OEM MANUAL

MODEL 5525ES SCSI INTERFACE

STREAMING 1/4 INCH TAPE CARTRIDGE DRIVE

wangtek

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WANGTEK

OPERATING AND SERVICE MANUAL NO. 63156-001 Rev. A2

FORWARD

This manual provides operating and service information for the 5525ES SCSI Interface 1/4" cartridge tape drive, manufactured by Wangtek Incorporated, 41 Moreland Road, Simi Valley, California.

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
FAX (805) 583-8249

WANGTEK-Europe
Unit 1A, Apollo House
Calleva Industrial Park
Aldermaston, Reading
RG7 4QW England
(44) 734-811463
Telex 851-848135
FAX 44-734-816076

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. This equipment is a Class B digital apparatus which complies with the Radio Interference Regulations, CRC c.1374.

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Section 1 GENERAL DESCRIPTION AND SPECIFICATIONS

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 5525ES SCSI Interface 1/4" Cartridge Tape Drive, also referred to as the drive.

1.2 Model Number Breakdown

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

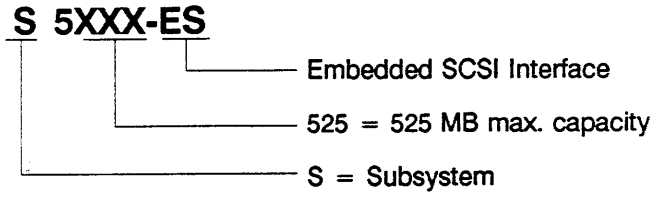


Figure 1-1
Model Number Breakdown

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.

1.3 Purpose of Equipment

The Wangtek Model 5525ES drive is a high performance, high capacity data backup device. This design combines the advances in 1/4" tape with a high performance SCSI Interface Controller. The result is an advanced state-of-the-art mass storage architecture which offers extremely high data through-put performance and reliability. The removable cartridge and QIC-525 standard data format also allow the drive to be used for data interchange and distribution. The 5525ES 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.

1.3.1 Features

The 5525ES drive consists of a microprocessor based, Small Computer System Interface (SCSI) controller with a data buffer size of 256K bytes offering fast synchronous and asynchronous data transfers, recording data recovery channels, servo control and other electronics.. The drive subsystem consists of a 1/4" cartridge tape transport mechanism and head position mechanism.

The specific features of the Wangtek Model 5525ES drive are:

- Advanced, High Resolution Head Positioning Mechanism.
- Industry Standard QIC-525 Data Format, Making Interchange With Other QIC-525 Cartridge Tape Subsystems Possible.

- Write Compatibility With QIC-320, QIC-150 and QIC-120 Standards.
- Read Compatibility with QIC-320, QIC-150, QIC-120 and QIC-24
- 5¼ Inch Half Height Form Factor.
- On Board Error Correction Code (ECC) Electronics Providing Data Reliability Of Less Then 1 Error In 10^{14} Bits.
- Read-After-Write Error Checking And Automatic Re-write Algorithms
- 256K Buffer Enabling Host Data Transfer Flexibility And Speed Matching
- SCSI Interface Data Transfer Rates Of Up To 4.8 MB Synchronous, And 2.8 MB Asynchronous. Sustained Transfer Rate Of 240K Bytes Per Second.
- High Speed, 120 Inches Per Second Read/Write/Search Servo.
- SCSI I & II Interface Implementation With Common Command Set (CCS) Support.

1.3.2 Applications

The 5525ES Cartridge Drive is a high capacity, high performance and reliable tape device. The applicable uses are:

- Unattended disk backup, reducing human intervention to minimal.
- Direct on-line data acquisition or data collection.
- Backup of Local Area Networks (LANs).
- Data collection of digital images through systems and software which conform to SCSI standards.
- Medical, seismic, telemetry and all traditional tape applications are well suited for this product.
- Enables archiving of data for 4 cents per megabyte (based on a media price of $20-$25 per 525 MB of data).

The drive supports all tasks associated with traditional tape applications, including journaling, archiving, data interchange, data acquisition, on line live data collection and backup & restore.

1.4 Physical Description of Equipment

The model 5525ES 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, the motor 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. The physical drive outline and mounting dimensions for the half height configuration can be found in Figure 1-2. A total of twelve (12) mounting holes are provided for mounting the drive, two (2) on each side and eight (8) on the bottom.

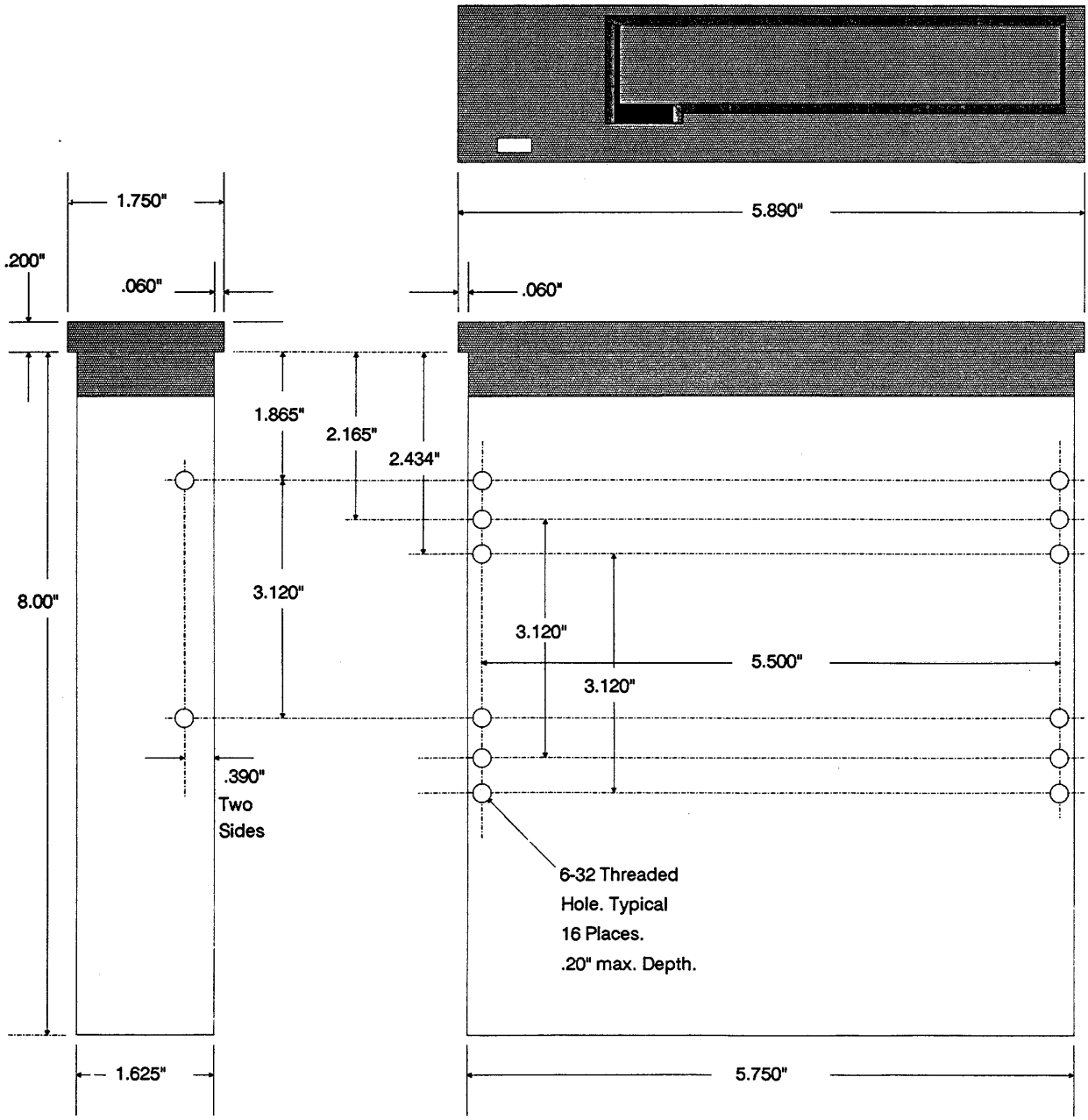


Figure 1-2
Half Height Drive Mounting Dimentions

The physical drive outline and mounting dimensions for the full height configuration can be found in Figure 1-3. A total of twenty (20) mounting holes are provided for mounting the drive, six (6) on each side and eight (8) on the bottom. All holes are threaded to accommodate 6-32 by 0.25" length screws. All cable connections are made at the rear of the drive. For more information about drive mounting and cable connections, refer to Section 2 Installation. 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.

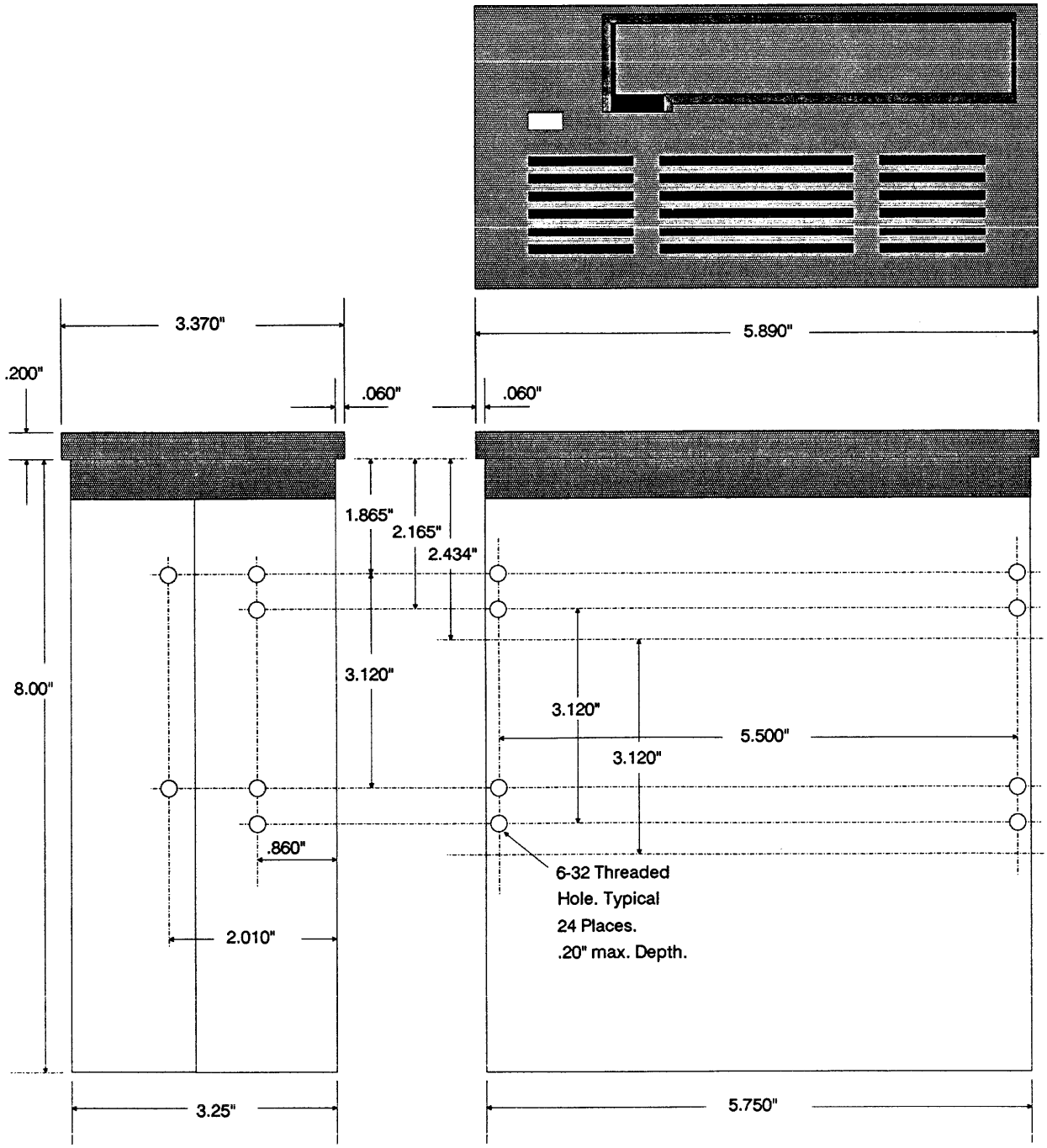


Figure 1-3
Full Height Drive Mounting Dimentions

1.5 Block Diagram Description of Tape Drive

The 5525ES consists of five (5) separate sections; the Interface, the Data Formatting Control, the Drive Motion Control, the Motor Driver board and the Drive Chassis. Figure 1-5 shows the block diagram outline of the tape device with major elements of each section.

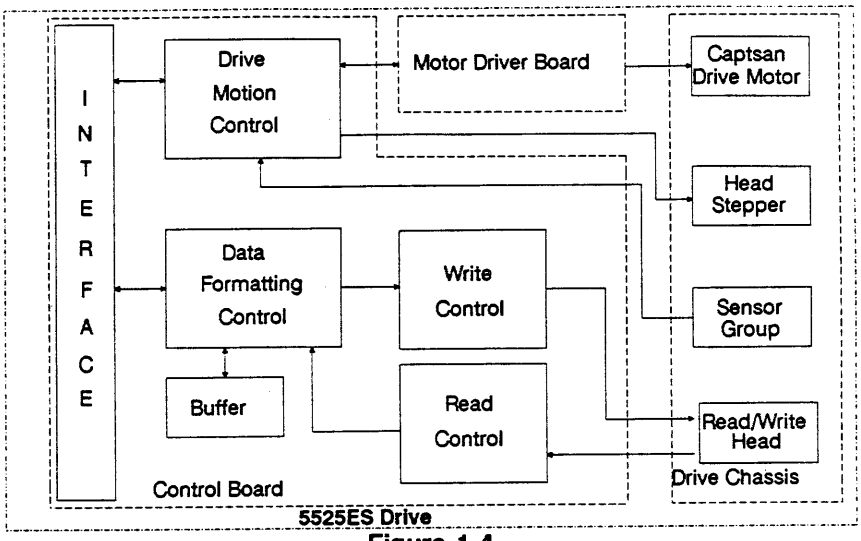


Figure 1-4
Functional Block Diagram

1.5.1 Interface

This module interprets all commands, status and data on the interface and routes the information to the Drive Motion Control or Data Formatting Control modules respectively.

1.5.2 Data Formatting Control

This module performs all data formatting while writing and data decoding while reading. As part of the formatting process, this module generates the 1-level Error Correction Code used to detect and correct errors while reading. This module also manages the flow of data through the 256K data buffer.

1.5.3 Drive Motion Control

This module receives motion commands from the interface and generates the necessary control signals to provide all tape motion and head positioning. The status of sensors on the drive chassis as well as feed back from the drive motor are used to insure proper tape motion and position control.

1.5.4 Motor Driver Board

This board receives drive signals from the Drive Motion Control module and provides the actual drive to the capstan motor. Feedback from the Hall Effect sensors in the motor pass through this board on their way back to the Drive Motion Control module.

1.5.5 Drive Chassis

The Drive Chassis contains the cartridge referencing mechanics, head positioner and capstan drive mechanics. A sensor group provides position and feedback signals to the Drive Motion Control module.

1.6 Mechanical and Electrical Specifications

Refer to Table 1-1 for the mechanical and electrical specifications for the model 5525ES drive and media.

Table 1-1
Mechanical and Electrical Specifications

Tape Cartridge Type	DC 6525, DC 6320, DC 6150, DC 600A or equivalent
Formatted Capacity	
DC 6525	525MB in QIC-525 mode
DC 6320	320MB in QIC-525 or QIC-320 mode
DC 6150	150MB in QIC-150 mode
DC 600A	125MB in QIC-120 mode
Recording Formats	QIC-525, QIC-320, QIC-150 or QIC-120
Read Compatibility	QIC-525, QIC-320, QIC-150, QIC-120 or QIC-24
Recording Code	GCR
Recording Density	
QIC-525 or QIC-320	16,000 BPI / 20,000 FRPI
QIC-150	10,000 BPI / 12,500 FRPI
QIC-120	10,000 BPI / 12,500 FRPI
Number of Tracks	
QIC-525 or QIC-320	26 (serpentine)
QIC-150	18 (serpentine)
QIC-120	15 (serpentine)
Tape Speed	120 IPS Read/Write, search or rewind (QIC-525 or QIC-320) 90 IPS Read/Write, search or rewind (QIC-150, QIC-120 or QIC-24)
Data Buffer Size	256K bytes
Interface	SCSI-1 or SCSI-2 (jumper selectable)
Data Transfer Rate	
Burst (Sync./Async.)	4.8 Megabytes Per Second / 2.4 Megabytes Per Second
Average Long Term Sustained	240 KBytes Per Second
Long Term Speed Variation	± 4%
Instantaneous Speed Variation	± 7%
Start/Stop Time	≤300 milliseconds
Voltage Requirements	+12 volts ± 5% +5 volts ± 5%
Ripple (min./max. must be within 5% supply tollerance)	200mVp-p both supplies
Current Requirements	
+12V Acceleration Surge maximum	2.5 Amps (max.) 1.5 Amp (nom.)
+5V	1.0 Amp (nom.)
Power Dissipation	
Standby	7.6 watts (nom.)
Operational	24.7 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 63 Hz-.1 inch displacement amplitude (peak to peak) 63 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

Table 1-1 (continued)
Mechanical and Electrical Specifications

Altitude	
Operational	-1,000 - 15,000 feet
Non-operational	-1,000 - 60,000 feet
MTBF	>40,000 hours at 15% duty cycle MIL-STD-217 Part Stress Calculation Method
MTTR	30 minutes average
Non-Recoverable Read Error Rate	$\leq$1 in 10^{14} bits
Dimensions (half height version)	
Height	1.625 inches (41.275 mm)
Width	5.750 inches (146.05 mm)
Depth	8.000 inches (210.82 mm), including signal and power connectors (add 0.25" for 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 half height 5 ¼" form factor
Dimensions (full height version)	
Height	3.25 inches (82.55 mm)
Width	5.750 inches (146.05 mm)
Depth	8.000 inches (210.82 mm), including signal and power connectors (add 0.25" for 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 ¼" form factor
Radio Immunity	3 volts per meter - 10KHz to 1GHz
Safety Compliance	UL, CSA, VDE, TUV, FCC Class B

1.7 Introduction to ¼" Data Cartridge Technology

The tape cartridge, shown in Figure 1-5, has several distinct physical features designed for industry use which are listed below:

- Position Sense Holes
- Mirror Mechanism
- File Protect Mechanism
- Tape Cover Door
- Capstan Drive Wheel

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 when activated.

The mirror mechanism is located within the cartridge casing, and is utilized for tape position sensing by deflecting the infra-red emitter light through the holes of the tape itself to the photo transistors located in the capstan/hole sensor assembly.

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.

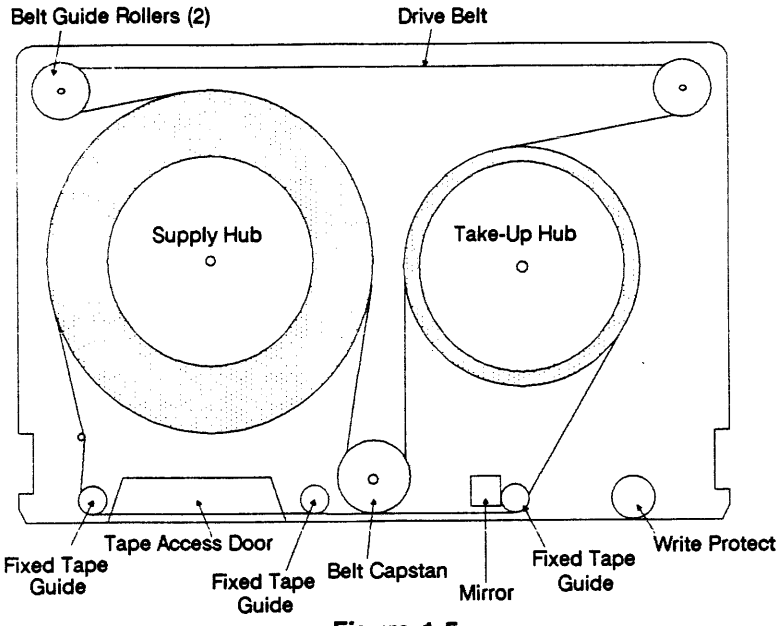
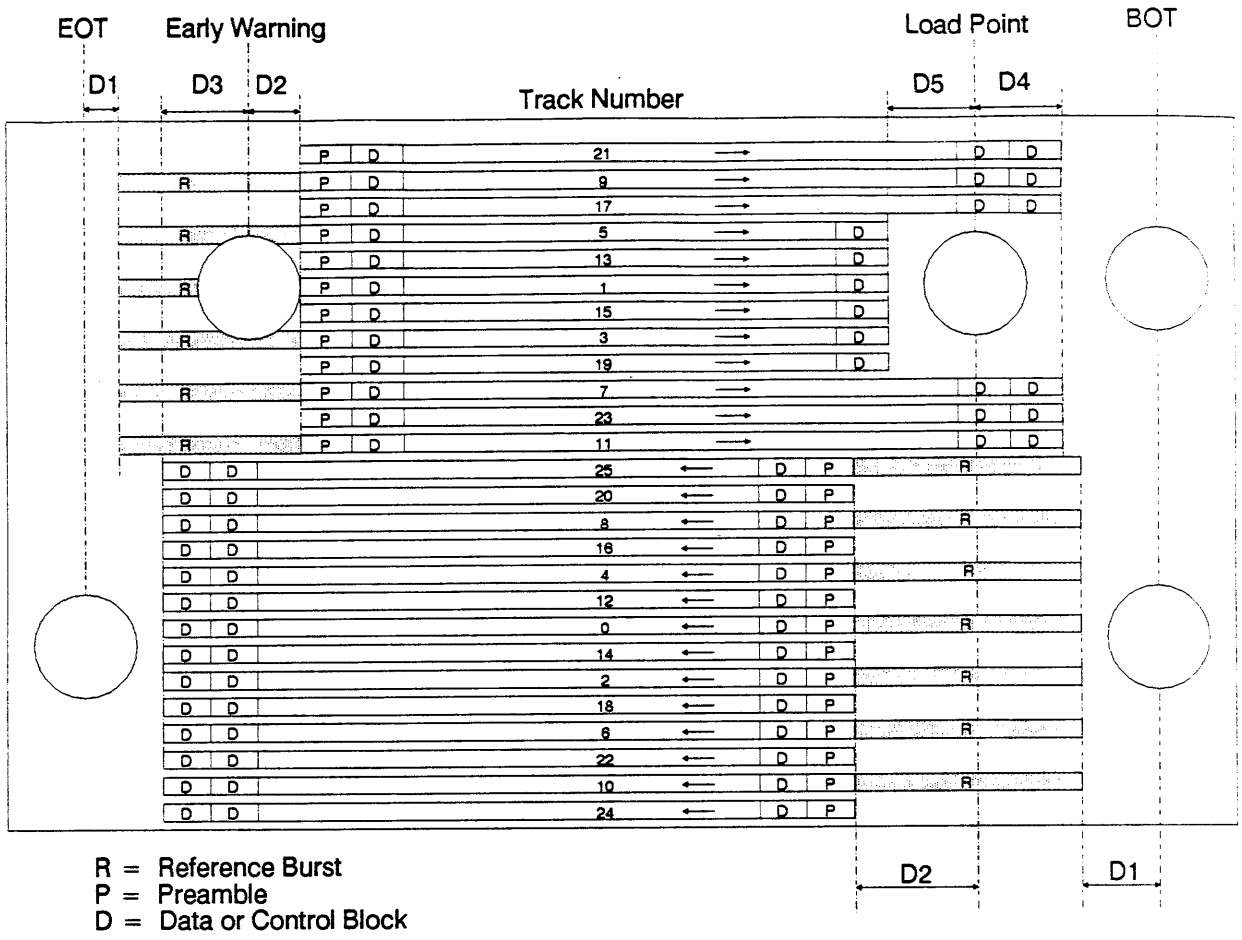


Figure 1-5
Data Cartridge

1.8 Data Recording

Data is recorded serially, one track at a time, using the Group Coded Recording (GCR) encoding method. There are a total of 26 tracks in the QIC-525/320 tape format as shown in Figure 1-6. The even numbered tracks are recorded while the tape is moving forward, from BOT to EOT. The odd numbered tracks are recorded in the reverse direction. To improve data reliability and interchangeability, 14 Reference Bursts are recorded at the beginning of their respective tracks. These bursts are written when the tape is recorded from BOT. During the read process, the drive will accuratily locate the position of each burst and compensate for any head positioning errors.



Dimension	Minimum	Maximum	Description
D1	0	15	BOT or EOT to Start of track reference burst
D2	3	4	Load Point or Early Warning to start of data
D3	-	36	Early warning to end of data on even tracks
D4	-	27	End of data to load point on tracks 1, 3, 5, 15, 17 and 25
D5	0.1	4	End of data to load point on tracks 7, 9, 11, 13, 19, 21 and 23
NOTE: All dimensions are in inches.			

Figure 1-6
QIC-525 Tape Position Holes and Track Locations

Section 2 INSTALLATION

2.1 Introduction

This section contains information on unpacking the drive, hardware preparation, installation and software availability.

2.2 Unpacking the Drive

The drive is shipped in a carton and an electrostatic discharge (ESD) protective bag. Only after taking the proper precautions to prevent ESD damage may the drive be removed from the protective bag.

> *WARNING The discharge of electrostatic energy that accumulates on the surface of the human body or other surfaces will damage or destroy the electronic components used in this device.*

2.2.1 Electrostatic Discharge (ESD) Protection

Before removing the drive from its protective bag, prepare a static safe working area. The surface on which the drive will be placed should be conductive. Conductive mats are available at most electronics supply dealers. A grounded conductive wrist strap should be worn at all times when handling the drive. If a wrist strap is not available, insure that some part of your body remains in contact with a ground source (ie. the computer chassis if the line cord is connected) at all times while handling the drive. To reduce the possibility of ESD damage, handle the drive by the metal sides of the drive chassis. Even after the drive is mounted in the computer chassis and properly grounded, ESD will still cause serious damage. Avoid touching any components or connectors on the circuit board. Save the ESD bag and desiccant pack incase in the unit needs to be repackaged.

2.2.2 Environmental and Shock Protection

The drive can be damaged by subjecting it to adverse temperature and humidity conditions as well as by mishandling. When packaged for shipment, a desiccant pack is enclosed in the ESD bag to absorb any unusually high amounts of moisture that may enter the bag. When the unit has been stored in a cool, dry location and is moved to a warmer, more humid location for unpacking, the drive should be allowed the temperature stabilize for at least 30 minutes before opening the ESD bag. If a cool unit is exposed to warm. humid air, moisture will condense on the surface on the drive. Some components can be damaged by this moisture.

The way that the unit is handled can also affect the reliability of the drive. Even a small drop of 1 inch onto a hard surface can cause the drive to become misaligned, resulting in data interchange problems. When handling the drive on a work bench, a conductive rubber mat should be used. This will reduce the possibility of damage or misalignment if the unit is dropped.

2.3 Terminator Pack Configuration

An interface signal termination pack is installed in the drive at locations RN1, RN2 and RN3. The rules for determining if the terminator packs must remain installed or be removed are as follows:

- One device at each end of the cable must have a terminator pack installed.
- The host adapter in most cases will have a terminator pack installed.
- Only one device, in a multiple device configuration, may have a terminator pack installed.
- The last device, the device attached to the cable connector furthest from the host adapter, must have a terminator pack installed.

These configurations are outlined in Figure 2-1. The terminator packs used by Wangtek may be blue, gray, yellow, or black in color are located near the interface connector in sockets. Refer to the installation or operation guide supplied with your host adaptor for the location of the terminator pack.

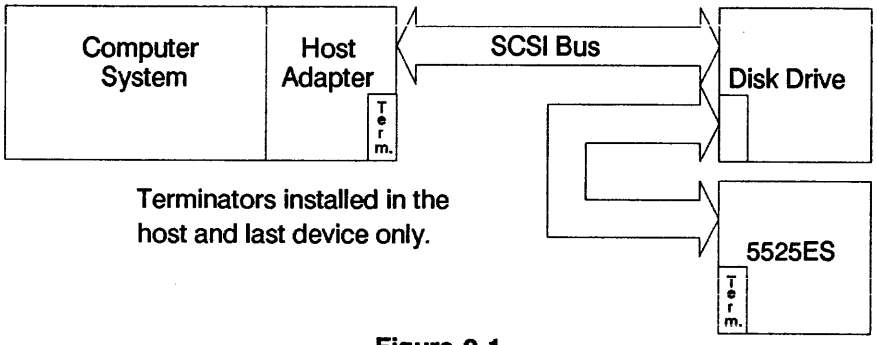


Figure 2-1
Terminator Pack Configuration

2.4 Jumper Configuration - Board Assembly #31320

The following paragraphs describe the functions of the various jumpers on the drive control board. For jumper locations, refer to Figure 2-2. The factory default settings are provided in Table 2-2.

2.4.1 E2 & E3 - Drive Test Mode

These jumpers are used to enable the drive's built-in test modes. Refer to Table 2-1 for configuration of these jumpers.

Table 2-1
Drive Test Mode Configuration

Operating Mode	E2	E3
Normal	-	-
Reserved	-	X
Burn-In	X	-
Diagnostic	X	X
NOTES: X = Installed - = Removed		

Table 2-2
Default Jumper Settings

Assy #31320			
Jumper		Jumper	
JP1-1	-	JP2-1	-
JP1-2	-	JP2-2	-
JP1-3	-	JP2-3	-
JP1-4	-	JP2-4	-
JP3	-	JP2-5	-
E2	-	JP2-6	-
E3	-	JP2-7	-
RN1	X	JP2-8	-
RN2	X	JP2-9	-
RN3	X	F1	-

Assy #33584	
Jumper	
JP1	X
NOTES: X = Installed - = Removed	

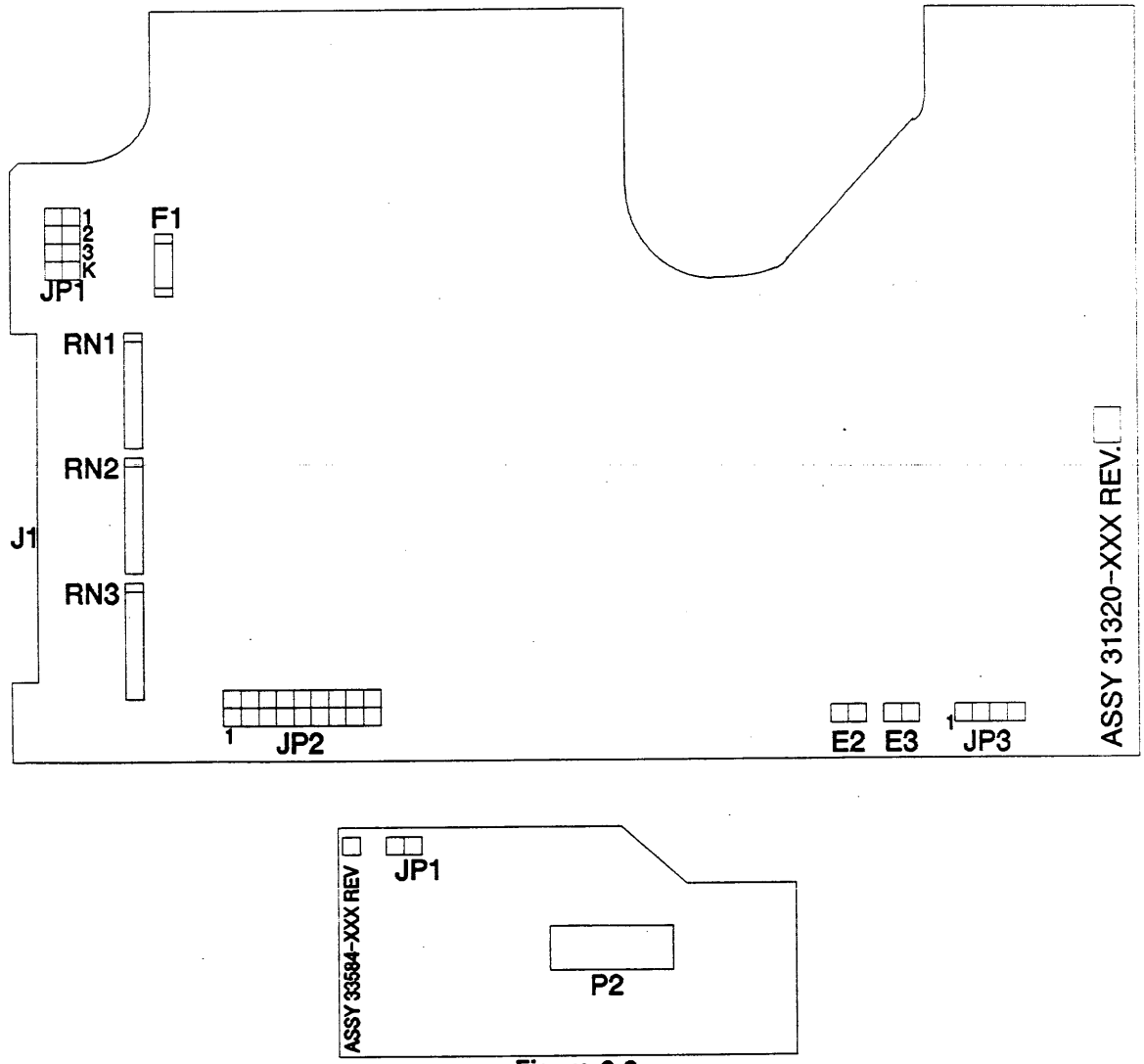


Figure 2-2
Jumper Locations

2.4.2 F1 SCSI Termination Power

Determines whether power for the SCSI bus terminator packs are supplied by the drive or the host. When a 1.5 amp fuse (Wangtek part #55735-152) is installed, termination power to RN1, RN2 & RN3 as well as interface pin 26 is supplied by the drive through a blocking diode. **The default configuration is not installed.**

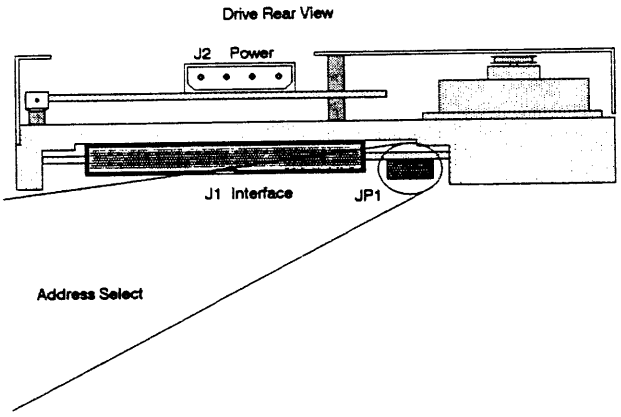
2.4.3 JP1 Pins 1-4 - SCSI Address

These jumpers are used to select the SCSI device address. Refer to Table 2-3 for proper address selection. **The default configuration is no jumpers installed, SCSI address = 0.**

Table 2-3
SCSI Device Address

Pin 3	Pin 2	Pin 1	SCSI Device ID
-	-	-	0
-	-	X	1
-	X	-	2
-	X	X	3
X	-	-	4
X	-	X	5
X	X	-	6
X	X	X	7

NOTES: X = Installed
- = Removed



2.4.4 JP2 Pin 1 - SCSI Type Selection

This jumper is used to select between the SCSI-1 interface when not installed or the SCSI-2 interface when installed. **The default configuration is not installed.**

2.4.5 JP2 Pins 2-9 - Drive Configuration

These jumpers select the default drive configuration options. Refer to Table 2-4 for configuration of these jumpers. **The default configuration is not installed.**

2.4.6 JP3 Pins 1-4 Diagnostic Test Connector

This connector is used to access the drives tape motion microcontroller directly, by passing the SCSI interface. The use of this connector is described in detail in Appendix C. To enable the function of this connector, E2 & E3 must be installed. **The default configuration is not installed.**

Table 2-4
Drive Configuration Selection

	JP2			
Option	2	3	4	5
Default	-	-	-	-
Reserved	-	-	-	X
Reserved	-	-	X	-
Reserved	-	-	X	X
Reserved	-	X	-	-
Reserved	-	X	-	X
Reserved	-	X	X	-
Reserved	-	X	X	X
Reserved	X	-	-	-
Reserved	X	-	-	X
Reserved	X	-	X	-
Reserved	X	-	X	X
Reserved	X	X	-	-
Reserved	X	X	-	X
Reserved	X	X	X	-
Factory Test	X	X	X	X
NOTES: X = Installed - = Removed				

	JP2			
Option	6	7	8	9
Default	-	-	-	-
Reserved	-	-	-	X
Reserved	-	-	X	-
Reserved	-	-	X	X
Reserved	-	X	-	-
Reserved	-	X	-	X
Reserved	-	X	X	-
Reserved	-	X	X	X
Reserved	X	-	-	-
Reserved	X	-	-	X
Reserved	X	-	X	-
Reserved	X	-	X	X
Reserved	X	X	-	-
Reserved	X	X	-	X
Reserved	X	X	X	-
Reserved	X	X	X	X
NOTES: X = Installed - = Removed				

2.5 Jumper Configuration - Board Assembly #33584

The following paragraph describes the function of the jumper on the motor driver board. For jumper locations, refer to Figure 2-2. The factory default settings are provided in Table 2-2.

2.5.1 JP1 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 0.33 microfarad capacitor. The default configuration is installed.

Section 3 OPERATION

3.1 Introduction

This section contains information regarding drive operation, backup strategy, drive care and cleaning, and problem solving information.

3.2 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. Refer to Figure 3-1. 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.

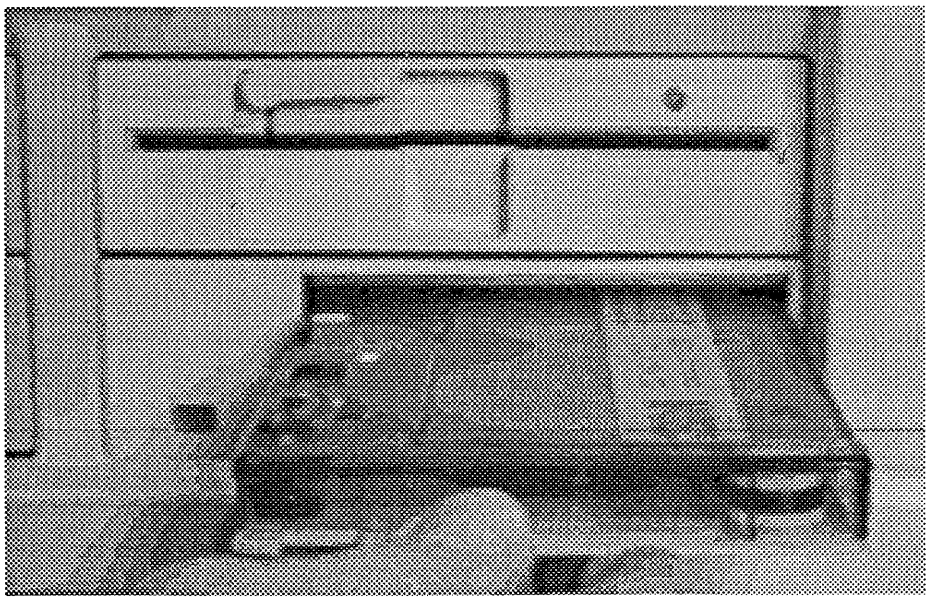


Figure 3-1
Cartridge Loading

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. Refer to Figure 3-2. 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 can be removed at this time.

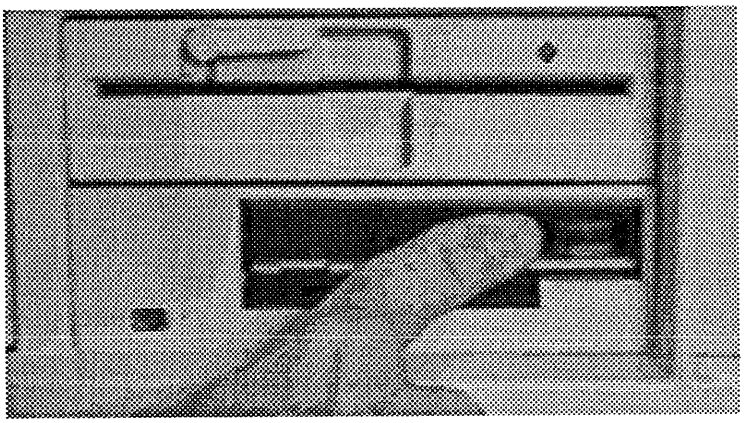


Figure 3-2
Cartridge Unloading

3.3 Tape Cartridge Characteristics

The tape cartridges designed for use in this product are the DC 6525, DC 6320, DC 6250, DC 6150, DC 600A or DC 300XL/P manufactured by 3M or equivalent types. The acceptable formats for each cartridge type are listed in Table 3-1.

Table 3-1
Tape Cartridge Compatibility

	Data Format Compatibility	
Tape	Write	Read
DC 6525	QIC-525/320, QIC-150, QIC-120	QIC-525/320, QIC-150, QIC-120, QIC-24
DC 6320	QIC-525/320, QIC-150, QIC-120	QIC-525/320, QIC-150, QIC-120, QIC-24
DC 6250	QIC-150, QIC-120	QIC-150, QIC-120, QIC-24
DC 6150	QIC-150, QIC-120	QIC-150, QIC-120, QIC-24
DC 600A	QIC-120	QIC-120, QIC-24
DC 300XL/P		QIC-24

3.3.1 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).

3.3.2 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. To reduce the possibility of tape contamination in the data zone, the cartridge should always be rewound to BOT prior to removing for storage. Never open the head access door or touch the tape or capstan with your fingers. 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.

3.4 Recommended Backup Strategy

The 5525ES is used primarily as a backup storage device to prevent the loss of valuable data due to accidental erasure or destruction due to storage device failure. The need to backup your data as well as the frequency of backup is best determined by the data's "value". If the data cannot be recreated but access to the data is still desired, then the data has a high value. If the data can be recreated at a high cost of man hours, the data value is high to medium. If the data can be easily recreated and is seldom used, the data value is medium to low. The frequency of backup should be determined by the frequency of access or change to the highest value data. For example, if the computer system was used the process income tax returns, requiring 0.75 man hours per return processed, the data value would be high to medium. The recommended frequency of backup would be every 8 hours for medium value data and every 4 hours for high value data. At no time should the frequency of backup require more time to be spent performing the backup then it took to create the data being backed up.

A second need to perform data backups is for archival purposes. If a particular piece of data must be retained, unchanged, for history reasons, an archival copy is made and stored in a safe place. For example, if a version of a document (e.g. a manual) needs to be kept unchanged so that it may be referred to at some future date. After the archive tape is made, it should be write protected to prevent loss by erasure or rewriting.

Another item that must be considered as part of a backup strategy is the location of the backup tape storage. If the data being backed up is medium to high, an off site backup strategy should be used to prevent the loss of data due to fire or theft. The off site backup should be stored at a location other than where the computer and on site backups are located, for example a data storage facility or an employees home, and would only be brought in to the computer site for update.

3.4.1 Daily Backups

The daily backup tape should be made at the end of each work day just before turning the computer system off. A tape with the name of the day (i.e. Monday, Tuesday...) on the label should be prepared in advance. Each day of the week, a complete backup of the hard disk would be performed. The following week, each tape would be reused. With this method, the maximum loss of data is limited to one day's work within the past week. If the capacity of the tape is much greater than the capacity of the hard disk, 150 megabytes per tape and 40 megabytes for the hard disk, several backup sessions can be stored on one tape to minimize the number of tapes required.

Another method used to provide the same protection with a minimum of tapes is to perform backups of only the files that change. For example, on Monday a complete backup of the entire disk is performed. On Tuesday, a backup of only the files that have changed is performed and so on through the end of the week. Depending on your actual computer usage, one whole week of daily backups may fit on one tape. This process can be carried out for weekly, monthly, quarterly, and annual backups.

One last consideration is unscheduled backups. An unscheduled backup is one made in addition to the normal, scheduled backups. For example, a complete backup should be made before any work is performed on the computer hardware or before the computer is sent to the repair shop to correct a problem, even if the problem doesn't involve the hard disk.

3.4.2 Backup Strategy - High Value Data

Outlined below is one possible backup strategy to be used with high value data. A graphic representation of the backup procedure is shown in Figure 3-3. A complete disk backup is made daily on a separate tape for each day. On the last day of the week, a weekly backup tape is made. Each daily tape is then reused the following week with the weekly backup tape being made on a 2nd weekly tape. This pattern will continue for each week of the month. On the last day of the last week of the month, a complete monthly backup tape is produced. The weekly tapes are then reused when needed. At the end of the next month, a 2nd monthly backup is made. This pattern will continue for the year. At the end of the last week of the last month of the year, an annual backup tape is made. This method would provide the following protection while using 25 tape cartridges for the year.

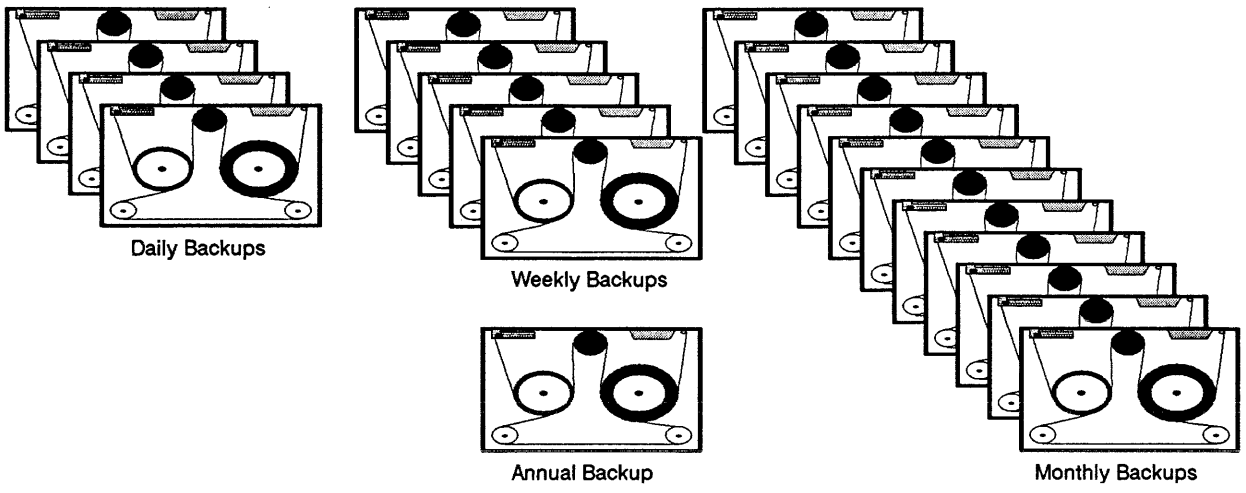


Figure 3-3
High Value Data Backup Method

- A maximum of one day lost within the past week.
- A maximum of one week lost within the past month.
- A maximum of one month lost within the past year.

More elaborate backup strategies can be used to provide better protection with the only limiting factor being the number of tapes used.

3.4.3 Backup Strategy - Medium Value Data

Outlined below is one possible back strategy to be used with medium value data. A graphic representation of the of the backup procedure is shown in Figure 3-4. A complete disk backup is made Monday on a tape marked "Weekly 1". On Tuesday through Friday, a backup of only the files that have changed (a modified files backup) is added or appended to the "Weekly 1" tape. The next week, a tape marked "Weekly 2" is used for the backups. This process is repeated for the Weekly 3 and Weekly 4 tapes. During the following week, the Weekly 1 tape is reused for the backups. This method would provide the following protection while using 4 tape cartridges:

- A maximum of one day lost within the last four weeks.

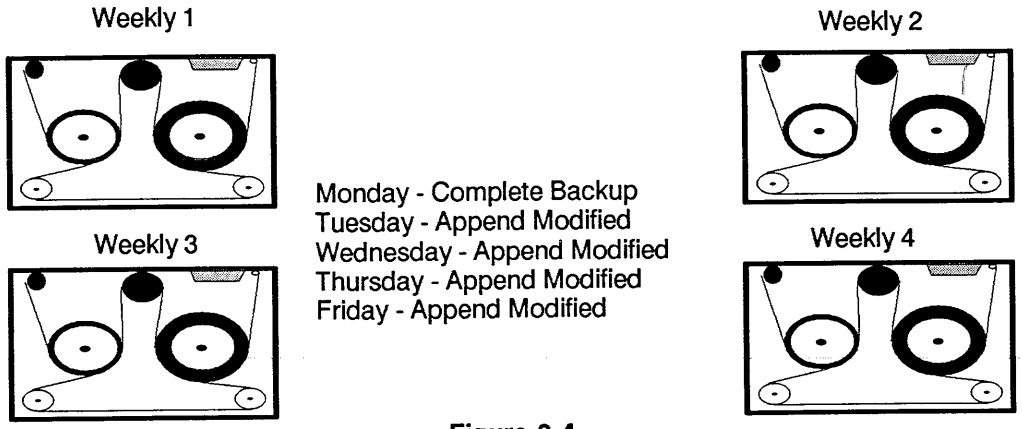


Figure 3-4
Medium Value Data Backup Method

Section 4 INTERFACE

4.1 Introduction

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

4.2 Power Connector And Contacts

The recommended power connector for the Wangtek Model 5525ES 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 P2 voltage, current and pin assignments are outlined in Table 4-1.

Table 4-1
P2 Power Connector Pin Assignments Current Requirements

VOLTS ±5%	PIN	OPERATION MODE	CURRENT
+12V DC	1	Standby	1.5 Amps
+12V DC		Operational	1.5 Amps
+12V DC		Max. Surge	2.5 Amps
+12V Return	2		
+5V Return	3		
+5V DC	4	Standby	1.0 Amp
+5V DC		Operational	1.0 Amp
+5V DC		Max. Surge	1.0 Amp

The maximum 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) 5mSec minimum
+5V input (0 to 4.75 V) 5mSec 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.

Table 4-2
Input Power Requirements

VOLTS	OPERATION MODE	POWER
+12V DC	Standby	2.1 Watts
+12V DC	Operational	19.2 Watts
+5V DC	Standby	5.5 Watts
+5V DC	Operational	5.5 Watts
Total	Standby	7.6 Watts
Total	Operational	24.7 Watts

4.3 Host Interface Connector - Single-Ended Option

The 5525ES interfaces with the Host via J1 using the single-ended scheme. The recommended connector is an AMP 86916-1 or equivalent as shown in Figure 4-1. The cable used should be a flat ribbon or twisted pair cable. All SCSI devices are connected together via daisy chain with a total cable length of not more than 20 feet or 6 meters. If the drive is the last device in the daisy chain, it must be terminated via 220/330 ohm resistor packs in position RN1, RN2, and RN3. Each signal is terminated to +5 volts, and to ground as seen in Figure 4-2.

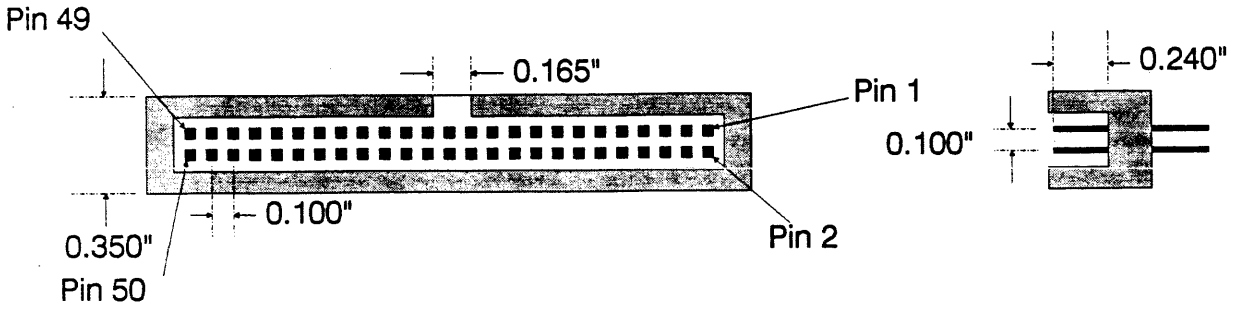


Figure 4-1
Interface Connector Dimensions

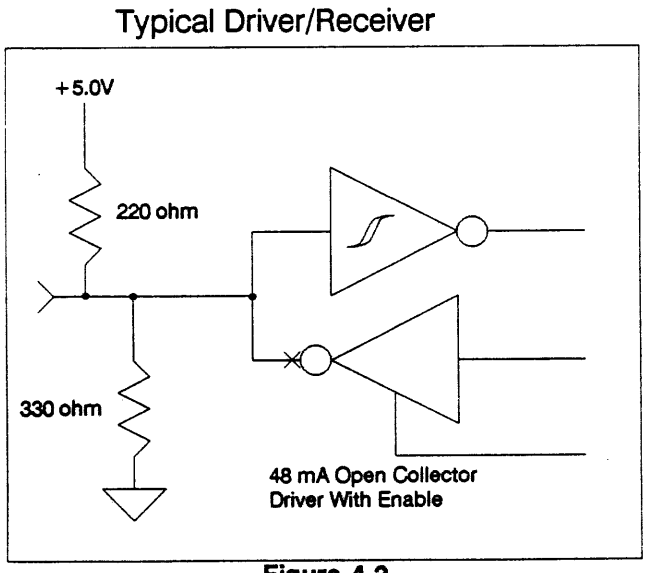


Figure 4-2
Interface Terminator Configuration

Table 4-3 provides the connector pin descriptions and its bus signals. A 1 Amp Fuse is provided for protection from improper cable installation.

Table 4-3
Interface Connector Pin Assignments

Pin#	Mnemonic	To	Description
2	DB0	B	Data Bus 0
4	DB1	B	Data Bus 1
6	DB2	B	Data Bus 2
8	DB3	B	Data Bus 3
10	DB4	B	Data Bus 4
12	DB5	B	Data Bus 5
14	DB6	B	Data Bus 6
16	DB7	B	Data Bus 7
18	DBP	B	Data Bus Parity
22	GND		Ground
24	GND		Ground
26	TPWR		Termination Power
28	GND		Ground
30	GND		Ground
32	ATN-	B	Attention-
34	GND		Ground
36	BSY-	B	Busy-
38	ACK-	B	Acknowledge-
40	RST-	H	Reset-
42	MSG-	B	Message-
44	SEL-	B	Select-
46	C-/D	B	Control-/Data
48	REQ-	B	Request-
50	I-/O	B	Input-/Output

NOTE: All odd pins are signal returns, which should be connected to ground at both the drive and the host with the exception of pin 25 which is not connected.
B = Bi-directional, D = Drive, H = Host.

The bus consists of eighteen signals. Nine signals comprise an 8-bit parallel data interface with parity. The remaining nine signals are used to control the bus and can be viewed as a 9-bit control bus. All information exchanges over the bus are performed asynchronously with a Request/Acknowledge handshake.

4.4 Electrical Interface (Single-Ended)

Output Characteristics. Each signal driven by the drive shall have the following output characteristics when measured at the interface connector (terminator not intalled):

Signal Assertion = 0.0 volts DC to 0.4 volts DC
Minimum driver output capability = 48 milliamps (sinking) at 0.5 volts DC
Signal = 2.5 volts DC to 5.25 volts DC

Input Characteristics. Each signal received by the drive shall have the following input characteristics when measured at the interface connector (terminator not intalled):

Signal true = 0.0 volts DC to 0.8 volts DC
Maximum total input load = 0.4 milliamps to 0.4 volts DC
Signal false = 2.0 volts DC to 5.25 volts DC
Minimum input hysteresis = 0.2 volts DC

4.5 SCSI Bus Signals

There are a total of eighteen signals. Nine are used for control and nine are used for data. (Data signals include parity). These signals are described as follows:

BSY (BUSY) - An "OR-tied" signal that indicates that the bus is being used.

SEL (SELECT) - A signal used by an initiator to select a target or by a target to reselect an initiator.

I/O (INPUT / OUTPUT) - A signal driven by a target that controls the direction of data movement on the DATA BUS with respect to an initiator. True indicates input to the initiator. This signal is also used to distinguish between SELECTION and RESELECTION phases.

MSG (MESSAGE) - A signal driven by a target during the MESSAGE phase.

REQ (REQUEST) - A signal driven by a target to indicate a request for a REQ/ACK data transfer handshake.

ATN (ATTENTION) - A signal driven by an initiator to indicate the ATTENTION condition.

RST (RESET) - An "OR-tied" signal that indicates the RESET condition.

(DB(7-0,P) (DATA BUS) - Eight data bit signals comprise the data bus. DB(7) is the most significant bit and has the highest priority during arbitration. DB(P) is the data bus parity (odd). Each of the eight data signals DB(7) through DB(0) is uniquely assigned as a target or initiator bus address (i.e., SCSI DEVICE ID). This identification is normally assigned and strapped during system configuration.

Signal Values. Signals may assume true or false values. There are two methods of driving these signals. In both cases, the signal shall be actively driven true, or asserted. In the case of OR-tied drivers, the driver does not drive the signal to the false state, rather the bias circuitry of the bus terminators pulls the signal false whenever it is released by the drivers at every SCSI device. If any driver is asserted, then the signal is true. In the case of non-OR-tied drivers, the signal may be actively driven false, or negated. In this document, wherever the term negated is used, it means that the signal may be actively driven false, or may simply be released (in which case the bias circuitry pulls it false), at the option of the implementor. The advantage to actively drive signals false is that the transition from true to false occurs more quickly, and noise margins may be somewhat improved; this may permit somewhat faster data transfer.

OR-Tied Signals. The BSY or RST signals shall be OR-tied only. In the ordinary operation of the bus, these signals are simultaneously driven true by several drivers. No signals other than BSY, RST, and DB(P) are simultaneously driven by two or more drivers, and any signal other than BSY and RST may employ OR-tied or non-OR-tied drivers. DB(P) shall not be driven false during the ARBITRATION phase. There is no operational problem in mixing OR-tied or non-OR-tied drivers on signals other than BSY or RST.

4.6 Command Description

This section describes the SCSI commands as implemented by the Model 5525ES. They are placed in sequence according to the value of their operation codes. Included in the explanation is a description of the Command Descriptor Block, Status Codes, and Sense Keys valid for these commands. The messages returned by the Message Phase are described herein. Table 4-4 lists the commands in the order of their Operation Code, and identifies the page number where the command can be found. All commands support the Link and Flag option, therefore they are not listed under each command description.

Table 4-4
SCSI Commands

Op Code (Hex)	Command	Ref. Page
00	Test Unit Ready	4-67
01	Rewind	4-61
02	Request Block Address	4-48
03	Request Sense	4-49
05	Read Block Limits	4-39
08	Read	4-37
0A	Write	4-70
0C	Seek Block	4-62
0D	Partition	4-35
10	Write Filemarks	4-74
11	Space	4-65
12	Inquiry	4-22
13	Verify	4-69
14	Recover Buffer Data	4-46
15	Mode Select	4-29
16	Reserve Unit	4-60
17	Release Unit	4-47
18	Copy	4-13
19	Erase	4-21
1A	Mode Sense	4-31
1B	Load / Unload	4-25
1C	Receive Diagnostic Results	4-44
1D	Send Diagnostic	4-63
1E	Prev./Allow Media Removal	4-36
2B	Locate	4-27
34	Read Position	4-42
3B	Write Buffer	4-72
3C	Read Buffer	4-40

4.7 Command Descriptor Block

A transaction is initiated by the Host, instructing the drive to execute a command. During the Command Phase, six or ten bytes of information making up the Command Description Block (CDB) are sent to the drive by the Host. The contents of a typical six byte Command Description Block (CDB) is shown in Figure 4-3. The following paragraphs contain bit definitions and mnemonic descriptions.

	Data Bits							
Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	LUN							
2								
3								
4								
5							Flag	Link

Figure 4-3
Typical Comand Description Block For Six Byte Commands

The Command Phase may be interrupted when one of the following conditions occurs:

- Reset Condition - This condition occurs when SCSI RST- signal is asserted by the Host, or as a result of a power failure or Power-Off condition in the drive. In this situation, the Command Phase and the connection established during the Selection or Reselection Phase are terminated by the drive de-asserting the BSY- signal.
- Parity Error Condition - If a Parity error is detected, the drive sends a Restore Pointers Message (03) and tries the transfer again. If the messages are not allowed, the command terminates with a Check Condition (Status 02) and a Hardware Error (4 Sense Key).

Operation Code Byte 0 Bits 0-7

Bits 5-7 equal zero and designate the command group. Bits 0-4 identify the command function, i.e., Read or Write Tape.

LUN (Logical Unit Number) Byte 1 Bits 5-7

Specifies the Logical Unit Number of the drive. This must always be zero.

LONG Byte 1 Bit 0

Bit 0 is used by the Erase Command to control whether the tape is repositioned to the BOT before starting to erase or if it must already be at the BOT at the time the Erase Command is received.

DFE (Data blocks, File mark, or End of media) Byte 1 Bits 0-1

Bits 1,0 determine whether the Space Command is to space over Data Blocks, Filemarks, Consecutive Filemarks, or to the End-Of-Data.

IMM (Immediate Mode) Byte 1 Bit 0

Bit 0 determines whether the status is to be returned immediately after the command is received by the drive or after it has finished its function.

MTN (Maximum Track Number) Byte 2 Bits 0-7

Byte 2 specifies the maximum track number for the drive connected to the controller.

MTS (Minimum Transfer Size) Byte 3 Bits 0-7

Byte 3 specifies the minimum number of blocks per burst to be transferred between the Host and the drive's Data Buffer during a read or write operation.

NOB (Number Of Blocks) Bytes 2-4

In fixed block mode Bytes 2-4 specify the number of Blocks to be read or written by the drive. In variable block mode these bytes specify length of a block to be read or written by the drive.

LOV (Length Of Verification) Byte2-4

Bytes 2-4 specify the number of blocks to be verified by the Verify Command.

#RSB (Number Of Requested Sense Bytes) Byte 4 Bits 0-7

Byte 4 is used by the Request Sense Command to specify the Number of Requested Sense Bytes. A 00 results in 04 being returned. (01 through 0E Hex results in that many bytes being returned. Any value over 0E Hex results in 0E being returned for SCSI-1.) For SCSI-2 it is 01 through 40H.

NOF (Number Of File Marks) Byte 4 Bits 2-4

Byte 2-4 specifies the Number of Filemarks to be written by a Write Filemark Command.

3PEN (Third Party Option Enable) Byte 1 Bit 4

Byte 4 is used by the Reserve and Release Unit commands to enable the Third Party Option. This option is intended for multiple-host systems in which the Copy command is used.

3PID (Third Party Identification) Byte 1 Bits 1-3

Byte 1 identifies the third party SCSI I.D. of the device reserving the drive.

ALL (Allocation Length) Byte 4 Bits 0-7

Byte 4 is used by the Inquiry Command to specify the number of configuration bytes to be sent to the Host. This information describes how the drive is configured.

PLL (Parameter List Length) Byte 4

Byte 4 is used by the Mode Select/Sense Command to specify the Parameter List Length.

RET (Retention Tape) Byte 4 Bit 1

Bit 1 is used by the Load Command. When this bit is set to one the tape goes through a retention cycle before performing the load operation. This bit must be set to zero for unload command.

SILI (Suppress Illegal Length Indicator) Byte 1, Bit 1

Bit 1 is used by Read Command. In variable block length mode this bit specifies whether to report Check Condition status to last if actual block length is different than specified. 0 = Report Check Condition and set ILI bit in sense data, 1 = do not report check condition status.

LOAD (Load/Unload) Byte 4 Bit 0

Bit 0 determines whether this is a Load or Unload command. A one equals Load, a zero equals Unload.

PRE (Prevent/Allow Media Removal) Byte 4 Bit 0

Bit 0 determines whether the tape cartridge may or may not be removed.

EOT (End Of Tape) Byte 4 Bit 2

Bit 2 is used by unload command. When this bit is set to one the tape is unloaded to EOT. When it is set to zero the tape is unloaded to BOT (Beginning Of Tape). This must be set to zero for load command.

PF (Page Format) Byte 2, Bit 4

Bit 4 is used by Mode Select and Mode Sense commands. It determines whether Parameter Pages are to be transferred. 0 = No Parameter Page, 1 = one or more Parameter Pages to be transferred.

SP (Save Page) Byte 1, Bit 0

Bit 0 is used by Mode Select command. It is not currently being used therefore it must be set to zero.

DBD (Disable Block Descriptor) Byte 1, Bit 3

Bit 3 determines whether Block Descriptor parameters to be transferred to the host by Mode Sense Command.

PCTL (Page Control) Byte 2, Bits 7-6

Bits 7-6 determines which type of values for Parameter Pages are to be transferred to host by Mode Sense Command.

PCODE (Page Code) Byte 2, Bits 5-0

Bits 5-0 specifically which Parameter Page or all supported pages to be transferred to host by Mode Sense Command.

FBM (Fixed Block Mode) Byte 1 Bit 0

Bit 0 is used by Read / Write commands. If set to one then the "NOB" specifies number of blocks to be read / written. If set to zero the "NOB" specifies the length of a block to be read / written.

FLAG

The Flag must be zero when the Link bit is zero. When the Link is one, the drive reflects the state of the Flag bit at the time the command terminates by sending an 0A or 0B message. Typically, when the Flag is one the Host may take some special action or interrupt its sequence of linked commands. When the Flag is zero and the Link is one, the sequence of linked commands continues.

LINK

The Host sets this bit to one to provide an automatic link to the next command and avoid the Bus Free Phase. Link bit of one is not allowed if IMM bit in the command is set to one.

4.8 Command Status Byte

After each command terminates, the Status Byte is sent from the drive to the Host during the Status Phase. Figure 4-4 shows the format of the Status Byte and Table 4-5 lists the Status Code (with their code bit values) supported by the Model 5525ES. If a command is terminated by an Abort, a Bus Device Reset, or a Hard Reset condition, a Status Byte is not sent.

Note:If a Check Condition is received, additional information is available to the Initiator by invoking the Request Sense Command.

	Data Bits							
Byte	7	6	5	4	3	2	1	0
0	0	0	0	Status Byte Code				

Figure 4-4
Command Status Byte

Table 4-5
Status Byte Code Bit Values

Status	4	3	2	1	0	Description
Good Status	0	0	0	0	0	Drive Completed the command successfully
Check Condition	0	0	0	1	0	An error, exception, or abnormal condition occurred
Busy	0	1	0	0	0	Drive is busy
Reservation Conflict	1	1	0	0	0	Initiator requested reservation of LUN already reserved
Intermediate Good	1	0	0	0	0	Good status for linked commands.

4.9 Command Completion Message

To conform to SCSI protocol, the drive sends a one byte message to the Host immediately following the Status Byte. This message could be a Command Complete (00), Linked Command Complete (0A), or Linked Command With Flag Complete (0B).

A Command Complete (Message 00) informs the Host that the command has terminated, a valid status has been sent, and BSY- is about to be de-asserted, freeing the bus for the next command.

A Linked Command Complete or Linked Command with Flag Complete (Messages 0A and 0B) informs the Host that the terminating command has the Link or Link and Flag bits set in the CDB. A valid status is sent but BSY- is not de-asserted and the drive goes directly into the Command Phase to get the next command.

If a command is terminated by an Abort, a Bus Device Reset, or a Hard Reset condition, a Command Completion Message is not sent.

4.10 Disconnect/Reconnect

Certain tasks, such as repositioning the tape or writing to tape from a full Data Buffer, do not require constant communication with the Host. To prevent tying up the SCSI bus and wasting time, the drive disconnects from the bus by de-asserting BSY-. The drive informs the Host that it is about to disconnect by means of an 04 Hex. During the Selection Phase the Host must send an Identify Message Code with bit 6 equal to one to inform the drive that it is capable of supporting Disconnect/Reconnect operations.

4.11 Command Descriptions

Each SCSI command supported by the drive is described in the following subsections. The commands are presented in alphabetical order. Included in each description is an explanation of the Possible Status Codes, and the Additional Sense Bytes.

4.11.1 COPY (Group 0, Op. Code 18)

The Copy Command is capable of backing up or restoring an individual file or a complete disk image. The data blocks within a file need not be located contiguously on the disk. The Model 5525ES responds as a Target while receiving the CDB and Segment Descriptors from the Host, and switches to the roll of Initiator for the transfer of data. The tape drive must be either the destination or source device. The Copy Command is also capable of copying from tape to tape. The Host must support the disconnect/reconnect option. If not, when the Copy Command is received by the drive, it immediately terminates the command and returns a Check Condition (Status 02) and an Illegal Request (Sense Key 5).

While writing to tape, when the drive places the data specified by one Segment Descriptor into the Buffer, it immediately proceeds to obtain the data specified by the next Segment Descriptor. Only after the data specified by the last Segment Descriptor is in the Buffer, does the drive determine if it is in the Buffered Mode. The drive disconnects from the Initiator while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	0	0	0	18
1	0	0	0	0	0	0	0	0	00
2	MSB	Parameter List Length							XX
3	Parameter List Length								XX
4	Parameter List Length							LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-5
CDB For Copy Command

PARAMETER LIST LENGTH - Specifies the number of bytes to follow the CDB. The value must be zero or some multiple of the Segment Descriptor plus the four byte Header. Examples of valid quantities are: 0, 4, 16, 28, 40 etc. If this field is zero, the command terminates immediately with a Good Status. As many as 256 Segment Descriptors may be retained in the drive at one time.

Segment Descriptor Header

The Segment Descriptor Header consists of four bytes and precedes one or more Segment Descriptors. When backing up a file, one Segment Descriptor is required for each group of contiguous blocks within the file. The Copy Command is capable of backing up a file that is fragmented into as many as 256 blocks.

COPY FUNCTION CODE - This field identifies the type of devices involved in the copy operation. Generally, a 00 = Direct access (disk) to sequential access (tape), would be a backup operation. 01 = Sequential access (tape) to direct access (disk). Generally, a this would be a restore operation. 03 = Sequential access (tape) to sequential access (tape). This may be used to create a duplicate copy of a tape. 02 = Direct access (disk) to direct access (disk) is not supported. In all permitted operations, the tape must be one of the copy devices. Any other code results in the command terminating with a Check Condition Status and an Illegal Request Sense Key.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	
0	Copy Function Code					0	0	0	Header
1	0	0	0	0	0	0	FIL	DIS	
2	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	

00 - 0B	Segment Descriptor/s

Figure 4-6
Segment Descriptor Header

DIS - This bit determines whether the target device is to be allowed to disconnect/reconnect from the drive while the drive is functioning as the Initiator. 0 = Disconnect/Reconnect is allowed. 1 = Disconnect/Reconnect is not allowed.

FIL - This bit determines whether the drive fills the data blocks with E5 Hex upon satisfying each Segment Descriptor, or only at the completion of the Copy Command. 0 = No Fill. 1 = Fill.

Segment Descriptor, Disk/Tape Or Tape/Disk

The type of device designated as the source and destination is determined by the Function Code in the Header. When the code is 00, as is the case when performing a backup, the source is a disk drive and the destination is a tape drive. When the code is 01, as when performing a restore, the reverse is true.

	Data Bits							
Byte	7	6	5	4	3	2	1	0
00	Source Address			0	0	Source LUN		
01	Destination Address			0	0	Destination LUN		
02	MSB	Tape - Block Length						
03	Tape - Block Length							LSB
04	MSB	Disk - Number of Blocks						
05	Disk - Number of Blocks							
06	Disk - Number of Blocks							
07	Disk - Number of Blocks							LSB
08	MSB	Disk - Logical Block Address						
09	Disk - Logical Block Address							
0A	Disk - Logical Block Address							
0B	Disk - Logical Block Address							LSB

Figure 4-7
Disk/Tape or Tape/Disk Segment Descriptor

SOURCE ADDRESS - This is the SCSI ID of the source device. "3rd Party Copy" is not supported. If source address or destination address is not this unit, the command will be rejected.

COPY (Group 0, Op. Code 18)

SOURCE LUN - This is the Logical Unit Number of the source device connected to the above device.

DESTINATION ADDRESS - This is the SCSI ID of the destination device.

DESTINATION LUN - This is the Logical Unit Number of the destination device connected to the above device.

TAPE-BLOCK LENGTH - This field specifies the number of bytes in each block on tape. In the QIC-525/QIC-320 mode, block size is variableand the optimum block size is 400 Hex (1024 Dec). In the QIC-150 or QIC-120 modes, block size is fixed and must be 200 Hex (512 Dec).

DISK-NUMBER OF BLOCKS - This field specifies the number of contiguous blocks on the disk to be backed up or restored by this Segment Descriptor. In the case of File Backup/Restore, this value would be the number of contiguous blocks in a given group of blocks. For disk image it could be the number of known good data blocks. The maximum allowable number is 2^{24} (16 million) and the MSB must be set to 00 Hex.

DISK-LOGICAL BLOCK ADDRESS - This field specifies the address of the first block in a group of contiguous blocks. If this is the first Segment Descriptor of a File Backup or Restore operation, this would be the first block of the file.

NOTE: The Source Address and Source LUN must not change from one segment descriptor to the next.

Segment Descriptor, Tape/Tape

The type of device designated as the source and destination is determined by the Function Code in the Header. When the code is 03, both the source and destination devices are tape drives. The role of the drive as the source or destination is determined by the Segment Descriptor.

	Data Bits							
Byte	7	6	5	4	3	2	1	0
00	Source Address			0	0	Source LUN		
01	Destination Address			0	0	Destination LUN		
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	MSB	Source Block Length						
05	Source Block Length							LSB
06	MSB	Destination Block Length						
07	Destination Block Length							LSB
08	MSB	Source Number of Blocks						
09	Source Number of Blocks							
0A	Source Number of Blocks							
0B	Source Number of Blocks							LSB

Figure 4-8
Tape/Tape Segment Descriptor

COPY (Group 0, Op. Code 18)

SOURCE ADDRESS - This is the SCSI ID of the source device.

SOURCE LUN - This is the Logical Unit Number of the source device connected to the above device.

DESTINATION ADDRESS - This is the SCSI ID of the destination device.

DESTINATION LUN - This is the Logical Unit Number of the destination device connected to the above device.

SOURCE BLOCK LENGTH - This field specifies the number of bytes in each block on the source tape.

DESTINATION BLOCK LENGTH - This field specifies the number of bytes in each block on the destination tape.

SOURCE NUMBER OF BLOCKS - This field specifies the number of blocks to be read from the source tape. If the block length for the two drives is different, the number of blocks will also be different.

Sense Byte Format For Copy Command

The Sense Bytes returned by the Request Sense Command are divided into three groups. The first ten bytes of Sense Data represent the status of the drive while acting as a Target, that is, receiving the CDB and Segment Descriptors. The second group of Sense Bytes represents the status of the source device. The third group represents the destination device. The total number of Sense Bytes is dependent upon the Target selected by the Model 5525ES. The drive is capable of accepting as many as 32 sense bytes from the Target device. Figure 4-8 represents the Sense Bytes when the Model 5525ES is controlling the source drive, Figure 4-9 represents the Sense Bytes when acting as the destination device.

The following definitions apply only to the first ten bytes of Figures 4-8 and 4-9. The other fields are defined in the Request Sense Command.

AVF - Address Valid Flag. This bit is always a one, indicating that the Segment Descriptor Block Residue is valid.

EXTENDED FORMAT - Bits 6-0 are 70 Hex and indicate that these first ten bytes are in extended format.

SEGMENT DESCRIPTOR NUMBER - This byte represents the current Segment Descriptor Number. Up to 256 (00 through FF Hex) Segment Descriptors are supported.

SENSE KEY - While the Model 5525ES is receiving the Copy Command and parameters, it is operating as a Target. The Sense Key during this time could be an 04, 05, or 06 and only the first ten bytes are valid.

While the Model 5525ES is controlling the copy operation, it is functioning as an Initiator. An 0A Hex (Aborted Command) during this time indicates a malfunction has been detected by either the source or destination device. The Sense Key, Status Information, and/or Error Codes are located in the respective area of the remaining Sense Bytes.

SEGMENT DESCRIPTOR BLOCK RESIDUE - This field represents the number of blocks specified in the Segment Descriptor that have not yet been copied at the time of the error. The Segment Descriptor is identified in the Segment Descriptor Number Field.

COPY (Group 0, Op. Code 18)

OFFSET TO SOURCE SENSE BYTES - This field is 0A Hex and points to the location of the Source Device Sense Bytes within the Extended Sense Byte format.

ADDITIONAL SENSE LENGTH - The Additional Sense Length specifies the number of bytes to follow, including this byte. The value of this field is determined by the number of sense bytes allocated by the manufacturer of the source device.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
00	AVF	Extended Format							F0
01	Segment Descriptor Number								XX
02	Sense Key								XX
03	MSB	Segment Descriptor Block Residue							XX
04	Segment Descriptor Block Residue								XX
05	Segment Descriptor Block Residue								XX
06	Segment Descriptor Block Residue							LSB	XX
07	Additional Sense Length								XX
08	Offset To Source Device Status Bytes								0A
09	Offset To Destination Device Status Bytes								19
0A	Source Status Byte								XX
0B	AVF	Extended Format							X0
0C	0	0	0	0	0	0	0	0	00
0D	FM	EOM	ILI	0	Sense Key				XX
0E	MSB	Sense Information							XX
0F	Sense Information								XX
10	Sense Information								XX
11	Sense Information							LSB	XX
12	Additional Sense Length								06
13	0	CNI	0	WRP	EOM	UDE	BNL	FIL	XX
14	0	0	NDT	0	BOM	BPE	0	0	XX
15	MSB	Data Error Counter							XX
16	Data Error Counter							LSB	XX
17	MSB	Data Underrun Counter							XX
18	Data Underrun Counter							LSB	XX
19	Destination Status Byte								XX
S+?	Length And Format Of The								XX
S+?	Destination Sense Bytes Is								XX
S+?	Dependent Upon The Manufacturer								XX
S+?	Of The Destination Device								XX

Figure 4-9
Extended Sense Byte Format - 5525ES As The Source

COPY (Group 0, Op. Code 18)

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
00	AVF	Extended Format							F0
01	Segment Descriptor Number								XX
02	Sense Key								XX
03	MSB	Segment Descriptor Block Residue							XX
04	Segment Descriptor Block Residue								XX
05	Segment Descriptor Block Residue								XX
06	Segment Descriptor Block Residue							LSB	XX
07	Additional Sense Length								XX
08	Offset To Source Device Status Bytes								0A
09	Offset To Destination Device Status Bytes								S+1
0A	Source Status Byte								XX
S	Length And Format Of The								XX
S	Destination Sense Bytes Is								XX
S	Dependent Upon The Manufacturer								XX
S	Of The Destination Device								XX
S+1	Destination Status Byte								XX
S+2	AVF	Extended Format							X0
S+3	0	0	0	0	0	0	0	0	00
S+4	FM	EOM	ILI	0	Sense Key				XX
S+5	MSB	Sense Information							XX
S+6	Sense Information								XX
S+7	Sense Information								XX
S+8	Sense Information							LSB	XX
S+9	Additional Sense Length								06
S+A	0	CNI	0	WRP	EOM	UDE	BNL	FIL	XX
S+B	0	0	NDT	0	BOM	BPE	0	0	XX
S+C	MSB	Data Error Counter							XX
S+D	Data Error Counter							LSB	XX
S+E	MSB	Data Underrun Counter							XX
S+F	Data Underrun Counter							LSB	XX

Figure 4-10
Extended Sense Byte Format - 5525ES As The Destination

COPY (Group 0, Op. Code 18)

Possible Sense Keys While The 5525ES Is The Destination

Although the Sense Key description in Table 4-6 is valid, due to the complexity of the copy operation a more detailed description of the possible Sense Keys is provided here. The Sense Keys listed below are valid in the Sense Key Field in Byte 02. This represents the result of the transfer of the CDB and Segment Descriptors.

04 Hardware Error:

- An error occurred in the Data Buffer RAM during Self-Diagnostics at power on.
- A Parity error occurred on the SCSI bus and the Host does not support Messages.
- An unrecoverable parity error occurred during transmission of the CDB, Segment Descriptor Header, or Segment Descriptor.

05 Illegal Request:

- The Host failed to send an Identify Message indicating it supports Disconnect/Reconnect.
- The Segment Descriptor Length was 1, 2, 3, or some value other than a multiple of the Segment Descriptors plus four.
- An invalid Copy Function Code.
- Reserved fields in the Segment Descriptor Header were not zero.
- Invalid specification of source or destination devices, or reserved fields in the Segment Descriptor were not zero. For example, the drive was not designated as either a source or destination, or it had been designated as both the source and destination devices.
- Block size of target device was greater than 0FFFF Hex.
- Block size of the tape drive was greater than 512 bytes.

06 Unit Attention:

- The drive has been reset or the cartridge changed.

Possible Sense Keys While The 5525ES Is The Source Or Destination Device

The Sense Key in byte 02 is always 0A when any of the conditions listed below occur. Bytes 03-06 represent the number of blocks specified in the Segment Descriptor that have not yet been copied. The 5525ES is acting as the Initiator during the execution of the Copy Command, therefore, even though it may be controlling either the source or destination device, the Abort (Sense 0B) may reflect a condition caused by the other device.

02 Not Ready:

- Drive not read or the cartridge is not in place.

05 Illegal Request:

- The drive was in the Read Mode when asked to write or in the Write Mode when asked to read.

06 Unit Attention:

- The drive has been reset or the cartridge changed.

COPY (Group 0, Op. Code 18)

07 Data Protected:

- An attempt was made to write on the cartridge with the Write Protect enabled.

0B Aborted Command:

- Either the source or destination device was unable to complete the command given to it by the Model 5525ES or it terminated the command with a status other than 00.
- The Target device de-asserted BSY- without first sending a Command Complete or Disconnect Message to the drive.
- The Target device placed the bus into an illegal phase by asserting REQ- with the C-/D, I-/O and MSG- signals in a reserved state.
- The Target did not assert REQ- the proper number of times to complete a given bus phase.
- The Target attempted to recover from an error by issuing a Restore Data Pointers message to the Model 5525ES during the data transfer phase of a Read or Write Command. The drive is not able to re-read or re-write on tape.
- The Target issued a Message Reject (Message 07) in response to an Initiator Detected Error (Message 05) or Message Parity Error (Message 09) sent by the Model 5525ES.
- The Cartridge was removed during the copy operation.

FM - Filemark bit located in the same byte as the Sense Key:

- An unexpected Filemark was read from the source tape.

4.11.2 ERASE (Group 0, Op. Code 19)

The Erase Command positions the tape to the BOT, erases to the EOT, and then rewinds the tape back to the BOT. The drive may disconnect from the Initiator while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	0	0	1	19
1	0	0	0	0	0	0	IMM	Long	0X
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	0	0	0	0	0	0	0	0	00
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-11
CDB For Erase Command

LONG - A Long Bit of one instructs the drive to erase the entire tape starting from BOT. The Long Bit must always be zero when not at BOT.

IMM - An IMM bit is valid only when drive is in SCSI-2 mode. This bit must be set to zero when the drive is in SCSI-1 mode. IMM = 0, the status is returned to host when erase operation is completed. IMM = 1, the status is returned to host as soon as erase is initiated.

NOTE: A check condition status is returned with the Sense Key set to Illegal Request if both the IMM and LINK bits are set to one.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention, 07 - Data Protected

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.3 INQUIRY (Group 0, Op. Code 12)

The Inquiry Command allows the Host to determine the configuration of the tape drive connected to the bus. The drive does not disconnect from the SCSI bus while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	0	1	0	12
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	Allocation Length								XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-12
CDB For Inquiry Command

ALLOCATION LENGTH - This field may specify up to 36 bytes (24 Hex) of data to be sent to the Host. Any value greater than 24 Hex sends 24 Hex bytes. A zero indicates no data is to be sent and is not considered an error.

Inquiry Data Block Format

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	SCSI Device Type						01
1	RMB	Device Type Qualifier							80
2	ISO Version		ECMA Version			ANSI Version			01
3	Reserved								00
4	Additional Bytes								1F
5	Wangtek Revision Level								XX
6	Density Code								XX
7	0	0	0	0	0	0	0	CI	0X
8-15	ASCII Message "WANGTEK" + 1 Space								ASCII Values
16-21	Wangtek Model Number In ASCII								ASCII Values
22-27	1 Space + "SCSI" + 1 Space								ASCII Values
28-35	Firmware Revision Level In ASCII								ASCII Values

Figure 4-13
SCSI-1 Format - Inquiry Data Block

SCSI DEVICE TYPE

The Device Type 01 represents a sequential access device.

INQUIRY (Group 0, Op. Code 12)

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	Peripheral Qual.			SCSI Device Type					01/7F H
1	RMB	Device Type Qualifier							80H
2	ISO Version		ECMA Version			ANSI Version			02H
3	0	0	0	0	Response Data Format				02H
4	Additional Bytes (N-4)								XX
5	Reserved								00H
6	Reserved								00H
7	0	0	0	Sync	Link	Res.	0	0	ASCII
8-15	Vendor I.D. "Wangtek"								ASCII
15-31	Product I.D. "320 MB"								ASCII
32-35	Product Revision Level								ASCII
36 - N	T.B.D.								ASCII

Figure 4-14
SCSI-2 Format - Inquiry Data Block

RMB

The Removable Media Bit is always set indicating that removable media is used by the device.

DEVICE TYPE QUALIFIER

The Device Type Qualifier is always set to 00H indicating that no unique device-type qualifier is used.

ISO VERSION

This field is 00, indicating that the drive does not comply with ISO version ISO DP 9316.

ECMA VERSION

This field is 00, indicating that the drive does not comply with ECMA version ECMA-111.

ANSI VERSION LEVEL

This field indicates the ANSI complience level. A value of 01 indicates complience with SCSI standard X3.131-1986. A value of 02 indicates complience with QIC-121 Rev. B.

RESPONSE DATA FORMAT

This field is valid for SCSI-2 only and has a value of 02, indicating complience with the QIC-121 SCSI-2 inquiry data format.

INQUIRY (Group 0, Op. Code 12)

ADDITIONAL BYTES

This field indicates that there are 35 (23 Hex) bytes following this byte.

WANGTEK REVISION LEVEL

This field represents the firmware level implemented in the on-board ROM. The numeric value corresponds to the alpha character of the firmware revision level, i.e., 01H = A, 02H = B, etc.

DENSITY CODE

This field represents the selected drive density. A 11 Hex = QIC-525/320 mode, 10 Hex = QIC-150 mode, 0F Hex = QIC-120 mode, 05 Hex = QIC-24 mode.

CI

The Cartridge In place bit will be set to 1 if a cartridge is installed.

ASCII MESSAGE

Bytes 8-15 are set to the ASCII values that represent the ASCII message string "WANGTEK". Bytes 16 - 21 are set to ASCII values representing the Wangtek model number (i.e. 5099ES, 5125ES or 5150ES). Bytes 22-27 are set to ASCII values representing the ASCII message string "SCSI". Bytes 28-35 are set to ASCII values representing the firmware revision level (i.e. ES41B170 AFD).

4.11.4 LOAD/UNLOAD (Group 0, Op. Code 1B)

This command has three basic functions:

- To position a newly inserted tape cartridge to the BOT.
- To ready the drive and tape just prior to removing the cartridge.
- To perform a retention pass on a new tape or one that has not been used for a prolonged period of time.

The drive may disconnect from the Initiator while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	0	1	1	1B
1	0	0	0	0	0	0	0	IMM	0X
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	0	0	0	0	0	EOT	RET	LOA	0X
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-15
CDB For Load/Unload Command

IMM - For those Hosts that do not support the disconnect feature, the Immediate bit provides a means of releasing the bus while the drive is busy repositioning the tape. 0=The status is returned to the Host when the tape has been repositioned. 1=The status is returned to the Host before the tape positioning starts.

EOT - The EOT bit determines if the Unload will position the tape to EOT or BOT when completed. 0=Tape is positioned to BOT. 1=Tape is positioned to EOT. A LOA bit of 1 with a EOT bit of 1 is invalid and will return a sense key of 05 - Illegal Request.

RET - The Retention bit determines whether a retention operation is to be performed as a part of the Load Command. It is recommended that a new tape, or one that has not been used for a prolonged period of time be retentioned before attempting to read or write the tape. 0=No Retention takes place. 1=A tape Retention is performed. A Retention bit of one and a Load bit of one will result in a check condition with a sense key of 05H, Illegal Request being returned.

LOA - The LOA bit determines whether this is a Load or Unload Command. 0=An Unload Command, the tape is positioned to the BOT or EOT depending on the state of the EOT bit. 1=A Load Command, the tape is positioned to the BOT.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention,

LOAD/UNLOAD (Group 0, Op. Code 1B)

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.5 LOCATE (Group 1, Op. Code 2B)

The **LOCATE** command causes the target to position the logical unit to the specified block address in a specified partition. Upon completion, the logical position will be before the specified location. Prior to performing the locatr operation, the target shall ensure that all buffered data, filemarke, and setmarks have been transferred to the medium.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	1	0	1	0	1	1	2B
1	0	0	0	Reserved		BT	CP	IMM	XX
2	0	0	0	0	0	0	0	0	00
3	MSB			Block Address					XX
4				Block Address					XX
5				Block Address					XX
6				Block Address				LSB	XX
7				Reserved					00
8				Partition					XX
9	0	0	0	0	0	0	Flag	Link	0X

Figure 4-16
CDB For Locate Command

BT - The Block address Type bit determines the interpretertation of the block address field. The bit must be 1indicating the block address field shall be interpreted as a physical block number.

CP - The Change Partition bit determines if a partition change is required before positioning to the requested block. 1 = Change to the partition specified in the partition field before positioning to the requested block. 0 = No partition change required, the partition field is ignored.

IMM - For those Hosts that do not support the disconnect feature, the Immediate bit provides a means of releasing the bus while the drive is busy repositioning the tape. 0 = The status is returned to the Host when the requested block has been located. 1 = The status is returned to the Host before the tape positioning starts.

BLOCK ADDRESS - The Block Address field specifies the physical block address to which the target shall position the tape to.

PARTITION - The Partition field specifies which partition to select if the CP bit is one. 0 = Data Partition. 1 = Directory partition.

NOTE: For QFA support, the CP field is one of two methods which can be used to change the active partition from the data to the directory and vice versa. The other method is to use the Device Configuration Page of the MODE SELECT command.

LOCATE (Group 1, Op. Code 2B)

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention, 07 - Data Protected, 0B - Aborted Command, 0D - Volume Overflow

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, UDE - Unrecoverable Data Error, BNL - Block Not Located, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.6 MODE SELECT (Group 0, Op. Code 15)

The Host issues the Mode Select Command to establish certain drive parameters. These parameters are sent to the drive as data. Figure 4-20 illustrates the contents of the parameter list. The parameters established by this command are not unique to the Host issuing the command. If a second Host changes the parameters at any time, these new parameters are used by all Hosts communicating with the drive. The unit will accept this command when positioned anywhere on tape. The drive does not disconnect from the SCSI bus while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	1	0	1	15
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	Parameter List Length								XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-17
CDB For Mode Select Command

PARAMETER LIST LENGTH (PLL) - This field specifies the number of bytes in the Parameter List. Only values 0, 4, or 12 (00, 04, 0C Hex) are valid. Any other value results in the command being rejected with an Illegal Request (Sense Key 5). When 0, no bytes are transferred and this is not considered an error.

Header

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	0	0	0	00
1	0	0	0	0	0	0	0	0	00
2	0	0	0	BUFM	0	0	0	0	X0
3	Block Descriptor Length								XX

Block Descriptor

0	Density Code								XX
1	MSB	Number Of Blocks							00
2	Number Of Blocks								00
3	Number Of Blocks							LSB	00
4	0	0	0	0	0	0	0	0	00
5	MSB	Block Length							XX
6	Block Length								XX
7	Block Length							LSB	XX

Figure 4-18
Mode Select Parameters

MODE SELECT (Group 0, Op. Code 15)

Mode Select Parameters

To conform with the SCSI specifications the first four bytes of the Parameter List comprise the Header, while the remaining bytes comprise the Block Descriptor.

BUFM - The BUFM enables the Buffered Mode for Write Commands. BUFM = 0 - The Buffered Mode is disabled in the Write Command. The command does not terminate and send a Good Sense until the last data block has been written onto the tape by the drive. BUFM = 1 - The Buffered Mode is enabled. The Write Command terminates and returns a Good Status as soon as the Host places the last data block in the buffer. If an error occurs while writing data after the command terminates, the drive returns a Check Condition Status on the next command received from the Host. The Host must then issue a Request Sense Command to determine the cause of the error.

BLOCK DESCRIPTOR LENGTH - This byte identifies the length of the block descripter. Valid values are 0 or 8.

DENSITY CODE - This byte identifies the bit density and format of the media used by the drive. 05 = QIC-24 tape format, 0F = QIC-120 tape format, 10 = QIC-150 tape format, 11 = QIC-525/320 tape format. 00 = Default (auto select) mode is retained to maintain compatibility with earlier versions of firmware.

NUMBER OF BLOCKS - This field must be zero. Therefore all blocks on the tape are formatted with the Block Length and Density Code as specified in the Block Descriptor.

BLOCK LENGTH - This field specifies the block length and mode. If this field is 00, the drive operates in variable length block mode. If this field is non-zero, the drive operates in fixed length block mode and the length of each block is equal to the value of this field. For QIC-24, QIC-120 and QIC-150 modes, this field must be set to a value of 512 (200 Hex) bytes.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.7 MODE SENSE (Group 0, Op. Code 1A)

The Mode Sense Command provides the Host with information pertaining to the configuration of the drive. The drive does not disconnect from the Initiator while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	0	1	0	1A
1	0	0	0	PF	DBD	Reserved			0
2	PC		PAGE CODE						0
3	0	0	0	0	0	0	0	0	0
4	PARAMETER LIST LENGTH								XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-19
CDB For Mode Sense Command

PLL - PARAMETER LIST LENGTH - This field specifies the number of bytes requested from the Parameter List. A maximum of 12 (0CHex) may be returned. When 0, no bytes are transferred and this is not considered an error.

PF - PAGE FORMAT - A PF applies to SCSI-2 mode only. A PF bit of zero will result in maximum transfer of 12 bytes of mode sense parameters (header and block descriptor). A PF bit of one will enable transfer of parameter pages as specified in PC and PAGE CODE fields.

DBD - DISABLE BLOCK DESCRIPTOR - A DBD bit applies to SCSI-2 mode only. A DBD bit of zero will enable transfer of block descriptor. A DBD bit of zero will disable transfer of block descriptor parameter.

PC - PAGE CONTROL - PC field is valid only when PF = 1. It must be set to zero when PF = 0. PCTL field as described below defines type of values to be returned for Parameter Page.

PC BIT 7	PC BIT 6	Type of Parameter Values to be Returned
0	0	Current Values
0	1	Changeable Values
1	0	Default Values
1	1	Saved Values. This is not supported by the drive. If PCTL = 1 received, the command will result in an Illegal Request (Sense Key 5)

MODE SENSE (Group 0, Op. Code 1A)

PAGE CODE - The PAGE CODE field is valid only when PF = 1. It must be set to zero if PF = 0. The PAGE CODE field specifies which Parameter Page(s) to be returned. Any PAGE CODE value other than described below will result in an Illegal Request.

PAGE CODE VALUES	DESCRIPTION
01	Page 01, Error Recovery and Reporting Parameter Page will be returned
02	Page 02, Disconnect/Reconnect control Parameter Page will be returned
10H	Page 10H, Device Configuration Parameter Page will be returned
11H	Page 11, Medium Partition Page will be returned
3FH	Pages 01, 02, 10H, 11H will be returned

MODE SENSE (Group 0, Op. Code 1A)

Mode Sense Parameter List

To conform with the SCSI specifications the first four bytes of the Parameter List comprise the Header, while the remaining bytes comprise the Block Descriptor.

Header

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	Sense Data Length								0B
1	0	0	0	0	0	0	0	0	00
2	WRP	0	0	BUFM	0	0	0	0	X0
3	Block Descriptor Length								08

Block Descriptor

00	Density Code								XX
01	MSB	Number of Blocks							00
02	Number of Blocks								00
03	Number of Blocks							LSB	00
04	0	0	0	0	0	0	0	0	00
05	MSB	Block Length							XX
06	Block Length								XX
07	Block Length							LSB	XX

Figure 4-20
Mode Sense Parameters

SENSE DATA LENGTH - The Sense Data Length of 11 (0B Hex) includes the four byte Header and eight byte Block Descriptor.

WRP - When this bit is one, the cartridge installed in the drive is Write Protected.

BUFM - The BUFM enables the Buffered Mode for Write Commands. BUFM = 0 - The Buffered Mode is disabled in the Write Command. The command does not terminate and send a Good Sense until the last data block has been written onto the tape by the drive. BUFM = 1 - The Buffered Mode is enabled. The Write Command terminates and returns a Good Status as soon as the Host places the last data block in the buffer. If an error occurs while writing data after the command terminates, the drive returns a Check Condition Status on the next command received from the Host. The Host must then issue a Request Sense Command to determine the cause of the error. While writing, the drive will drop out of the Buffered Mode if: a hardware error is detected, a media error occurs, or soft EOM is reached. However a Mode Select command with BUFM=1 can be sent at this time. A Rewind issued at this point will cause the drive to rewind to BOT and return to Buffered Mode.

BLOCK DESCRIPTOR LENGTH - Specifies the number of bytes in the Block Descriptor. This value is 08.

MODE SENSE (Group 0, Op. Code 1A)

DENSITY CODE - This byte identifies the bit density and format of the media used by the drive. 05 = QIC-24 tape format, 0F = QIC-120 tape format, 10 = QIC-150 tape format, 11 = QIC-525/320 tape format. The value returned by this field is determined by the last Mode Select Command, or is the default value based on cartridge type following a power-up reset. When a read command is issued, the drive will automatically determine the format recorded on the tape, then switch to the proper mode and read or append data.

NUMBER OF BLOCKS - This field must be zero indicating that all blocks on the tape are to be formatted with the Block Length and Density Code as specified in the Block Descriptor.

BLOCK LENGTH - This field indicates the selected block length and mode. If this field is 00, the drive is in variable length block mode. If this field is non-zero, the drive is in fixed length block mode and the block length is equal to the value of this field.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.8 PARTITION (Group 0, Op. Code 0D)

The Partition command allows the initiator to define whether the tape is to be partitioned for Quick File Access (QFA, also known as FlexFormat™) mode or non QFA mode of operation. It mainly allows the initiator to select either the data or directory partition to perform all other tape commands in QFA mode. It is also used to report the current status of a partition. This command will be honored in both SCSI-1 and SCSI-2 modes. No data is transfered for this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	1	0	1	1D
1	0	0	0	0	SEL	Partition Select			0X
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	0	0	0	0	0	0	0	0	0X
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-21
CDB For Partition Command

SEL - The select bit deturmines if status is to be reported for the selected partition or whether the partition is to be changed. When SEL=0, the selected partition will be reported during the "Data In" phase in the format shown below. When SEL=1, the partition specified by PARTITION SELECT field is selected.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	Partition Select			0X

Figure 4-22
Partition Status Format

PARTITION SELECT - This field specifies whoch partition is to be selected when SEL=1. This field is ignored when SEL=0.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.9 PREVENT/ALLOW MEDIA REMOVAL (Group 0, Op Code 1E)

This command simply lights or extinguishes the warning light, indicating that it is not safe or safe to remove the tape cartridge. This command is canceled by a bus device reset message or a hard reset. The drive does not disconnect from the Initiator while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	1	1	0	1E
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	0	0	0	0	0	0	0	PRE	0X
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-23
CDB For Prevent/Allow Media Removal Command

PRE - 0=The "Not Safe To Remove" LED is turned off when an Unload Command is performed or the tape is positioned at the BOT. 1=The "Not Safe To Remove" LED is always lit. Initially The LED is turned off when the power-on diagnostics are completed successfully. The LED remains on when a Load/Unload Command is issued following a Prevent Media Removal Command.

Possible Status Codes

00 - Good, 02 - Check Condition, 08 Busy, an auto-load operation or another command is in progress, 18 Reservation Conflict

Possible Sense Keys

00 - No Sense, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge not in place, BOM - Beginning-Of-Media, WRP - Cartridge Write Protected, BPE - SCSI Bus Parity Error, EOM - End-Of-Media.

4.11.10 READ (Group 0, Op. Code 08)

The Read Command transfers a specified number of data blocks from the tape drive to the Initiator. The amount of data transferred is a multiple of 512 byte blocks. The command terminates when one of the following conditions occur:

- The Number of Blocks specified in the CDB has been satisfied.
- A Filemark has been read.
- Physical End-Of-Media has been reached.
- An recoverable read error has occurred.

When the command terminates for a reason other than satisfying the NOB in the CDB, the residue (number of requested blocks not yet transferred to the Host) can be obtained from the Sense Information Bytes sent by a Request Sense Command. The drive may disconnect from the SCSI bus while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	1	0	0	0	08
1	0	0	0	0	0	0	SILI	FBM	0X
2	MSB				Number Of Blocks				XX
3					Number Of Blocks				XX
4					Number Of Blocks			LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-24
CDB For Read Command

FIXED BLOCK MODE - A Fixed Block Mode (FBM) is associated with number of blocks field. If drive is in variable block mode and FBM is set to one or drive is in fixed block mode and FMB is set to zero will result in an Illegal Request (Sense Key 5). Also a FBM other than 1 results in an Illegal Request for QIC-24, QIC-120 and QIC-150 modes.

SUPPRESS ILLEGAL LENGTH INDICATOR - Suppress Illegal Length Indicator (SILI) applies only to variable block length mode. If SILI-0 and actual block length is different from the specified length (number of block field) than Check Condition status is returned. The ILI and AVG bits are set to one in sense data. The information bytes in sense data contains the difference of number of blocks minus actual block length. If SILI = 1 and actual block length is different from the specified length (number of blocks) then Check Condition status is not returned. The combination of the SILI bit and the FBM bit both set to one causes Illegal Request (Sense Key 5). **Also, the SILI bit must be zero when SCSI-1 mode is selected.**

NUMBER OF BLOCKS - If FBM = 1 then it specifies the number of blocks to be read from the tape and transferred to the Initiator. When this value is zero no data is transferred and the current position is not changed. This is not considered an error. If FBM = 0 then it specifies length of block to be transferred and only one block is transferred.

READ (Group 0, Op. Code 08)

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 03 - Media Error, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention, 08 - Blank Check, 0B - Aborted Command

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, UDE - Unrecoverable Data Error, FIL, FM - Filemark Detected, NDT - No Data Detected, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

Data Error Counter

For each block requiring multiple passes to be read correctly, this counter is incremented only once. It is cleared when any other command is issued.

Data Underrun Counter

This counter is incremented each time the tape must be stopped to allow the Host to empty the Data Buffer. It is cleared when any other command is issued.

4.11.11 READ BLOCK LIMITS (Group 0, Op. Code 05)

This command returns the maximum and minimum block length limits of the tape drive. The drive supports a 512 byte block in QIC-24, QIC-120 and QIC-150 mode only; the drive does not disconnect from the SCSI bus while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	1	0	1	05
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	0	0	0	0	0	0	0	0	00
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-25
CDB for Read Block Limits Command

The data is returned to the Host in the format. For QIC-24, QIC-120 and QIC-150 modes both the maximum and minimum value is 512 bytes (02 00 Hex), indicating that the drive supports a 512 byte block. For QIC-320 format minimum block length is 1 byte and maximum block length is 32768 (8000 Hex).

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	0	0	0	00
1	MSB			Maximum Block Length					XX
2				Maximum Block Length					XX
3				Maximum Block Length				LSB	XX
4	MS B			Maximum Block Length					XX
5				Maximum Block Length				LSB	XX

Figure 4-26
Read Block Limits Data Format

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.12 READ BUFFER (Group 1, Op. Code 3C)

The Read Buffer Command is intended to be used in conjunction with the Write Buffer Command as a Diagnostic tool. This command tests the SCSI Bus and the drive 256K Data Buffer without accessing the tape drive, therefore, the data on the tape is not altered.

Included in the data transferred to the Host is a four byte Header. This Header is created by the drive. The location of the Header is determined by the Mode bits. Upon termination of the command, the location occupied by the Header is restored to its original value. The Header informs the Host of the size of the Data Buffer, minus the four byte Header.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	1	1	1	0	1	1	3C
1	0	0	0	0	0	Mode			0X
2	Buffer I.D.								XX
3	MSB	Buffer Offset							XX
4	Buffer Offset								XX
5	Buffer Offset							LSB	XX
6	MSB	Transfer Length							XX
7	Transfer Length								XX
8	Transfer Length							LSB	XX
9	0	0	0	0	0	0	Flag	Link	0X

Figure 4-27
CDB For Read Buffer Command

Header

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	Reserved								XX
1	MSB	Available Length							XX
2	Available Length								XX
3	Available Length							LSB	XX

Figure 4-28
Read Buffer Header

MODE - The Mode Bits determine whether the four byte header is to be written in the last bytes of the buffer, or the four bytes just preceding the area designated by the Buffer Offset. Mode = 0Hex will request the header first followed by the data. Mode = 1Hex requests the data first followed by the header. Mode = 2Hex requests the data only. Mode = 3-7Hex is reserved.

READ BUFFER (Group 1, Op. Code 3C)

Buffer I.D. - The 256K data buffer is divided into 256 1K segments. The starting address of each segment is specified by the Buffer I.D. To perform a read buffer at the first segment (or beginning) of the buffer, a Buffer I.D. of 00Hex must be specified. To perform a read buffer at the 128 segment, a Buffer I.D. of 7FHex must be specified.

BUFFER OFFSET - This field specifies where the first data byte received from the Host is to be placed in the Buffer. When the mode bit is zero, this field must also be zero.

TRANSFER LENGTH - This field specifies the number of bytes to be written into the Buffer by the Host. The value includes the four byte Header.

Possible Status Codes

00 - Good Status, 01 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 04 - Hardware Error, 05 - Illegal Request

4.11.13 READ POSITION (Group 1, Op. Code 34)

The READ POSITION command reports the current position of the logical unit and any data blocks in the buffer. No tape movement shall occur as a result of the command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	1	1	1	1	0	0	34
1	0	0	0	0	0	0	0	BT	0X
2	Reserved								00
3	Reserved								00
4	Reserved								00
5	Reserved								00
6	Reserved								00
7	Reserved								00
8	Reserved								00
9	0	0	0	0	0	0	Flag	Link	0X

Figure 4-29
CDB For Read Position Command

BT - The Block address Type bit determines the reporting method of the block location field. The bit must be 1, requesting the target to rrturn its current first block location and last block location as a device-specific value.

NOTE: For tape formats which do not support logical block address a physical block address is returned for the first block location and the last block location fields and a value of zero is returned for the number of bytes field.

BOP - The Beginning Of Partition bit of one indicates that the logical unit is at the beginning-of-partition in the current partition.

EOP - The End Of Partition bit of one indicates that the logical unit is at the end-of-partition in the current partition.

BPU - A Block Position Unknown bit of one indicates that the first and last block locations are not known or cannot be obtained.

READ POSITION (Group 1, Op. Code 34)

	Data Bits							
Byte	7	6	5	4	3	2	1	0
0	BOP	EOP	Reserved			BPU	Reserved	
1	Partition Number							
2	Reserved							
3	Reserved							
4	MSB	First Block Location						
5	First Block Location							
6	First Block Location							
7	First Block Location							LSB
8	MSB	Last Block Location						
9	Last Block Location							
10	Last Block Location							
11	Last Block Location							LSB
12	Reserved							
13	MSB	Number Of Blocks In Buffer						
14	Number Of Blocks In Buffer							
15	Number Of Blocks In Buffer							LSB
16	MSB	Number Of Bytes In Buffer						
17	Number Of Bytes In Buffer							
18	Number Of Bytes In Buffer							
19	Number Of Bytes In Buffer							LSB

Figure 4-30
Read Position Data Format

4.11.14 RECEIVE DIAGNOSTIC RESULTS (Group 0, Op. Code 1C)

The Receive Diagnostic Results command requests analysis data be sent to the initiator after completion of a Send Diagnostic command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	1	0	0	1C
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	MSB			Allocation Length					XX
4				Allocation Length				LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-31
CDB For Receive Diagnostic Results Command

Allocation Length - The Allocation Length specifies the number of bytes that the initiator has allocated for returned diagnostic data. An allocation length of zero indicates that no diagnostic data will be transfered. Any other value indicates the maximum number of bytes that shall be transfered. The drive terminates the Data In phase when allocation length bytes have been transfered or when all available diagnostic data have been transferred to the initiator.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

RECEIVE DIAGNOSTIC RESULTS (Group 0, Op. Code 1C)

Diagnostic Data Format - T.B.D.

4.11.15 RECOVER BUFFERED DATA (Group 0, Op. Code 14)

The primary function of this command is to determine how much data is trapped in the Data Buffer and transfer it to the Host. This data was unable to be written to tape due to the Volume Overflow or other type of exception. The data is transferred to the Host in the same order as it would have been written to tape. The drive does not disconnect from the SCSI bus while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	1	0	0	14
1	0	0	0	0	0	0	0	FBM	0X
2	MSB			Number Of Blocks					XX
3				Number Of Blocks					XX
4				Number Of Blocks				LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-32
CDB For Recover Buffered Data Command

FIXED BLOCK MODE - A Fixed Block Mode (FBM) bit other than 1 results in an Illegal Request (Sense Key 5).

NUMBER OF BLOCKS (NOB) - This field specifies the number of data blocks to be transferred from the Data Buffer to the Host. If this value is equal to the size of the Data Buffer (80 Hex) and the buffer is not filled to capacity, the command terminates with a Check Condition (Status 02). The EOM bit in byte 02 of the Sense Data is set and the Sense Information bytes represent the number of requested bytes not transferred.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

If more data is requested than is in the Data Buffer, only the EOM bit in byte 2 of the Sense Data block is set. The EOM bit in byte 8 remains reset unless the tape is positioned at the physical EOT.

4.11.16 RELEASE UNIT (Group 0, Op. Code 17)

The Release Unit Command releases the tape drive that has been reserved for the Initiator issuing the command or the Third Party Initiator named in the CDB. In either case, the drive must have been reserved by the Initiator issuing the Release Command. An attempt to release a unit not currently reserved is not considered an error. The drive does not disconnect from the Initiator while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	1	1	1	17
1	0	0	0	3PEN	3PID			0	XX
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-33
CDB For Release Unit Command

3PEN - Third Party Option is disabled. This drive is released from the Initiator issuing the command. 0 = Third Party Option is disabled. The drive is reserved for the Initiator issuing the command. 1 = Third Party Option is enabled. The drive is reserved for the Initiator specified in the 3PID field.

3PID - Identifies the SCSI device to which the drive is being reserved. Valid only when 3PEN = 1.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.17 REQUEST BLOCK ADDRESS (Group 0, Op. Code 02)

The Request Block Address command causes the drive to transfer the current tape block address to the initiator. The current tape block address is the next block to be read or written. This command is part of the Quick File Access (QFA, also known as FlexFormat™) operation. This command will be honered in both SCSI-1 and SCSI-2 modes. No data is transfered.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	0	1	0	02
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	Allocation Length								XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-34
CDB for Request Block Address Command

ALLOCATION LENGTH - This field specifies the number of bytes to be transfered to the initiator in the "Data In" phase. The value must be in the range of 0-3Hex bytes. An allocation length of zero specifies the default data transfer length.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.18 REQUEST SENSE (Group 0, Op. Code 03)

Information pertinent to the completion of a command is obtained by the Request Sense Command. Although a Request Sense Command may be issued at any time, it is typically issued immediately following a command that has resulted in a Check Condition (02 Status Message). Sense Data remains valid until reset by a subsequent command issued by the same Initiator selecting the same LUN as the one that resulted in the Check Condition. In the case of the single initiator option, the drive will assume that the Request Sense command is from the same initiator. A Request Sense Command also resets the Sense Data (byte 2 bits 5-7, byte 8 bits 0-2, byte 9 bits 2,5 and Sense information bytes 3-6). All other sense information is preserved or in the case of Data Error and Underrun Counters, updates may occur.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	0	1	1	03
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	Number of Requested Sense Bytes								XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-35
CDB for Request Sense Command

The Request Sense Command returns a Check Condition Status only upon a catastrophic failure in reporting the sense data. For example, a one bit in a reserved field of the CDB or repeated bus parity errors. Under these conditions it is likely that the sense data returned is not valid. The drive does not disconnect from the SCSI bus while executing this command.

Number Of Requested Sense Bytes (NORSB) - Specifies the number of sense bytes requested by the Host. A value of 00 transmits 4 bytes, while any other value up to a maximum of 63 (3f Hex) sends the number of bytes requested. The command terminates when either the number of bytes requested or all available bytes are transferred, whichever is less.

When the Request Sense Command is in response to a Check Condition Status caused by a Copy Command, the NORSB must be large enough to accommodate the sense data from all devices involved in the copy operation. Refer to the Copy Command description for details.

The following Figure represents the Sense Byte Format when the Request Sense Command is in response to all commands other than a Copy Command. Refer to Figures 4-9 and 4-10 for the Sense Byte Format for the Copy Command.

REQUEST SENSE (Group 0, Op. Code 03)

	Data Bits							
Byte	7	6	5	4	3	2	1	0
0	AVF	Error Code (70H OR 71H)						
1	0	0	0	0	0	0	0	0
2	FM	EOM	ILI	0	Sense Key			
3	MSB	Sense Information						
4	Sense Information							
5	Sense Information							
6	Sense Information							LSB
7	Additional Sense Length (56 Bytes)							
8	0	CNI	0	WRP	PEOM	UDE	BNL	FIL
9	0	0	NDT	0	BOM	BPE	0	0
10	MSB	Data Error Counter						
11	Data Error Couner							LSB
12	MSB	Data Underrun Counter						
13	Data Underrun Counter							LSB
14	Track Number							
15	Cartridge Type							
16	MSB	Filemark Count						
17	Filemark Count							LSB
18	MSB	Physical Block Number						
19	Physical Block Number							
20	Physical Block Number							LSB
21	Additional Sense Code							
22	Additional Sense Code Qualifier							
23	Tape Module Error Code							
24	Buffer Manager Error Code							
25	SCSI Module Error Code							
26-35	Least Recent Last 10 SCSI Commands Most Recent							
46-63	Reserved							

Figure 4-36
SCSI-1 Extended Sense Data Format
(for all sense keys except 0A-Copy Aborted)

REQUEST SENSE (Group 0, Op. Code 03).

	Data Bits							
Byte	7	6	5	4	3	2	1	0
0	1	Error Code (70H or 71H)						
1	Segment Number							
2	FM	EOM	ILI	Sense Key = 0A				
3	MSB	Residue						
4	Residue							
5	Residue							
6	Residue							LSB
7	Additional Sense Length							
8	Starting Byte Number of Sense Data For Source (10)							
9	Starting Byte Number of Sense Data For Target (N)							
10 - N	Sense Data Received From Source Device							
N - P	Sense Data Received From Target Device							

Figure 4-37
SCSI-1Extended Sense Data Format
(for sense key 0A-Copy Aborted)

AVF - Address Valid Flag. When the AVF is one, the Sense Information (bytes 3-6) contain valid information

FM - When the Filemark bit is set to one, a Filemark has been encountered during a read operation.

EOM - The End-Of-Media bit as a one indicates that the tape has reached the Logical End-Of-Media.

ILI - The Illegal Length Indicator as a one indicates that the Mode Select or Copy Command has specified a block length other than 512 bytes.

SENSE KEY - Defines the type of failure associated with the current Check Condition (02 Status). The Sense Keys are defined in Table 4-6.

SENSE INFORMATION - When the AVF bit is one, the Sense Information bytes represent the difference between the number of blocks requested by the command and the actual number of blocks transferred (the residue).

ADDITIONAL SENSE LENGTH - The Additional Sense Length specifies the number of bytes to follow this byte. For all commands except the Copy Command, this field is 38 Hex. Refer to the Copy Command description Figures 4-8 and 4-9 for an explanation of the data returned by the Copy Command.

CNI - Cartridge Not In Place. This bit is not reset by the Request Sense Command.

WRP - Cartridge Write Protected. This bit is not reset by the Request Sense Command.

PEOM - Physical End-Of-Media. This bit is not reset by the Request Sense Command.

REQUEST SENSE (Group 0, Op. Code 03)

UDE - Unrecoverable Data Error.

BNL - Block Not Located.

FIL - Filemark Detected (Same as FM).

NDT - No Data Detected.

BOM - Physical Beginning-Of-Media. This bit is not reset by the Request Sense Command.

BPE - SCSI Bus Parity Error.

DATA ERROR COUNTER - For write operations, this is the number of blocks re-written since the start of the current write operation. For read operations, this is the number of blocks that required retries since BOT. For 525 MB density read operation, this is number of blocks corrected using ECC algorithm.

DATA UNDERRUN COUNTER - For write operations, this is the number of times that the underrun logic was forced to rewrite a data block in an underrun condition. (An underrun can occur without tape reposition.) For read operations, this is the number of times a reposition cycle was required due to Host underrun.

TRACK NUMBER - The track number (0-25) that the read/write head is currently positioned to.

CARTRIDGE TYPE - T.B.D.

FILEMARK COUNT - This is the number of filemarks encountered since BOM. This counter is not reset by a Request Sense command, but is reset when tape is positioned back to BOM.

PHYSICAL BLOCK NUMBER -The number of the next physical block to be read/written by the host.

REQUEST SENSE (Group 0, Op. Code 03)

	Data Bits							
Byte	7	6	5	4	3	2	1	0
0	AVF	Error Code (70H OR 71H)						
1	0	0	0	0	0	0	0	0
2	FM	EOM	ILI	0	Sense Key			
3	MSB	Sense Information						
4	Sense Information							
5	Sense Information							
6	Sense Information							LSB
7	Additional Sense Length (56 Bytes)							
8	MSB	Command Specific Information						
9	Command Specific Information							
10	Command Specific Information							
11	Command Specific Information							LSB
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Field Replaceable Unit Code							
15	SKSV	C/D	0	0	BPV	Bit Pointer		
16	MSB	Field Pointer						
17	Field Pointer							LSB
18	0	CNI	0	WRP	PEOM	UDE	BNL	FIL
19	0	0	NDT	0	BOM	BPE	0	0
20	MSB	Data Error Counter						
21	Data Error Couner							LSB
22	MSB	Data Underrun Counter						
23	Data Underrun Counter							LSB
24	Track Number							
25	Cartridge Type							
26	MSB	Filemark Count						
27	Filemark Count							LSB
28	MSB	Physical Block Number						
29	Physical Block Number							
30	Physical Block Number							LSB
31	Tape Module Error Code							
32	Buffer Manager Error Code							
33	Scsi Module Error Code							
34 - 43	Least Recent	Last 10 SCSI Commands						Most Recent
44 - 63	Reserved							

Figure 4-38
SCSI-2 Extended Sense Data Format
(for all sense keys except 0A-Copy Aborted)

REQUEST SENSE (Group 0, Op. Code 03)

	Data Bits							
Byte	7	6	5	4	3	2	1	0
0	1	Error Code (70H or 71H)						
1	Segment Number							
2	FM	EOM	ILI	Sense Key = 0A				
3	MSB	Residue						
4	Residue							
5	Residue							
6	Residue							LSB
7	Additional Sense Length							
8	Starting Byte Number of Sense Data For Source (18)							
9	Starting Byte Number of Sense Data For Target (N)							
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Field Replaceable Unit Code							
15	0	0	0	0	0	Bit Pointer		
16	MSB	Field Pointer						
17	Field Pointer							LSB
18 - N	Sense Data Received From Source Device							
N - P	Sense Data Received From Target Device							

Figure 4-39
SCSI-2 Extended Sense Data Format
(for sense key 0A-Copy Aborted)

Command Specific Information - This field contains information that depends on the command which was executed last. Further meaning for this field is defined within the command description.

Field Replaceable Unit -The value of this field will be zero, indicating that no specific mechanism or unit has been identified to have failed or that the data is not available.

SKSV - The Sense Key Specific Valid bit of one indicates that the Sense Key Specific fields (bytes 15, 16 & 17) are valid. If the Sense Key field is set to 5H-Illegal Request and the SKSV bit is set to one, the sense key specific fields are as defined in Figure 4-39. If the Sense Key field is set to: 1H-Recovered Error, 4H-Hardware Error, or 3H-Media Error and the SKSV bit is one, the sense key specific fields are as defined in Figure 4-40.

	Data Bits							
Byte	7	6	5	4	3	2	1	0
15	SKSV	Reserved						
16	MSB	Actual Retry Count						
17	Actual Retry Count							LSB

Figure 4-40
SCSI-2 Sense Key Specific Fields

REQUEST SENSE (Group 0, Op. Code 03)

Table 4-6
Sense Keys

Sense Key		Meaning
0	No Sense	No Sense. Command Status Byte of 00, indicates that the command terminated normally, 08 indicates that the drive is busy, or 02 indicates a Check Condition caused by a Filemark (FM) or End-of-Media (EOM).
1	Recovered Data	Indicates that the last command completed successfully with some recovery action performed by the target. Details may be determinable by examining the additional sense bytes and the information bytes. When multiple recovered errors occur during one command, the choice of which error to report (first, last, most severe, etc.) is device specific.
2	Not Ready	The tape drive cannot be accessed. Operator intervention may be required.
3	Media Error	An unrecoverable error occurred that was either caused by a flaw in the media, or an error in the recorded data.
4	Hardware Error	The drive detected an unrecoverable hardware failure during the performance of a command or internal diagnostics.
5	Illegal Request	There was an illegal parameter in the Command Description block or associated additional parameters or an inappropriate sequence of commands was issued
6	Unit Attention	The tape cartridge may have been changed or the drive reset since the last command was issued. This error is reported by the first command following this condition and the function of this condition is not performed. The Unit Attention is reported to all Initiators that subsequently issue commands to the drive.
7	Data Protect	A write or erase operation was attempted on a device with the cartridge in the Safe statae.
8	Blank Check	The drive encountered the End-of-Recorded Media. This is not the same as the physical EOM.
9	Vendor Unique	This sense key is available for reporting vendor unique conditions.
A	Copy Aborted	A Copy Command was aborted due to an error on the source or destination device.
B	Aborted Command	The drive aborted the command either at the request of the Initiator or due to a hardware failure, such as the removal of a cartridge during a read or write operation. The Initiator may recover by trying the command again.
C	Equal	Not Used
D	Volume Overflow	The physical End-of-Media has been reached. The data remaining in the buffer may be read with a Recover Buffer Data Command.
E	Misconpare	Indicates that the sourse data did not match the data read from the medium.
F	Reserved	Reserved

C/D - A Command/Data bit of one indicates that the illegal parameter is in the command descriptor block. A C/D = 0 indicates that the illegal parameter is in the data oarameters sent by the initiator during the DATA OUT phase.

REQUEST SENSE (Group 0, Op. Code 03)

BPV - A Bit Pointer Valid bit of zero indicates that the value in the bit pointer field is not valid. A BPV = 1 indicates that the bit pointer field specifies which bit of the byte designated by the field pointer field is in error. When a multiple-bit field is in error, the bit pointer field shall point to the most-significant bit of the field.

Bit Pointer - The Bit Pointer field indicates which bit of the byte designated by the field pointer field is in error.

Field Pointer - The Field Pointer field indicates which byte of the command descriptor block or of the parameter data was in error. Bytes are numbered starting from zero. When a multiple-byte field is in error, the pointer shall point to the most-significant byte of the field.

The **Additional Sense Code & Qualifier** specifies detailed information related to the additional sense code. If the error or exception condition is reportable by the device the value returned will be as specified. If the condition is not reportable by the device, a value of 00h is used.

Additional Sense Code (ASC) and ASC Qualifier Assignments

Bytes 21	Bytes 22	Description
00	00	No additional sense information
00	01	Filemark detected
00	02	End-of-Medium detected
00	03	Setmark detected
00	04	Beginning of Medium or beginning of partition detected
00	05	End of Data detected
03	00	Peripheral device write fault
03	01	No Write current
03	02	Excessive write errors
04	00	Logical unit not ready, cause not reportable
04	01	Logical unit not ready, manual intervention required
04	02	Logical unit not ready, initializing command required
04	03	Logical unit is in process of becoming ready
04	04	Logical unit not ready, format in progress
0C	00	Write error - Sense Key says whether recovered
11	00	Unrecovered read error
11	01	Read retries exhausted
11	02	Error too long to correct
11	03	Multiple read errors
11	04	Physical End of Medium encountered
11	0A	Miscorrected error
14	00	Recorded entity not found
14	01	Record not found
14	02	Filemark not found
14	03	End of Data not found
14	04	Block sequencer error
15	02	Positioning error detected by read of medium
17	00	Recovered read data with no error correction applied
17	01	Recovered read data with retries
17	02	Recovered read data with positive head offset

REQUEST SENSE (Group 0, Op. Code 03)

Bytes 21	Bytes 22	Description
17	03	Recovered read data with negative head offset
18	00	Recovered read data with error correction applied
1A	00	Parameter List Length Error
1B	00	Synchronous data transfer error
20	00	Invalid data transfer error
21	00	Logical block address out of range
24	00	Invalid field in CDB (check field pointer)
25	00	Unsupported LUN
26	00	Invalid field in parameter list (check field pointer)
27	00	Write protected
28	00	Not ready to ready transition (Medium may have changed)
29	00	Power on, reset, or BUS DEVICE RESET occurred
2A	01	MODE SELECT parameters changed by another initiator
2B	00	COPY cannot execute since host cannot disconnect
2C	00	Command sequence error
2D	00	Overwrite error on update in place
30	00	Incompatible medium installed
30	01	Cannot read medium - unknown format
30	02	Cannot read medium - incompatible format
31	00	Medium format corrupted
33	00	Tape length error
37	00	Rounded Parameter
39	00	Saving parameters not supported
3A	00	Medium not present
3B	00	Sequential positioning error
3B	01	Tape position error at Beginning of Medium
3B	02	Tape position error at End of Medium
3B	08	Reposition error
43	00	Message error
44	00	Internal target failure
45	00	Select / Reselect failure
47	00	SCSI parity error
48	00	Initiator detected error message received
49	00	Invalid message error
4A	00	Command phase error - used when nothing specific to report
4B	00	Data phase error - used when nothing specific to report
50	00	Write append error
50	01	Write append position error
51	00	Erase fault
52	00	Cartridge fault
53	00	Media load / eject failed
53	01	Unload tape failure

REQUEST SENSE (Group 0, Op. Code 03)

TAPE MODULE ERROR CODE -

Code	Description
00	No errors
01	No Cartridge
02	Cartridge Write Protected
03	Drive not ready
04	Drive (microprocessor) Error
05	Wrong type of cartridge
06	Drive's command register error
07	Cannot find tape type
08	Drive (microprocessor) busy
09	Reserved
0A	Drive (microprocessor) does not respond
0B-2F	Reserved
30	Maximum number of write retry exceeded (16 tries)
31	Illegal density code
32	Unable to find last written block for write append (after ramp up)
33	Not used
34	No read interrupts (time out)
35-4F	Reserved
50	Requested block not found
51	Requested block not found because CRC error occured where block should be
52	Requested block number exceeded the last block recorded on last track
53-84	Reserved
82	Motor stalled or moves very slow
83	Tape moved over 1000 ft. without seeing BOT or EOT. Possibly no cartridge in but cartridge slide in out position.
84	Tape broken or ran off reel
85	Tape does not maintain correct speed
86	Drive (microprocessor) RAM error
87	Cartridge write protected
88	No tape edge found
89	Formatter and Drive Microprocessor communication error
8A	Cartridge removed while tape was moving
8B	Failed to determine tape type correctly
8C	Illegal command received while busy
8D	Tape edge detection failure
8E	Cannot find reference burst correctly
8F	Burst too wide or too narrow
90	ECC chip failure after reset
91	ECC failure - DMA Write
92	ECC failure - DMA Read
93	ECC RAM error
94	ECC Failure - Encode operation
95	ECC Failure - Incorrect parity

REQUEST SENSE (Group 0, Op. Code 03)

BUFFER MANAGER ERROR CODE - T.B.D.

SCSI MODULE ERROR CODE - T.B.D.

LAST 10 SCSI COMMANDS - T.B.D.

4.11.19 RESERVE UNIT (Group 0, Op. Code 16)

The Reserve Unit Command reserves the tape drive for the exclusive use of the Initiator issuing the command or by an Initiator specified in the CDB as a third party. There is only one tape drive connected to the bus, reserving the drive also reserves itself. The drive remains reserved for that Initiator until released by a Release Unit Command. If an Initiator other than the one for which the drive is reserved issues a command to the drive, the drive returns a Reservation Conflict Status and disconnects from the requesting Initiator. The drive does accept Request Sense Commands, Inquiry Commands, and messages from Initiators other than the one for which it reserved. A Bus Device Reset (Message 0C) resets the drive and releases the reservation. When the Initiator for which this drive is reserved sends an Abort (Message 06), any read or write operation terminates, but does not release the reservation. The drive does not disconnect from the Initiator for which it is reserved while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	1	1	0	16
1	0	0	0	3PEN	3PID			0	XX
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-41
CDB For Reserve Unit Command

3PEN - Selects the Third Party Option. This option is intended for multiple-host systems in which the Copy Command is used. 0 = Third Party Option is disabled. The drive is reserved for the Initiator issuing the command. 1 = Third Party Option is enabled. The drive is released from the Initiator specified in the 3PID field.

3PID - Identifies the SCSI device to which the drive is being reserved. Valid only when 3PEN = 1.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.20 REWIND (Group 0, Op Code 01)

The Rewind Command causes the drive to rewind the tape to the physical Beginning-Of-Tape (BOT) or load point. The drive may disconnect from the SCSI bus during execution of this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	0	0	1	01
1	0	0	0	0	0	0	0	IMM	0X
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-42
CDB for Rewind Command

IMM - IMMEDIATE. For IMM = 0, the status is returned to the Host when the rewind operation is completed. For IMM = 1, the status is returned to the Host as soon as the rewind is initiated.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

For Buffered Mode 1h (buffered mode of the MODE SENSE command) the target shall discard any buffered data after a REWIND command is validated if the previous command was terminated with a CHECK CONDITION status.

4.11.21 SEEK BLOCK (Group 0, Op. Code 0C)

The Seek Block command causes the drive to position the tape to read the specified block in the current partition. This command is part of the Quick File Access (QFA, also known as FlexFormat™) operation. This command will be honered in both SCSI-1 and SCSI-2 modes. No data is transfered.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	1	1	0	0	0C
1	0	0	0	0	0	0	0	IMM	XX
2	0	0	0	0	MSB	Block Address			0X
3	Block Address								XX
4	Block Address							LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-43
CDB for Seek Block Command

IMM - For IMM=0, the status is returned after locating the specified block. For IMM=1, the status is returned as soon as the locate operation has started.

BLOCK ADDRESS - This field specifies the tape block to be located. After successful completion of the command, the tape will be positioned to read the requested block.

If the specified block is not found in the current partition, then a Check Condition status is returned and the Sense Key is set to Blank Check (08Hex). If the specified block is in error (not recoverable) then Check Condition status is returned and the Sense Key is set to Media Error (03Hex).

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.22 SEND DIAGNOSTIC (Group 0, Code 1D)

The Send Diagnostic command requests the target to perform diagnostic tests on itself. Except when the Self-Test bit is one, this command is usually followed by a Receive Diagnostic Results command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	1	1	0	1	1D
1	0	0	0	PF	0	SelfTest	DevOfL	UnitOfL	XX
2	0	0	0	0	0	0	0	0	00
3	MSB	Parameter List Length							XX
4	Parameter List Length							LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-44
CDB for Seek Block Command

PF - a Page Format bit of one specifies that the Send Diagnostic parameters conform to the SCSI-2 standard. A PF bit of 0 specifies conformance with SCSI-1.

SelfTest - A Self Test bit of one directs the drive to perform it's default power-up self-test. It the self-test successfully passes, the command will be terminated with a Good status; otherwise the command will be terminated with Check Condition status and the sense key will be set to 04-Hardware Error. A self-test bit of zero requests the drive to perform the diagnostic operation specified in the parameter list.

DevOfL - A Device Offline bit of one grants permission for the drive to perform diagnostic operations that result in alteration of reservations, log parameters, or sense data. A DevOfL bit of zero prohibits diagnostic operations that may be detected by subsequent I/O processes.

UnitOfL - A Unit Offline bit of one grants permission to the drive to perform write or repositioning operations that affect the tape. A UnitOfL bit of zero prohibits diagnostic operations that may be detected by subsequent I/O processes.

Parameter List Length - The Parameter List Length field specifies the length in bytes of the parameter list to be transfered from the initiator to the drive. A PLL of zero indicates that no data will be transfered and the PF bit will be ignored.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention

SEND DIAGNOSTIC (Group 0, Code 1D)

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.23 SPACE (Group 0, Op. Code 11)

The Space Command provides a means of positioning the tape forward a pre-determined number of blocks. The command can space over data blocks. Filemarks, or to the End-Of-Data. The drive may disconnect from the SCSI bus while executing this command. For information on operations near EOT, refer to paragraph 4.14.10 Early Warning Handling.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	0	0	1	11
1	0	0	0	0	0	0	DFE		0X
2	MSB	Count							XX
3	Count								XX
4	Count							LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-45
CDB For Space Command

DFE - DATA, FILEMARKS,END-OF-DATA - The DFE field determines the type of blocks to be spaced over. The DFE bits are defined in this Table.

Table 4-8
DFE Bit Definitions

Bit 1	Bit 0	Description
0	0	Data Blocks
0	1	Filemark
1	0	Consecutive Filemark
1	1	End Of Recorded Data

COUNT - The Count Field specifies the number of blocks, filemarks or consecutive filemarks to be spaced over. A value of zero results in no tape movement and is not considered an error. A negitive value -N (2's complement notation) results in a logical reverse spaceing over N blocks or filemarks ending on the BOM side of the last block or filemark.

Spacing Over Data Blocks

The number of data blocks to be spaced over is determined by the Count Field. If a Filemark or EOM is encountered while spacing over the data blocks, the tape movement is stopped. The command terminates with a Check Condition (Status 02) and a No Sense (Sense Key 0). The number of blocks remaining to be spaced over is located in the Sense Information bytes returned by a Request Sense Command. If termination was caused by a Filemark, the tape is positioned following the Filemark.

SPACE (Group 0, Op. Code 11)

Spacing Over Filemark Blocks

As specified in the Count Field, 0 to 127 (0-7FH for Forward, 80-FFH for Reverse) Filemarks may be spaced over. While in Space Over Filemark mode, data blocks are ignored. When the command terminates normally, the tape is positioned following the last Filemark read. If an EOM is encountered, the command terminates with a Check Condition (Status 02) and the number of Filemarks remaining to be spaced over is located in the Sense Information bytes returned by a Request Sense Command.

Spacing Over Consecutive Filemark Blocks

The number of Consecutive Filemarks to be spaced over is specified in the Count Field. The tape is positioned following the last Filemark in the sequence. If a data block is encountered, the count is restored to its original value and the space operation continues, following the data block. If an EOM is encountered, the command terminates with a Check Condition (Status 02).

Spacing To The End-of-Data

When spacing to the End-Of-Data, the Count Field is ignored. The drive will first start reading on track 0. If data is detected, the drive will rewind to BOT, position to track 2 and read. This process will continue until no data is detected at the start of an even track. The drive will position to the previous even track and start reading forward. The tape continues in the forward direction until no blocks are detected. The tape is then repositioned to allow data to be appended by future Write Commands. Any length of tape equivalent to thirty-two blocks, that has no good blocks, is interpreted as the End-Of-Data.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict -08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention, 07 - Data Protected, 0B - Aborted Command

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, UDE - Unrecoverable Data Error, FIL, FM - Filemark Detected, NDT - No Data Detected, BNL - Block Not Located, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

Data Error Counter

For each block requiring multiple passes to be read correctly, this counter is incremented only once. It is cleared when any other command is issued.

Data Underrun Counter

This counter is incremented each time a data underrun condition occurs. This counter is cleared when any other command is issued.

4.11.24 TEST UNIT READY (Group 0, Op Code 00)

This command performs a test to ensure that the tape drive is powered on and ready and a tape cartridge is installed. The command does not initiate the diagnostic routine. The Controller does not disconnect during execution of this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	0	0	0	0	00
1	0	0	0	0	0	0	0	0	00
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	0	0	0	0	0	0	0	0	00
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-46
CDB for Test Unit Ready Command

Possible Status Codes

00-Good Status, 02-Check Condition, 18-Reservation Conflict, 08-Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00-No Sense, 02-Not Ready, 04-Hardware Error, 05-Illegal Request, 06-Unit Attention

Additional Sense Bits

CNI-Cartridge Not In Place, WRP-Cartridge Write Protected, EOM (or EOT)-End-Of-Media, BOM (or BOT)-Beginning-Of-Media, BPE-SCSI Bus Parity Error.

TEST UNIT READY (Group 0, Op Code 00

The following table defines the responses to the TEST UNIT READY command. Higher priority responses (e.g., BUSY or RESERVATION CONFLICT) are also permitted.

Table 4-9
Test Unit Ready Responses

Condition	Status	Sense Key	Additional Sense Code / Qualifier
Logical unit not supported by target	CHECK	5h	25h / 00h
Medium not present in removable medium	CHECK	2h	3Ah / 00h
Not ready, manual intervention required	CHECK	2h	04h / 01h
Not ready, initialize command required	CHECK	2h	04h / 02h
Logical unit in progress to become ready	CHECK	2h	04h / 03h
Logical unit ready	GOOD	0h	00h / 00h

4.11.25 VERIFY (Group 0, Op. Code 13)

The Verify Command performs a CRC Check on a specified number of data blocks on the tape without involving the Host. Verification starts at the present position of the tape and continues for the specified number of blocks. Due to a write error the same data block may have been written more than once, a good CRC need only be found in one instance for that block to be verified. The command terminates as a result of one of the following conditions:

- The specified number of blocks have been verified.
- A Filemark has been detected.
- The End-Of-Data has been reached.
- A CRC failure occurred.

Upon termination, the tape is positioned to read the block following the last data block or Filemark read correctly. The drive may disconnect from the SCSI bus while executing this command.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	0	1	1	13
1	0	0	0	0	0	0	0	FBM	0X
2	MSB	Length Of Verification							XX
3	Length Of Verification								XX
4	Length Of Verification							LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-47
CDB For Verify Command

FIXED BLOCK MODE - For QIC-24, QIC-120, and QIC-150 modes, a Fixed Block Mode (FBM) bit other than 1 results in an Illegal Request (Sense Key 5).

LENGTH OF VERIFICATION - The value of these bytes indicates the number of blocks to verify. If the verification length is zero, no data will be verified and the current position on the logical unit will not be changed. If the verification length is greater than the approximate capacity of the unit, an illegal command will result.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention, 08 - Blank Check, 0B - Aborted Command

Additional Sense Bits

In QIC-525 mode FBM = 1, CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, UDE - Unrecoverable Data Error, FIL, FM - Filemark Detected, NDT - No Data Detected, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

4.11.26 WRITE (Group 0, Op. Code 0A)

The Write Command transfers a specified number of data blocks from the Initiator to the tape drive. The amount of data transferred is a multiple of the 512 byte blocks. Tape is erased automatically while writing on track zero.

HDR3 pin 1 determines the default state of the drive's Buffered Mode. The Mode Select Command is used to change the state of Buffered Mode. Refer to the description of Buffered Mode (BUFM) in Mode Select or Mode Sense for details.

The command terminates when one of the following conditions occur:

- The Number of Blocks specified in the CDB has been satisfied.
- A read Unrecoverable Data Error (UDE) occurred during an append operation.
- An unrecoverable write error occurred. (Failed after 16 attempts to write the block correctly).
- The physical or logical End-Of-Media has been reached.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	0	1	0	1	0	0A
1	0	0	0	0	0	0	0	FBM	0X
2	MSB			Number Of Blocks					XX
3				Number Of Blocks					XX
4				Number Of Blocks				LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-48
CDB For Write Command

When the command terminates for a reason other than satisfying the NOB in the CDB, the residue (number of requested blocks not yet written to tape) can be obtained from the Sense Information Bytes sent by a Request Sense Command. The drive must disconnect from the SCSI bus while executing this command.

Fixed Block Mode - - A Fixed Block Mode (FBM) is associated with number of blocks field. If drive is in variable block mode and FBM is set to one or drive is in fixed block mode and FMB is set to zero will result in an Illegal Request (Sense Key 5). Also a FBM other than 1 results in an Illegal Request for QIC-24, QIC-120 and QIC-150 modes. If SCSI-2 and QIC-320 modes are selected and FBM is set to zero, write command operates in variable block mode regardless of drives current mode.

Number Of Blocks - Specifies the number of blocks to be transferred to tape. When this value is zero no data is transferred and the current position is not changed. This is not considered an error.

WRITE (Group 0, Op. Code 0A)

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention, 07 - Data Protected, 0B - Aborted Command, 0D - Volume Overflow

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, UDE - Unrecoverable Data Error, BNL - Block Not Located, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

Data Error Counter

This counter is incremented each time a block must be rewritten due to an error during a read-after-write check. The counter is incremented by 1 for each block that requires a rewrite or several rewrites. The counter reflects the number of blocks that required rewrites, not the total number of rewrites. It is cleared when any other command is issued.

Data Underrun Counter

This counter is incremented each time the logic is forced to rewrite a data block due to an underrun condition. An underrun can occur without tape repositioning. It is cleared when any other command is issued.

4.11.27 WRITE BUFFER (Group 1, Op. Code 3B)

The Write Buffer Command is intended to be used in conjunction with the Read Buffer Command as a Diagnostic tool. This command tests the SCSI Bus and the drive Data Buffer without accessing the tape drive, therefore, the data on the tape is not altered.

The Host designates the portion of the buffer to be tested by specifying the location and amount of data to be written into the buffer. Included in the data transferred by the Host is a four byte header. Upon termination of the command, the location occupied by the header is restored to its original value. The Header must be all zeros or the command terminates with an Illegal Request (Sense Key 5).

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	1	1	1	0	1	1	3B
1	0	0	0	0	0	0	0	Mode	0X
2	0	0	0	0	0	0	0	0	00
3	0	0	0	0	0	0	0	0	00
4	0	0	0	0	0	0	0	0	00
5	MSB			Buffer Offset					XX
6				Buffer Offset				LSB	XX
7	MSB			Transfer Length					XX
8				Transfer Length				LSB	XX
9	0	0	0	0	0	0	Flag	Link	0X

Figure 4-49
CDB For Write Buffer Command

Header

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	Reserved								XX
1	MSB			Available Length					XX
2				Available Length					XX
3				Available Length				LSB	XX

Figure 4-50
Write Buffer Header

MODE - The Mode Bits determine whether the four byte header is to be written in the last bytes of the buffer, or the four bytes just preceding the area designated by the Buffer Offset. Mode = 0Hex will request the header first followed by the data. Mode = 1Hex requests the data first followed by the header. Mode = 2Hex requests the data only. Mode = 3-7Hex is reserved.

WRITE BUFFER (Group 1, Op. Code 3B)

BUFFER OFFSET - This field specifies where the first data byte received from the Host is to be placed in the Buffer. When the mode bit is zero, this field must also be zero.

TRANSFER LENGTH - This field specifies the number of bytes to be written into the Buffer by the Host. The value includes the four byte Header.

Possible Status Codes

00 - Good Status, 01 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention.

4.11.28 WRITE FILEMARK (Group 0, Op. Code 10)

This command writes a specified number of Filemark blocks to the tape. The drive may disconnect from the SCSI bus while executing this command. For information on operations near EOT, refer to paragraph 5.9 Drive Operation.

	Data Bits								
Byte	7	6	5	4	3	2	1	0	Hex
0	0	0	0	1	0	0	0	0	10
1	0	0	0	0	0	0	0	IMM	0X
2	MSB			Number Of Filemarks					XX
3				Number Of Filemarks					XX
4				Number Of Filemarks				LSB	XX
5	0	0	0	0	0	0	Flag	Link	0X

Figure 4-51
CDB For Write Filemark Command

IMMEDIATE - The IMM is valid when the drive is in the Data Buffering mode as set by the BUFM bit in the Mode Select Command. IMM = 1 - The drive returns status upon verification of the CDB. IMM = 0 - The command returns status after all buffered data and Filemarks have been written. IMM = 0 and NOF = 0 - The drive writes the contents of the Data Buffer onto the tape before it terminates the Write Filemark Command. No Filemarks are written.

NUMBER OF FILEMARKS (NOF) - Specifies the number of Filemark blocks to be written. When this value is zero, the drive purges the Data Buffer of all data and no Filemarks are written. If the purge is successful, the drive issues a Good Status. If not, it issues a Check Condition (Status 02). The Sense Information Bytes returned by the Request Sense Command reflect the number of blocks remaining in the Data Buffer.

Possible Status Codes

00 - Good Status, 02 - Check Condition, 18 - Reservation Conflict, 08 - Busy, an auto-load operation or another command is in progress.

Possible Sense Keys

00 - No Sense, 02 - Not Ready, 04 - Hardware Error, 05 - Illegal Request, 06 - Unit Attention, 07 - Data Protected, 0B - Aborted Command, 0D - Volume Overflow

WRITE FILEMARK (Group 0, Op. Code 10)

Additional Sense Bits

CNI - Cartridge Not in Place, WRP - Cartridge Write Protected, EOM - End-Of-Media, UDE - Unrecoverable Data Error, BNL - Block Not Located, BOM - Beginning-Of-Media, BPE - SCSI Bus Parity Error

Data Error Counter

This counter is incremented each time a block must be rewritten due to an error during a read-after-write check. The counter is incremented by 1 for each block that requires a rewrite or several rewrites. The counter reflects the number of blocks that required rewrites, not the total number of rewrites. It is cleared when any other command is issued.

Data Underrun Counter

This counter is incremented each time the logic is forced to rewrite a data block due to an underrun condition. An underrun can occur without tape repositioning. It is cleared when any other command is issued.

4.12 General Interface Theory Of Operation

The 5525ES Streaming Tape Drive is designed to interface with the Small Computer System Interface (SCSI) bus structure. This section describes the operation of the SCSI bus as well as the operation of the 5525ES. It is not the intention of this document to define SCSI in detail, however several aspects of the SCSI bus structure are discussed to clarify the drive functions with respect to this bus. Familiarity with the ANSI X3.131-1986 SCSI-1 and the X3T9.2 (QIC-88-7) SCSI-2 bus standards will benefit the user.

> *NOTE: - Throughout this text the SCSI bus signals are referred to as they appear at connector J1: e.g. BUSY = BSY-, IN/OUT = I-/0, MESSAGE = MSG-, CONTROL/DATA = C-/D.*
> *1 = high (false)signal level, 0 = low (true) signal level.*

This section provides a thorough explanation regarding the 5525ES interface operation and should be read before attempting to write Host Software Drivers.

4.12.1 SCSI Bus Description

The Small Computer System Interface is a standard interface established to support mass storage for microcomputers and minicomputers. The interface is a multiplexed bus comprised of nine data bits and nine control signals. The SCSI commands for the 5525ES Streaming Tape Drive are based on the ANSI X3.131 SCSI-1 and X3T9.2 SCSI-2 Specifications.

The SCSI bus supports any combination of up to eight Initiators and/or Target Devices. The drive functions with any combination of Initiators and/or Target devices connected to the SCSI bus and is called a Logical Unit (LUN). The terms Initiator and Target are used interchangeably with Host and the drive, respectively. Refer to Figure 4-52 for a configuration of devices supported by the SCSI bus.

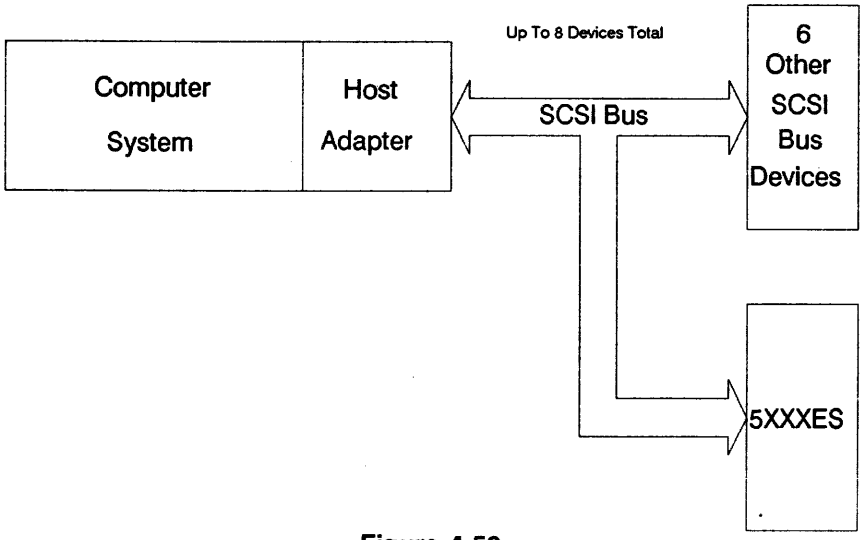


Figure 4-52
SCSI Bus Device Support Configuration

Four basic SCSI configurations are supported by the 5525ES and SCSI bus.

- Single Initiator, Single Target
- Single Initiator, Multiple Targets
- Multiple Initiators, Multiple Targets
- Multiple Initiators, Single Target

Communication with the SCSI bus occurs between a single Initiator and a single Target when a Host Adapter and a device communicate, one as the Initiator and the other as the Target. The Initiator (usually the Host Adapter) originates an operation and the Target (in this case the 5525ES, a peripheral device) performs an operation. Examples of system configurations supported by the SCSI bus are shown in Figure 4-53.

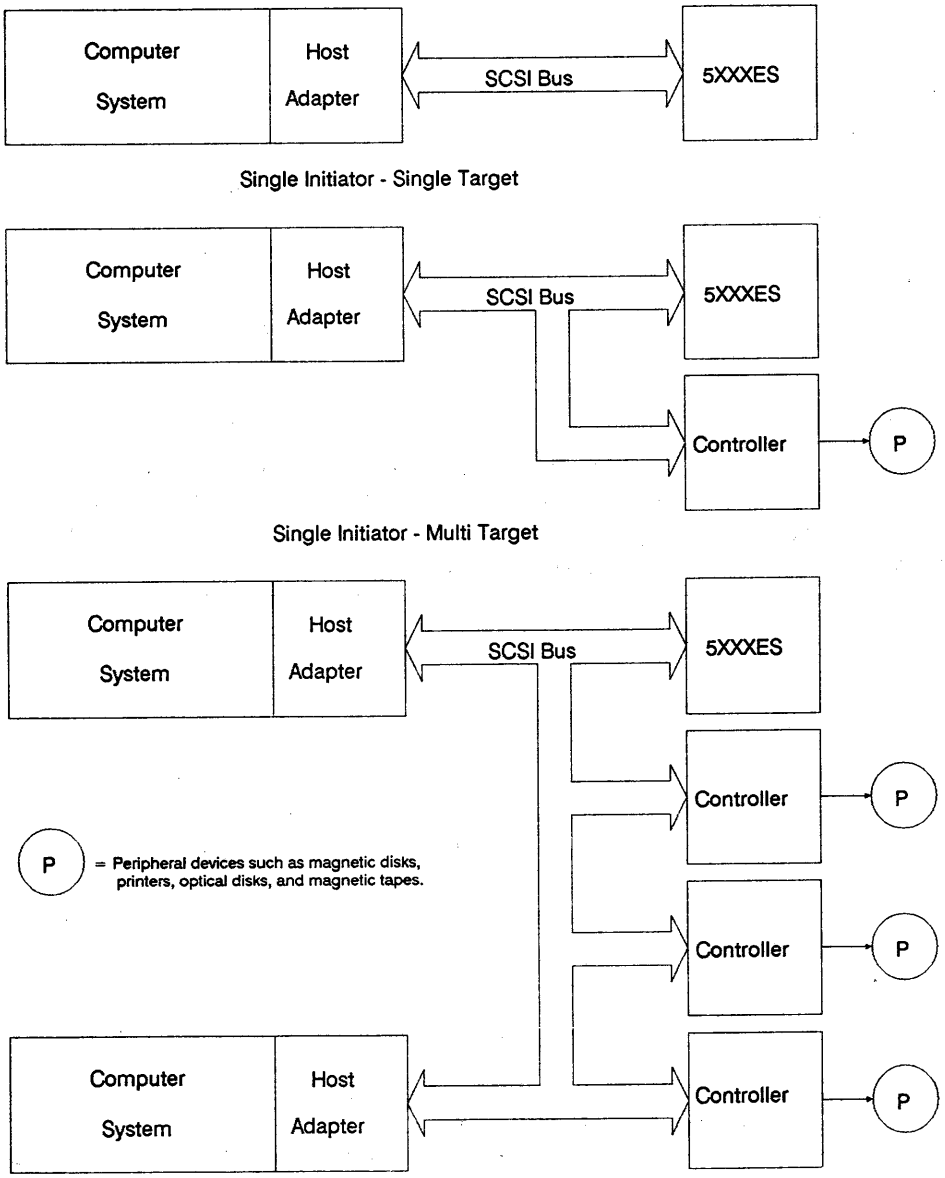


Figure 4-53
SCSI Bus Configurations

SCSI bus functions are assigned to both the Initiator and the drive. The Initiator can arbitrate for control of the SCSI bus and select the drive. The drive can request the transfer of a command, data, status, or other information via the SCSI bus. In some cases, the drive can arbitrate for control of the SCSI bus to Re-select an Initiator and continue an operation that had been Disconnected or issue commands to another SCSI device on the bus.

SCSI bus data transfer operations are performed in the asynchronous transfer mode and follow a defined REQ-/ACK- handshake protocol, as defined in the ANSI SCSI Specification. One byte of information can be transferred with each handshake.

4.12.2 SCSI Bus Operation

The SCSI bus operation is divided into eight phases. These phases are discussed separately in this section:

- Bus Free Phase
- Arbitration Phase
- Selection Phase
- Reselection Phase
- Command Phase
- Data Phase
- Status Phase
- Message Phase

Control Phases

Information Transfer Phases

The SCSI bus phases follow the sequence shown in Figure 4-54. All SCSI command sequences start with the Bus Free Phase. The normal progression is from the Bus Free Phase to the Arbitration Phase. During Arbitration, Initiators and Targets vie for control of the SCSI bus. The bus is awarded to the device with the highest priority SCSI bus address (DB7- is highest).

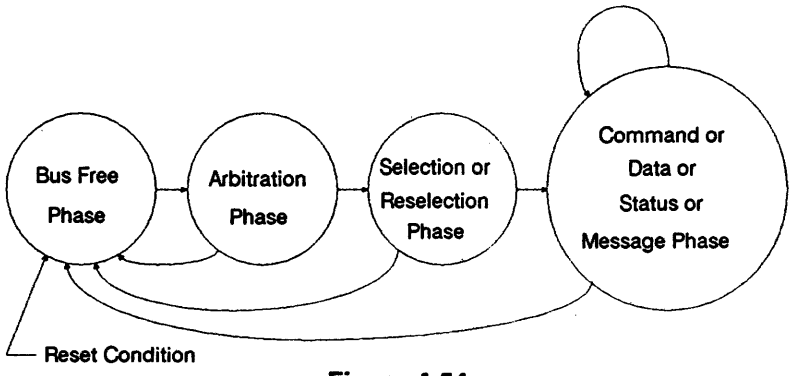


Figure 4-54
Arbitration, Selection, and Message Out Phase Command Timing

Once an Initiator or the 5525ES has control of the SCSI bus, it enters the Selection or Reselection Phase. This phase allows the device in control of the bus to select a specific device for communication. The Initiator can select the drive to begin an operation, or the drive can re-select an Initiator to continue an operation that had been disconnected earlier. After a physical path is established for an Initiator and Target, the SCSI bus enters on the Information Transfer Phases.

Bus Free Phase

When the SCSI bus is idle (not involved in any of the SCSI bus phases) it is in a Bus Free Phase. The Bus Free Phase indicates that no Host Adapter or device is actively using the bus and the bus is available.

Control Phases

Each SCSI system implements one of the following sets of phases for sharing the bus between devices:

- Selection
- Arbitration and Selection
- Arbitration, Selection and Reselection

This section describes the Arbitration, Selection, and Reselection sequence and,in doing so covers the other two sequences also.

Arbitration

Arbitration starts the command execution cycle. A device must allow the bus to be in the Bus Free Phase a minimum of 1.2 μsec. (bus settle and bus free delay) before arbitrating for the bus. All devices wishing to arbitrate for the bus must do so within 1.8 μsec. of detecting the Bus Free state or wait for the next time the bus is free. All devices wishing to control the bus assert BSY- and place their ID on the bus. The device with the highest ID wins the arbitration, gains control of the bus, and asserts SEL- to force all other devices off the bus.

Selection

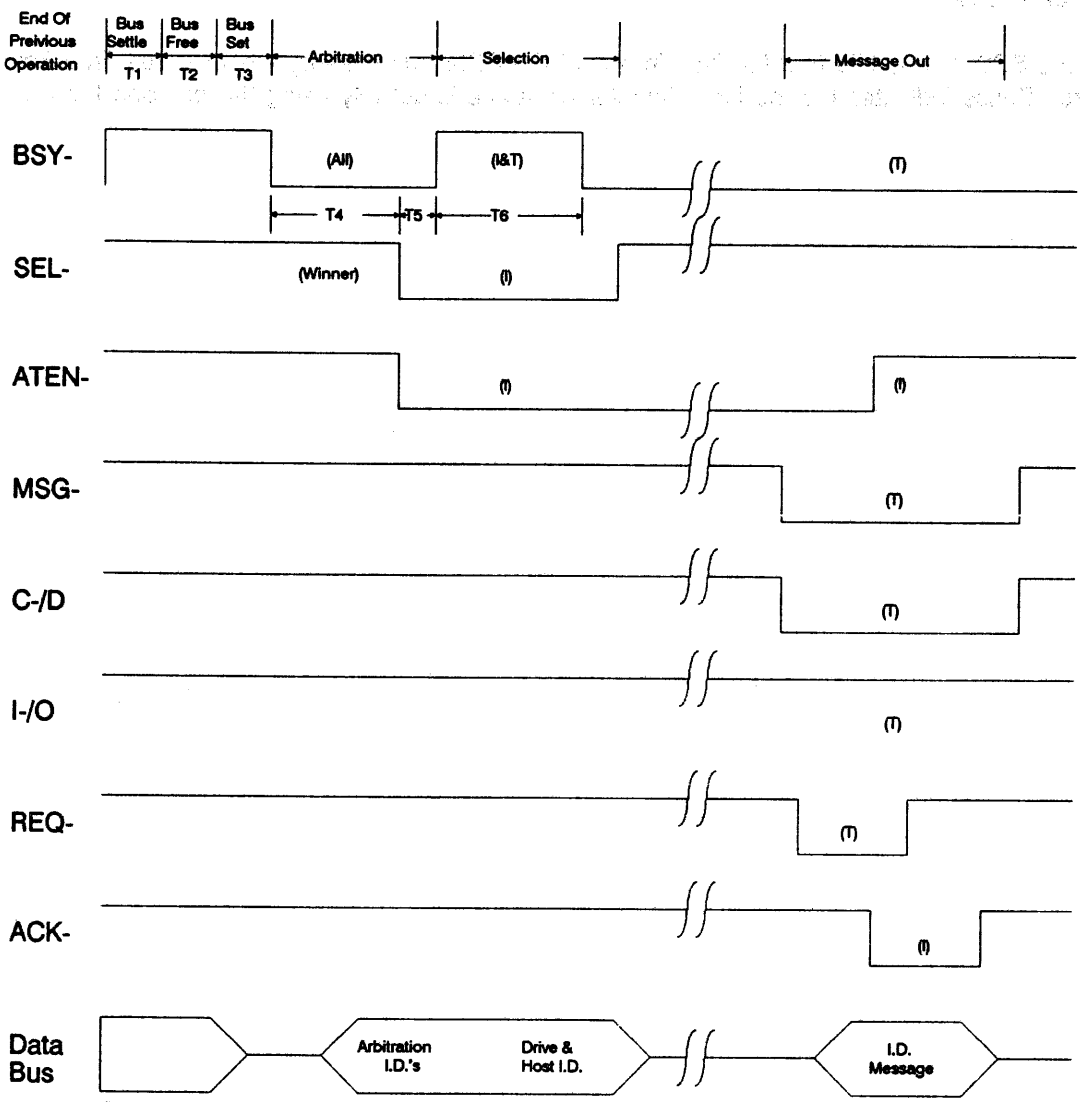
As previously stated, selection begins when the device with the highest ID gains control of the bus. This device becomes the Initiator and, while maintaining SEL- and its own ID asserted, it de-asserts BSY- and asserts the ID of the Target device it wants to select. When the Target recognizes that it is the desired device, it asserts BSY- which completes the physical path between the Host and Target.

If the Initiator supports the Disconnect/Reconnect feature, it must assert ATN- at the same time as SEL-. The Target interrogates the ATN- immediately after asserting BSY- to determine whether there is a Message pending. The Initiator then sends an Identify Message with bit 6 set. Refer to Section 4.12.7 Information Transfer Phase - Message. Figure 4-55 illustrates the time relationship of the control signals during an Arbitration, Selection, and Message Out Phase.

In non-arbitrating systems, the Initiator goes directly to the Selection Phase from the Bus Free Phase.

Reselection

Reselection is initiated by the same Target device that caused the disconnection to take place. The Disconnect/Reconnect features provides a means of releasing the SCSI bus for use by another Initiator and Target during the time the original Target does not require the SCSI bus. For example, when the drive is selected by a Host to write data to the tape, the drive has the option of disconnecting from the SCSI bus. This would be the case when the Host desires to write a block of data larger than the capacity of the data buffer. When the Host fills the data buffer, the drive stores the ID of the Host, sends a Disconnect (Message 04) to inform the Host that it is about to disconnect, and de-asserts BSY- which finalizes the disconnect. The SCSI bus is now free to be used by other combination of Initiators and Targets. When the drive writes a sufficient amount of data to the tape, it needs to re-establish the link to allow the Host to refill the data buffer with data. To do this it identifies the original Host and arbitrates for

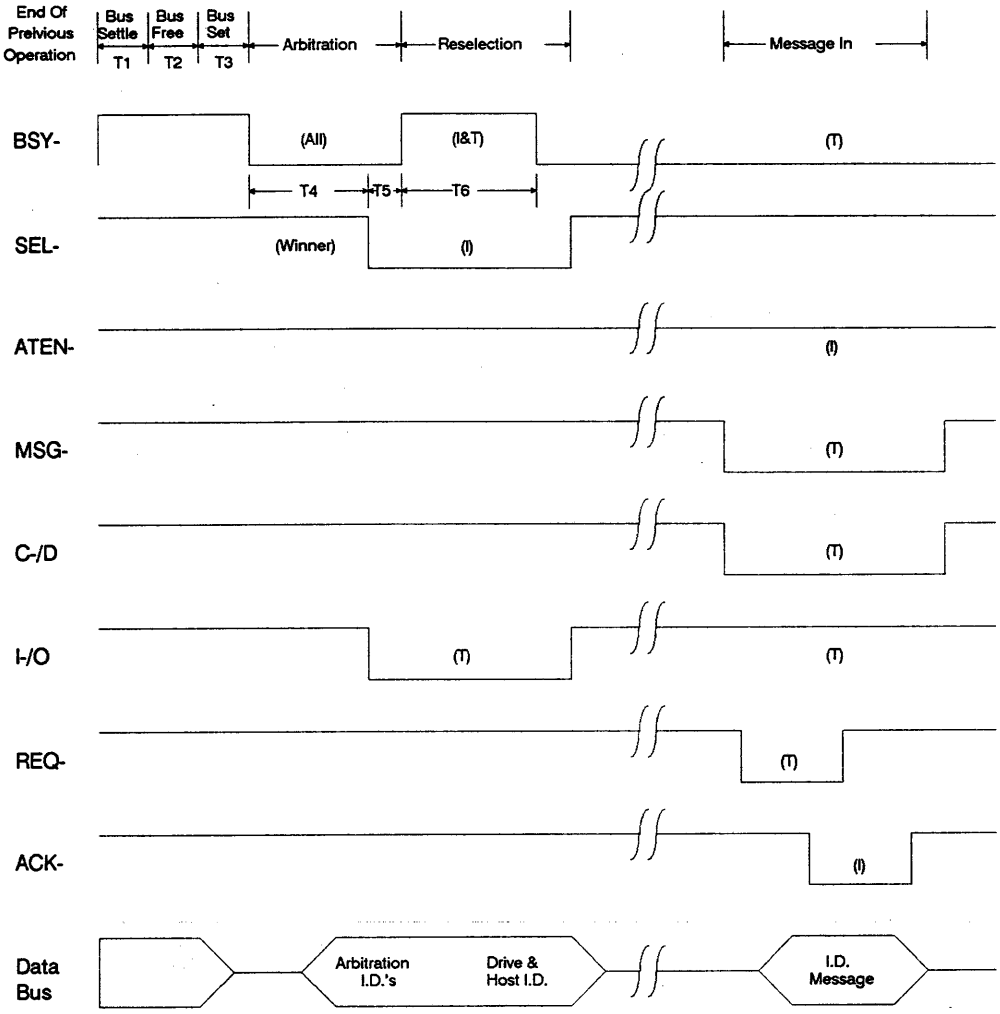


T1 = 400 nanoseconds
T2 = > 800 nanoseconds
T3 < 1.8 microseconds
T4 > 2.2 microseconds
T5 > 1.2 microseconds
T6 < 250 milliseconds

Note: The value in parenthesis indicates the source, Initiator (I) or Target (T), of the signal during each phase.

Figure 4-55
Arbitration, Selection, and Message Out Phase Command Timing

the bus. Figures 4-56 and 4-57 show the sequence in which the drive responds as a Target to the Arbitration, Reselection, and Message In and Out Phases.



T1 = 400 nanoseconds
T2 = > 800 nanoseconds
T3 < 1.8 microseconds
T4 > 2.2 microseconds
T5 > 1.2 microseconds
T6 < 250 milliseconds

Note: The value in parenthesis indicates the source, Initiator (I) or Target (T), of the signal during each phase.

Figure 4-56
Arbitration, Selection, and Message In Phase Command Timing

The Selection or Reselection is terminated when one of the following conditions occurs:

- Selection or Reselection Phase is successfully completed.
- A Selection or Reselection time-out occurs. The time-out condition results when the drive or Initiator does not respond to the Selection/Reselection Phase within an optional time-out period of 250 msec.
- A RST- signal occurs on the SCSI bus. When this signal is asserted, all SCSI bus sequences are immediately terminated and the SCSI bus signals are released by all Targets and Initiators.

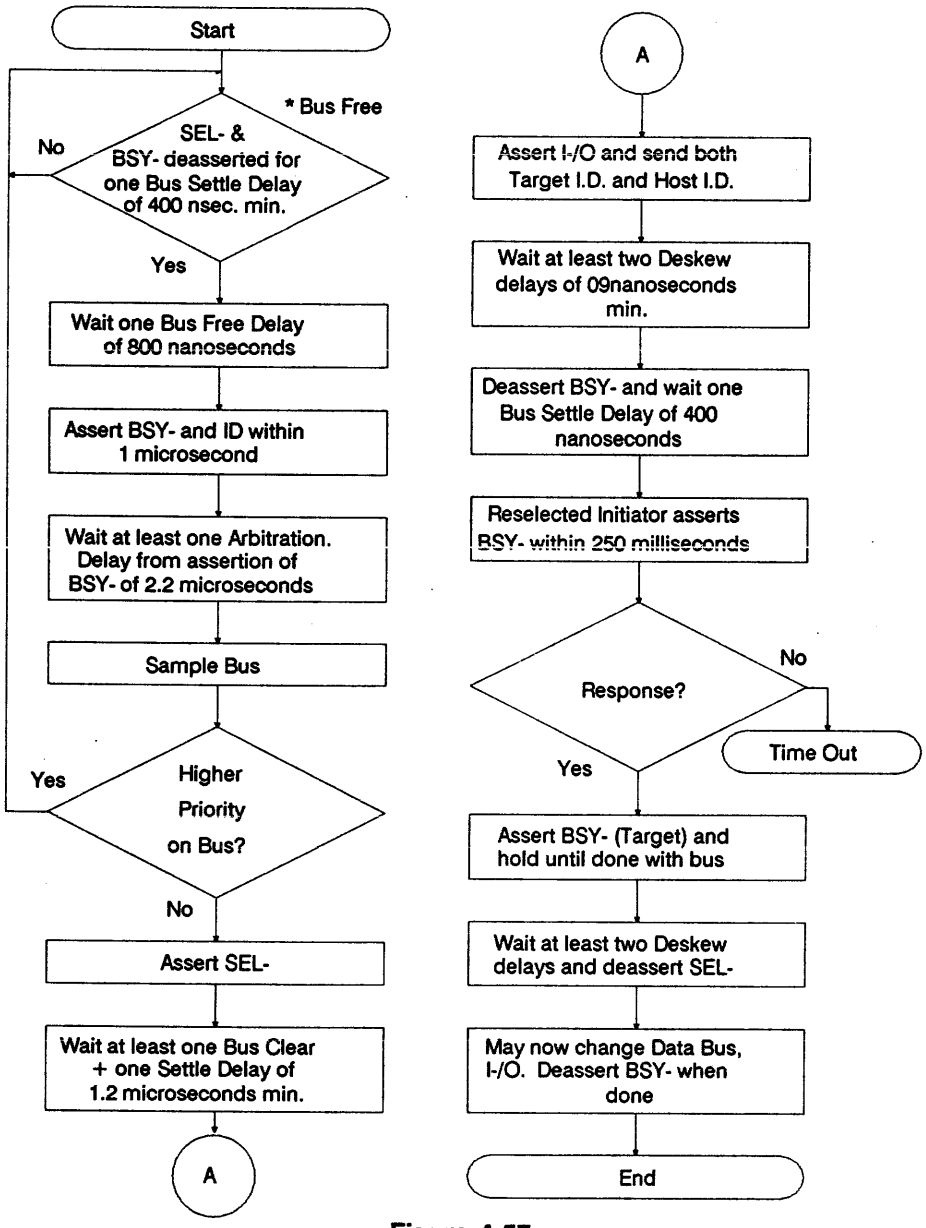


Figure 4-57
Reselection Phase Response

4.12.3 Information Transfer Phase - General

Once the Initiator completes the Selection Phase, all other phase changes are under control of the Target. Because the Command, Data, Status and Message Phases are all used to transfer data or control information via the SCSI bus, they are grouped together as the Information Transfer Phase. The Information Transfer Phase is used to transfer one or more bytes on the bus. The type of transfer is determined by the I-/O, C-/D, and MSG- signals as shown in Table 4-10, and as qualified by REQ-. A valid combination indicates to the Initiator the type of byte transfers that are to follow.

Although the 5525ES uses the SCSI asynchronous REQ/ACK handshake protocol for all transfers across the bus, the data transfers require less overhead then the Command, Message, and Status transfers, therefore the data transfer rate is faster.

NOTE: Although the direction is relative to the Host, the drive dictates the direction since it is responsible for driving the signals.

Table 4-10
Information Transfer Phase

Signal Mnemonic			Type Of Transfer
MSG-	C-/D	I-/O	
1	1	1	Data Out Phase
1	1	0	Data In Phase
1	0	1	Command Phase
1	0	0	Status Flag Byte
0	0	1	Message Out Phase
0	0	0	Message In Phase
0 = Low Active, 1 = High Not Active			

4.12.4 Information Transfer Phase - Command

The Command Phase allows the drive to request a command from the Initiator in the form of a 6-byte or 10-byte Command Description Block (CDB). The type of command and certain options are defined in the CDB. The 5525ES utilizes SCSI Group 0 and Group 1 commands.

Reset Condition

This condition occurs when the SCSI RST- signal is asserted by the Host or as a result of a power failure or Power-Off condition in the drive. In this situation, the Command Phase and the connection established during the Selection or Reselection Phase are terminated by the drive de-asserting the BSY- and all other signals that it may be driving.

Parity Error Condition

If a Parity Error is detected, the drive completes the command transfer phase, i.e., the Command Out Phase, and if messages are supported, the drive sends a Restore Pointers Message and requests the command bytes again. If messages are not supported, the command terminates with a Check Condition (Status 02) and a Hardware Error (Sense Key 4).

4.12.5 Information Transfer Phase - Data

The Data In and Out Phases constitute the transfer of data between the Initiator and the drive. The Data In Phase allows the drive to send data to the Initiator, while the Data Out Phase allows the drive to request data from the Initiator. The direction of the data transfer depends on the command being performed. Some commands do not have data to be transferred. The asynchronous data transfer mode is supported by the drive.

The Data Phase may be interrupted when one of the following conditions occurs:

Reset Condition

This condition occurs when the SCSI RST- signal is asserted by the Host or as a result of a power failure or Power-Off condition in the drive. In this situation, the Command Phase and the connection estab-

lished during the Selection or Reselection Phase are terminated by the drive de-asserting the BSY- and all other signals that it may be driving.

Parity Error Condition

When the drive detects a Parity error on the SCSI bus during a Data Out Transfer, it continues the current operation until a block boundary is encountered. It then terminates the command with a Check Condition (Status 02) and a Hardware Error (Sense Key 4).

4.12.6 Information Transfer Phase - Status

The 5525ES uses the Status Phase after each command to send information to the Initiator regarding the completion of the command. The status is a single byte in the format defined in Table 4-5. If the Initiator detects a parity error on the status byte, it should send the drive an Initiator Detected Error (Message 05). The drive then attempts to repeat the message.

4.12.7 Information Transfer Phase - Message

This phase includes both Message In and Message Out Phases. The Message In Phase allows the drive to send messages to the Initiator. The Message Out Phase allows the drive to request messages from the Initiator. The message system allows communication between an initiator and target for the purpose of interface management. One or more messages may be sent during a single MESSAGE phase.

Table 4-11
Message Codes

Code	Message Name	Direction	
00h	Command Complete	In	
02h	Save Data Pointer	In	
03h	Restore Pointers	In	
04h	Disconnect	In	Out
05h	Initiator Detected Error		Out
06h	Abort		Out
07h	Message Reject	In	Out
08h	No Operation		Out
09h	Message Parity Error		Out
0Ah	Linked Command Complete	In	
0Bh	Linked Command Complete (With Flag)	In	
0Ch	Bus Device Reset		Out
80h to FFh	Identify	In	Out
***	Synchronous Data Transfer Request	In	Out

In = Target to Initiator Out = Initiator to target
*** = Extended Message
Codes not listed above are reserved or not supported.

The **ABORT** message is sent from the initiator to the target to terminate the present operation. The target goes to the BUS FREE phase following the successful receipt of this message. All pending data and status for the issuing initiator is cleared. Pending data and status for other initiators is not cleared.

The **BUS DEVICE RESET** message is sent from an initiator to direct a target to clear all current operations on that SCSI device. This message resets the 5525ES drive to an initial state with no operations pending for any initiator. After the receipt of this message the 5525ES drive enters BUS FREE phase on

the SCSI bus. A UNIT ATTENTION condition is created for all initiators and all operational parameters are reset to a default state.

The **COMMAND COMPLETE** message is sent from a target to an initiator to indicate that the execution of a command (or series of linked commands) has terminated and that valid status has been sent to the initiator. After successfully sending this message, the 5525ES drive enters the BUS FREE phase on the SCSI bus. The command may have been executed successfully or unsuccessfully as indicated in the status.

The **DISCONNECT** message is sent from a target to inform an initiator that the present connection is going to be broken (the target plans to disconnect by releasing the SCSI bus), but that a later reconnect will be required in order to complete the current operation. This message shall not cause the initiator to save the data pointer. After successfully sending this message, the drive enters the **BUS FREE** phase. The SCSI bus may be then used by other devices connected to the bus. The Disconnect message sent from the initiatior to the target instructs the target to disconnect from the SCSI bus. After receiving this message, the 5525ES enters the **MESSAGE IN** phase on the SCSI bus and sends **SAVE DATA POINTERS** message to the initiator and then enters the **BUS FREE** phase. The drive will attempt to reconnect to the initiator after the disconnect delay time specified through the **MODE SELECT** command.

The **IDENTIFY** message is sent by either the initiator or the 5525ES drive to establish the initiator-target connection. The IDENTIFY message format is presented below:

	BITS							
BYTES	7	6	5	4	3	2	1	0
0	Identify	DiscPrv	LUNTAR	Reserved		LUNTRN		

The identify (Identify) bit shall be set to one to specify that this is an IDENTIFY message.

A disconnect privilege (DiscPrv) bit of one specifies that the initiator has granted the target the privilege of disconnecting. A DiscPrv bit of zero specifies that the target shall not disconnect. This bit is set to zero when an IDENTIFY message is sent by the 6130FS drive to an initiator during a reselection process.

A logical unit target (LUNTAR) bit shall be set to zero.

The logical unit number target routine number (LUNTRN) field specifies a logical unit number if the LUNTAR bit is zero.

An IDENTIFY message is invalid if a reserved bit is set to one or if the LUNTAR bit is set to one. The 6130FS drive responds to an invalid IDENTIFY message by immediately sending a MESSAGE REJECT message.

The **INITIATOR DETECTED ERROR** message is sent from an initiator to inform a target that an error has occurred that does not preclude the target from retrying the operation. A RESTORE POINTERS message or a disconnect followed by a reconnect, shall cause the initiator pointers to be restored to their defined prior state.

The **LINKED COMMAND COMPLETE** message is sent by the 5525ES drive to an initiator to indicate that the execution of a linked command has completed and that status has been sent. The initiator shall then set the pointers to the initial state for the next linked command.

The **LINKED COMMAND COMPLETE (WITH FLAG)** message is sent by the 5525ES drive to an initiator to indicate that the execution of a linked command (with the flag bit set to one) has completed and that status has been sent. The initiator shall then set the pointers to the initial state of the next linked command.

The **MESSAGE PARITY ERROR** message is sent from the initiator to the target to indicate that the last message byte it received had a parity error.

In order to indicate its intentions of sending this message, the initiator shall assert the ATN signal prior to its release of the ACK signal for the REQ/ACK handshake of the message that has the parity error. This provides an interlock so that the target can determine which message has the parity error. If the 6130FS device receives this message under any other circumstance, it signals a catastrophic error condition by entering the BUS FREE phase without any further information transfer attempt.

The **MESSAGE REJECT** message is sent from either the initiator or target to indicate that the last message byte it received was inappropriate or has not been implemented.

In order to indicate its intentions of sending this message, the initiator shall assert the ATN signal prior to its release of the ACK signal for the REQ/ACK handshake of the message byte that is to be rejected. If the target receives this message under any other circumstance, it rejects this message.

The **NO OPERATION** message is sent from an initiator in response to a target's request for a message when the initiator does not currently have any other valid message to send.

The **RESTORE POINTERS** message is sent from a target to direct the initiator to restore the most recently saved pointers for the current logical unit to the active state. Pointers to the command, data, and status locations for the current logical unit shall be restored to the active pointers. Command and status pointers shall be restored to the beginning of the present command and status areas. The data pointer shall be restored to the value at the beginning of the data area in the absence of a SAVE DATA POINTER message or to the value at the point at which the last SAVE DATA POINTER message occurred for current logical unit operation.

The **SAVE DATA POINTER** message is sent by the 5525ES device to direct the initiator to save a copy of the present active data pointer for the current logical unit.

The **SYNCHRONOUS DATA TRANSFER REQUEST** message is sent by both an initiator and the target to establish the synchronous data transfer parameters. This is an extended (multibyte) message. The format of the SYNCHRONOUS DATA TRANSFER REQUEST message is presented below:

BYTE	VALUE	DESCRIPTION
0	01h	Extended Message
1	03h	Extended Message Length
2	01h	Synchronous Data Transfer Request Code
3	m	Transfer period (m times 4 nanoseconds)
4	x	REQ / ACK offset

A SYNCHRONOUS DATA TRANSFER REQUEST (SDTR) message exchange is initiated by the 5525ES device before the first data transfer after a power-on, reset condition or the receipt of the BUS DEVICE RESET message.

The SDTR message exchange establishes the permissible transfer periods and the REQ/ACK offsets for all logical units on the two devices.

The transfer period is the minimum time allowed between leading edges of successive REQ pulses and of successive ACK pulses to meet the device requirements for successful reception of data.

The REQ/ACK offset is the maximum number of REQ pulses allowed to be outstanding before the leading edge its corresponding ACK pulse is received at the target. This value is chosen to prevent overflow conditions in the device's reception buffer and offset counter. A REQ/ACK offset value of zero indicates the asynchronous data transfer mode; a value of FFH indicates unlimited REQ/ACK offset.

The originating device (the device that sends the first of the pair of SDTR messages) sets its values according to the rules above to permit it to receive data successfully. If the responding device can also receive data successfully with these values, it returns the same values in its SDTR message. If it requires a larger transfer period, a smaller REQ/ACK offset, or both in order to receive data successfully, it substitutes values in its SDTR message as required, returning unchanged any value not required to be changed. Each device when transmitting data shall respect the limits set by the other's SDTR message, but it is permitted to transfer data with larger transfer periods, smaller REQ/ACK offsets, or both than specified in the other's SDTR message. The successful completion of an exchange of SDTR messages implies an agreement as follows:

Responding Device SDTR Response		Implied Agreement
(1)	Non-Zero REQ / ACK offset	Each device transmits data with a transfer period equal to or greater than and a REQ / ACK offset equal to or less than the values received in the other device's SDTR message.
(2)	REQ/ACK offset equal to 0	Asynchronous transfer
(3)	MESSAGE REJECT message	Asynchronous transfer

If an abnormal condition (BUS FREE, parity error) prevents the devices from returning an appropriate response, both devices shall aborts the negotiations and should go to asynchronous data transfer mode for data transfers between the two devices. Once the negotiation is aborted, the 5525ES device will not re-initiate the SYNCHRONOUS DATA TRANSFER REQUEST message exchange.

The implied synchronous data transfer agreement shall remain in effect until a BUS DEVICE RESET message is received, until a hard reset condition occurs, or until one of the two SCSI devices elects to modify the agreement. The default data transfer mode is asynchronous data transfer mode. The default data transfer mode is entered at power on, after a BUS DEVICE RESET message, or after a hard reset condition.

4.12.8 SCSI Bus Protocol

Communication between the Host and the 5525ES relies upon a well-defined SCSI protocol for bus arbitration, device selection, issuing commands, transferring data and returning status. Following is a typical sequence that the Host may perform when executing a command:

- If there is more than one device capable of gaining control of the bus, the host must arbitrate for and win the bus. When arbitration is not implemented, the Host goes from the Bus Free Phase to the Selection Phase.
- The Host must then select the drive.
- After the drive is selected, it puts the bus into the Command Phase and receives the command bytes from the Host.
- The drive now performs the function directed by the command bytes. For simple commands like Test Unit Ready the drive goes to the Status Phase almost immediately. A command such as Inquiry requires that the bus be put into the Data In Phase so that the requested data can be sent to the Host. A Mode Select Command requires that the bus be put into the Data Out Phase so that the drive can receive the Mode bytes from the Host. A Read or Write Command also causes the drive to put the bus in the Data In or Data Out Phase.
- If the system supports Disconnect/Reconnect operations, the drive will perform disconnects and reconnects for commands that take several seconds such as Read or Rewind. To do this, the drive puts the bus into the Message In Phase, and sends the Save Data Pointers and Disconnect messages. The drive releases the bus, placing it in the Bus Free state. When the drive is ready to reconnect, it must arbitrate for and win the bus, re-select the Host, and go to the Message In Phase to send the Identify Message to the Host. When this is done, the drive puts the bus into the state needed to continue executing the command. For the Read Command, this could be the Data In Phase or for a Rewind Command, the Status Phase.
- When the drive completes a command or an unrecoverable error occurs, the drive puts the bus into the Status Phase and sends the Host a single status byte. This byte informs the Host that either the command executed correctly, could not be performed because the drive was busy or reserved, or that an error condition exists and the Host should issue a Request Sense Command to determine the cause of the failure.
- From the Status Phase, the drive puts the bus into the Message In Phase and sends the Command Complete message.
- Finally, the drive disables its drivers from the bus. The bus is now in the Bus Free Phase, allowing other devices to use the bus.
- The Host may assert ATN- to send messages to the drive at any time during the Command, Data In, Data Out, Message In, or Status Phases. When the drive detects the ATN- asserted, it puts the bus into the Message Out Phase to receive the message(s) from the Host. Examples of the messages that the Host might want to send include the Identify Message immediately after selecting the drive, or the Initiator Detected Error message in the case of a Host detected parity error on the bus. It should be noted that during DMA operations the drive checks for ATN- only between the blocks of data.

Figure 4-58 shows a simple Write Command sequence for non-arbitrating, single initiator configuration.

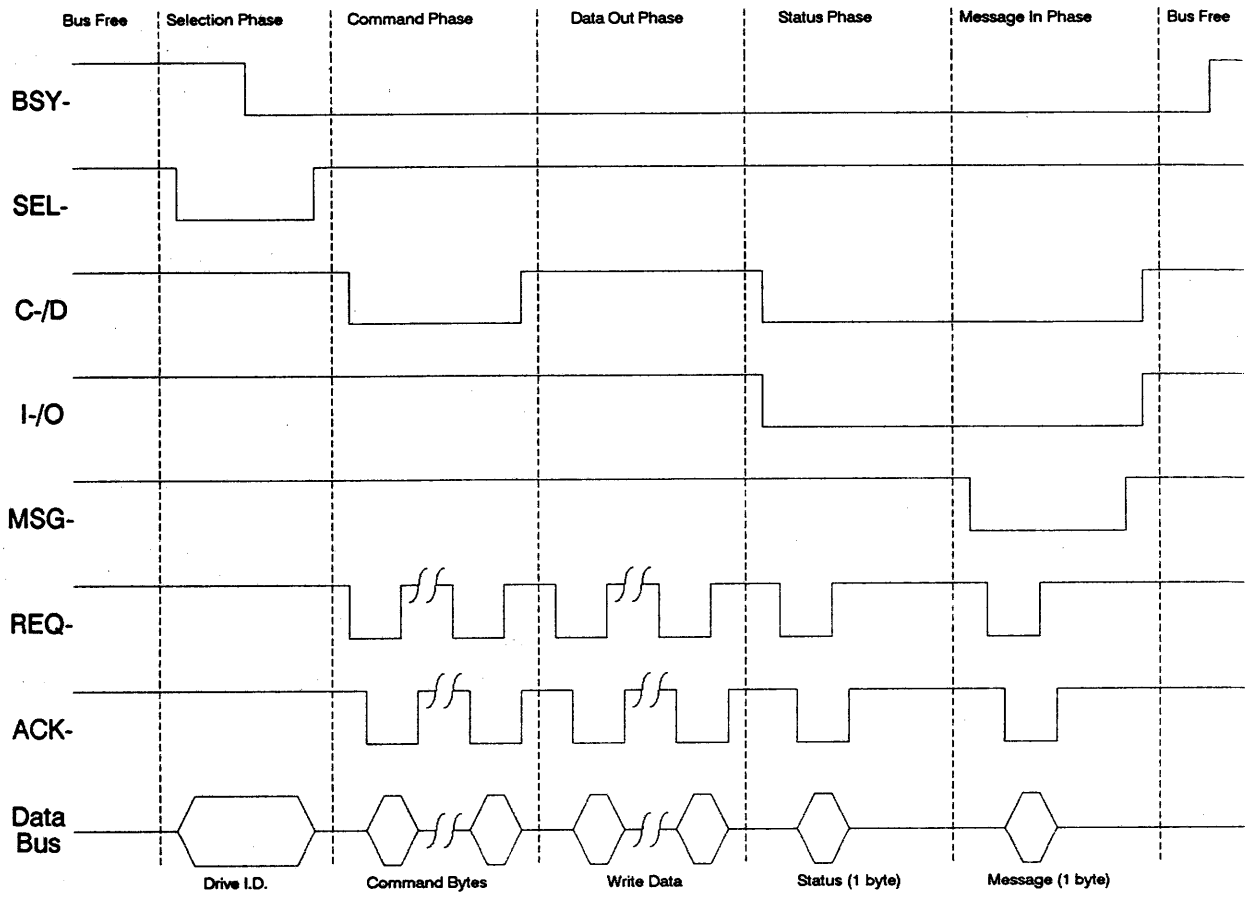


Figure 4-58
Typical Write Sequence

4.13 SCSI Bus Error Handling

In SCSI, parity errors that occur in communications between the Host and the 5525ES are handled by means of Messages. This section describes the procedure followed when a parity error is detected by the Initiator or device.

4.13.1 Parity Error During Command Phase

When a parity error is detected by the 5525ES during the Command Phase, it switches to the Message In Phase and sends the Restore Pointers (Message 03) to the Host. This causes the Host to put its command pointer to the start of the command bytes buffer. If the Host is not asserting ATN-, the drive returns to the Command Phase and asserts REQ-, anticipating the repeat of the command bytes. The Host may abort the action by asserting ATN- before asserting ACK- during the Restore Pointers message handshake. This causes the drive to go to the Message Out Phase and receive an Abort message.

4.13.2 Parity Error During Data Out Phase

While in the Data Out Phase, the drive checks the bus parity after each byte, if using Programmed I/O, and after each block transfer is using DMA. If a bus parity error is detected, the drive terminates the command and sends a Check Condition (Status 02) and a Command Complete (Message 00) to the Host. In response to a Request Sense Command from the Host, the drive sends a Hardware Error (Sense Key 4) and a BPE in byte 09 of the Sense Data. In this case it is advisable for the Host to rewind the tape and start the operation again.

4.13.3 Parity Error During Data In Phase

When the Host detects a parity error during the Data In Phase, it switches to the Message Out Phase by asserting ATN-, MSG-, and sends and Initiator Detected Error (Message 05) to the drive. If the drive is able to recover the data correctly, it sends Restore Pointers (Message 03) during a Message In Phase and transfers the data to the Initiator again. If the drive is unable to recover the data, it terminates the command with a Check Condition (Status 02) and a Hardware Error (Sense Key 4). In this case it is advisable for the Host to rewind the tape and start the operation again.

4.13.4 Parity Error During Status Phase

If the Host detects a parity error during the Status Phase, it asserts ATN- before asserting ACK-. This causes the drive to switch to the Message Out Phase so that it fan accept an Initiator Detected Error (Message 05) from the Host. This message causes the drive to enter the Message In Phase and send a Restore Pointers (Message 03) to the Host. If the Host is no longer asserting ATN-, the drive returns to the Status Phase and sends the status byte again. To abort this attempt, the Host must assert ATN- during the handshake for the Restore Pointers Message. The drive then accepts the Abort Message in the Message Out Phase.

4.13.5 Parity Error During Message Out Phase

When the drive detects a parity error during a Message Out Phase, it continues to accept message bytes but no longer acts upon them. Instead, it waits until ATN- is de-asserted (indicating the end of the Message Out Phase) and then asserts REQ- while leaving the bus phase in Message Out. This indicates to the Host that the message(s) must be sent again. The Host should respond by asserting ATN- and begin sending the message(s) again.

4.13.6 Parity Error During Message In Phase

If at any time the Host detects a parity error during the Message In Phase, it continues to assert ATN- while completing the handshake. The drive then accepts the Message Parity Error (Message 09). This causes the drive to return to the Message In Phase and attempts to repeat the message sequence. Besides the Message Parity Error message, the drive may also accept the No Operation Message Reject, Abort, and Bus Device Reset messages at this time.

4.14 Application Notes

4.14.1 Purpose

The purpose of this section is to provide the reader with additional information about 5525ES operations and usage. It does not cover all possible conditions that the user of this product may encounter.

4.14.2 Default Mode Parameters

After a power-on cycle, BUS RESET, or the receipt of the BUS DEVICE RESET message the 5525ES drive is set to the default mode. The default parameters may be examined by the initiator through the MODE SENSE command. The 5525ES drive address on the SCSI bus is determined during the default initialization by the setting of the address jumpers on the controller board. The jumper settings is shown in Section 2 - Installation.

4.14.3 RESET Operation

If the 5525ES drive detects BUS RESET, or it receives the BUS DEVICE RESET message, all active or suspended SCSI commands for all initiators are cleared and the device is re-initialized to the default state. Any medium access operation in progress is completed, to assure the medium format integrity. The 5525ES drive responds with a BUSY status to any command received before the re-initialization procedure is completed.

4.14.4 UNIT ATTENTION condition

The UNIT ATTENTION condition occurs in the following cases:

- power-on, BUS RESET, or BUS DEVICE RESET message
- mode parameters changed by other initiator
- medium has been removed and reinstalled

Any command other then INQUIRY or REQUEST SENSE command sent to the 5525ES drive after the UNIT ATTENTION condition was detected will result in the CHECK CONDITION with the Sense Key in the sense data set to UNIT ATTENTION and the additional sense code set to the value specifying the actual cause of the UNIT ATTENTION condition.

After the CHECK CONDITION status for the UNIT ATTENTION condition was sent to the initiator, the UNIT ATTENTION condition is cleared. The INQUIRY command does not clear the UNIT ATTENTION condition.

4.14.5 Buffered Mode of Operation

The buffered mode of operation is recommended for writing data to the tape. This mode allows for the streaming operation, faster then the start/stop operation resulting from the unbuffered mode. The buffered mode also allows a greater amount of data to be written to the medium by reducing a number of gaps caused by the start/stop operation.

Any buffered data that remains to be written to the medium after the completed WRITE command will be transferred to the medium during the subsequent WRITE command execution or the execution of the REWIND, SPACE, LOAD/UNLOAD or WRITE FILEMARK commands.

4.14.6 Loading and Unloading

The 5525ES drive attempts to load the tape automatically, every time the cartridge is inserted into the drive. Any command sent to the drive during the autoload operation is terminated with BUSY status. The CHECK CONDITION status with the sense data set to UNIT ATTENTION / MEDIUM CHANGE is reported on any subsequent command (except INQUIRY).

The successful execution of the autoload operation is necessary before any medium access command could be accepted by the drive. If the autoload operation has failed, any command requiring the medium access will terminate with the CHECK CONDITION status and the Sense Key set to NOT READY (02h) and the Additional Sense Code and Qualifier set to INITIALIZATION COMMAND REQUIRED (04h/02h).

The autoload operation as well as the LOAD command execution position the medium to the BOT of the currentily active partition, as selected by the device configuration mode parameters. Actual medium partitioning values are read from the medium and stored in the medium partition parameters page. The error condition occures if the specified active partition is not present on the volume.

If the blank medium cartridge is used (not previously used), the LOAD command returns the CHECK CONDITION status to the initiator with the Sense Key in the sense data set to MEDIUM ERROR (03h) and the additional sense code and qualifier set to UNKNOWN FORMAT (03h/01h). The MODE SELECT command with the medium partition parameters page (code 11h) should be sent to the drive to initialize the tape to the specified partition(s). The following LOAD command will position the medium to the BOT of the specified active partition.

If the partition one is specified as the active partition but it is not found on the loaded medium, the CHECK CONDITION status is returned, the Sense Key code in the sense data is set to MEDIUM ERROR (03h) and the additional sense code and qualifier is set to SEQUENTIAL POSITIONING ERROR (3Bh/00h).

The UNLOAD command writes to the medium any data remaining to be written and positions the medium to the BOM for removal. The manual eject is necessary to remove the tape cartridge from the 5525ES drive. Even if the cartridge is not removed after the UNLOAD command, the LOAD command is required before any medium access command will be accepted.

4.14.7 Changing the number and/or partition size on the volume

To change the medium partitioning, the initiator must send the MODE SELECT command with the medium partition parameters page (code 11h) to the 6130FS drive. The medium is unconditionally reformatted according to the medium partition parameters page setting. The MODE SELECT command with new partitioning parameters must be sent **after** the medium is loaded through the LOAD command.

> *WARNING: ALL DATA PRESENT ON THE MEDIUM WILL BE DESTROYED AS THE RESULT OF THE RE-PARTITIONING OF THE MEDIUM.*

4.14.8 WRITE operation command sequence

The typical command sequence for the write operation:

INQUIRY
LOAD
TEST UNIT READY

MODE SENSE
MODE SELECT
WRITE
WRITE FILEMARK

After the power-on or reset, the REQUEST SENSE command should follow the INQUIRY command.

4.14.9 READ operation command sequence

The typical command sequence for the read operation:

INQUIRY
LOAD
TEST UNIT READY
MODE SENSE
MODE SELECT
READ

After the power-on or reset, the REQUEST SENSE command should follow the INQUIRY command.

4.14.10 Early Warning & End Of Media Handling

Write (525 MB Mode)

LEOM is declared when the write process is 1024 blocks (approximately) from the Early Warning (EW) hole. At this time, the drive writes its entire buffer on to the tape. The LEOM indication bit is turned on in the control field of the last recorded block. (Bit 7, Control Byte 3 set to one. Refer to Block Format section). The command is terminated with a check condition. The residue is set equal to number of blocks specified in CDB (Command Descriptor Block) minus number of blocks transferred. LEOM is determined by counting the number of blocks that were written on track 0, including all rewrites, and subtracting 400h.

The sense key that will be reported at this time will be 40h (LEOM and No Sense). The drive will then go into the unbuffered mode, regardless of the Mode Select setting. It will take one command at a time, and put all the data from it onto the tape. The LEOM indication bit is turned on in the control field of every block.

This will continue until the EW hole is encountered, where the scenario will remain the same except that the sense key will change to a value of 4Dh.

The PEOM hole is never actually reached during a write. It will, instead, stop about 60 blocks after the EW hole. This corresponds to a spot which is about half way between the EW and the PEOM holes. When this point is reached, PEOM is declared, a sense key of 44h (LEOM and Hardware Error) is returned, and no more data will be taken from the host.

Read (525 MB Mode)

During the read process, LEOM is declared in one of the following situatons:

1. The drive detects End Of Data (EOD) and LEOM of control field of any block read is set to one.

2. The drive detects EOD and it is positioned past LEOM mark (1024 blocks before EW hole).

In both cases the status returned is 48h (LEOM and Blank Check).

Write (150 MB Mode)

150 write mode has a unique problem in that in order to be completely QIC-02 compatible the drive must write completely to the EW hole. In order to preserve this on the 525 MB drive the following scenario will be used in order to handle EOM while in the 150 MB mode.

The drive will write data from its buffer on to tape until it reaches a point 1200 blocks before early warning hole at which time it will drop out of buffered mode and flush the entire buffer on to tape. It will then write 2 blocks at a time until reaching the EW hole at which point it will terminate the command with check condition. The reported sense key will be a 40h. Additional writing to tape (2 blocks) will also terminate with a check condition. The reported sense key will be a 4Dh. This will continue until the physical EOM hole is reached at which point the drive will report a 43h. This scenario will create tapes which should be QIC-02 compatible when restoring from a multi-tape backup set and Sytron software.

Read (150 MB Mode)

The LEOM is declared when the drive reaches to EOD and it is positioned past LEOM mark (1200 blocks before EW hole).

If PEOM were to occur, the drive would terminate the command with a check condition, and report a sense key of 43h. This condition should never occur if the tape was written properly.

4.14.11 Soft EOM Definition

The 5525ES generates the Soft EOM status approximately 1024 blocks before the start of the warning zone on the last track of a tape.

4.14.12 Drive Response To Soft EOM

As soon as the drive generates the Soft EOM status it stops accepting data from the Initiator. If the Initiator has indicated that it supports the disconnect feature, the drive disconnects from the bus while writing the buffered data to tape. There is now enough space remaining before the physical EOM to write from 640 (280 Hex) to 768 (300 Hex) blocks.

4.14.13 Initiator Notification Of Soft EOM

When the drive is in the non-buffered mode, it notifies the Initiator of the Soft EOM condition by issuing a Check Sense during the status phase and setting bit six in Byte 2 of the returned Sense Bytes. If the drive is in buffered mode, this mode is automatically terminated at this time. In all cases, notification is by returning a Check Condition (Status 02) to the Initiator. The corresponding Sense Data contains the following:

- Byte 2 - Sense Key = 40 (End Of Media)
- Byte 0 - Valid Bit = 1, if the residue is greater than zero.
- Bytes 3-6 - Information Bytes contain the number of blocks not yet transferred to the drive.

4.14.14 Methods Of Proceeding Past Soft EOM

Following the Soft EOM condition the Initiator may still issue Write or Write Filemark Commands. The drive continues to return a Good Status (00) with each command until the Early Warning is encountered. A Sense Data corresponding to these commands contain:

- Byte 2 - Sense Key = 0, No Sense.
- Byte 0 - Valid Bit = 0.

4.14.15 Drive Response To Early Warning

When the Early Warning hole has been reached (UTH- =0, LTH- = 1), the drive terminates all data transfer. As described below, the data remaining in the Buffer may either be recovered by the Initiator or written onto the tape.

4.14.16 Initiator Notification Of Early Warning

Following the detection of Early Warning, a Check Condition (02 Status) is returned and as stated previously, no data is written onto the tape. The corresponding Sense Data contains the following:

- Byte 2 - Sense Key = 4D (EOM and Volume Overflow)
- Byte 0 - Valid Bit = 1, if the residue is greater than zero.
- Byte 3 - 6 - Information Bytes contain the number of blocks not yet transferred to the tape.

4.14.17 Method Of Proceeding Past Early Warning

The Initiator has one option for proceeding after notification of the Early Warning:The Initiator may use the Recover Buffered Data Command to recover the unwritten data from the Controller's Data Buffer.

To write the data remaining in the buffer to tape it must be reloaded in the buffer in one or two block increments. A Write Command requesting one or more blocks or a Write Filemark Command requesting zero or more Filemarks will transfer up to two blocks of data from the buffer to the tape. This procedure may be repeated until all data has been written. The Check Condition is returned after the current command writes two blocks of data.

The corresponding Sense Data contains the following:

- Byte 2 - Sense Key = 4D, EOM and Volume Overflow.
- Byte 0 - Valid Bit = 1, if the residue is greater than zero.
- Bytes 3 - 6 - Information Bytes specify the number of blocks not yet transferred to the drive.

Information Bytes specify the amount of residue contained in the Data Buffer, as well as the number of blocks not yet transferred to the drive.

4.14.18 Drive Response To The Hard End-Of-Media

The first command following the detection of the Hard End-Of-Media terminates with a Check Condition (02 Status). The corresponding Sense Data contains the following:

- Byte 2 - Sense Key = 44 if write (EOM and Hardware Error) or 43 if read (EOM and Media Error)
- Byte 0 - Valid Bit = 1, if the residue is greater than zero.
- Bytes 3 - 6 - Information Bytes specify the number of blocks not yet transferred to the drive.
- Byte 8 - Data Bit 3=1, Physical EOM. A recover data buffer command is the only option the initiator has to recover the unwritten data from the drive's buffer.

4.14.19 Method Of Proceeding Past The Physical End-Of-Media

The first command following the detection of the physical end of media terminates with a check condition (02 status). At this time it is unnecessary and is incorrect to set the valid bit due to the fact that the tape controller never invoked a DMA operation by placing the SCSI Bus in the data phase. Since a data transfer never occurred, there is no residue. Sense bytes are set as follows:

- Byte 0 - Valid Bit = 0
- Byte 2 - Sense Key = 44 if write (EOM and Hardware Error) or 43 if read (EOM and Media Error)
- Byte 8 - Data Bit 3 = 1, Physical EOM

4.14.20 Read To Physical End-Of-Media

The drive continues to read beyond the Early Warning Point to the end of the last recorded block. When a Read Command terminates beyond the Early Warning Point, it returns a Good Status (00). If a Request Sense Command is performed, an EOM is returned for information purposes only and the Sense Key will be No Sense. If physical EOM is encountered, the drive returns a sense key 43H.

4.14.21 Error Reporting

If an unrecoverable error occurs during the execution of a command, it terminates immediately and returns a Check Condition (Status 02). The Host should cease any further read or write functions and issue a Request Sense Command to determine the type of error. When the drive detects a write error, it attempts to rewrite this block of data up to fifteen times on sequential blocks of tape. After the sixteenth try it is considered an unrecoverable error and terminates. Therefore, it is recommended that no further attempts be made to write to a tape following a Write Error. Instead, continue the write operation including the error block on a new tape. However, in the case of a Read Error, it is possible to issue another Read Command to recover the data beyond the error.

4.14.22 Residue Reporting For Buffered Mode Writes

The 5525ES calculates the residue for write functions the same way in Buffered Mode as in Non-Buffered Mode. The difference lies in how to interpret the residue. When performing a Write Command in the Buffered Mode, the drive returns a Good Status and Command Completion Message at the time the last byte requested by that command is placed in the Data Buffer, rather than when it is written onto the tape. If an unrecoverable error occurs while writing this data onto the tape, the drive calculates the total number of unwritten blocks and places this value in the Information bytes of the Sense Data Block. In the Buffered Mode, it is possible for this amount to be greater than the number of blocks specified by the command in progress at the time of the error. For example, the following sequence of commands are issued to the drive.

- Write 372 blocks, write 5 blocks, write 3 blocks, write 4 blocks.
- An unrecoverable error occurs while writing block 370 of the first command.

In the Non-buffered Mode, the first command would terminate at the time of the error and return a Check Condition (Status 02). The Host would issue a Request Sense Command and receive a 3 in the Information Bytes of the Sense Data Block.

In the Buffered Mode, assuming that the data transfers on the SCSI bus are fast enough, the error on block 370 of the first command could have occurred while the last command was placing its third block of data into the Data Buffer. The last command now terminates with a Check Condition Status due to the write error caused by the first command.

The Data Buffer contains 14 blocks:

- The last 3 unwritten blocks from the first command,
- All 5 of the unwritten blocks from the second command,
- All 3 of the unwritten blocks from the third command,
- The first 3 unwritten blocks from the fourth command.

The residue number returned by the Request Sense Command equals 15 (0F Hex), the 14 blocks in the Data Buffer plus the one remaining in the block count from the last command.

Interpreting the residue as a result of an error during a Write Filemark Command requires a slightly different procedure. Normally, the Command Complete Message for a Write Filemark Command is sent to the Host when the Filemarks are written on the tape, as in the Non-Buffered Mode. For example, the following commands are issued to the drive:

- Write 5 Data Blocks, Write 3 Filemarks.

If an error occurred while writing block 2 of the Write 5 Command, the Command Completion Message and Check Condition Status would be interpreted as being caused by the Write Filemarks Command. In keeping with the SCSI protocol, the residue reported by the Request Sense Command is the 3 Filemarks, not the 4 remaining data blocks. The Host must issue a Recover Buffer Data Command with a block count equal to the Data Buffer size (128K) in order to determine the number of data blocks not yet written. The host can then either subtract the residue reported by the command (the number of free blocks remaining in the buffer) from the buffer size, or count the number of blocks sent by the command.

4.14.23 Reporting Read Errors And Spacing Over Bad Blocks

There are two basic types of Read Errors, Media Error (3 Sense Key) and Blank Check (8 Sense Key). A Media Error is the result of the Block Numbers being out of sequence, or a CRC failure. In an attempt to read the block in question, the drive performs up to sixteen reposition and read cycles. If the block has not been read correctly by the end of the sixteenth try, a Media Error (3 Sense Key) and Unrecoverable Data Error (UDE) is placed in the Sense Data Block. The Blank Check (8 Sense Key) is the result of the drive detecting a blank area (no data) on the tape. This is the case when trying to read a new or erased tape, or when reading beyond the recorded area on the tape. The drive performs three reposition and read cycles over the tape before terminating and placing the Blank Check Sense Key and No Data Detected (NDT) in the Sense Data Block.

Commands that can result in a read error are: Read, Space Over Data Blocks, Space Over Filemarks, Space To End Of Media, Copy, and Verify. In an attempt to recover as much data beyond the error as possible, the Space Over Bad Block feature is automatically enabled for any read mode command immediately following the error. While the drive is passing over the bad blocks it makes three to five tries rather than the usual sixteen before returning a sense to the Host in the normal fashion. If a good block is found with a block number one higher than the last block searched for, no status is sent to the Host, and the drive continues normally from that point.

If a good block has been found but the block number is more than one higher than the last block read successfully, a Media Error (3 Sense Key) is returned. The Host now knows that there is good data on the tape and may attempt to recover the data by issuing more Read Commands.

If no data is found, the drive returns a Blank Check (8 Sense Key). The Host must then decide whether or not to continue the search. If another Read Command is issued, the tape moves the equivalent of 32 blocks before trying again. This is the amount of tape the drive reads in trying to find a block of data and is the minimum distance that a good block could be from the current position on the tape.

4.14.24 Disconnect - Reconnect

When the drive is performing a task that does not require communication with the Host, it physically disconnects from the bus while maintaining a logical connection. Examples of when this might occur are, writing to the tape from a full Data Buffer or repositioning the tape. While the physical connection to the bus is broken, the bus is free to be used by other devices. Both the disconnect and reconnect is initiated by the drive.

When the Host first selects the drive it must send a C0 Identify Message, indicating that it allows the Controller to disconnect and reconnect, and is capable of supporting messages other than Command Complete.

To disconnect from the bus the drive performs the following sequence:

1. The drive sends a Save Data Pointers Message if there was no problem with the data transferred since the start of the command or since the last Save Data Pointers message.

2. The drive sends a Disconnect Message indicating it is about to disconnect.

3. The drive physically disconnects from the bus by tri-stating its bus drivers and de-asserting BSY-.

The bus is now free for an Initiator to select any device on the bus, including the drive that caused the disconnect. Therefore the drive continuously polls the bus for selection by another Initiator. If the drive is selected, it only allows the Initiator to perform the following actions:

- Immediately following the selection, the Initiator may send the Identify, No Message, Abort, or Board Reset messages to the drive.
- The Initiator can then issue a Request Sense or Identify Command. Any other command returns a Reserved or Busy Status to the Initiator.

When the drive is ready to reconnect the physical connection with the Host, it must:

1. Win arbitration for the bus.

2. Re-select the Host. If the Host does not respond within 250 msec., the drive de-asserts the Data Bus signals and waits another 200 usec. for the Host to respond. If the Host still fails to respond, the drive drops all bus signals and allows the bus to enter the Bus Free Phase. The drive now responds in the same manner as it would if it had received an Abort Message from the Host.

3. Send an Identify Message to reestablish the path between the tape drive and the Host. This message is always 80 Hex since the drive is doing the reselection and is always LUN 0. When the drive sends an Identify message to the Host, a Restore Pointers Message is implied and the Host should respond accordingly.

The 5525ES performs a disconnect/reconnect for the following commands:

- Tape positioning commands: Rewind - Erase - Load/Unload
- Data transfer commands: Read - Write - Write Filemarks - Copy
- Commands that read but do not transfer data: Space Data - Space Filemarks - Space Consecutive Filemarks - Space To End Of Media - Verify.

4.14.25 Hardware Error

If the HARDWARE ERROR was reported by the 5525ES drive, no command other then INQUIRY and REQUEST SENSE is accepted. The BUS RESET or power-on cycle is required to clear this condition.

4.14.26 Modes Of Operation

The Wangtek 525 MB drive is capable of operating in multiple density environment. It can Read / Write QIC-525 / 320, QIC-150, QIC-120 and Read QIC-24 densities. All these densities are written on appropriate cartridge types. Whenever a new cartridge is inserted, the drive rewinds the tape to beginning of media (BOM) and automatically detects the cartridge type and density (format) used for the data previously written. It also detects the blank / erased tape.

The 525 MB drive operates in two distinct modes of Read / Write operations;

- Implicit Mode
- Explicit mode

The drive defaults to Implicit Mode after power-up, reset or when a new cartridge is inserted.

IMPLICIT MODE

In this mode, the drive automatically detects the previously recorded density during its Tape Initialization Process. If it is a QIC-525 density then it also finds the size of the recorded block. The Mode Sense command will reflect the density and block size fornd on the tape.

If a Read operation is issued the drive switches to the previously recorded density and reads the tape. More data can be appended at the end of recorded data on the medium. This Write Append operation is carried out in the same density (previously recorded) regardless of the cartridge type being used.

If a Write or Write Filemark command is issued at BOM and no Mode Sense command was issued after cartridge insertion, then the drive records the data in the highest density allowed by the cartridge type. For QIC-525 density the drive uses 400H (1024) bytes for the block size. If the Mode Sense command was issued before the Write/Write Filemark command, then the drive recordes data in the previously recorded density and block size. Any Mode Select command issued to the drive at BOM, with density

Table 4-12
Implicit Mode

CARTRIDGE TYPES	QIC-525 FORMAT	QIC-150 FORMAT	QIC-120 FORMAT	QIC-24 FORMAT
DC6320	READ WRITE BOM WRITE APPEND	READ WRITE APPEND	READ WRITE APPEND	READ ONLY
DC600XTD	NOT APPLICABLE	READ WRITE BOM WRITE APPEND	READ WRITE APPEND	READ ONLY
DC600A	NOT APPLICABLE	NOT APPLICABLE	READ WRITE BOM WRITE APPEND	READ ONLY
DC300XL/P	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	READ ONLY

code other than zero (default density) will take the drive out of Implicit Mode. Table 4-12 shows the density used when a cartridge is read or written, while the drive is in the Implicit Mode.

EXPLICIT MODE

In Explicit Mode the drive explicitly uses the density specified by the host via Mode Slect command (density code other than zero) for Read and Write operation.

For Write operation if cartridge type does not allow to use specified density "Check Condition" status is returned and sense key is set to "Illegal Request".

Similarly for Read operation, if specified density does not match to the recorded density than a "Check Condition" status is returned and sense key is set to "Illegal Request".

Since drive defaults to Implicit Mode after power-up, Reset or whenever a new cartridge is inserted, a Mode Select command is required with desired density code to put the drive into Explicit Mode. The valid density codes for Explicit mode are:

DENSITY CODE	EXPLICIT FORMAT SELECTED
05H	QIC-24 (READ ONLY)
0FH	QIC-120
10H	QIC-150
11H	QIC-320 / 525

Table 4-13 shows which cartridge type should be used for specified density:

Table 4-13
Explicit Mode

CARTRIDGE TYPES	QIC-525 FORMAT	QIC-150 FORMAT	QIC-120 FORMAT	QIC-24 FORMAT
DC6320	READ WRITE BOM WRITE APPEND	READ WRITE BOM WRITE APPEND	READ WRITE BOM WRITE APPEND	READ ONLY
DC600XTD	ILLEGAL REQUEST	READ WRITE BOM WRITE APPEND	READ WRITE BOM WRITE APPEND	READ ONLY
DC600A	ILLEGAL REQUEST	ILLEGAL REQUEST	READ WRITE BOM WRITE APPEND	READ ONLY
DC300XL/P	ILLEGAL REQUEST	ILLEGAL REQUEST	ILLEGAL REQUEST	READ ONLY

TAPE INITIALIZATION

After power-up, reset or whenever a new cartridge is inserted the drive rewinds the tape to BOM, detects the cartridge type and detects the recorded density as part of Tape Initialization process. Sometime this process takes more than a minute. During this process drive reports "cartridge in" status only in the

request sense data. When Tape Initialization is completed then "cartridge in" and "BOM' status is reported in request sense data.

Since Tape Initialization takes a long time, it is recommended that host issues the Rewind command after insertion of a new cartridge so that it does not time out. During Tape Initialization, the drive can be put into Explicit Mode via a Mode Select command with proper density code.

In the Implicit mode and during Tape Initialization the drive receives a Write command than the drive disconnects the host. When Tape Initialization is completed the drive receives the write data in proper density according to cartridge type.

If in Explicit mode and during Tape Initialization the drive receives a write command then drive receives the data into specified density format until the buffer is full and then disconnects the host. If cartridge type does not allow to write the data into specified density, then a "Check Condition" status is returned and sense key is set to "Illegal Request".

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 provides a general overview of the drive electronics and its connections. There are two primary sources of input signals to the drive. These are Power input and Interface signals received from the host. All internal and external connectors and signal information are listed below.

- J1 50 Pin interface connector to/from the host
- J2 8 Pin dip socket connector to/from CIN and sensor assembly
- J3 8 Pin connector from the read head
- J4 16 Pin header to the motor control board
- J5 8 Pin connector to the write head
- J6 7 Pin connector to the head stepper motor

An Electrical Interconnect Diagram is provided in Figure 5-1

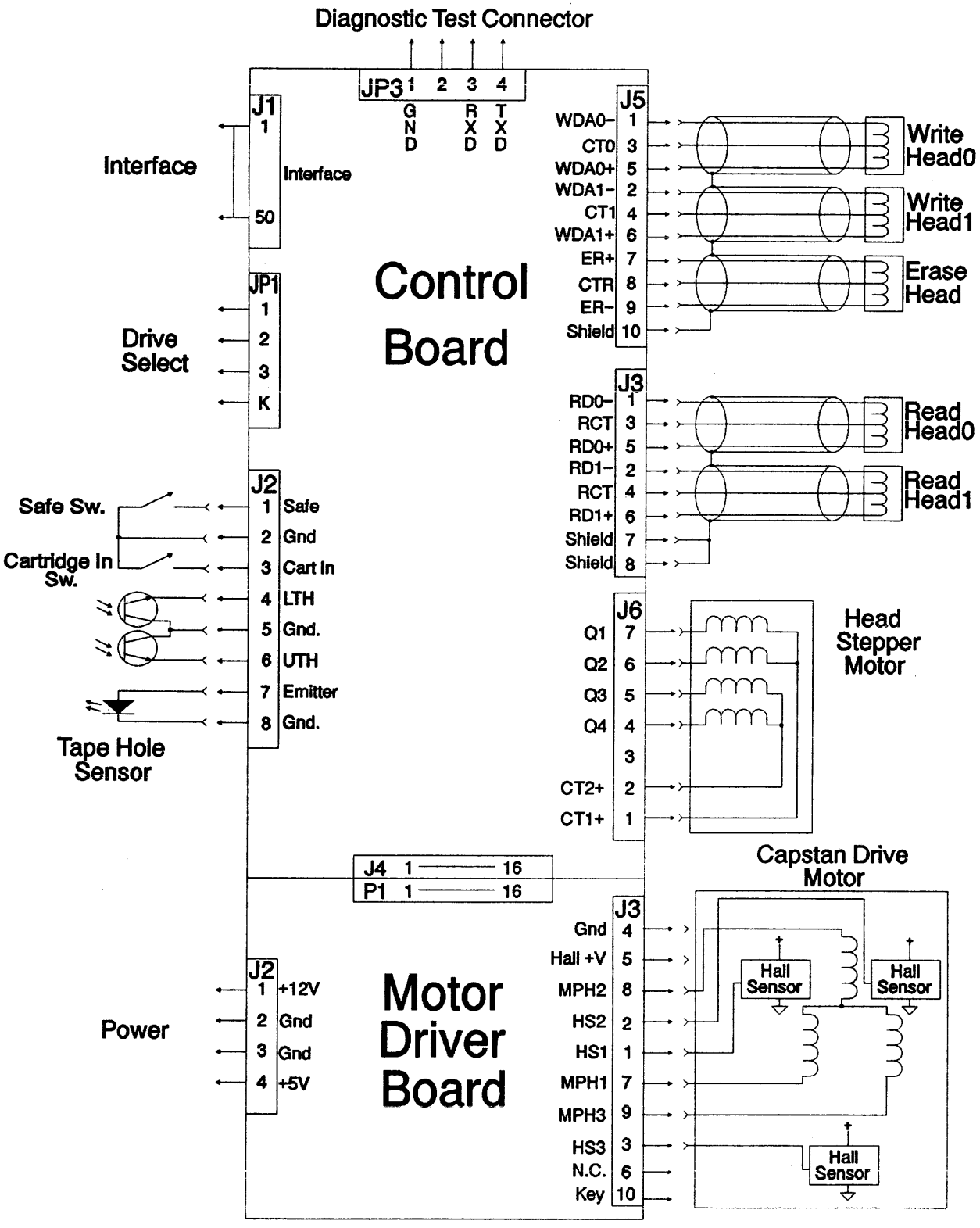


Figure 5-1
Electrical Interconnection Diagram

5.3 Functional Discriptions

A Functional Block Diagram of the 5525ES is provided in Figure 5-2.

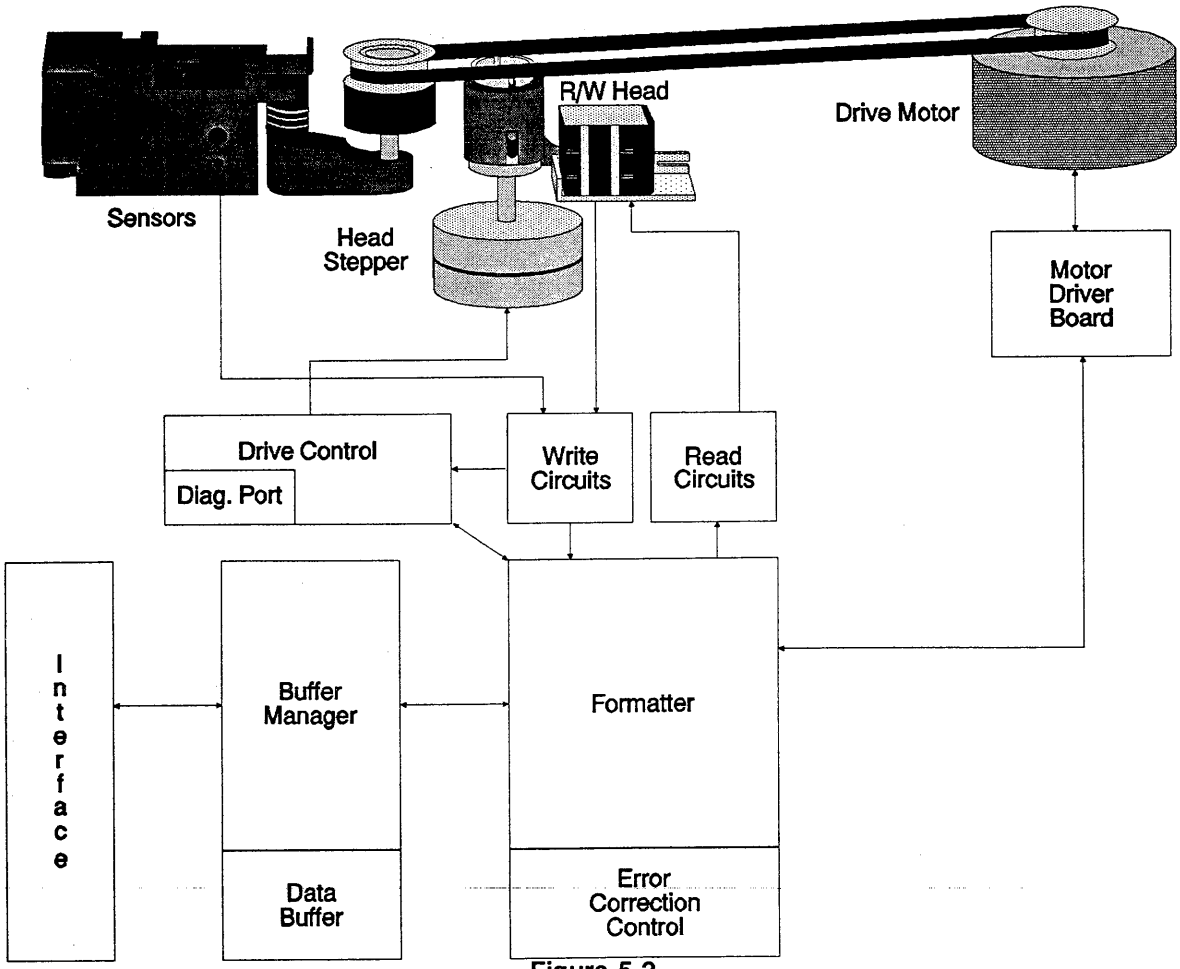


Figure 5-2
Functional Block Diagram

5.3.1 Interface

The interface signals, consisting of commands, ststus, write data and read data are combined to provide a multiplexed interface bus. The Interface block is responsible for all comunication and protocal on the SCSI bus. All commands are pased through the Buffer Manager to the Formatter whare they are decoded.

5.3.2 Buffer Manager & Data Buffer

All data transfered into or out of the drive passes through the Buffer Manager. When opperating in buffered mode, all write data is routed to the Data Buffer at high speed. When the tape has reached operating speed, the write data will be transfered from the Data Buffer to the tape. During read operations, the first read will cause the buffer to pre-read the tape, filling the buffer. Subsiquent reads will transfer data from the buffer to the interface at high speed.

5.3.3 Formatter & Data Error Correction Control

The Formatter is responsible for all data encoding, decoding and error corection as it pases from the the Data Buffer to the tape. Write data is translated from parallel to a serialstream, the Error Correction Code (E.C.C.) is calculated and appended to the stream. The stream is then transformed into Group Code Recording format and grouped into data frames. Read data is decoded, checked and corrected if required, translated into parallel format and sent to the Data Buffer.

The Formatter also controls the Capstan Drive Motor through the Motor Driver Board. Motor communtation signals are sent to the Motor Driver Board, where they are amplified to drive the capstan drive motor. Feedback from the motor's Hall sensors are routed back to the Formatter to control the direction and speed of the motor.

5.3.4 Drive Control

The Drive Control block accepts and executes track position commands from the Formatter. This block also provides direct access to the drive Formatter through the Diagnostic Port, by-passing the interface. The Diagnostic Port is used to access test and adjustment procedures built into the drive during the manufacturing process.

5.3.5 Motor Driver Board

The tape velocity servo can be characterized as a microprocessor controlled digital phase lock servo using pulse width modulation to drive a low inertia brushless DC motor. 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. The velocity control and error detection logic is implemented in the Formatter. Communtation signals are amplified and supplied to the drive motor by the Motor Driver Board. Feedback signals from the motor's Hall sensors are routed back to the Formatter to control the direction and speed of the motor.

5.3.6 Write And Erase Circuits

The Write and Erase circuits are depicted in Figure 5-3. The internal signals which control the circuits are "Write Enable" (WEN) and Erase Enable (EEN). The Wangtek Custom Write I.C. consists of write logic plus tape hole sensor logic. The state of the "Write Data Signal" (WDA+) determines if positive or negative current flows through the selected head. The write drivers are disabled during a power up/down sequence and while the "SAFE" switch is enabled. The output of the Write I.C. is connected to the write head in order to record data onto tape.

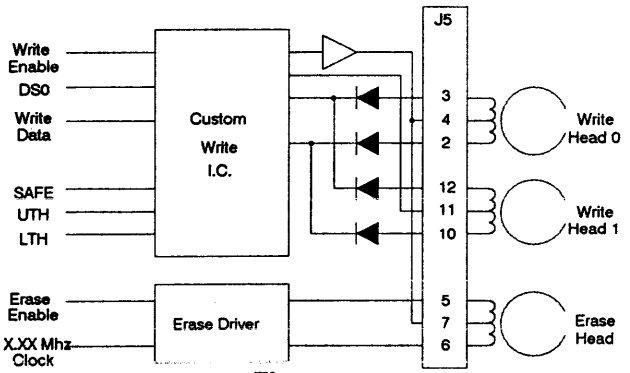


Figure 5-3
Write And Erase Circuits

5.3.7 Read Circuits

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 2441 Read Signal Processor Chip which outputs the Read Data in digital form.

5.4 Track Calibration Routines

T.B.D.

5.4.1 Writing Track 0 Reference Burst

T.B.D.

5.4.2 Track Zero Burst Detection

T.B.D.

5.5 Major Component Functions

5.5.1 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 photo transistors located in the sensor housing perpendicular to the emitter. The photo transistor 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. Connector J2 also routes the CIN and SAFE signals to the drive CPU for processing.

5.5.2 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 J6 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 a peripheral driver in order to move the stepper motor the desired number of steps.

In normal operation, 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 rotation. 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 with a stepper motor to provide controlled rotation of the shaft. The shaft is attached to a threaded sleeve which, as the lead screw is rotated, will push the magnetic head mounting assembly up and down depending on the sequence of inputs.

5.5.3 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. It has two track capability, due to the two read heads, two write heads, and full width erase bar. Refer to Figure 5-4. The head assembly has read, write, and erase functions and also utilizes two intrigal tape cleaner blades at each end of the assembly. The magnetic head is designed to be compatible with the QIC-525 recording format. It is also compatible with the QIC-120 & QIC-150 recording format guidelines.

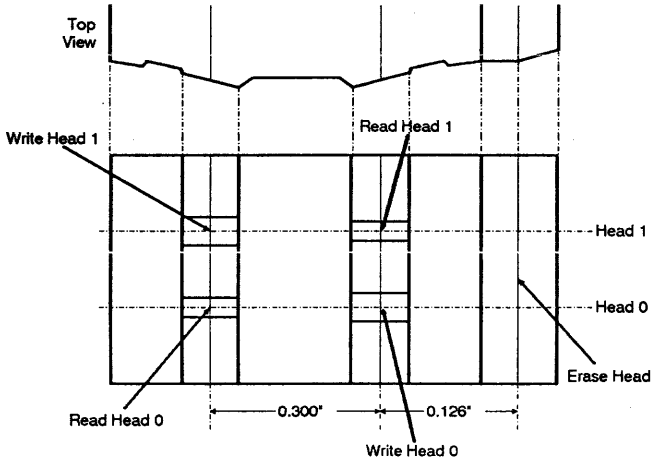


Figure 5-4
Read / Write Head Assembly

5.6 Electro-Static Discharge Specification

This section describes the ESD test amplitude and criteria for the 5525ES when tested in a computer system. The purpose is to describe a standard ESD qualification test that ensures satisfactory operation of the 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.

5.6.1 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.

5.6.2 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.

5.6.3 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 casting. 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 Occurence Rates

TEST AMPLITUDE AND CRITERIA					
		EFFECTS			
GROUP	TEST	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.

6.2.3 Duty Cycle

The drive duty cycle is defined as follows:

$$DutyCycle = \frac{Tape\ Motion}{Power\ On\ Time} 100$$

The typical usage duty cycle for the drive is 15%

6.2.4 Mean Time Between Failure

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

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

Based on the typical usage duty cycle of 15%, the MTBF of the drive is 30,000 hours. This value is based on the MIL-STD-217 Part Stress Calculation Method.

6.2.5 Mean Time To Repair

The mean time to repair the drive is 30 minutes.

6.2.6 Data Reliability

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

Hard Errors (Read): less than 1 in 10^{14} bits

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

6.3 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	8 (or as required) (2 hours with new tapes)
Capstan Cleaning	20 (or as required) with used tapes

6.3.1 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.

6.3.2 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. Allow the capstan material to dry completely before inserting a tape cartridge. NEVER clean the capstan with the head cleaning solution or Freon TF as severe damage may result.

6.4 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.*

6.4.1 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.

6.5 Power Malfunction

6.5.1 No +5 VDC and/or +12 VDC

- Insure that the power supply connector P2 is installed properly. Check for shorts on the Main board. If any are found, return the drive to a Wangtek authorized repair center.

6.6 Tape Motion Malfunction

6.6.1 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.

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

- Return unit to a Wangtek authorized repair center.

6.6.3 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.

6.6.4 Motor starts to drive cartridge but stops immediately.

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

6.6.5 Motion causes excessive noise.

- Return unit to a Wangtek authorized repair center.

6.7 Status Malfunction

6.7.1 No UTH or LTH signals.

- Insure that J2 connector is seated properly. If the problem is not resolved, return the unit for repair to an authorized Wangtek repair center.

6.7.2 UTH and/or LTH present at all times.

- Return the unit to a Wangtek authorized repair center.

6.7.3 SAFE signal not functioning.

- Insure that the J2 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

6.7.4 CIN signal not functioning.

- Insure that the J2 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

6.7.5 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.

6.7.6 L.E.D. always lit.

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

6.8 Data Malfunction

6.8.1 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

6.8.2 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.

6.8.3 Drive will not read on one track.

- Return the drive to a Wangtek authorized repair center.

6.8.4 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

6.8.5 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

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

- Return the unit to a Wangtek authorized repair center.

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

- Return the unit to a Wangtek authorized repair center.

6.8.8 Excessive data errors in all modes.

- Return the unit to a Wangtek authorized repair center.

6.8.9 The drive is non-operational. No tape movement, SCSI interface inoperative.

- Check the +5, +12 volt supplies. Make sure the SCSI 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.

6.8.10 The drive does not respond to SCSI selection.

- Verify that the JP1 jumpers represent the correct drive.
- Verify that the JP2 jumpers represent a valid configuration
- Verify that the SCSI cable is inserted firmly.
- A diagnostic error has occurred, return the unit to a Wangtek authorized repair center.

6.8.11 The drive only operates after the SCSI reset.

- Power supply up-ramp is too slow. Use a power supply with a faster rise time.

6.8.12 Tape drive does not respond to commands.

- Cartridge in drive?
- Check drive interface cable polarity.
- Issue an Inquiry Command and check bytes 07 Hex and 0E Hex for drive presence and ready status. A good status from the inquiry indicates a drive, cable or I/O driver problem.
- Change the interface cable. If this does not correct the problem, return the unit to a Wangtek authorized repair center

6.8.13 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. The drive is bad. Sense Data indicates a hardware error. 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.

6.8.14 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.

6.8.15 Cannot read tape beyond a predefined track

- Tape was recorded with incorrect number of maximum tracks set by a Set Read/Write Parameters Command.
- Any odd to even track change should cause mechanical head movement within the drive. 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.

6.8.16 Tape Does Not Stream

- Host data handshake is too slow. Speed up DMA rate or reduce the SCSI bus activity.
- Minimum transfer size is too large. Use the Set Read/Write Parameters Command to adjust the number of blocks the drive accumulates before sending data to or receiving data from the Host.

6.9 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.*

6.9.1 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.

6.9.2 Front Bezel

Remove the screws on each 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

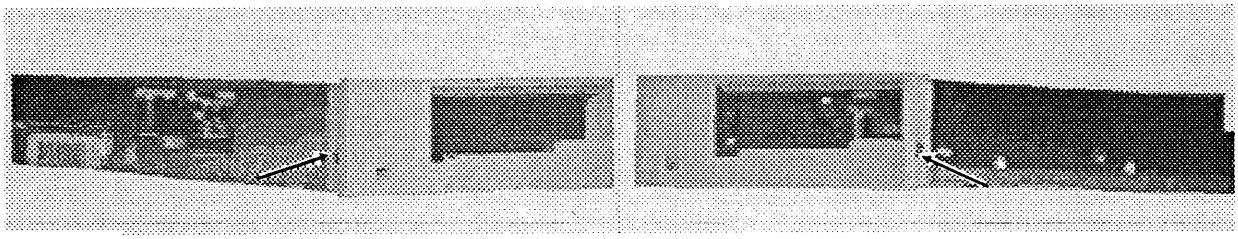


Figure 6-1
Front Bezel Removal

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.

6.9.3 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 three mounting screws (indicated by arrows) and the spacer located near the drive motor. Lift the rail away from the drive taking precautions not to damage the flex cable which is mounted under the rail.

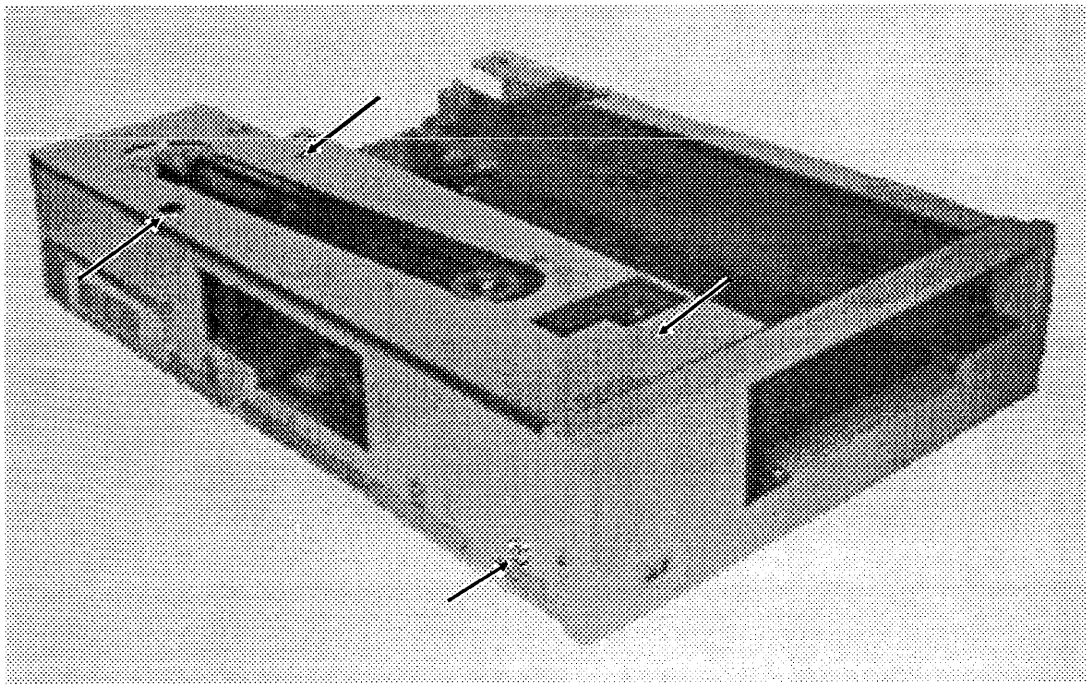


Figure 6-2
Left Side Rail Removal

> *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 conductor cable is not damaged during installation. Check also that the cartridge ejector slides freely.

6.9.4 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 6-2. 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 three (3) 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

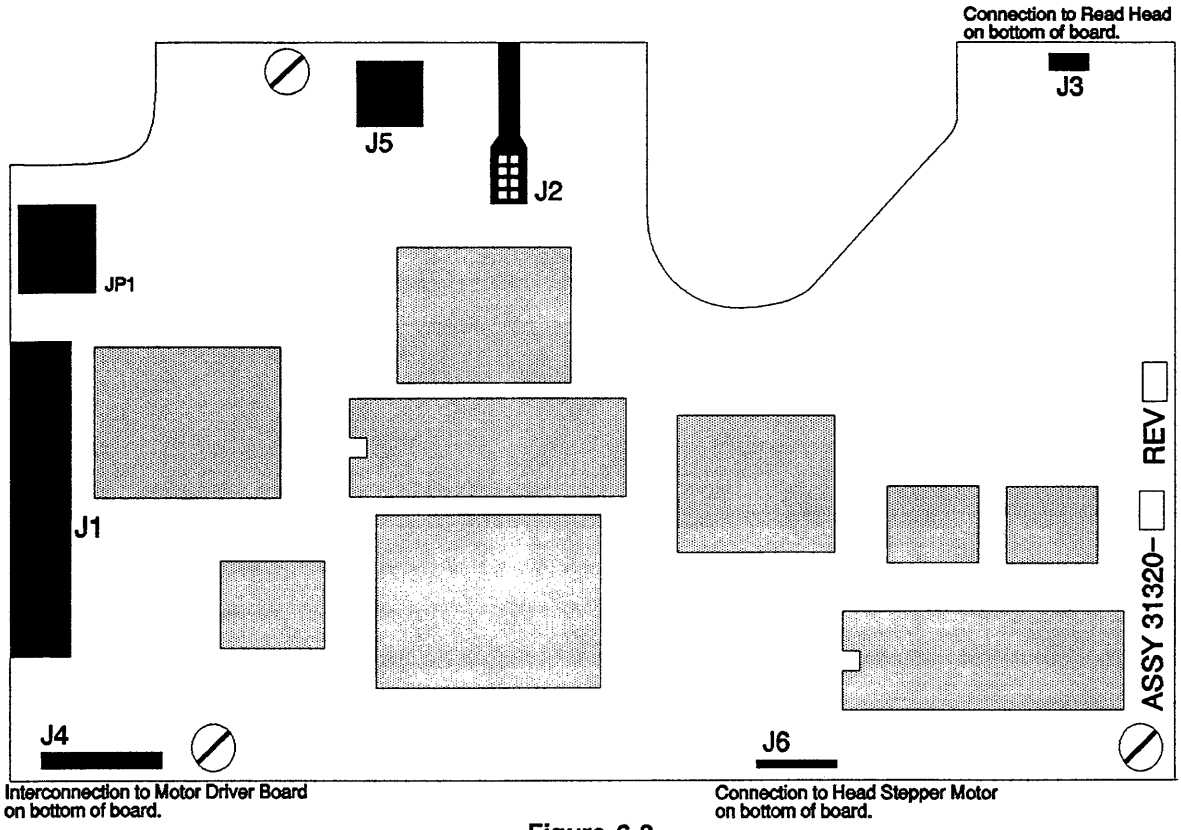


Figure 6-3
Main Board Removal

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.

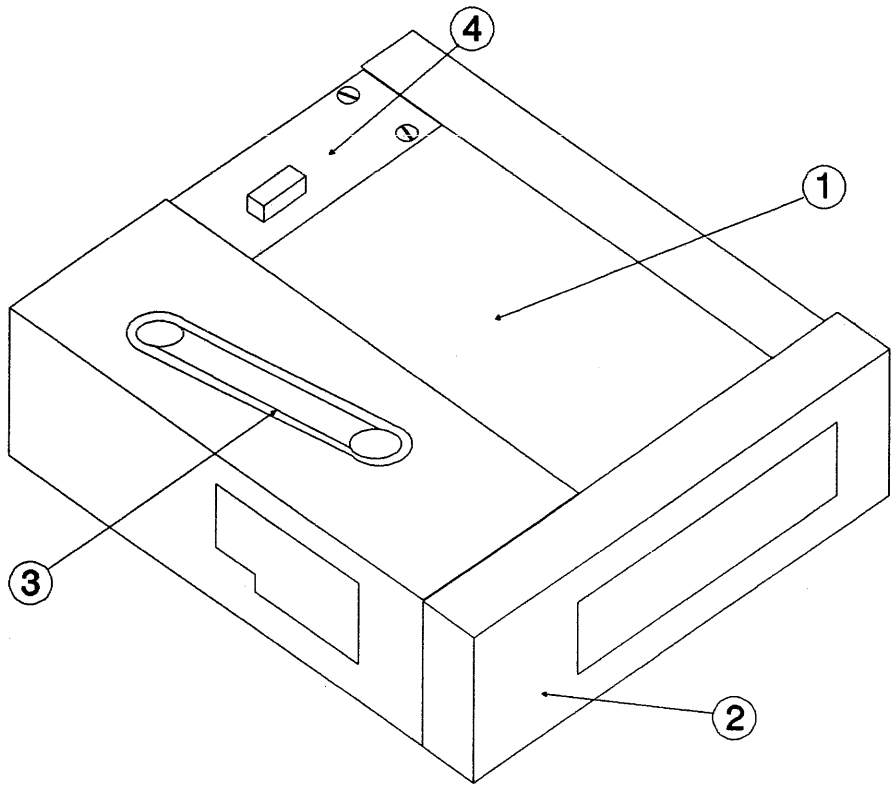
Section 7 PARTS LISTS, APPENDIX AND SCHEMATICS

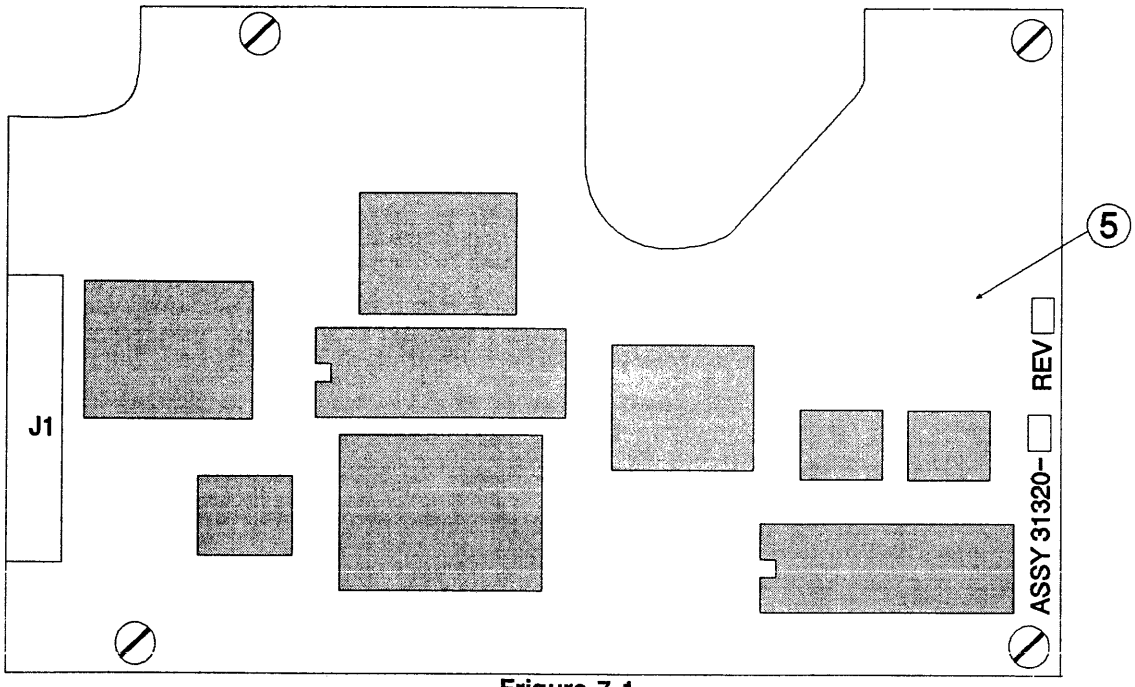
7.1 Introduction

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.





Frigure 7-1
Illustrated Parts Breakdown

Table 7-1
Illustrated Parts List

Index #	Wangtek Part #	Description
1	33566-XXX	Chassis Assembly
2	33559-001	Bezel, Half Height Black
3	23732-001	Drive Belt
4	33584-XXX	Motor Driver PCBA
5	33579-XXX	Main Board/Insulator PCBA
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.

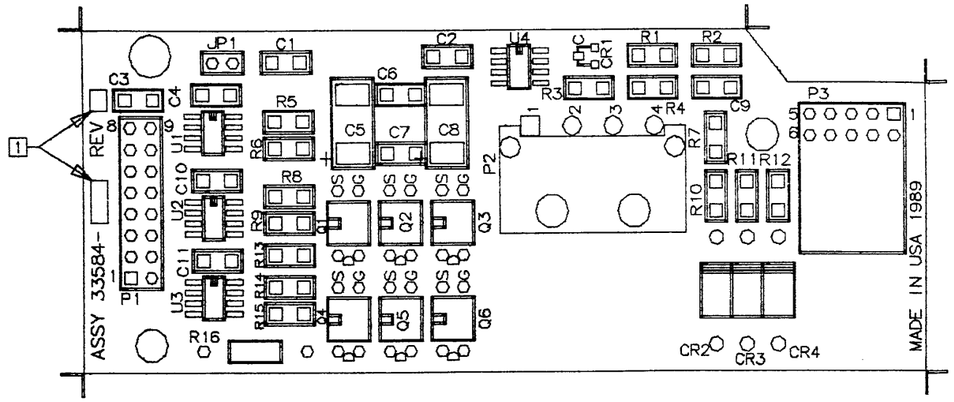
TRACK - A recording strip parallel to the edge of the magnetic tape containing recorded information.

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

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



NOTES: (UNLESS OTHERWISE SPECIFIED)

[1] IDENTIFY THE BOARD WITH THE APPROPRIATE ASSY DASH NUMBER AND REV LETTER ON THE COMPONENT SIDE OF THE BOARD IN THE AREA SHOWN PER WANGTEK MARKING SPECIFICATION 40024.

2 THE FLATNESS OF THE ASSEMBLED BOARD TO BE WITHIN .060.

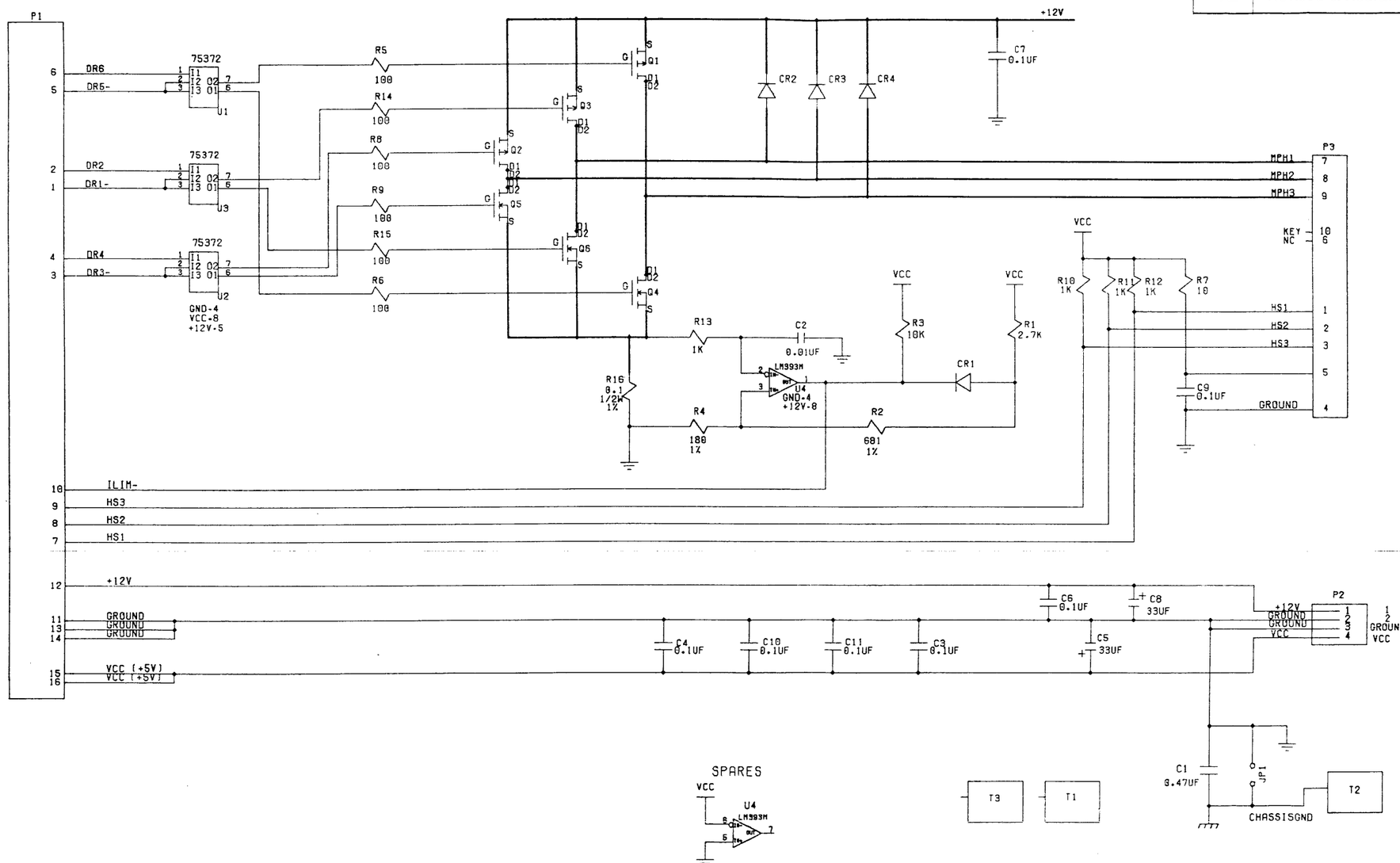
3 BEFORE PERFORMING FINAL TEST, ALL ASSEMBLED BOARDS MUST BE BURNED IN PER WANGTEK SPECIFICATION NO. 40068-001.

33580-001	320 MB
NEXT ASSY	USED ON

CONTRACT NO.		wangtek
DRAWN RAISA WESENBERG	DATE 4/26/89	TITLE ASSY, PCB, MTR DRVR BRD-320MB
CHECKED		
ISSUED		

SIZE	FSCM NO.	DRAWING NUMBER	REV
D		33584-000	A
SCALE	RELEASE DATE	SHEET 1	

Application		Revisions			
Next Assy	Used On	Rev.	Description	Date	Approved
		X1	Engineering Rel Per E.O.# 12721	8/15/89	
		X2	Revised & Redrawn Per E.O. # 12781	8/30/89	



2. All Capacitor Values Are In Microfarads.
1. All Resistor Values Are In Ohms.

Notes: Unless Otherwise Specified.

Unless otherwise specified, dimensions are in inches.	Approvals	Date
	Drawn R. Wesenberg	8/30/89
Material	Checked	
Finish	Issued	
DO NOT SCALE DRAWING Form WXXXA 2/89		

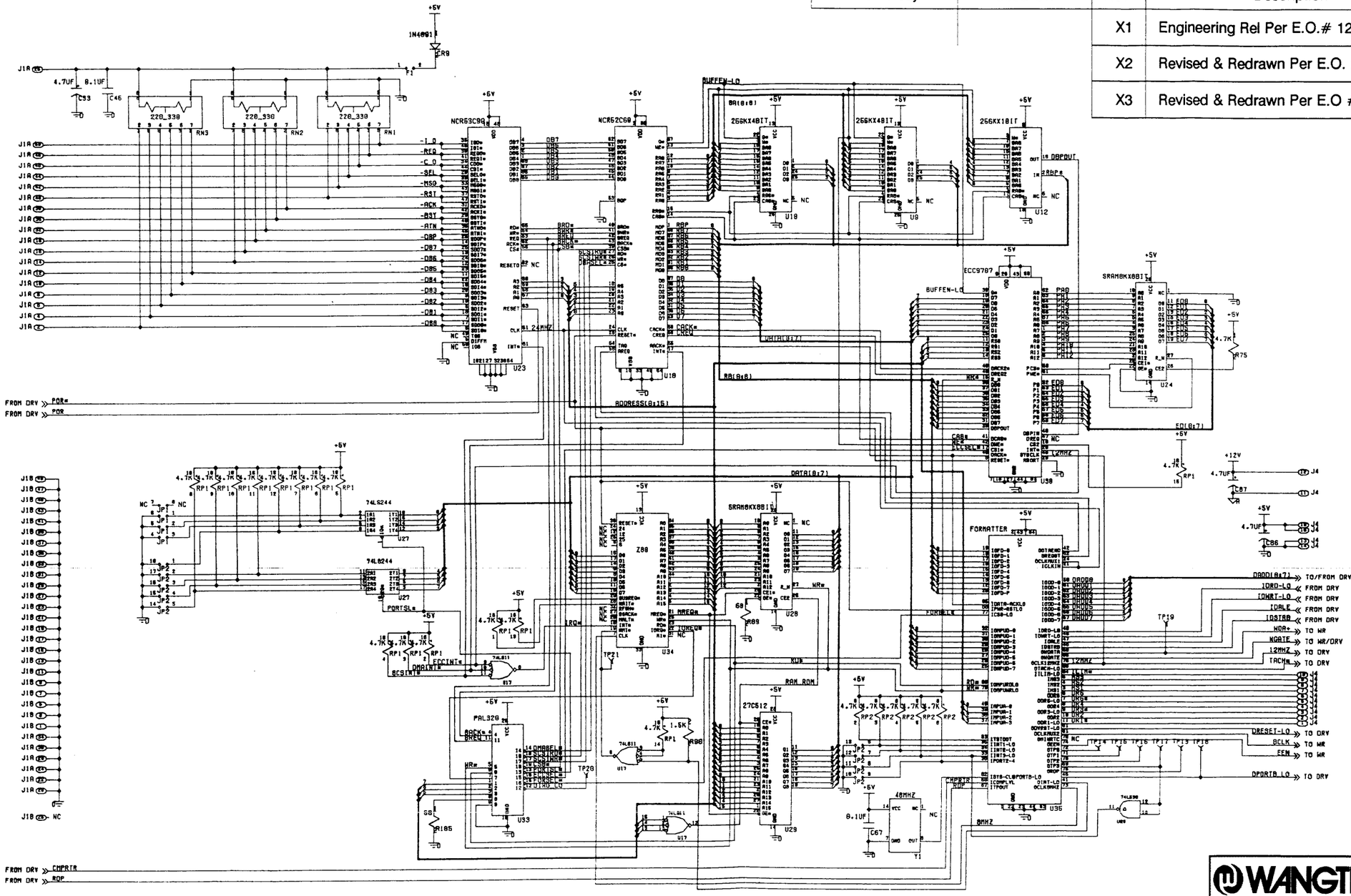
WANGTEK
41 Moreland Road
Simi Valley, CA. 93065

TITLE
Schematic, Motor Driver Board 320MB

Size	FSCM	DWG. NO.	REV.
B		43602-001	X2
Scale		Sheet 1 of 1	

Application	
Next Assy	Used On

Revisions			
Rev.	Description	Date	Approved
X1	Engineering Rel Per E.O.# 12721	8/15/89	
X2	Revised & Redrawn Per E.O. # 12752B	8/23/89	
X3	Revised & Redrawn Per E.O # 12820	9/13/89	



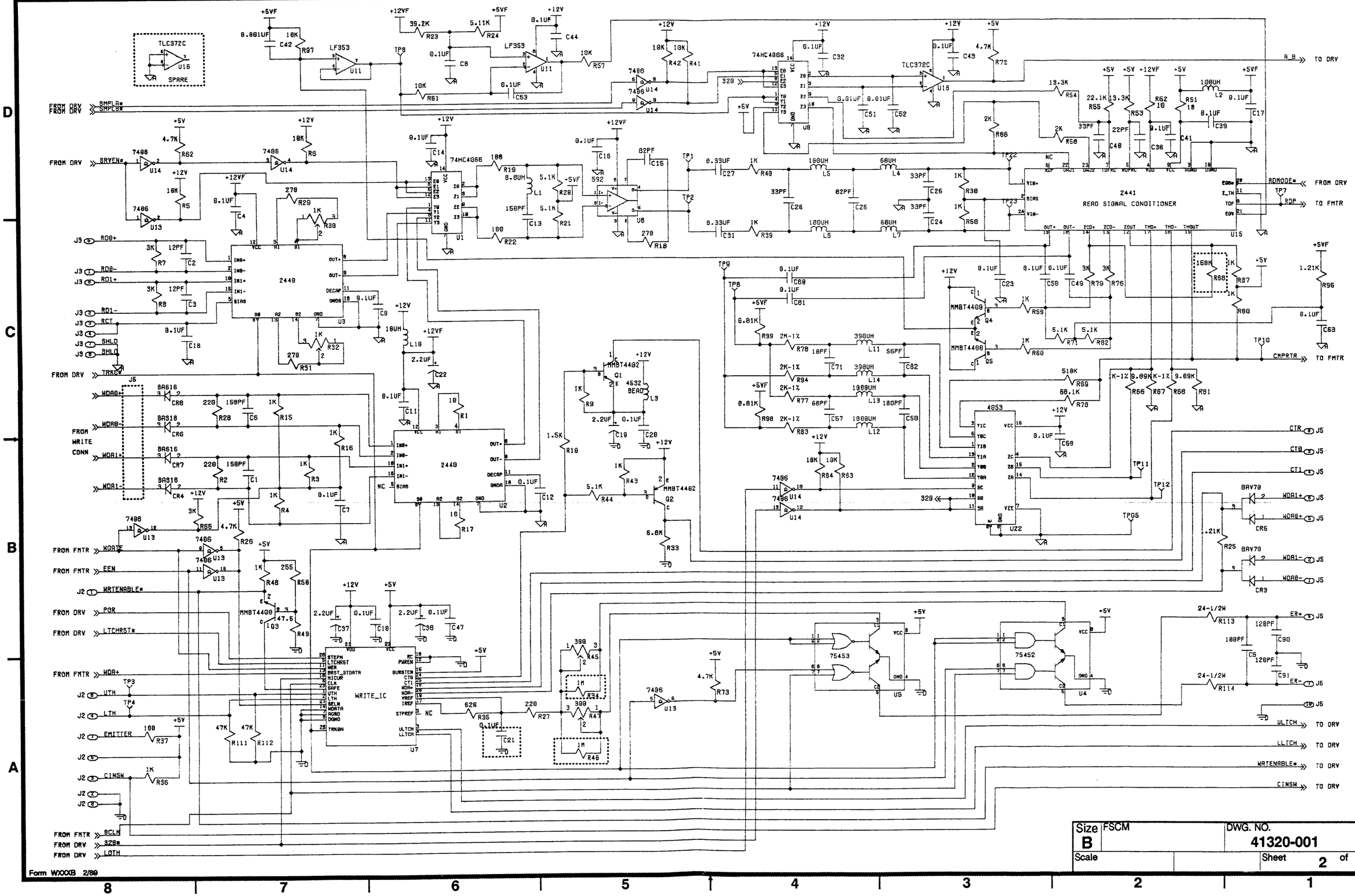
Notes: Unless Otherwise Specified.

Unless otherwise specified, dimensions are in inches.	Approvals	Date
	Drawn R. Wesenberg	9/13/89
Material	Checked	
Finish	Issued	
DO NOT SCALE DRAWING Form WXXXA 2/89		

WANGTEK
41 Moreland Road
Simi Valley, CA. 93065

TITLE
Schematic, Embedded SCSI 320MB

Size	FSCM	DWG. NO.	REV.
B		41320-001	X3
Scale		Sheet 1 of 3	



Size	FSCM	DWG. NO.	REV.
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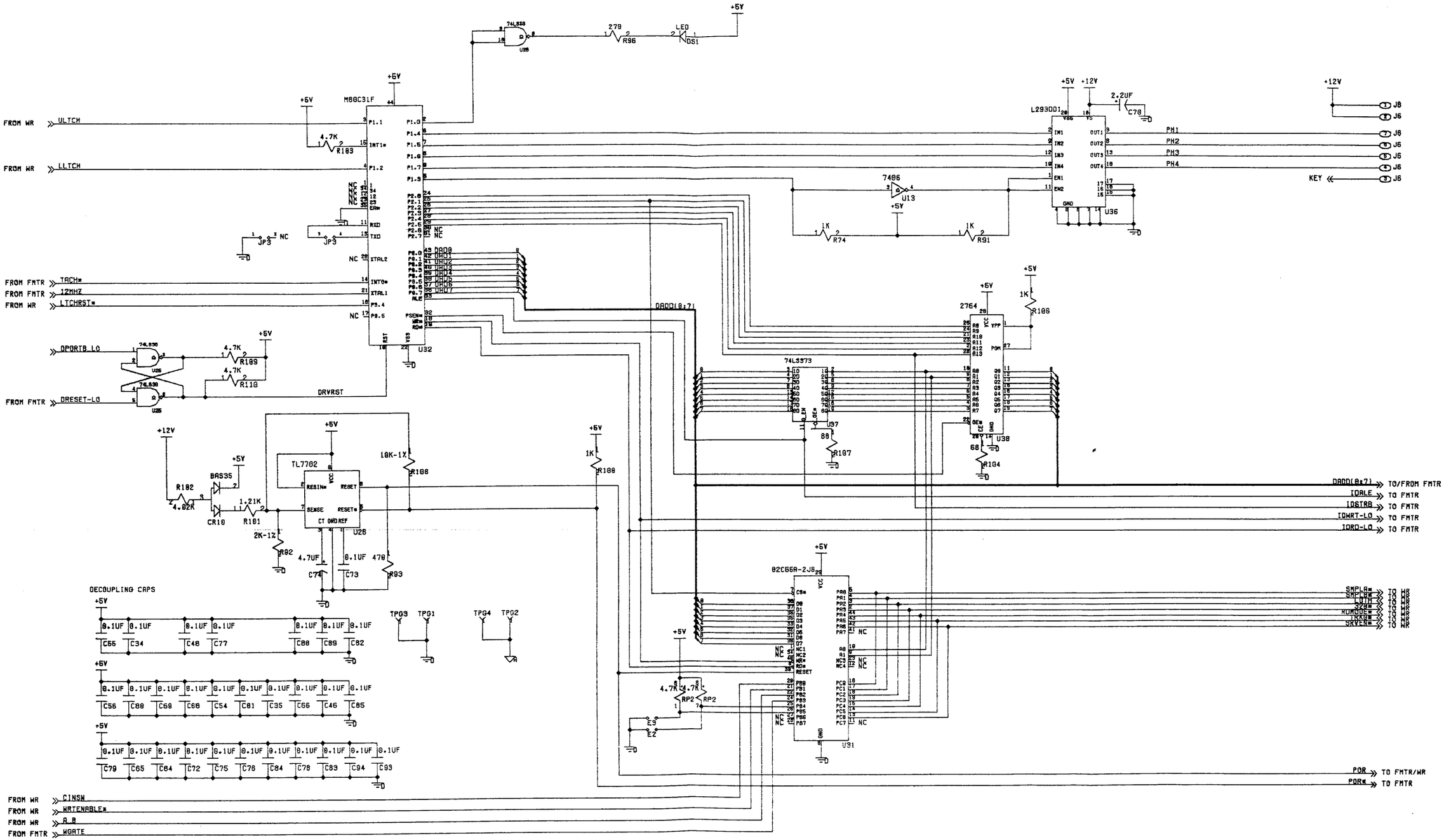
Scale		Sheet 2 of 3	

Form WXXXB 2/89



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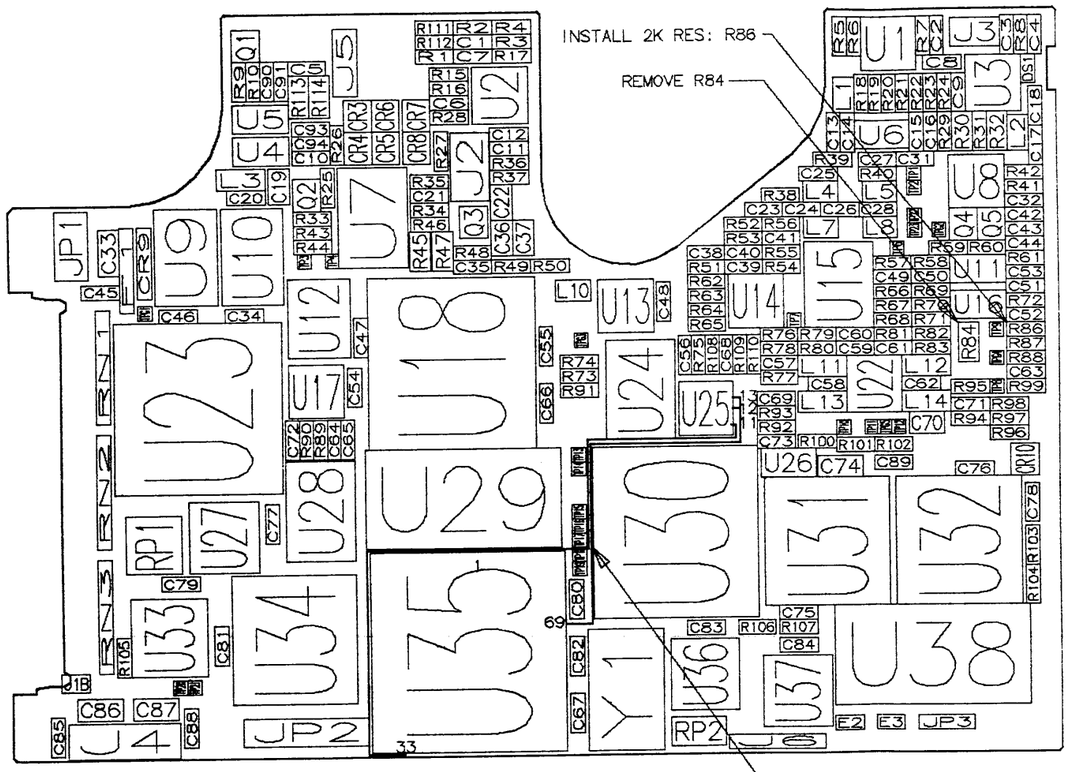
Scale		Sheet 3 of 3	

Form WXXXB 2/89



OUTLINE DETAILS OF COMPONENT PLACEMENT

CONTRACT NO.		wangtek
DRAWN RAISA WESENBERG	DATE 7/12/89	TITLE ASSY, PCBA EMBEDDED SCSI 320MB
CHECKED		
DESIGN		
DESIGN ACTIVITY		SIZE / FSCM NO. / DRAWING NUMBER 31320-000 X2
		SCALE / RELEASE DATE / SHEET 2