600 foot tape. Subtract one minute of time for each decrease in length of 150 feet.

4.7.24 RUN SELF-TEST 3 Command (CBH)

The Run Self-Test 3 Command shall instruct the drive to perform the self-test operations. The cartridge will be write protected. Following transfer of the command byte, the drive will deactivate Ready and commence with the self-test. At the completion of the self-test, Ready shall be asserted indicating that response information is available. The host shall receive six bytes of response information using the Request/Ready handshake protocol. The first two bytes of response information shall conform to the Standard Status Description. Information bytes 2, 3, 4, and 5 are described in Table 4-5. The normal completion of this command shall cause Ready to be activated.

This test checks the drive write protect switch.

The tape must be write protected. The running time is not dependent upon tape length. This test requires 1 to 10 minutes.

4.7.25 READ FIRMWARE IDENTIFICATION Command (CFH)

The Read Firmware Identification Command shall instruct the drive to transfer to the host six bytes of firmware identification. The drive shall transfer the bytes using the Request/Ready handshake protocol. Normal completion of this command shall cause Ready to be activated. The identification will contain a letter and two digits of revised information.

4.7.26 Power-On/Reset

The POWER-ON/RESET sequence provides the host with the information on power-on occurrences in the drive. It also provides a convenient mechanism for initializing the drive during hardware and software debugging of the host interface. A power-on condition or a pulse on the reset line resets the drive, and forces it to assert EXCEPTION. When the power on reset times out or when the reset pulse terminates, the drive initializes operating parameters for subsequent command. The drive waits for the host to issue a command. If the command issued was a READ STATUS command, the drive now executes the command by transferring the six required status bytes, and sets bit 0 of byte 1 (the second byte) to indicate that power-up or a reset occurred.

4.8 Status Description

All Drive Status is contained in 6 byte groups as defined in the following sections. Table 4-6 presents a summary of the six status bytes returned by the Read Status command.

4.8.1 Status Byte Descriptions

Bytes 0 and 2 contain exception status (EXC) to define the reason that the drive asserted EXCEPTION. A description of each status bit is as follows:

STATUSBYTE 0

Table 4-6
Status Bytes

Byte 0 Bits 7654 3210	Byte 1 Bits 7654 3210	Acronym	Description
--- ---	--- --X	POR	Power On Reset Occurred
--- ---	--- --X-	ERM	End of Recorded Media
--- ---	--- -X-	RES	Reserved For Bus Parity Error
--- ---	--- X--	BOM	Beginning Of Media
--- ---	--X ---	MBD	Marginal Block Detected (not used)
--- ---	-X- ---	NDD	No Data Detected
--- ---	-X- ---	ILL	Illegal Command
--- ---	X-- ---	ST1	Status Byte 1 Bits
--- --X	--- ---	FMD	File Mark Detected
--- -X-	--- ---	BNL	Bad Block Not Located
--- -X-	--- ---	UDE	Unrecoverable Data Error
--- X--	--- ---	EOM	End Of Media
--X ---	--- ---	WRP	Write Protected Cartridge
-X- ---	--- ---	DFF	Device Fault Flag
-X- ---	--- ---	CNI	Cartridge Not In Place
X-- ---	--- ---	ST0	Status Byte 0 Bits
Byte 2 (MSB) Byte 4 (MSB)	Byte 3 (LSB) Byte 5 (LSB)	DEC URC	Data Error Counter Underrun Counter

BIT 0 FMD - File Mark Detected bit is set when a File Mark is detected during a Read Data or Read File Mark Sequence. The bit is reset by a Read Status Sequence.

BIT 1 BNL - Block in error Not Located bit is set when an unrecoverable read error occurs and the formatter cannot confirm that the last block transmitted was the block in error. The bit is reset by a Read Status Sequence.

BIT 2 UDE - Unrecoverable Data Error bit is set when the formatter cannot read a block after sixteen retries and obtain a correct check sum. The UDE bit is also set when the formatter cannot correctly write a block within sixteen retries. It is also set when the formatter cannot locate a block. The UDE bit is reset by a READ STATUS sequence.

BIT 3 EOM - End of Media is set when the logical early warning hole of the last track is detected during a write operation. This bit will remain set as long as the drive is at logical end of media. The EOM bit will not be reset by a Read Status Sequence.

BIT 4 WRP - Write Protected bit is set if the cartridge write protect plug is set in the file protect "safe" position. Operator must change the write protect plug position before the status bit will reset.

BIT 5 DFF - Drive Fault Flag bit is set when the drive detects a problem other than data errors during command execution. Reset or Read Status sequence will reset this bit.

BIT 6 CNI - Cartridge Not in Place bit is set if a cartridge is not fully inserted into the drive. The Operator must correct this condition before the status bit will reset.

BIT 7 ST0 - Status Byte 0 is set if any other bit in Status Byte 0 is set.

STATUSBYTE 1

BIT 0 POR - The Power-On/Reset is set after the host asserts RESET or when the host is powered up. The bit is reset by a Read Status Sequence

BIT 1 ERM - End of Recorded Media is set when the drive detects the ERM condition. When reading, this happens at EOM and at the successful completion of a SEARCH TO END OF RECORDED MEDIA command. During the WRITE mode, it occurs when writing into EOM. This bit is reset by a Read Status Sequence.

BIT 2 RES - Reserved

BIT 3 BOM - Beginning of Media bit is set whenever the cartridge is logically at beginning of tape, track 0. The bit is reset when the tape moves away from beginning of tape. This is the only bit in this byte that does not set EXCEPTION when it goes true, nor is it reset by the Read Status Sequence.

BIT 4 MBD - The Marginal Block Detected bit is set when the formatter takes more than eight but less than sixteen retries to read a block with correct CRC. This status bit warns the host that the tape is marginal and should be replaced. This bit is reset by the Read Status Sequence. The embedded drive does not support this bit.

BIT 5 NDD - No Data Detected bit is set when an unrecoverable data error occurs due to lack of recorded data. Absence of recorded data is the failure to detect a data block within 20 inches of tape after three consecutive retries. This bit is reset by a Read Status Sequence.

BIT 6 ILL - Illegal command bit is set if any of the following occurs. The bit is reset by a Reset Status Sequence.

- SELECT command is issued with no drives or more than one drive indicated.
- ONLINE not asserted when a WRITE, WRITE FILE MARK, READ or READ FILE MARK command is issued.
- A command other than WRITE or WRITE FILE MARK is issued during the execution of a Write Data Sequence.
- A command other than READ or READ FILE MARK is issued during the execution of a Read Data Sequence.
- A command to SELECT a new drive is issued when the current drive's tape is not at BOT.

BIT 7 ST1 - Status Byte 1 bit is set if any other bit in Status Byte 1 is set.

Refer to EXCEPTION STATUS SUMMARY and EXCEPTION STATUS DESCRIPTION for a further explanation.

Bytes 2 and 3 contain the data error counter (DEC) which accumulates the number of blocks rewritten for WRITE operations and the number of soft read errors during READ operations. These bytes are cleared by a Read Status sequence.

Bytes 4 and 5 contain the underrun counter (URC) which accumulates the number of times that streaming was interrupted because host failed to maintain minimum throughput rate. These bytes are cleared by a Read Status Sequence.

4.9 Exception Status Summary

The Exception Status Summary is provided in Table 4-7.

4.9.1 Exception Status Description

1. **NO CARTRIDGE.** Selected drive did not contain a cartridge when BOT, RET, ERASE, WRITE, WFM, READ or RFM was issued or cartridge was removed while the drive is selected. FATAL.
2. **Drive FAULT FLAG.** The drive detected a problem other than data errors during command execution. FATAL.
3. **WRITE PROTECTED.** Selected drive contained write protected (safe) cartridge when ERASE, WRITE or WFM was issued. FATAL.
4. **END OF MEDIA.** Tape has passed the logical early warning hole of the last track during WRITE command. CONTINUABLE.
5. **READ OR WRITE ABORT.** The maximum limit of same block rewrites occurred during a WRITE or WFM command or recoverable reposition error occurred during a WRITE, WFM, READ or RFM command. Tape has returned to BOT. FATAL.
6. **READ ERROR, BAD BLOCK XFER.** The maximum limit of same block retries failed to recover block without CRC error, last block transferred contained data from the erroneous data block for off line reconstruction. CONTINUABLE.
7. **READ ERROR, NO DATA.** No recorded data found on tape for 20 inches. CONTINUABLE.

Table 4-7
Exception Status Summary

Byte 0 Bits 7654 3210	Byte 1 Bits 7654 3210	Description
110X 0000	0000 0000	No Cartridge
0010 0000	0000 0000	Device Fault Flag
1001 0000	X000 X000	Write Protected
1000 1000	0000 0000	End Of Media
100X 0100	1000 1000	Read or Write Abort
100X 0100	0000 0000	Read Error, Bad Block Transfer
100X 0110	1010 0000	Read Error, No Data
100X 1110	1010 0000	Read Error, No Data & EOM
100X 0001	0000 0000	Read A File Mark
XXXX 0000	1100 X000	Illegal Command
XXXX 0000	1000 X001	Power On Reset
100X 0001	0001 0000	Marginal Block Detected (not used)
Note: "X" denotes either 0 or 1		

8. READ ERROR, NO DATA AND EOM. The maximum limit of same block retries failed to recover the next or subsequent blocks and the logical end of tape holes on the last track were encountered. CONTINUABLE.

9. FILE MARK READ. A file mark block was read during a READ or RFM command. CONTINUABLE.

10. ILLEGAL COMMAND. One of the following events occurred:

- Attempt to select other than one drive.
- Attempt to change drive selection when tape has been moved away from BOT by a read or write operation.
- Attempt to BOT, RETENTION, or ERASE simultaneously.
- Attempt to WRITE, WFM, READ, or RFM with ONLINE not asserted.
- Attempt to issue a command other than WRITE or WFM during a WRITE command. FATAL.
- Attempt to issue a command other than READ or RFM during a READ command. FATAL.
- Attempt to issue any command not implemented.

11. POWER-ON/RESET. A power-on/reset or a reset by the host has occurred. FATAL.

12. MARGINAL BLOCK DETECTED. A data block was detected by the drive after than eight but less than sixteen retries. CONTINUABLE.

4.10 Interface Timing

Interface signal timing is specified in the following timing sections and corresponding timing diagrams.

4.10.1 Reset Timing

Figure 4-3 presents the interface timing diagram which results from the assertion of RESET. As indicated in the diagram the host is required to maintain reset assertion for at least 25 microseconds.

4.10.2 Read Status Timing

A hardware reset or a power-on reset (generated by the drive) will generate an EXCEPTION condition, indicated by the assertion of EXCEPTION on the interface. The host clears EXCEPTION by performing a Read Status command. Figure 4-4 shows the timing for the Read Status command.

4.10.3 Select Command Timing

The drive will respond to the Select Command as defined by the QIC specification. The unit will produce an EXCEPTION condition if a drive other than 0 is selected. Timing for the Select Command sequence is shown in Figure 4-5.

4.10.4 Position Command Timing

Figure 4-6 illustrates timing for the Rewind, Erase, and Retention commands.

4.10.5 Write Data Timing

One of the two major commands of the unit is Write Data. This is the mechanism by which user data is recorded on the tape media. Figure 4-7 shows the Timing Diagrams associated with this command.

4.10.6 Read Data Timing

Once data has been recorded on tape it is recovered by the Read Data command, the second major command. Figure 4-8 presents the interface timing for the Read Data Command.

4.10.7 Write File Mark Command Timing

The File Mark is a method by which the user can separate logical or physical record on the tape. The Write File Mark Command Timing diagram is shown in Figure 4-9.

4.10.8 Read File Mark Command Timing

To position the tape at a file mark a Read File Mark Command is issued. Figure 4-10 shows the timing for this command.

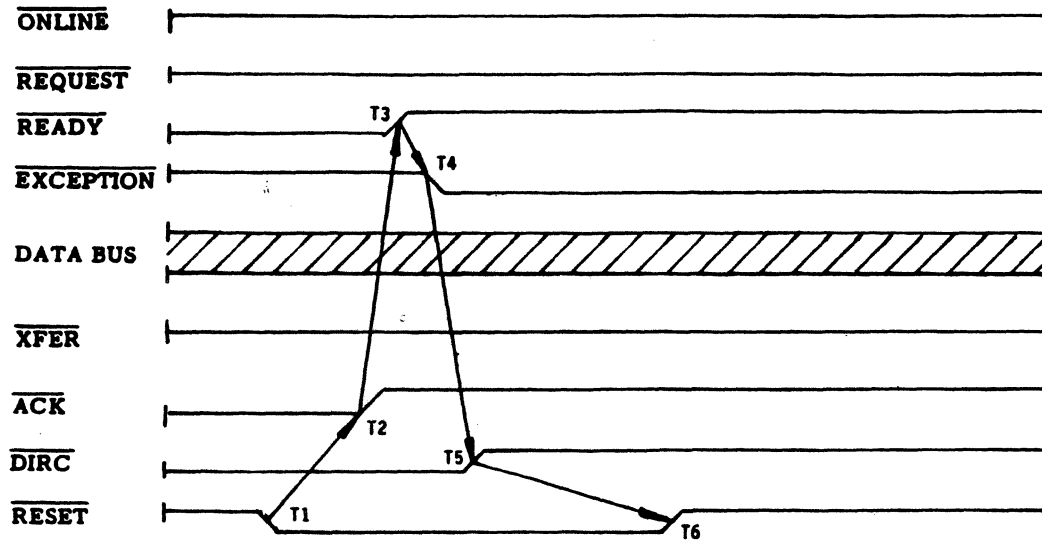
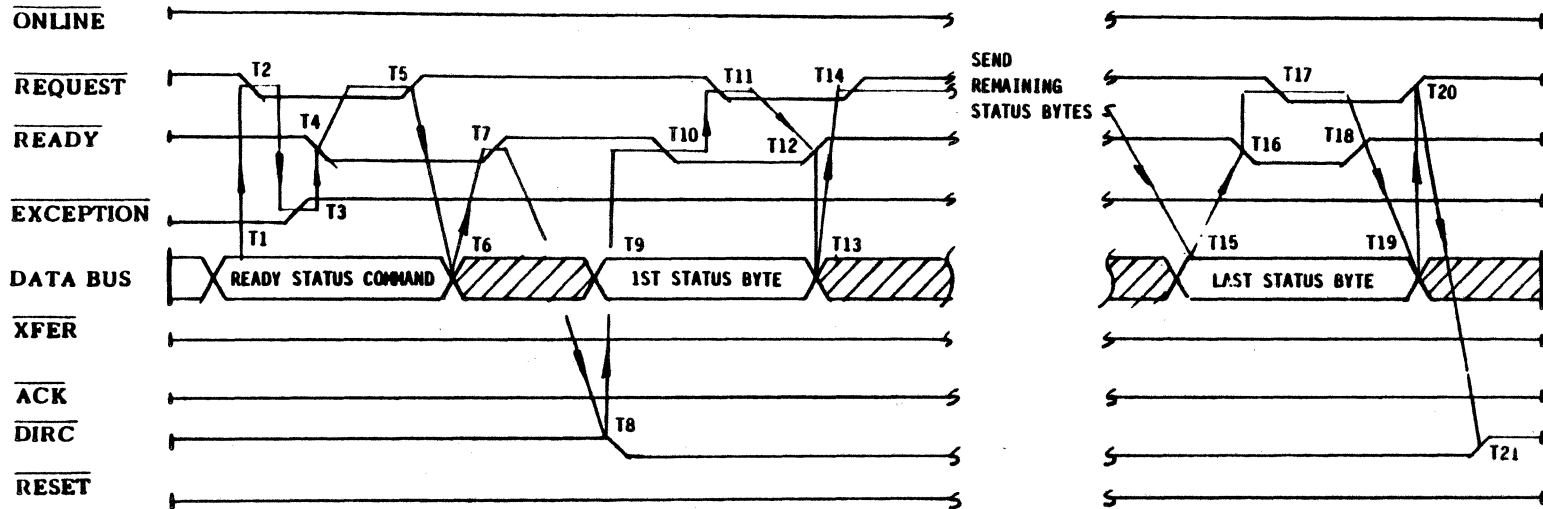


Figure 4-3
Reset Timing

Reset Command	
Activity	5XXEQ Timing
T1 - Host Asserts RESET	N.A.
T2 - Drive De-Asserts ACK	T1-T2 = 90nS
T3 - Drive De-Asserts READY	T1-T3 = 390nS
T4 - Drive Asserts EXCEPTION	T1-T4 = 440nS
T5 - Drive De-Asserts DIRC	T1-T5 = 500nS
T6 - Host De-Asserts RESET	N.A.

Figure 4-4
Read Status Command Timing



Read Status Command	
Activity	5XXXEQ Timing
T2 - Host Asserts REQUEST	N.A.
T4 - Drive Asserts READY	$104 \mu\text{S} \leq T2-T4 \leq 140 \mu\text{S}$
T7 - Drive De-Asserts READY	$40 \mu\text{S} \leq T5-T7 \leq 44 \mu\text{S}$
T8 - Drive Asserts DIRC	$99 \mu\text{S} \leq T7-T8 \leq 211 \mu\text{S}$
T10 - Drive Asserts READY	$141 \mu\text{S} \leq T7-T10 \leq 251 \mu\text{S}$
T12 - Host De-Asserts READY	$T11-T12 = 50\text{nS}$
T21 - Drive De-Asserts DIRC	$T20-T21 = 68 \mu\text{S}$

NOTES:

1. Time for T14 to READY for next status byte is from 64 μS min. to 71 μS max.
2. Time from T20 to READY for next command is from 178 μS min. to 184 μS max.

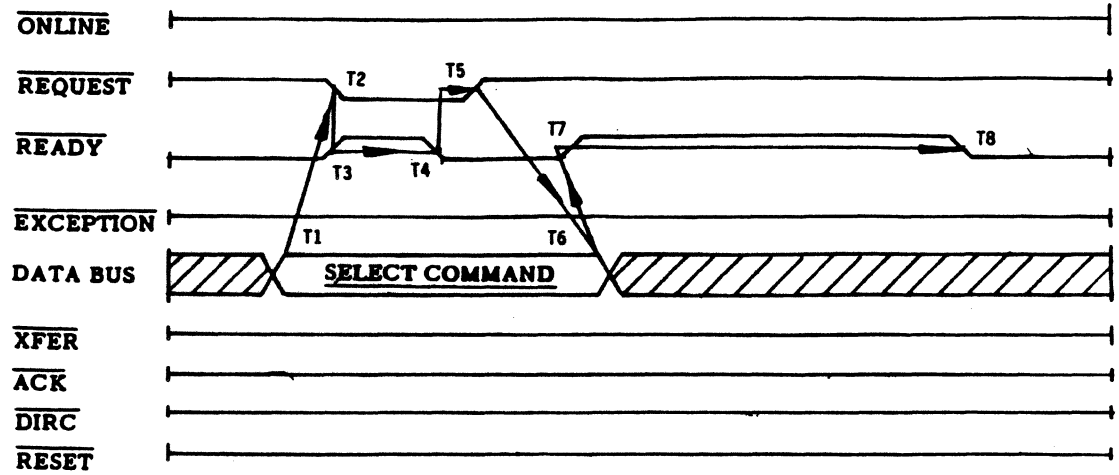
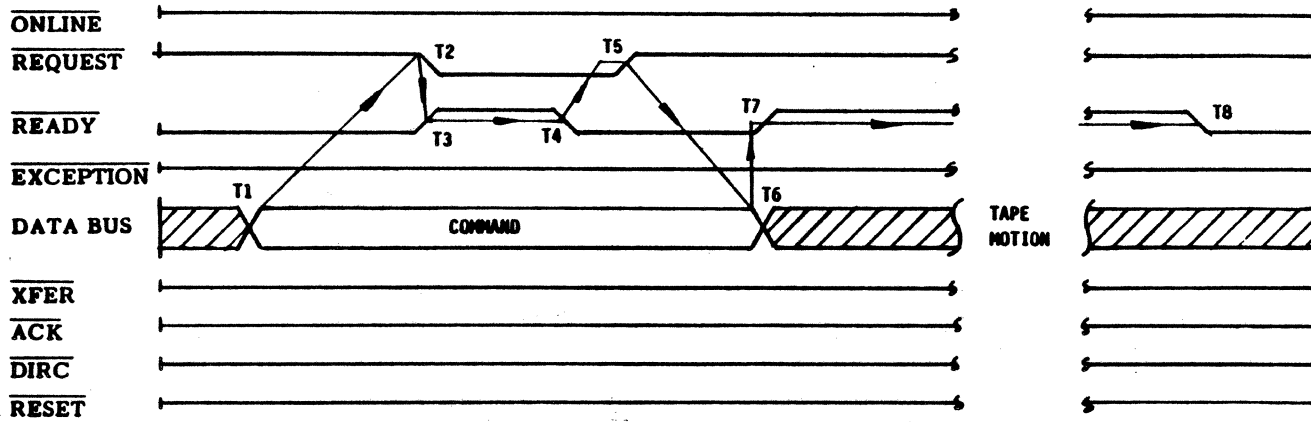


Figure 4-5
Select Command Timing

Select Command	
Activity	5XXXEQ Timing
T2 - Host Asserts REQUEST	N.A.
T3 - Drive De-Asserts READY	T2-T3 = 50nS
T4 - Drive Asserts READY	124 μS ≤ T3-T4 ≤ 140 μS
T7 - Drive De-Asserts READY	T5-T7 = 44μS
T8 - Drive Asserts READY	T7-T8 = 55.4mS

Figure 4-6
BOT, Retension or Erase Command Timing

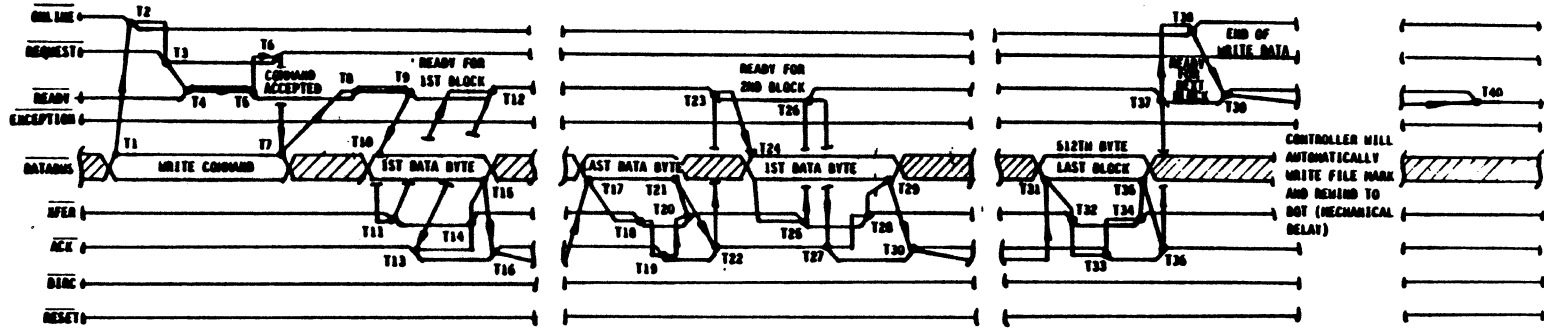


BOT, Retension or Erase Command	
Activity	5XXXEQ Timing
T2 - Host Asserts REQUEST	N.A.
T3 - Drive De-Asserts READY	T2-T3 = 50nS
T4 - Drive Asserts READY	$107 \mu\text{S} \leq \text{T3-T4} \leq 139 \mu\text{S}$
T7 - Drive De-Asserts READY	T5-T7 = 44 μS
T8 - Drive Asserts READY	T7-T8 = see note.

NOTE:

1. T7 to T8 time will depend on the tape position when BOT command is given. It will be 1 1/2 minutes in a worst case situation for a 600 foot tape. In case of a RETENSION or ERASE command, the T7 to T8 time will be approximately 3 minutes.

Figure 4-7
Write Data Command Timing

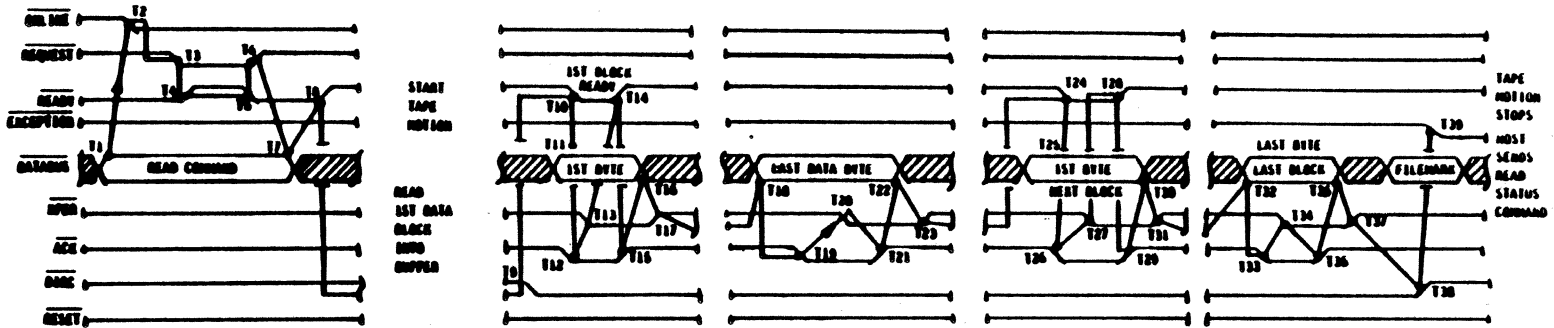


Write Data Command	
Activity	5XXXEQ Timing
T3 - Host Asserts REQUEST	N.A.
T4 - Drive De-Asserts READY	T3-T4 = 50nS
T5 - Drive Asserts READY	$2.58\text{mS} \leq T4-T5 \leq 2.625\text{mS}$
T8 - Drive De-Asserts READY	$40 \mu\text{S} \leq T6-T8 \leq 44 \mu\text{S}$
T9 - Drive Asserts READY	T8-T9 = see note.
T12 - Drive De-Asserts READY	$50 \text{ nS} \leq T11-T12 \leq 60 \text{ nS}$
T13 - Drive Asserts ACK	$1.94 \mu\text{S} \leq T11-T13 \leq 4.56 \mu\text{S}$
T16 - Drive De-Asserts ACK	$40 \text{ nS} \leq T14-T16 \leq 80 \text{ nS}$
T23 - Drive Asserts READY	$1.9 \text{ mS} \leq T22-T23 \leq 2.5 \text{ mS}$

NOTE:

1. T8 to T9 time will depend on the position at the time of the command. It will be 1 1/2 minutes in a worst case situation for a 600 foot tape.

Figure 4-8
Read Data Command Timing

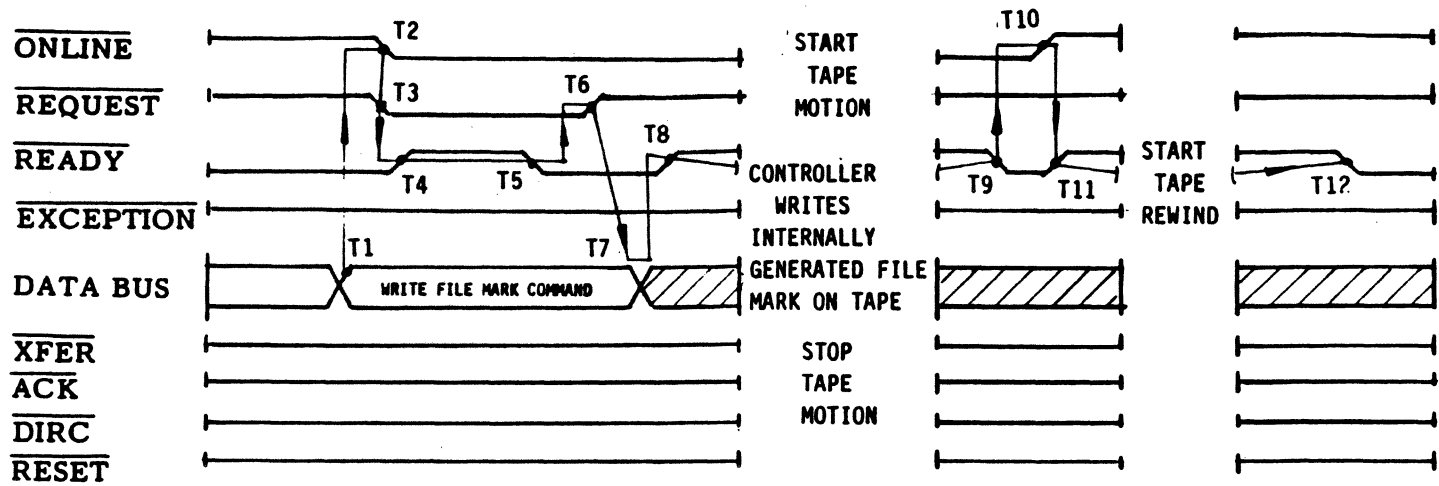


Read Data Command	
Activity	5XXXEQ Timing
T3 - Host Asserts REQUEST	N.A.
T4 - Drive De-Asserts READY	T3-T4 = 50nS
T5 - Drive Asserts READY	$104 \mu\text{S} \leq T4-T5 \leq 138 \mu\text{S}$
T8 - Drive De-Asserts READY	$41 \mu\text{S} \leq T5-T8 \leq 44 \mu\text{S}$
T10 - Drive Asserts READY	T8-T10 = see note.
T14 - Drive De-Asserts READY	$40 \text{ nS} \leq T13-T14 \leq 60 \text{ nS}$
T15 - Drive De-Asserts ACK	$520 \text{ nS} \leq T13-T15 \leq 1.21 \mu\text{S}$

NOTE:

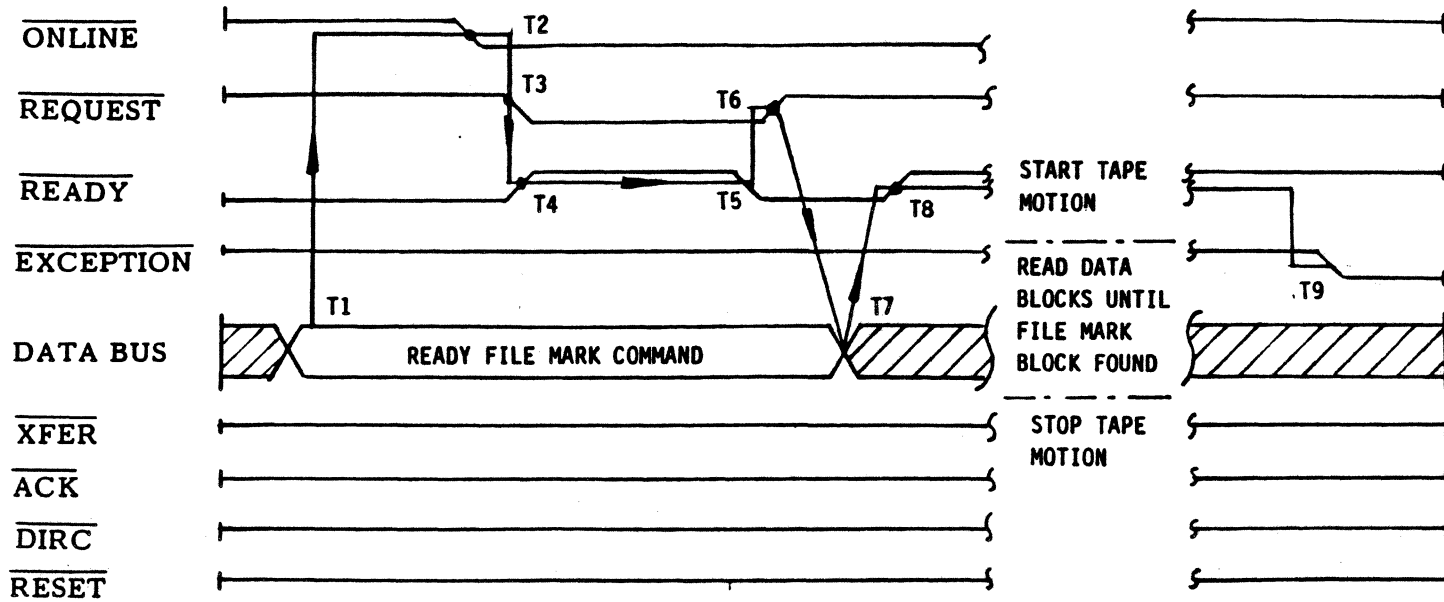
1. T8 to T10 worst case time is 1 1/2 minutes for a 600 ft. tape.
2. T17 - ACK assertion for next byte is from a min. of 1.93 μS to a max. of 4.0 μS .
3. Direction signal will be de-asserted only if the drive sees a Filemark or if an occurs.

Figure 4-9
Write File Mark Command Timing



Write File Mark Command	
Activity	5XXXEQ Timing
T3 - Host Asserts REQUEST	N.A.
T4 - Drive De-Asserts READY	T3-T4=50nS
T5 - Drive Asserts READY	104 μS ≤ T4-T5 ≤ 372 μS
T8 - Drive De-Asserts READY	41 μS ≤ T6-T8 ≤ 43 μS

Figure 4-10
Read File Mark Command Timing



Read File Mark Command	
Activity	5XXXEQ Timing
T3 - Host Asserts REQUEST	N.A.
T4 - Drive De-Asserts READY	T3-T4 = 50nS
T5 - Drive Asserts READY	$104 \mu\text{S} \leq \text{T4-T5} \leq 140 \mu\text{S}$
T8 - Drive De-Asserts READY	$40 \mu\text{S} \leq \text{T6-T8} \leq 44 \mu\text{S}$

NOTE:
1. After T9, host must issue a Read Status command. Any other command will be rejected by the drive as an illegal command.

Section 5

THEORY OF OPERATION

5.1 Introduction

This section provides a general overview of the drive theory of operation and a detailed functional theory of operation.

5.2 General Information

This section shall provide a general overview of the basic drive board and its connectors. There are two primary sources of input signals to the drive. These are Power input and Command signals received from the formatter/controller.

The command signals, with the exception of write data, are combined with the internally generated signals to provide multiplexed data. Decoding is accomplished in the microprocessor (CPU), which performs the following functions.

- Decodes formatter/controller signals
- Transmits signals to the formatter/controller
- Receives signals from the sensor assemblies
- Controls the motor velocity and control
- Controls the stepper motor (head) positioning
- Controls write and read threshold levels and gains

A crystal oscillator (18 MHz) and associated logic control the CPU, and the rest of the system timing. A 50 pin connector provides the interface between the external formatter/controller and the drive. All internal and external connectors and signal information are listed below.

- J1 50 Pin edge connector to/from formatter/controller
- J2 8 Pin socket connector from Read Heads
- J3 8 Pin header to/from brushless DC motor
- J4 8 Pin dip socket connector to/from CIN and sensor assembly
- J5 7 Pin Header to stepper motor
- J6 4 Pin Receptacle from power supply
- J7 12 Pin socket connector to Write/Erase heads

The block diagram shown in Figure 5-1 depicts the functional building blocks of the model 5099EQ/5125EQ/5150EQ drive.

5.3 Capstan Motor Control

The tape velocity servo for the 5099EQ/5125EQ/5150EQ tape drive can be characterized as a microprocessor controlled digital phase lock servo using pulse width modulation to drive a low inertia brushless DC motor. This servo control method can be modeled by four major functional blocks, as shown in Figure 5-2. The velocity control and error detection logic is implemented in the microprocessor. The processor's firmware operates the motor control logic to control the direction of rotation and the motor current level. In addition, the microprocessor calculates the time difference between successive tachometer pulses fed back from the motor and referenced to an internal clock. With the generated error signal, the microprocessor implements a proportional plus integral digital compensation to provide for accurate control of the motor velocity, resulting in control of the tape velocity across the read/write heads.

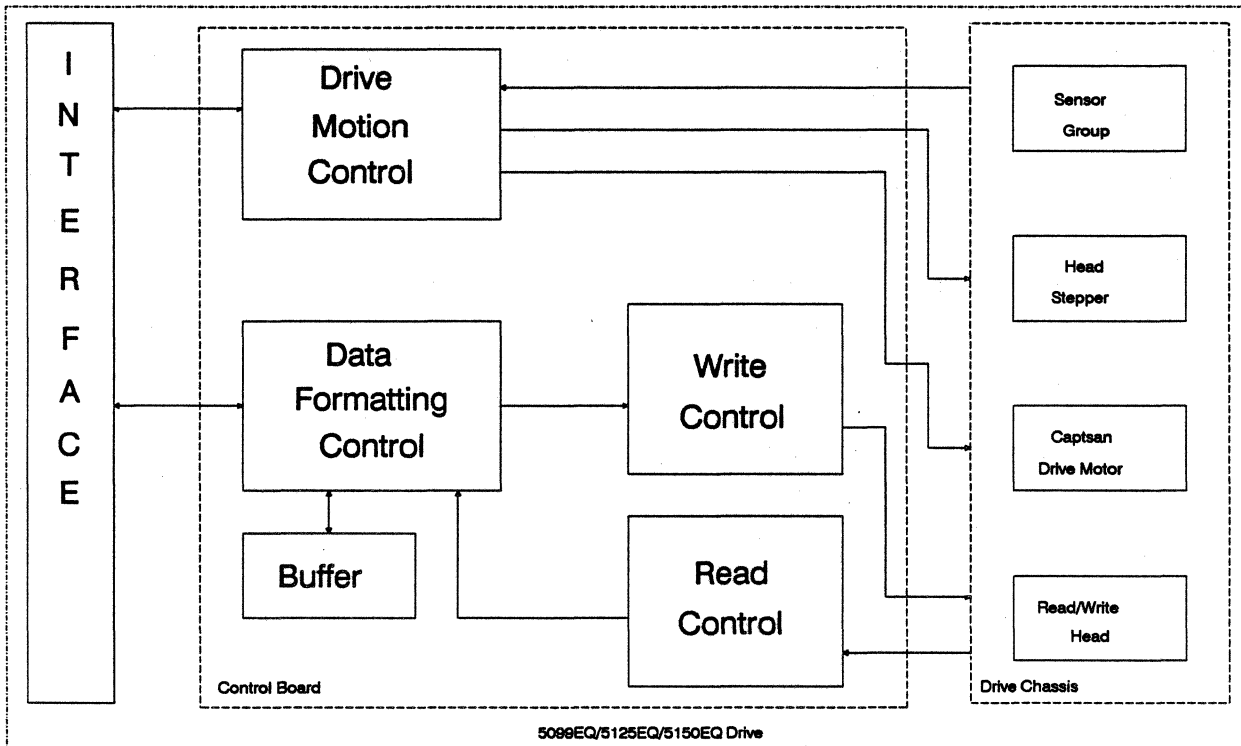


Figure 5-1
Functional Block Diagram

The brushless DC motor is an eight pole three phase DC motor. The motor has three hall effect sensors to detect rotor position. These are used to drive commutation circuitry and also to provide velocity feedback to the tach circuit.

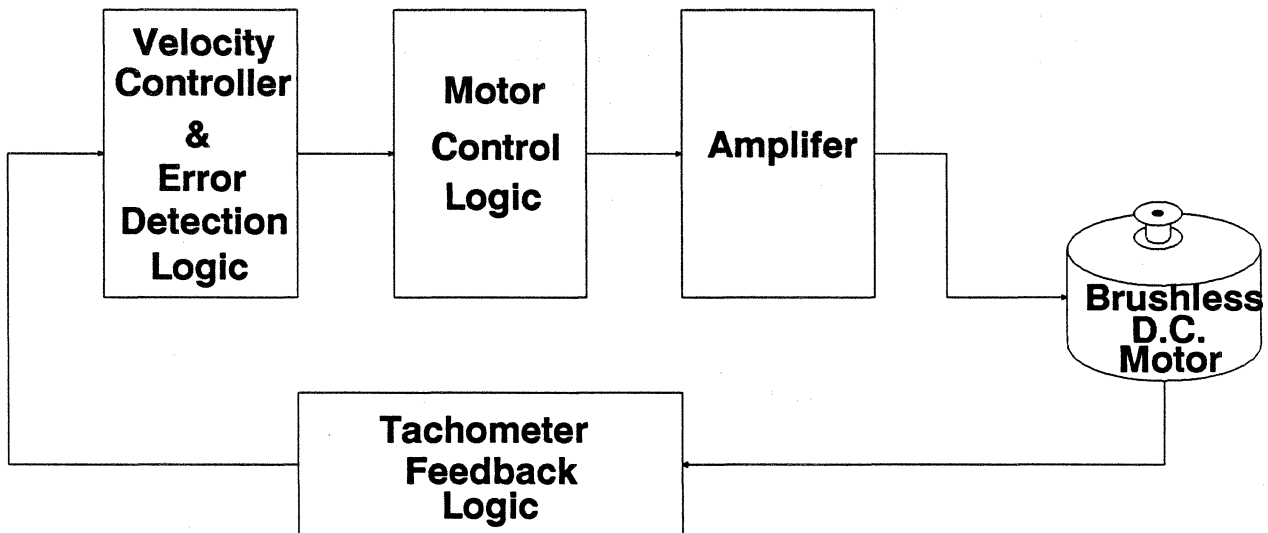


Figure 5-2
Capstan Motor Control

5.4 Write And Erase Controls

The Write and Erase circuits are depicted in Figure 5-3. The interface signals which control the circuits are "Write Enable" (WEN) and Erase Enable (EEN). The Wangtek custom write IC consists of write logic plus the tape hole sensor logic. The state of the "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 are allowed. The write drivers are disabled during a power up/down sequence and while the "SAFE" switch is enabled. The HI-CUR (High Current) line is used to inform the drive that a high coercivity tape cartridge is inserted in the drive. The output of the write IC is connected to the write head in order to write data onto tape.

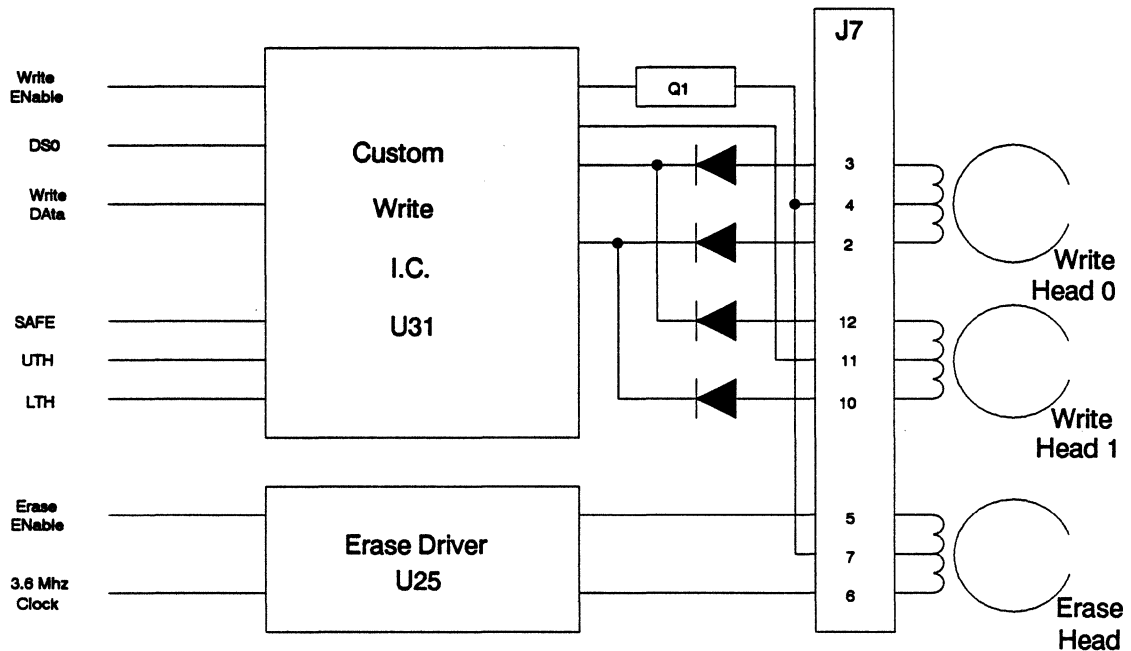


Figure 5-3
Write And Erase Circuits

5.5 Read Data

Read data from the tape head is first amplified, passed through a Miller integrator circuit which limits the bandwidth, amplified again through a differential amplifier, and passed through a comparator circuit and a limiter circuit. The signal is further processed by a TL041 Read Signal Processor Chip which output the Read Data in digital form.

5.6 Track Calibration Routines

There are two different track zero calibration routines which are described in this section. The routines include Writing Track 0 Reference Burst, Track Zero Burst Detection for 18, 15 & 9 Track Operation.

5.6.1 Writing Track 0 Reference Burst

The accurate positioning of the head for writing the track zero reference burst is of utmost importance. In order to position the head in the exact location, it is not possible to rely on a mechanical reference position as a calibration point. Therefore, the edge of tape has been detected as the reference point for writing the track zero burst. This operation is performed using the following sequence of events.

- Detect tape type.
- Step head down to mechanical reference point.
- Move head to edge detect reference point.
- Move head to detect the lower edge of tape.
- Re-position to the beginning of tape.
- Step from tape edge to Track zero.

5.6.2 Track Zero Burst Detection

The track zero reference burst search is the operation of positioning head 0 to the center of the data written on the tape. This operation is performed using the following sequence of events.

- Step down to mechanical reference position.
- Step up to start position for detecting 15/18 track burst.
- Rewind to BOT
- Start tape motion, start movement of head up to detect lower edge of the track zero burst. Stop head and tape motions.
- If not located, step up to start position for detecting 9 track burst.
- Rewind to BOT
- Start tape motion, start movement of head up to detect lower edge of the track zero burst. Stop head and tape motions.
- If no burst is detected, (i.e. blank tape) the drive will recalibrate to the mechanical 15 track burst position.
- Re-position to beginning of tape.
- Move head up passing the upper edge of the burst.
- Start tape motion, start movement of head down to detect the upper edge of the track zero burst. Stop head and tape motions.
- Rewind to BOT
- Step down to calculated center of track zero reference burst, plus one step.
- Re-position to beginning of the tape.
- Move head up one step to be at the center of the burst

5.7 Major Component Functions

5.7.1 Cartridge

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

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

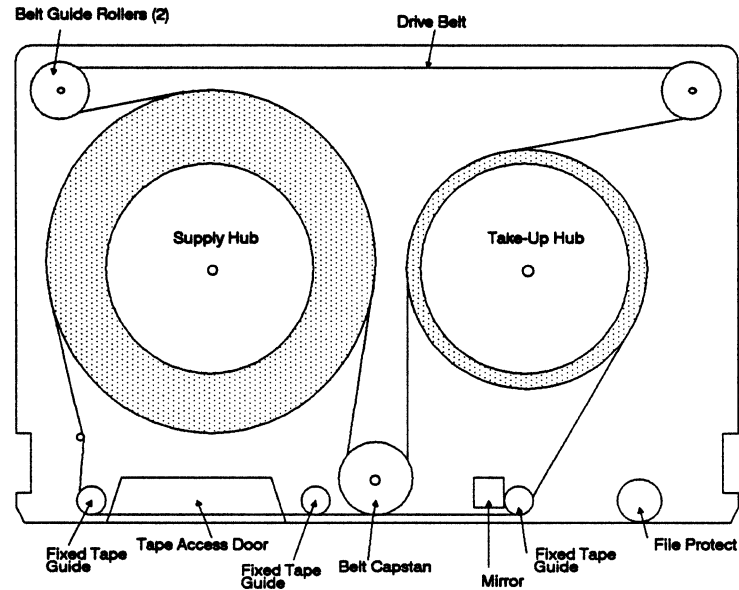


Figure 5-4
Tape Cartridge

The three reference points are positioned on the tape cartridge base and case to prevent improper insertion into the tape drive. A spring-loaded ball on the drive tensions the cartridge base plate against all reference points.

The cartridge-in position sensor is located in the capstan/hole sensor assembly. It is activated via a switch connected to the drive capstan, which triggers as the drive capstan contacts the cartridge capstan roller. When activated, the signal is routed to the drive CPU to indicate that a cartridge is in place and the drive is now ready to accept further commands.

The cartridge has a rotatable plug which can be manually positioned by the user to protect the data on tape from being erased or written over. A micro switch in the capstan/hole sensor assembly detects this plug position and routes the signal to the CPU which then inhibits the write/erase amplifier circuitry, if activated.

The mirror mechanism is located within the cartridge casing, and is utilized for tape position detection by deflecting the infra-red emitter light through the holes of the tape itself to the phototransistors.

The cartridge door and capstan do not generate any signals to the drive, but are an integral part of the cartridge assembly. The capstan wheel is driven by the drive capstan and in turn, causes the tape reels to turn and move tape. The cartridge door protects the tape from contaminants when not in use.

5.7.2 Sensor Assembly

The Sensor Assembly is designed to detect tape hole positions (BOT, EOT, LP, EW) utilized by the drive to determine tape position and tape status. An infra-red emitter located on the sensor housing, emits a light to the mirror mechanism opposite the emitter within the cartridge casing, creating a light field.

As the tape hole passes through this field, light passes through these holes and strikes either one or both of the phototransistors located in the sensor housing perpendicular to the emitter. The phototransistor signals are then processed by the logic situated in the Wangtek custom IC and then further sent to the drive CPU where they are processed to determine the tape position.

5.7.3 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 with six wires. Two of these wires are twelve (12) volt lines for the individual motor windings. The other four wires receive electrical impulses derived from the drive CPU and amplified by peripheral driver (U33) in order to move the stepper motor the desired number of steps.

Interface signals determine the desired track location and are transmitted to the drive CPU. The CPU converts these signals into discrete mechanical movements referred to as steps. Each step represents one phase transition of the stepper motor, which is equal to 7.5 degrees of movement. The steps are changed in a logical sequence to move the stepper motor the desired number of steps for the required track selected.

The head positioning mechanism is a lead screw type. The stepper motor is composed of this shaft connected to the motor windings. The shaft is attached to a threaded sleeve which is attached to the magnetic head mounting assembly. The shaft/screw will rotate as a result of motor stepping, while the nut moves up and down and with the head assembly. Depending on the sequence of inputs, the motor will rotate the shaft in a clockwise or counter-clockwise direction.

5.7.4 Magnetic Head

The head assembly consists of a closed magnetic circuit constructed of laminated high permeability metal with wound coils for inducing and detecting flux reversals on magnetic tape. Refer to Figure 5-5. The head assembly has read, write, and erase functions and also utilizes two tape cleaner blades at each end of the assembly.

The magnetic head is designed to be compatible with either the QIC-24, QIC-120 or QIC-150 data format guidelines. It has two track capability, due to the two read heads, two write heads, and full width erase bar.

The head receives write/erase commands from the controller, which are routed to the appropriate write and erase driver circuits on the Main board and to the head via connector J7. The write and erase heads cannot be enabled simultaneously, with the exception of Track 0 where they are both activated, at which

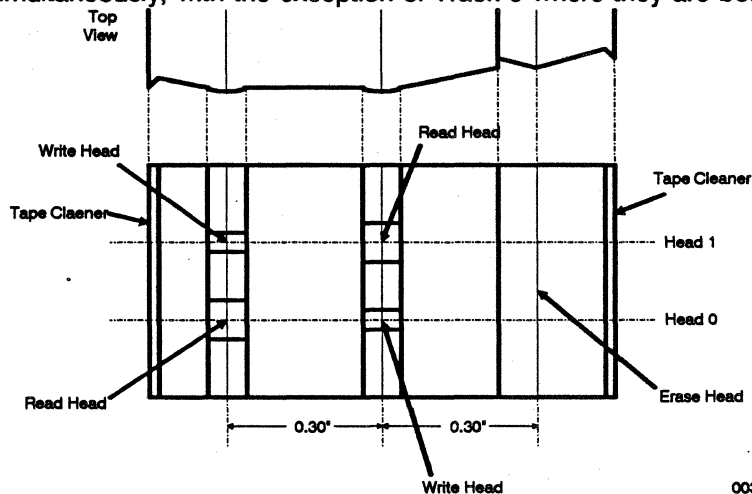


Figure 5-5
Read / Write Head

time all data on all tracks is erased from the tape. The erase signal is AC driven. The signal is derived from the CPU clock signal which is divided down to 3.33MHz by the motor control gate array chip. Read signals are routed from the head to the Main board via connector J2. The signals are then routed to the amplifier/differentiator and peak detector where they are digitized.

5.8 Electro-static Discharge Specification

This section describes the ESD test amplitude and criteria for the Wangtek drive when tested in a computer system. The purpose is to describe a standard ESD qualification test that ensures satisfactory operation of the Wangtek drive in the field under typical ESD conditions.

The test procedures consist of applying a series of electrostatic discharges of particular amplitudes and wave forms to the drive and observing the effects of such discharges. The electrostatic discharges are provided by a commercial generator designed to simulate waveforms typically observed in the field.

The ESD amplitudes vary from 2.5 to 17.5 kV in increments of 2.5 kV. A test using 25kV is also performed. The test is divided into four groups that differ by the effects allowed. The test amplitude and criteria are defined in Table 5-1.

5.8.1 Definitions Of Effects

- MINOR EFFECT - A transient, observable event such as display jitter or video snow.
- SOFT ERROR - A read, write, or data transfer error, or change of logic state that is recoverable within sixteen programmed retries.
- HARD ERROR - An error that is not recoverable within sixteen retries, or that cause data corruption detected later, program malfunction, or lockup of the computer system.
- OPERATOR INTERVENTION - An action by the operator necessary to restore normal operation. There are three kinds of operator intervention: normal reset, power off-on sequencing, and major reset.
- NORMAL RESET - The operator can restore normal operation using panel, console, or keyboard controls only. It does not include power off-on sequencing unless this is specified as the normal reset for the system.
- LOCKUP - A situation in which normal operation must be restored by a power off-on sequence or a major reset.
- MAJOR RESET - This involves re-initialization of the program or reloading of memory.
- COMPONENT FAILURE - Any failure causing faulty operation and requiring repair by service personnel.

5.8.2 Test Criteria

All products shall be tested with the test amplitudes listed in Table 5-1 and shall meet the corresponding group test criteria and limits.

5.8.3 Test Procedures

Direct discharges to the drive are preferred, paying particular attention to areas frequently touched by the operator, such as the front of the casing. Discharges to the interior of the drive are not required if it is not normally accessible to the operator. Try to identify direct discharge test points on each surface by exploratory use of the test generator probe. If direct discharge to a surface is not possible because it is

nonconductive, the recourse shall be testing with indirect discharges to the side of a radiating plane facing the product.

During the course of testing, the drive shall be operated in its required configuration and mode of operation.

Apply 50 discharges per test point with each group 1, 2, and 3 amplitude tests and 5 discharges per test point for group 4 (25kV).

If the maximum permissible occurrence rate is exceeded at a Group 2 or 3 test point (See Table 5-1), the test may be repeated using 150 discharges. The combined occurrence of the 200 discharges shall then determine if the test criteria is met.

Table 5-1
Maximum Permissible Occurrence Rates

TEST AMPLITUDE AND CRITERIA					
GROUP	TEST	EFFECTS			
		ALLOWED	PARTIALLY ALLOWED	MAXIMUM PERMISSIBLE OCCURENCE RATE	PROHIBITED
1	2.5 KV 5.0KV	none	none	0%	all types
2	7.5KV 10.0KV 12.5KV	minor effects, soft errors	effects requiring operator intervention	4%	component failures hard errors, data corrupt, program malufunction, lockups
3	15.0KV 17.5KV 25.0KV	minor effects	hard errors, data corruption, program malfunctions, lockups	6%	component failures
4	25.0KV	all effects except component failures	none	none	component failures

Section 6

MAINTENANCE

6.1 Introduction

This section contains information regarding product reliability, preventative maintenance procedures, a trouble shooting guide, removal and replacement procedures, and adjustment procedures.

6.2 Product Reliability And Failure Definitions

The failure definitions listed in this section shall be used in conjunction with the Wangtek, Inc. Warranty and also the recommended maintenance schedule, neither of which is contained in this document.

6.2.1 Critical Failure

Critical failure is defined as any persistent failure of the drive. Failures caused by operator error, mishandling, power supply out of specification, drive controller out of specification, interface malfunction, or operation in an adverse (out of specification) environment will not be considered as critical failures.

6.2.2 Infant Mortality Failure

Infant mortality failure is defined as any critical failure that occurs during the first 140 hours of operation after installation. These failures, irrespective of frequency, shall not be considered in computation of the MTBF.

6.3 Duty Cycle

The drive duty cycle is defined as follows:

$$\text{Duty Cycle} = \frac{\text{Tape Motion Time}}{\text{Power On Time}} \times 100$$

The typical usage duty cycle for the drive is 15%

6.4 Mean Time Between Failure

The Mean Time Between Failures (MTBF) of the drive is defined as follows:

$$\text{MTBF} = \frac{\text{Power On Hours}}{\text{Number of Critical Failures}} \times 100$$

Based on the typical usage duty cycle of 15%, the MTBF of the drive is 15,000 power-on hours.

6.5 Mean Time To Repair

The mean time to repair the Wangtek drive is estimated to be 30 minutes.

6.6 Data Reliability

The data reliability for the drive shall be as stated below:

Soft Errors (Read): less than 1 in 10 to the 8th bits
 Hard Errors (Read): less than 1 in 10 to the 11th bits

A Soft Error is defined as any data error which is recovered within sixteen retries. A Hard Error is defined as any data error which is not recoverable, i.e., cannot be read after 16 retries.

6.7 Preventive Maintenance

The drive preventive maintenance schedule is provided in Table 6-1.

Table 6-1
 Recommended Preventive Maintenance Schedule

Item	Interval (hours)
Head Cleaning Capstan Cleaning	8 (or as required) 20 (or as required)

6.7.1 Read/Write Head Cleaning Procedure

The head cleaning procedure assures that the head is free of contamination to insure the proper tape to head contact and prevent the loss of data. The head should be cleaned after 2 hours of use with a new cartridge, and every 8 hours of normal operation thereafter.

It may be necessary to "dock" the head assembly in order to gain access to the read/write head for cleaning. To dock the head, press inward on the tape carriage plate (black in color) where the cartridge is normally inserted. Stop pushing when the travel is restricted and the latching mechanism releases. The carriage plate will automatically slide out (approximately 3/8 inch). At this point, the head is docked.

Clean the head using a lint free polyurethane swab soaked with head cleaning solution, or Freon TF. Be sure to clean the tape cleaner blades on each side of the head as well. Return the head to the Ready (to load tape) position by pushing the carriage plate inward until it's motion is restricted from any further travel.

Another method of cleaning the head, which is easier to perform, is to use the Perfect Data QIC II Drive Head Cleaning Kit (Part No. 102791-21) which consists of a "mock" tape cartridge with a cleaning pad, cleaning solution and an arm for moving the cleaning pad across the head. The cartridge is simply inserted into the drive in the same fashion as a tape cartridge. Prior to inserting the cleaning cartridge, apply a few drops of the cleaning solution to the pad. After insertion of the cartridge, move the handle up and down to clean the entire head surface. After cleaning, remove the cartridge and proceed with normal tape operation.

6.7.2 Capstan Cleaning Procedure

The capstan should be cleaned by using a cotton swab soaked with water only. Wipe the cotton swab around the entire circumference of the capstan until the debris is removed from the capstan. Allow the capstan material to dry completely before inserting a tape cartridge. NEVER clean the capstan with the head cleaning solution, alcohol, or Freon TF as severe damage to the capstan may result.

6.8 Troubleshooting Guide

NOTE: This troubleshooting guide is meant to be a guide only. It does not go into a detailed theory regarding the troubleshooting practices.

6.8.1 Initial Checks

Prior to the initiation of any troubleshooting procedure, check the drive and associated system components for any obvious problems. It is advisable to check the cables, interface connectors, host system, tape cartridge, and power supply for obvious defects prior to removing the drive for troubleshooting. Check the drive connectors, jumpers, and terminators for proper placement and seating for your configuration. The following paragraphs describe some of the symptoms and the recommended procedure to correct the failure.

6.9 Power Malfunction

6.9.1 No +5 VDC and/or +12 VDC

- Insure that the power supply connector J6 is installed properly. Check for shorts on the Main board. If any are found, return the drive to a Wangtek authorized repair center.

6.10 Tape Motion Malfunction

6.10.1 Drive will not run in any mode.

- Insure that the motor turns freely by hand. If not, return unit to a Wangtek authorized repair center.

6.10.2 Motor "runs away" (into very high speed).

- Return unit to a Wangtek authorized repair center.

6.10.3 Motor turns but does not drive cartridge.

- Change cartridge and clean capstan. If this does not correct the problem, return the unit to a Wangtek authorized repair center.

6.10.4 Motor starts to drive cartridge but stops immediately.

- Check the cartridge for tape run off, or excessive torque. Replace as required.

6.10.5 Motion causes excessive noise.

- Return unit to a Wangtek authorized repair center.

6.11 Status Malfunction

6.11.1 No UTH or LTH signals.

- Insure that J4 connector is seated properly. If the problem is not resolved, return the unit for repair to an authorized Wangtek repair center.

6.11.2 UTH and/or LTH present at all times.

- Return the unit to a Wangtek authorized repair center.

6.11.3 SAFE signal not functioning.

- Insure that the J4 connector is seated properly.
- Insure that a cartridge is installed in the drive. The SAFE switch is mechanically gated with the CIN switch. If this does not correct the problem, return the unit to a Wangtek authorized repair center

6.11.4 CIN signal not functioning.

- Insure that the J4 connector is seated properly.
- Replace the cartridge, again checking the signal function. If this does not correct the problem, return the unit to a Wangtek authorized repair center

6.11.5 L.E.D. not lighting.

- Check continuity of the L.E.D. Replace the Main Board if necessary.
- Insure that the host is actually selecting the drive.

6.11.6 L.E.D. always lit.

- Insure that the drive is actually deselected by the host.

6.12 Data Malfunction

6.12.1 Drive will not read or write.

- Insure that +12 VDC is present on the main board.
- Insure that the head is making contact with the tape surface when the cartridge is loaded.
- Replace the cartridge and repeat the procedure.
- If this does not correct the problem, return the unit to a Wangtek authorized repair center

6.12.2 Drive will not read all tracks.

- Insure that the proper firmware is installed.
- Check that the stepper motor is rotating during track change commands. If not, return the unit to a Wangtek authorized repair center.

6.12.3 Drive will not read on one track.

- Return the drive to a Wangtek authorized repair center.

6.12.4 Drive will not write but will read previously written tape.

- Insure that the cartridge is not write protected.
- Check that the SAFE signal is functioning properly.
- Check the write driver transistors for shorted or opened components, replace the Main Board if necessary.
- If this does not correct the problem, return the unit to a Wangtek authorized repair center

6.12.5 Drive will not erase previously written information.

- Insure that the cartridge is not write protected.
- Check that the SAFE signal is functioning properly.

- Check the erase driver transistors for shorted or opened components, replace the Main Board if necessary.
- If this does not correct the problem, return the unit to a Wangtek authorized repair center

6.12.6 Excessive errors in read while write mode but not in read only mode.

- Return the unit to a Wangtek authorized repair center.

6.12.7 Excessive errors in read only but not in read after write mode.

- Return the unit to a Wangtek authorized repair center.

6.12.8 Excessive data errors in all modes.

- Return the unit to a Wangtek authorized repair center.

6.12.9 The drive is non-operational. No tape movement, QIC-02 interface inoperative.

- Check the +5, +12 volt supplies. Make sure the QIC-02 cable is inserted properly.
- The drive performs a diagnostic test at power-up or upon reset. If the diagnostic test passes successfully, the tape drive LED lights for a short time. If the diagnostics fail, the LED does not light and the drive halts. Return the unit to a Wangtek authorized repair center.

6.12.10 Tape drive does not respond to commands.

- Cartridge in drive?
- Check drive interface cable polarity.
- Change the interface cable. If this does not correct the problem, return the unit to a Wangtek authorized repair center

6.12.11 Cannot Write Tape

a)No Tape Movement

- Check cartridge Write Protect.
- The drive failed Data Buffer test during diagnostics and does not allow the Buffer to be used. Return the unit to a Wangtek authorized repair center.

b)Tape Movement

- Too many re-writes. Check voltages. Try a new tape.
- Clean tape heads.
- Change the interface cable. If this does not correct the problem, return the unit to a Wangtek authorized repair center.

6.12.12 Cannot Read Tape.

a)No Tape Movement

- The drive failed Data Buffer Test during diagnostics and does not allow the Buffer to be used. Return the unit to a Wangtek authorized repair center

b)Tape Movement

- Too many retries. Retention tape.
- Clean tape heads. Try another drive. Single errors can be bypassed using the space over feature. If this does not correct the problem, return the unit to a Wangtek authorized repair center.

6.12.13 Cannot read tape beyond a predefined track

- Any odd to even track change should cause mechanical head movement within the drive. If drive does not respond to internal track commands, return the unit to a Wangtek authorized repair center.
- A large number of reposition cycles near the end of tape may cause the tape drive hole sensor to loose track of actual position. Rewind the tape and retry.

6.13 Parts Removal & Replacement Procedures

This section contains parts removal and replacement procedures.

NOTE: All power should be disconnected prior to proceeding with any replacement of components on the drive. Also, the formatter/controller and chassis must be removed (if installed) in order to gain access to the components on the Main board.

6.13.1 Drive Belt

Without a cartridge installed and the baseplate in the unloaded position, gently grasp the drive belt and remove it by pulling upward. The belt should slide easily over the capstan spindle.

With the drive still in the unloaded position, gently install the new belt over the motor pulley and the capstan drive pulley. Rotate the capstan by hand to seat the drive belt in the center of each pulley.

6.13.2 Front Bezel

Remove the screws at either side of the bezel. There will be two screws if the drive has a half high bezel, and four screws if the drive has a full high bezel. Refer to Figure 6-1

Remove the front bezel by pulling straight out away from the drive.

Carefully re-install the front bezel. Install the mounting screws and tighten being sure not to over-tighten as the bezel may become damaged.

Check that the front bezel is correctly installed by loading a cartridge, checking that there is no interference between the bezel and cartridge base plate.

6.13.3 Left Side Rail Assembly

Loosen the side rail mounting screw located below the access hole in the rail indicated in Figure 6-2. Remove the other two mounting screws (indicated by arrows) and the spacer located near the drive

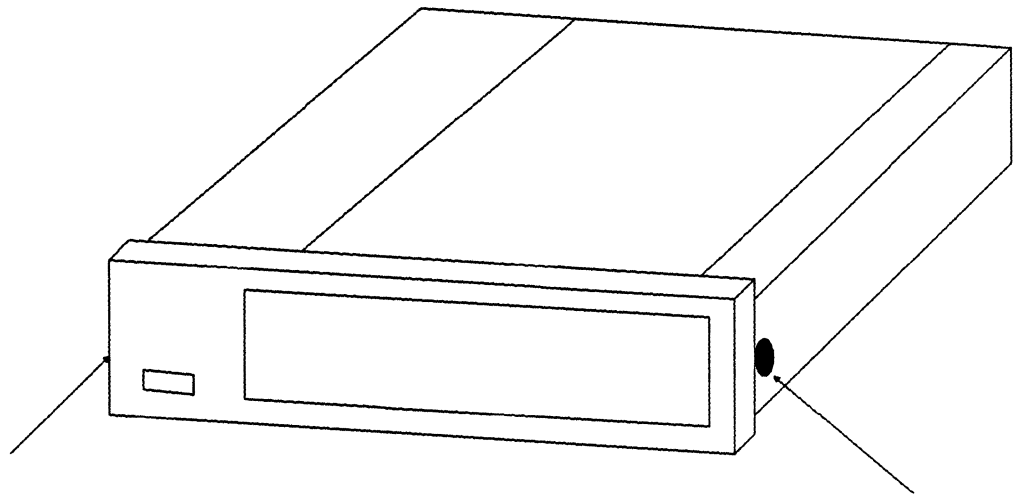


Figure 6-1
Front Bezel Removal

motor. Lift the rail away from the drive taking precautions not to damage the flex cable which is mounted under the rail.

CAUTION: The head assembly is now unprotected. Be careful not to damage the head flexures or the sensor housing the UTH/LTH flex cable and components.

Installation of the left rail is made easier if the drive belt is first removed, as described earlier in this section. With a finger holding the cartridge ejector back against the spring tension, install the rail in the opposite order of removal. Check that the spacer is properly installed under the rear of the rail and that the flat connector cable is not damaged during installation. Check also that the cartridge ejector slides freely.

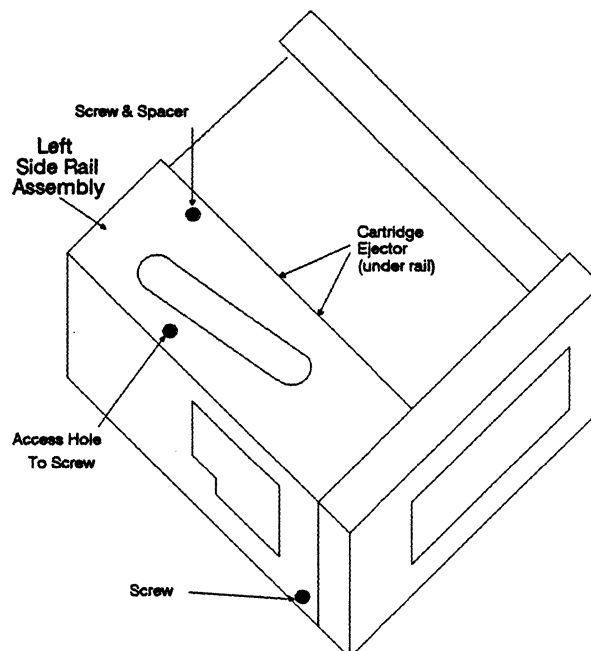


Figure 6-2
Left Side Rail Removal

6.13.4 Main Board

Dock the head assembly by pushing inward on the tape carriage plate. Carefully remove the four (4) connectors from the main board as indicated in Figure 6-3. These connectors are J5, J7, and J8 which are removed by sliding the connector bodies at a right angle from the main board away from the connector pins. Connector J4, the flex cable, is removed by lifting the connector body from each end with a small flat blade screw driver. Care should be exercised as the flex cable is extremely fragile.

Remove the five (5) screws that attach the main board, as indicated by the arrows in Figure 6-3. Carefully lift the main board from the chassis, taking notice of the motor connector pins, J9 at the rear edge of the board. This is accomplished by lifting the end of the board near the motor straight up to clear the motor connector pins and then sliding the board away from the chassis until the L.E.D. clears the mounting hole in the chassis.

To install the main board, move the connector cables from the chassis cavity to allow sliding the PCBA into the chassis slot. After the L.E.D. is located in the chassis slot, lower the main board to the chassis mounting holes, taking precautions not to damage the J9 motor connector pins at the rear edge of the board. Align the J9 motor pins and press the connector into position. Install the five (5) mounting screws making sure that the screw with the ground lug is placed in the mounting hole located nearest the J1 interface connector. Replace the connectors on the board. Insure that all the jumper locations are configured in the same way as the previous board.

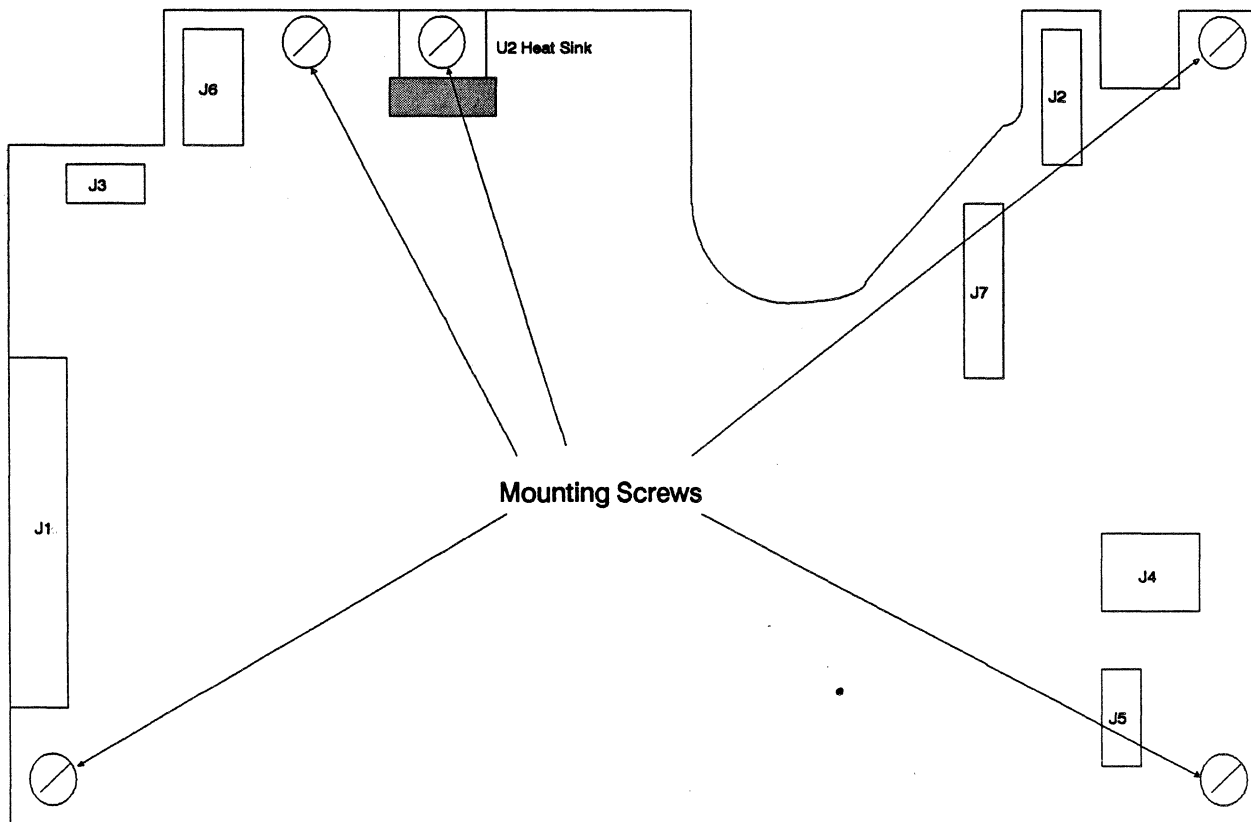


Figure 6-3
Main Board Removal

6.13.5 Chassis Option

Remove the front bezel as described in paragraph 6.13.2

Loosen the four (4) mounting screws that connect the chassis to the drive and slide the chassis sideways with respect to the drive.

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

6.14 Adjustment Procedures

This section covers the maintenance checks and adjustments which are to be performed during the normal life of the drive. The following equipment is required for the checks and adjustments described in this section.

1. Dual trace oscilloscope
2. Blank tape cartridge
3. Wangtek calibrated "K" factor tape
4. Small flat blade screwdriver
5. # 1 Phillips head screwdriver

6.15 Read Amplifier Gain Adjustment

1. With no power applied to the drive, install the Test jumper at HDR1 pin 4.
2. Apply power to the drive.
3. Insert a 15 track 600XTD gain tape that has been pre-recorded with a 150 Khz data pattern. Upon insertion of the tape, the drive will start moving tape continuously from BOT to EOT while automatically switching from head 0 to head 1.
4. Connect a scope probe to TP4 on the main board. Adjust R33 for a value of 3.0 volts p-p X "K" where "K" is the K factor listed on the gain tape while the tape is moving from BOT to EOT. Refer to Table 6-2.
5. When reading the tape while moving from EOT to BOT, if the amplitude of head 1 is greater then the value adjusted to for head 0 in step 4, readjust the amplifier to the proper value while reading with head 1.
6. Check the amplitude difference between head 0 and head 1. If the amplitude of the lower value head is less than the corresponding "K" factor -20% value listed in Table 6-2, the head is out of specification and must be replaced.

Table 6-2
"K" Factor Adjustment Values

Tape "K" Factor	TP 4	-20%
1.15	3.45	2.76
1.14	3.42	2.74
1.13	3.39	2.71
1.12	3.36	2.69
1.11	3.33	2.66
1.10	3.30	2.64
1.09	3.27	2.62
1.08	3.24	2.59
1.07	3.21	2.57
1.06	3.18	2.54
1.05	3.15	2.52
1.04	3.12	2.50
1.03	3.09	2.47
1.02	3.06	2.45
1.01	3.03	2.42
1.00	3.00	2.40
0.99	2.97	2.38
0.98	2.95	2.35

Section 7 PARTS LISTS, APPENDIX AND SCHEMATICS

7.1 Introduction

This section contains the illustrated parts breakdown, recommended spare parts list, appendix, and schematics.

7.2 Illustrated Parts Breakdown

Figure 7-1 used in conjunction with Table 7-1 are used to identify and cross reference Wangtek part numbers for all replaceable subassemblies.

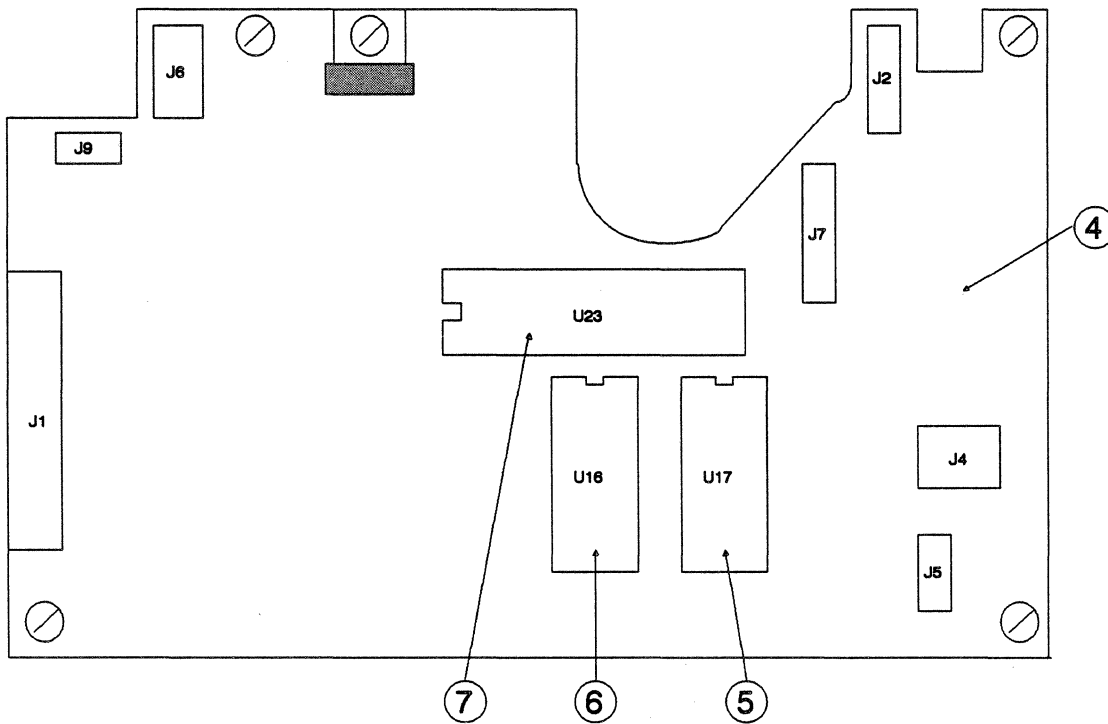
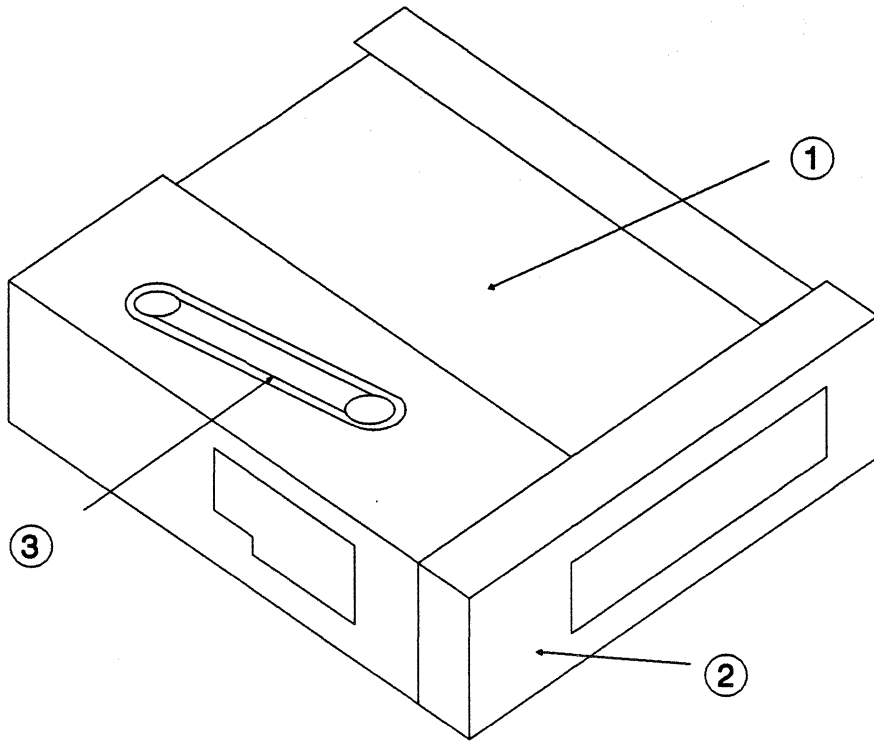


Figure 7-1
Illustrated Parts Breakdown

**Table 7-1
Illustrated Parts List**

Index #	Wangtek Part #	Description
1	30429-001	Chassis Assembly, 9 tk
	30429-101	Chassis Assembly, 15/18 tk
2	30016-012	Bezel, Half Height Black
	30016-014	Bezel, Half Height Gray
3	20120-003	Drive Belt
4	30428-XXX	Main Board/Insulator Assembly
5	20965-XXX	U17 Prom
6	55176-001	U16 RAM 8K byte
7	20776-001	U23 63705VOP
Not Shown	55045-001	Option Shunt Jumper
NOTE: XXX = Refer to the part I.D. label for proper version number.		

7.3 Appendix A - Glossary of Terms

AZIMUTH - The angular deviation, in minutes of arc, of the mean flux transition line from the normal to the cartridge reference plane.

BACKUP - A copy of the information from the hard disk which is stored for safekeeping. This copy is used to recover the information on the disk should the disk become damaged. The backup media used for the Wangtek backup system is a cartridge tape.

BACKUP SYSTEM - The software and hardware necessary to create backups on a computer system.

BATCH FILE - A series of commands, stored in a file, that cause the computer to execute a number of complex operations, such as running some programs, updating other computer files, or sending output data to the printer.

BIT - A single digit in binary number system.

BIT CELL - A length of magnetic recording tape within which the occurrence of a flux transition signifies a "one" bit and the absence signifies a "zero" bit.

BLOCK - A group of 512 consecutive bytes transferred as a unit.

BOT - Beginning of tape marker indicating beginning of tape.

BUFFER - An amount of space, usually in the computers memory, where information is temporarily held until being transferred to its final destination (e.g. the disk or tape). It serves as a holding area for information that is being moved.

BYTE - A group of 8 binary (10 GCR) bits operated on as a unit.

CARTRIDGE - A four by six inch enclosure containing 0.250 inches (6.30 mm) wide magnetic tape wound on two co-planar hubs and driven by an internal belt which is coupled by an internal belt capstan to the external drive (Ref. ANSI X3.55-1977).

COMMAND-DRIVEN - Implies that a system or program is run by direct commands that are entered by the user, with a minimal amount of help or prompting. To operate this type of system, the user must be familiar with the valid commands that the system will understand, their various options, and their format.

CONFIGURATION (system) - Refers to the various options, both hardware and software, that are integrated with a computer to create a complete system.

CRC - Cyclical Redundancy Check. A two byte code derived from information contained in the data block and block number byte and recorded after the data block and block number byte for read after write check and read only check.

DENSITY - The maximum allowable flux transitions per unit length for a specific recording standard.

DIRECTORY - A table of contents to the various files stored on a computer device (such as a tape or hard disk). When the user puts programs or data files on the disk, they will be stored in a directory. A directory is like a label installed on the drawer of a file cabinet to identify the contents of the drawer.

DRIVE - This is a short term for disk drive or tape drive. A disk drive is made up of mechanical and electrical components which operate a diskette (floppy disk) or Winchester disk (hard disk), and allow the

user to store and/or retrieve data from them. A tape drive may read from or write to cassette tapes, quarter inch cartridges or half-inch reel to reel tapes.

EARLY WARNING - Early Warning marker indicating the approaching end of the permissible recording area.

EOT - End of Tape marker indicating the end of tape.

ERASE - To remove all magnetically recorded information from the tape.

FILE MARK - An identification mark following the first block in a file.

FLUX TRANSITION - A point on the magnetic tape which exhibits maximum free space flux density normal to the tape surface.

FLUX TRANSITION SPACING - The distance on the magnetic tape between flux reversals.

GROUP CODE RECORDING - GCR. A data encoding method where a 4-bit group of data bits is encoded into a 5-bit group for recording on magnetic tape (Ref. ANSI X3.54-1976).

HARD DISK - A device that the computer uses to store information for permanent retrieval. It consists of a rigid metal disk with a coating which can be written on with magnetic fluxes, similar to the way a stereo records on a cassette tape.

HARDWARE - The physical components (e.g., wires, electronics, mechanical components, etc.) that make up a computer and its various peripherals.

K - Stands for thousand, or when applied to computer storage, kilobytes. This is a unit of measure of storage capacity equal to 1024 bytes in memory.

LOAD POINT - Load point marker indicating the beginning of the permissible recording area.

MAGNETIC TAPE - An oxide coated mylar base tape capable of accepting and retaining magnetically recorded information.

Mb - Stands for Megabyte. A megabyte is approximately one million (1,000,000) bytes.

MENU - A display on the computers screen that functions in a manner analogous to a restaurant menu. There are various selections for the user to choose from on the menu, and the user indicates a selection by pressing a key corresponding to the menu item. Each item on the menu will be an operation that the user may wish the computer system to execute.

MENU-DRIVEN - Implies that a program or system is operated through the use of a series of menus which help guide the user through the operations of the system, by simply pressing a key. Generally, they are very user-friendly: giving helpful hints and prompts to indicate what is expected from the user.

NIBBLE - A group of four binary (five GCR) bits operated on as a unit.

OPERATING SYSTEM - The software in the computer that controls the computer environment for the user and interprets commands so that they may be converted to electronic signals which the computer understands.

PARAMETER - A piece of information that the user fills in for the computer. It is passed on to the program or controlling system to inform the computer specifically what the user wants done.

PATH - A route that the computer follows in its search for information on the disk or tape. A path is like tracing your family history on a family tree. The root of the tree is the main directory on the computer system. Each branch of the tree is like each of the directories listed in your main (or root) directory. An example of a path would be as follows:

PERIPHERAL - A device with which the computer communicates. The computer generally controls these devices indirectly through the means of a controller (another piece of hardware) and a series of programs or other types of software. Examples are disk drives, tape drives, or printers.

POSTAMBLE - Guard information recorded after the data block.

RAM - Stands for Random Access Memory. It is the memory that the computer uses to hold the operating system and programs, from which all the operations are performed. Most RAMs are volatile, which means that it is erased when the power is removed from the computer.

RECORDED BLOCK - A group of consecutive bits comprising preamble, data block marker, data block, block number, GCR and postamble.

REF. TAPE CARTRIDGE - A magnetic tape cartridge selected for a specific property to be used as a reference.

RESTORE - To copy information from the tape (or other backup device) to the hard disk.

RETENTION - An operation which restores normal tension to the tape wound on the hubs of the cartridge.

SOFTWARE - The programs or instructions that the computer utilizes to carry out any operations. Software is generally stored on magnetic media such as floppy disks, tape, or hard disk. It must be loaded into RAM before it may be utilized.

STREAMING - A method of recording on magnetic tape where the tape is continuously moving and data blocks are continuously recorded.

SUBDIRECTORY - A directory within another directory. Similar to a box of files within a file cabinet drawer.

TRACK - A recording strip parallel to the edge of the magnetic tape containing recorded information.

UNDERRUN - A condition developed when host transmits or receives data at a rate less than that required by the device or streaming operation.

VOLUME - This documentation refers to each disk, floppy or hard, as a volume. These volumes may be backed up onto tape, creating tape volumes.

7.4 Appendix B - Schematics

40951-001

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	B	SEE ED 10467 PREVIOUSLY ENG. RELEASE	7/31/87 8/4/87	S.A.
	B1	SEE ED 10537	9/4/87	MHR S.A.
	C	SEE ED 10578A	9/23/87	MHR S.A.

JUMPER CONFIGURATION FOR EMBEDDED QIC-82 BOARD

JUMPER	FUNCTION	CONNECTION	NO CONNECTION
E2	18 MHz CLOCK	YES	
E7-E10	8K STATIC RAM	YES	
E8-E9	2K STATIC RAM		YES
E11	GROUND TO CHASSIS	YES	
E3-E4	LAST TRACK STATUS		YES
HDRE1-1	SEARCH DISABLE/ALIGNMENT		YES
HDRE1-2,3	STEPPER PHASE/ALIGNMENT FACTORY PRESET.	PRE-ALIGNMENT SET	PRE-ALIGNMENT SET
HDRE1-4	TEST/ALIGNMENT		YES
HDRE1-5	15 IRK/ALIGNMENT		YES
E5	15% WRITE PRECOMP.		1,2
	10% WRITE PRECOMP.	1	2
	5% WRITE PRECOMP.	2	1
	0% WRITE PRECOMP.	1,2	
E12-E13	HI DENSITY	YES	
E1	NOT USED		
E13-E14	NOT USED		YES

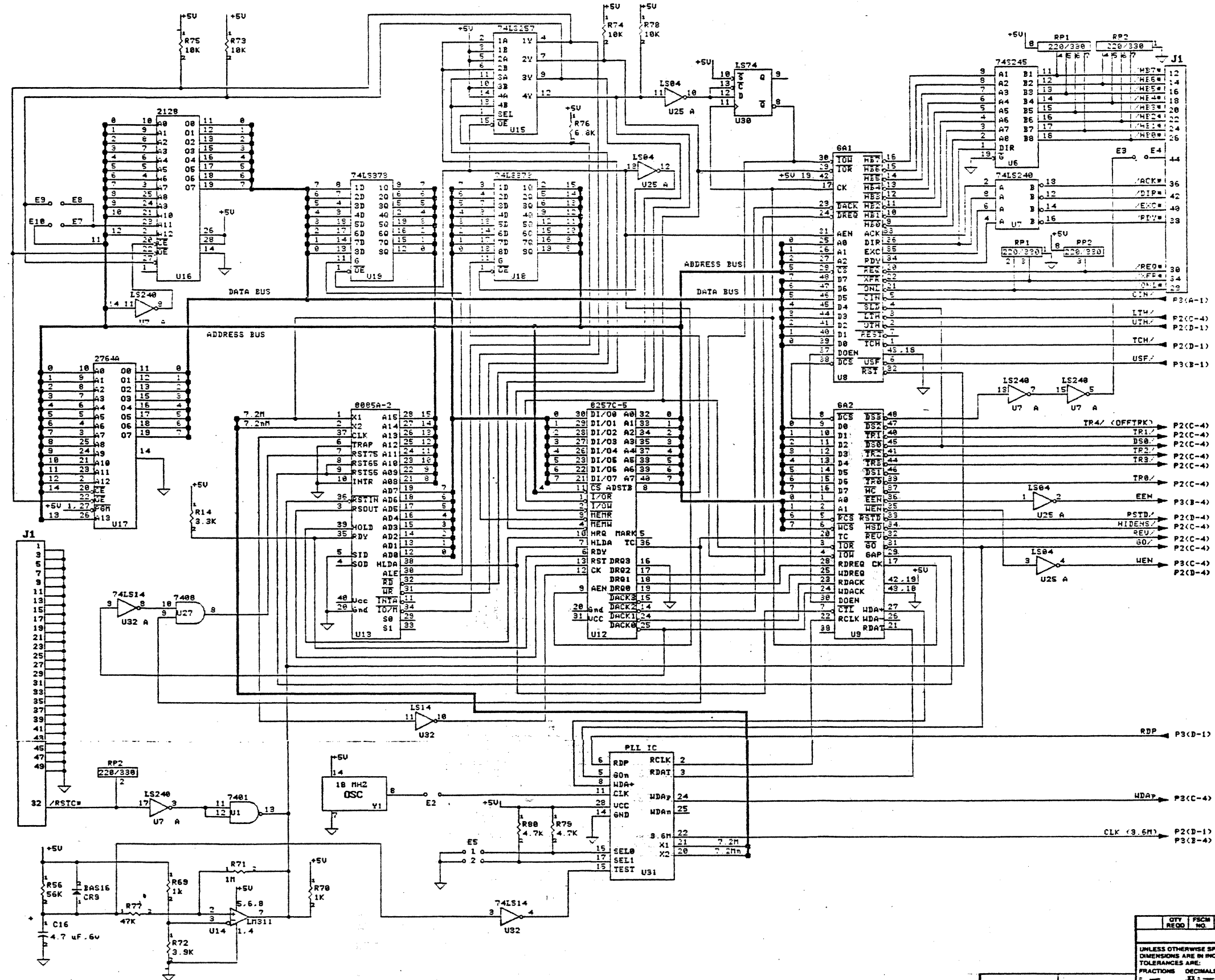
POWER AND GROUND TABLE

IC NO.	+5V	+12V	GND	SPARE GATES
U1, U25, U32 U24, U27, U28 U29, U33	14		7	74LS04 U25 U25 U25 U27 U27 U27 U29 U29 U29
U15	15		3	74LS08 U27 U27 U27
U6, U7, U8, U4 U10, U11, U19 U19	20		10	74LS06 U29 U29 U29
U2		14	3	75452 U34
U22	20		10	
U25	22	21	12, 3	
U21		12	7, 10	
U31, U16, U17	20		14	LS240 U10 U10 U10
U12	40		20	LS240 U3 U3 U3
U12	31		20	LS240 U3 U3 U3
U20, U34, U14	8		4	
U22	3	4	3, 10	
U33	11		4, 5, 12 13	
U8, U3	42, 13		43, 18	

1. U7 74LS240 HAVE PINS 1 & 19 TIED TO GROUND.
 NOTES: UNLESS OTHERWISE SPECIFIED

QTY	FSCM	PART OR	NOMENCLATURE	MATERIAL
REQD	NO.	IDENTIFYING	OR DESCRIPTION	SPECIFICATION
PARTS LIST				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES ± .005 ± .005 ± .005			CONTRACT NO.	wangtek SUN VALLEY, CA 94088
MATERIAL			APPROVALS DATE	
30428 EMB 21602			DRAWN MR 7/31/87	SCHEMATIC - EMBEDDED QIC-82
NEXT ASSY USED ON			CHECKED S. Taheri 8/4/87	
APPLICATION			ISSUED S. Taheri 8/4/87	SIZE FSCM NO. DWG. NO. REV.
				D 40951-001
				SCALE NONE

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
		SEE SHT 1	8/14/87	S. I.



NOTES: UNLESS OTHERWISE SPECIFIED

QTY		FSCM		PART OR IDENTIFYING NO.		NOMENCLATURE OR DESCRIPTION		MATERIAL SPECIFICATION	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES									
MATERIAL									
CONTRACT NO.									
APPROVALS									
DATE									
DRAWN									
CHECKED									
ISSUED									
SIZE FSCM NO.									
DWG. NO.									
REV.									
SCALE									
SHEET 2 OF 4									

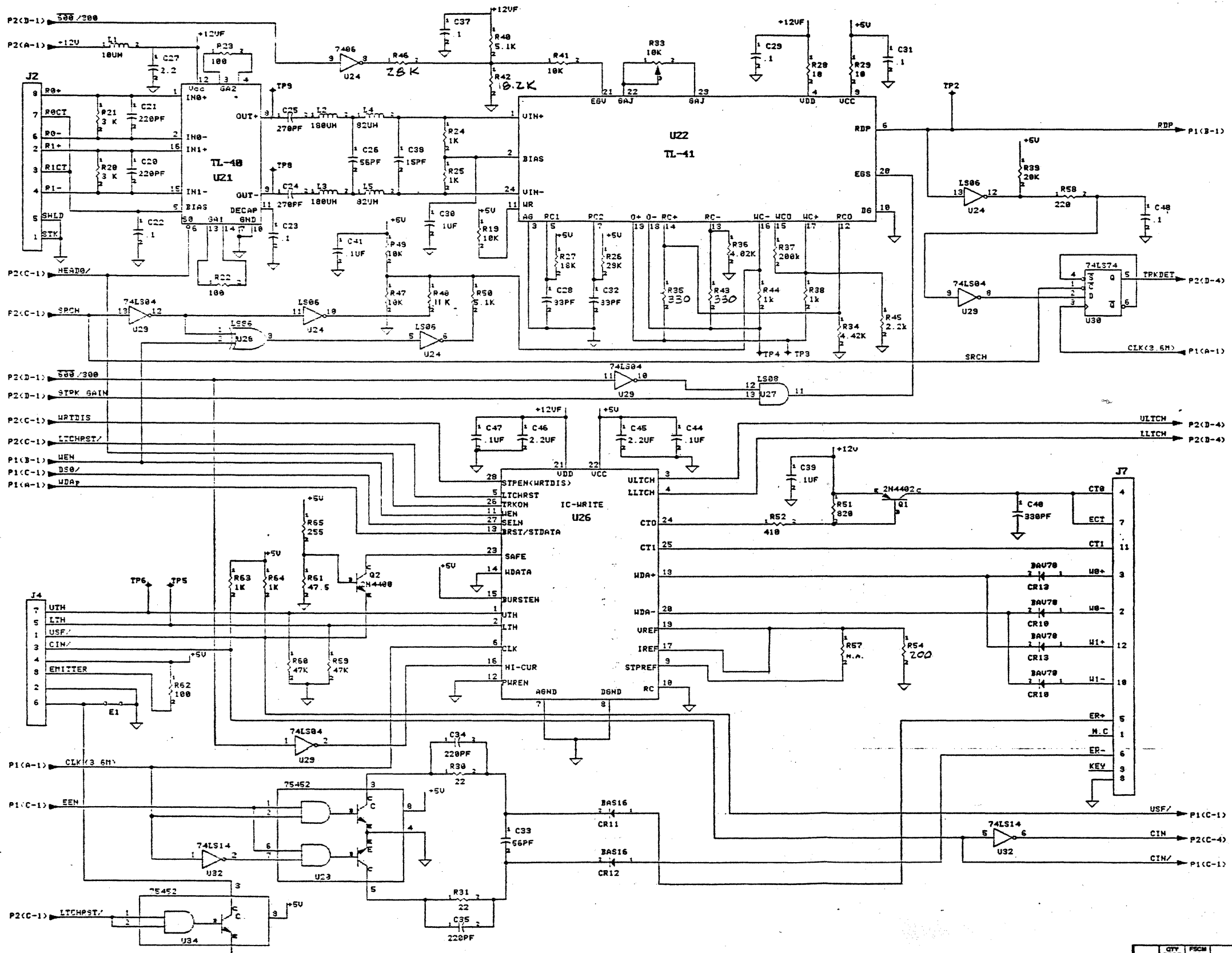
30428	EMB 21C-02	FINISH
NEXT ASSY	USED ON	APPLICATION



SCHEMATIC - EMBEDDED QIC-02

40951-001

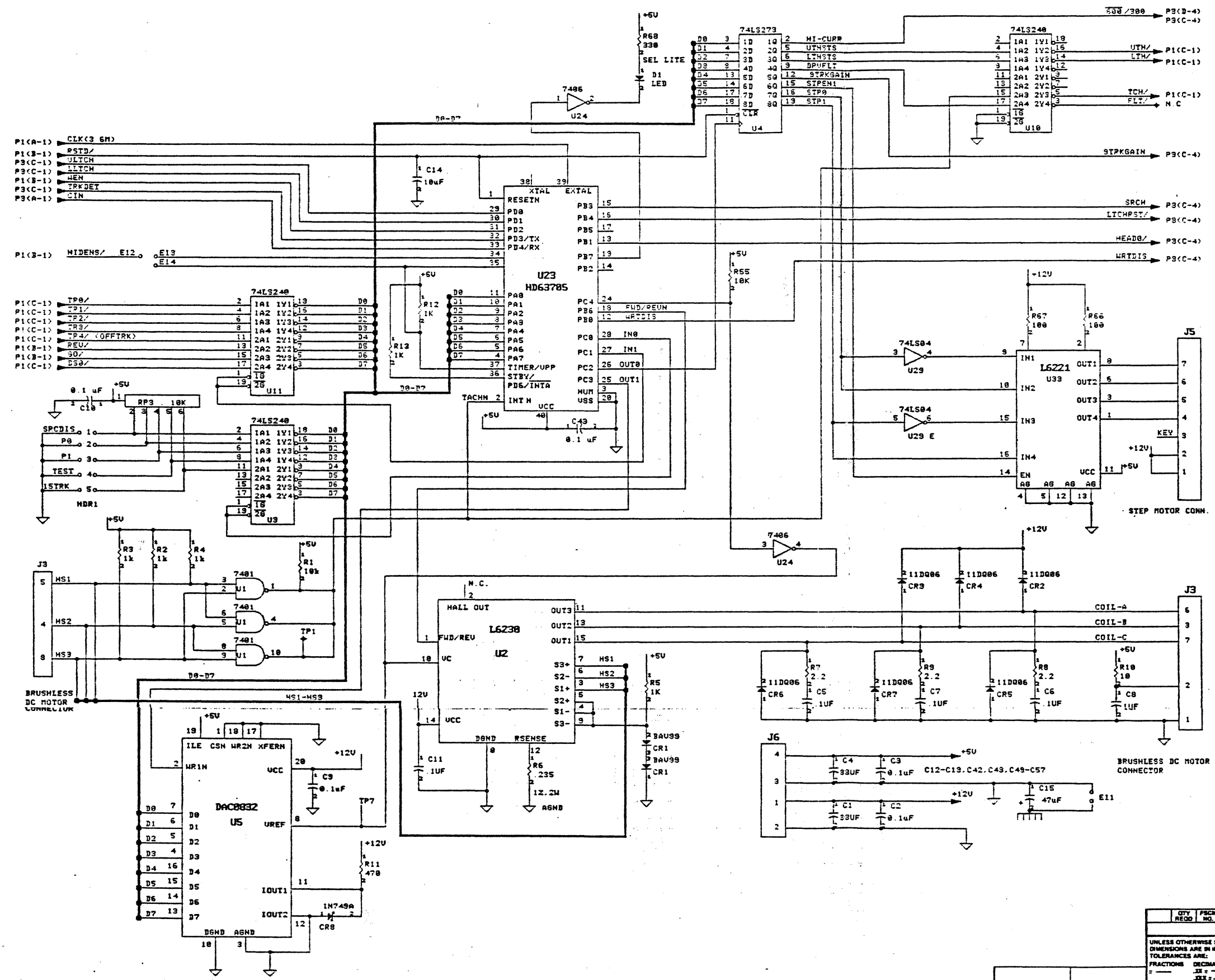
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
		SEE SHT 1	1/4/87	S-I



NOTES: UNLESS OTHERWISE SPECIFIED

QTY	PSCM	PART OR	NOMENCLATURE	MATERIAL
REQD	NO.	IDENTIFYING NO.	OR DESCRIPTION	SPECIFICATION
PARTS LIST				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES ± .010 ± .005 ± .010		CONTRACT NO.		
MATERIAL		APPROVALS	DATE	 SANTA CLAY, CA 95068 SCHEMATIC - EMBEDDED QIC-02
FINISH		DRAWN	DATE	
		CHECKED	DATE	
30428	EMB QIC-02	ISSUED	DATE	SIZE / PSCM NO.
NEXT ASSY	USED ON			DWG. NO.
APPLICATION		DO NOT SCALE DRAWING		REV
				40951-001 C
				SHEET 3 OF 4

REVISIONS				
DATE	DESCRIPTION	DATE	APPROVED	
8/14/87	SEE SHT 1		S. T	



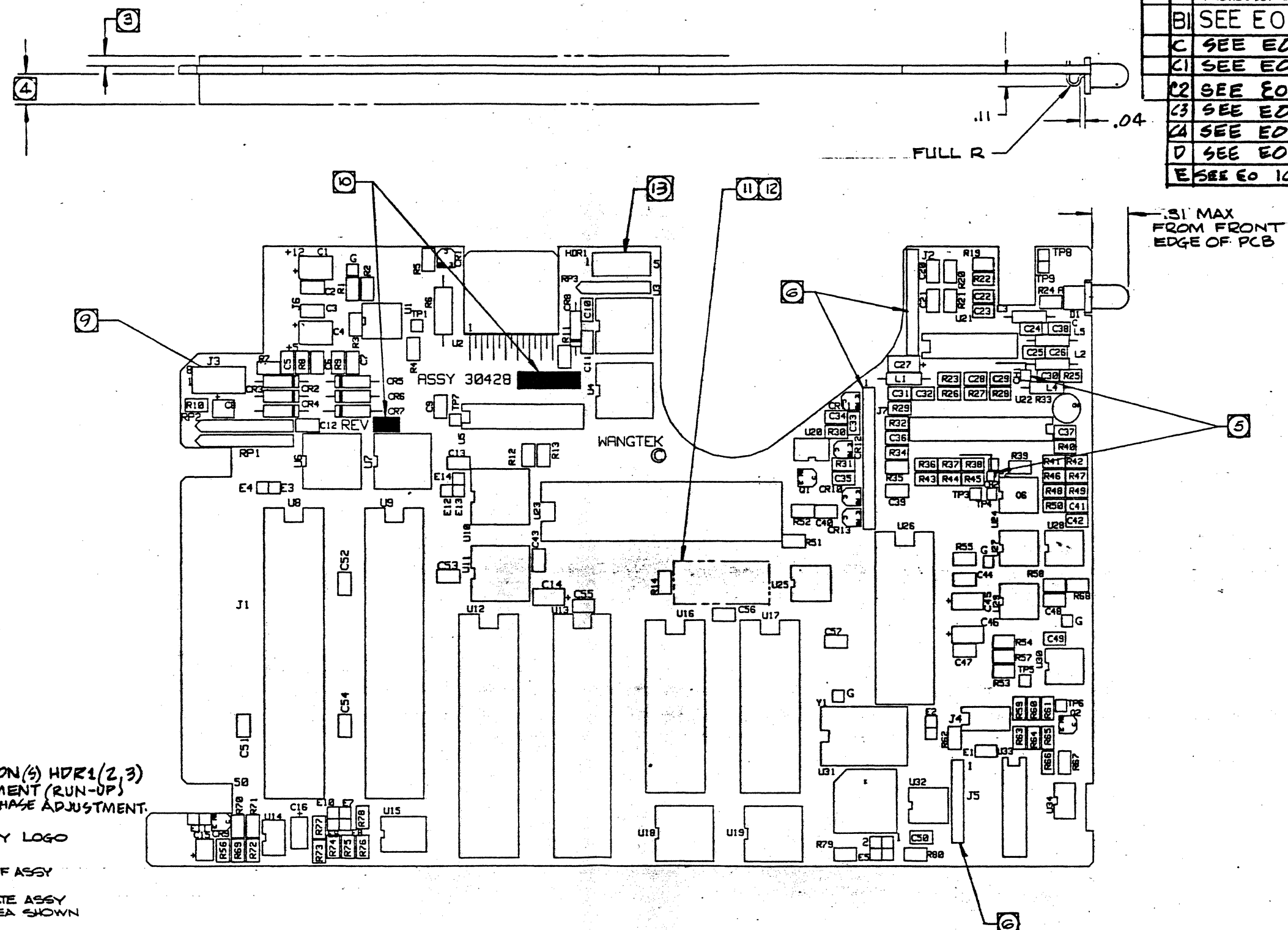
NOTES: UNLESS OTHERWISE SPECIFIED

QTY	FRGM	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
PARTS LIST				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES			CONTRACT NO.	
			APPROVALS	
			DATE	
MATERIAL			DRAWN MR 7/31/87	
FINISH			CHECKED S. Tabin 8/14/87	
NEXT ASSY			REVIEW S. Tabin 8/14/87	
USED ON			SIZE / FROM NO.	
			DWG. NO. 40951-001	
			REX C	
			SHEET 4 OF 4	




SCHEMATIC - EMBEDDED QIC-02

ZONE	REV	DESCRIPTION	DATE	APPROVED
B		SEE EO 10467 PREVIOUSLY ENG. RELEASE	7/27	S.S.
B1		SEE EO 10537	9/10/71	MR. KS S.S.
C		SEE EO 10578A	9/23/71	D.H.
C1		SEE EO 10648A	10/14/71	MR. S.S.
C2		SEE EO 10671	10/17/71	MR. S.S.
C3		SEE EO 10608	10/20/71	MR. S.S.
C4		SEE EO 10609 & 10686	10/21/71	MR. S.S.
D		SEE EO 10635	10/28/71	MR. S.S.
E		SEE EO 10720	11/4/71	MR. S.S.



- 13 ADD JUMPERS, ITEM 4, AT LOCATION(S) HDR1(2,3) AS REQUIRED PER THE DRIVE ALIGNMENT (RUN-UP) PROCEDURE FOR THE STEPPER MOTOR PHASE ADJUSTMENT.
 - 12 MARK ASSEMBLY VENDORS COMPANY LOGO USING PERMANENT INK.
 - 11 MARK JULIAN DATE (DAY OF THE YEAR) OF ASSY USING PERMANENT INK.
 - 10 IDENTIFY THE BOARD WITH THE APPROPRIATE ASSY VERSION NUMBER & REV LETTER IN AREA SHOWN PER WANGTEK SPECIFICATION 40024.
 - 9 MOUNT PINS OF J3 TO THE SOLDER SIDE OF THE BOARD.
 - 8 LEAD HEIGHT FOR U23 IS .040 MAX.
 - 7 THE SEALED SOCKET PLUGS USED FOR LOCATION U23 SHOULD BE RAISED .080 ABOVE THE BOARD.
 - 6 REMOVE PIN 3 FROM J3, PIN 9 FROM J7 AND PIN 9 FROM J2.
 - 5 INSTALL CABLE CABLE HOLDERS 1 & 2 (CH1, CH2) FACING CONNECTOR J7.
 - 4 MAX COMPONENT HEIGHT IS .250.
 - 3 MAX LEAD PROJECTION IS .062, EXCEPT FOR U16, U17 & J4 WHICH IS .080.
 - 2 BEFORE PERFORMING FINAL TEST, ALL ASSEMBLED BOARDS MUST BE BURNED-IN PER WANGTEK SPECIFICATION 40068-001.
 - 1 FLATNESS OF THE ASSEMBLED BOARD SHALL BE WITHIN .120.
- NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	FRSM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
PARTS LIST				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES — .01 ± .01 ± 10 XXX ± .005		CONTRACT NO.		
MATERIAL		APPROVALS	DATE	 ASSY, PRINTED WIRING BD EMBEDDED QIC-02
FINISH		DRAWN	6/30/71	
NEXT ASSY		CHECKED	S. Tabin 7/27/71	
USED ON		ISSUED	S. Tabin 7/27/71	SIZE / FRSM NO.
APPLICATION		DO NOT SCALE DRAWING		DWG. NO. 30428-000
				REV E
				SHEET 1 OF 13