

Viper[®] SCSI

Models 60S, 125S, and 150S
1/4-Inch Streaming Cartridge Tape Drive

Theory of Operation and Maintenance Manual



ARCHIVE[®]
CORPORATION

Viper[®] SCSI

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1/4-Inch Streaming Cartridge Tape Drive

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PREFACE

Archive Viper tape drives are manufactured to ensure high performance in a 1/4-inch streaming tape drive. Viper enhanced mechanics and performance features include an embedded controller in a half-high 5-1/4 inch form factor drive.

The manual contains detailed technical information about Viper SCSI (Small Computer Systems Interface) tape drives. SCSI technology provides a flexible environment by allowing up to eight devices to be daisy chained. Archive Viper drives conform to ANSI Specification X3.31 and QIC tape format standards.

Archive's commitment to high quality and advanced technology mean Viper tape drives are efficient and reliable for data backup in varied installations and environments.

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CHAPTER 1 INTRODUCTION

1.1 Overview

Archive's Viper® SCSI models 60S, 125S, and 150S are 1/4-inch streaming tape drives that provide reliable and cost-efficient backup for high-capacity Winchester disk drives. Other applications include software distribution, transaction logging, data collection, data exchange, and program loading. Viper SCSI drives, featuring LSI circuitry and surface-mount technology, conform to ANSI X3.131 and QIC format standards. Backward read compatibility with previous Archive drives is standard with all Viper models.

1.2 Viper Capacities

Viper drives are available in internal and external models. Storage capacity varies from 45 megabytes to 150 megabytes. Table 1-1 shows the capacity for each model.

Table 1-1. Viper Streaming Tape Drive Storage Capacities

VIPER MODEL	STORAGE CAPACITY
60SI	* 45 or 60 megabytes
125SI	125 megabytes
150SI	* 125 or 150 megabytes
Viper 60E	60 megabytes
Viper 150E	150 megabytes

*Formatted capacity is determined by type of data cartridge used. Refer to Chapter 2 for data cartridge specifications.

1.3 Physical Description

The Viper drive consists of multiple mechanical subassemblies, two electrical assemblies (PCB's), and a front bezel. All are assembled in a half-height, 5 1/4-inch drive chassis configured to fit inside a standard half-height floppy disk slot.

1.4 System Configurations

The SCSI standard supports up to eight IDs. These IDs can refer to host adapters or peripheral devices such as printers, magnetic disks, optical disks, or tape drives. Figure 1-1 shows examples of SCSI systems.

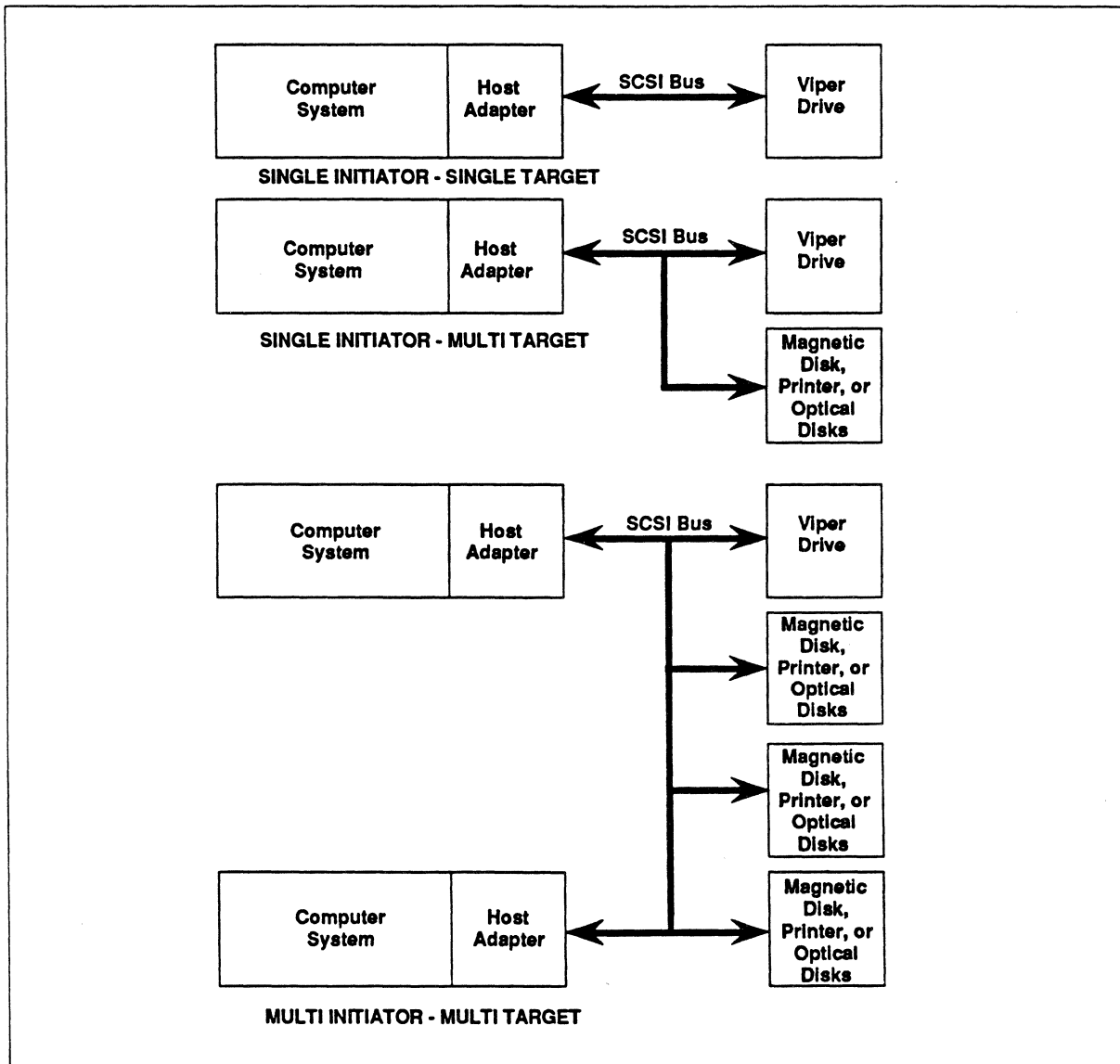


Figure 1-1. SCSI Bus Support Configurations

1.5 Viper Drive Models

Figure 1-2 shows a top view of a Viper Internal drive and its subassemblies. Figure 1-3 shows a front view of a Viper external drive.

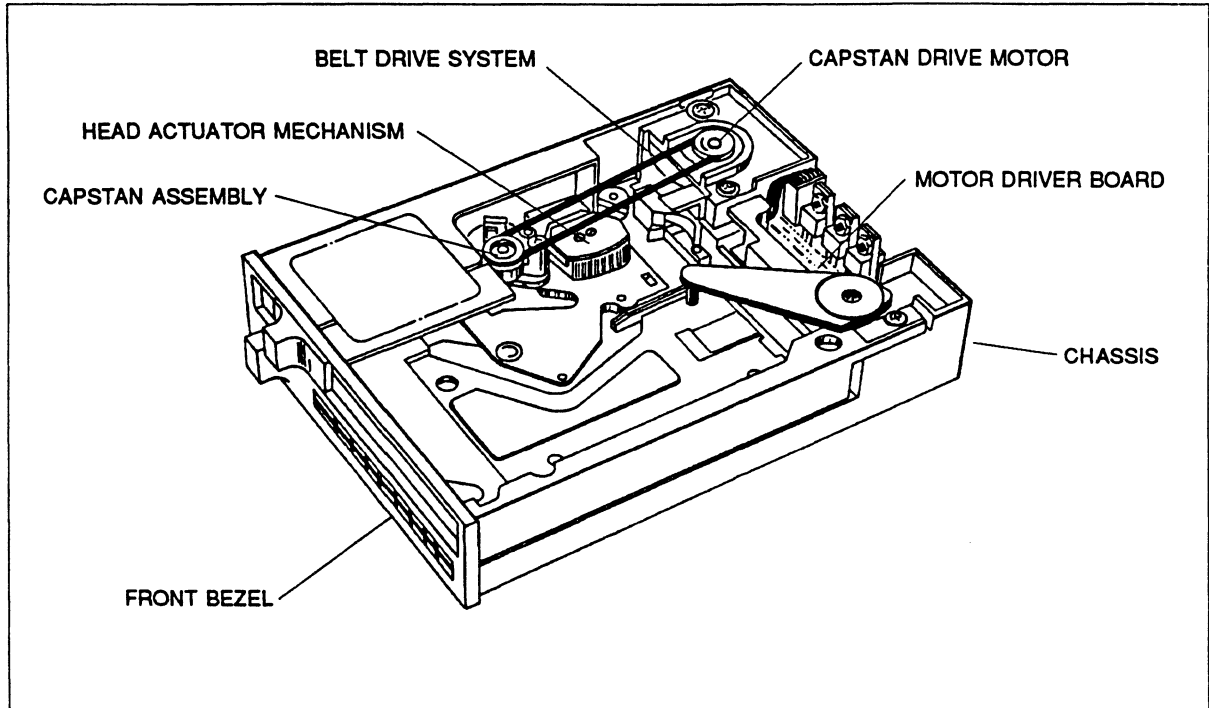


Figure 1-2. Top View of Viper Drive

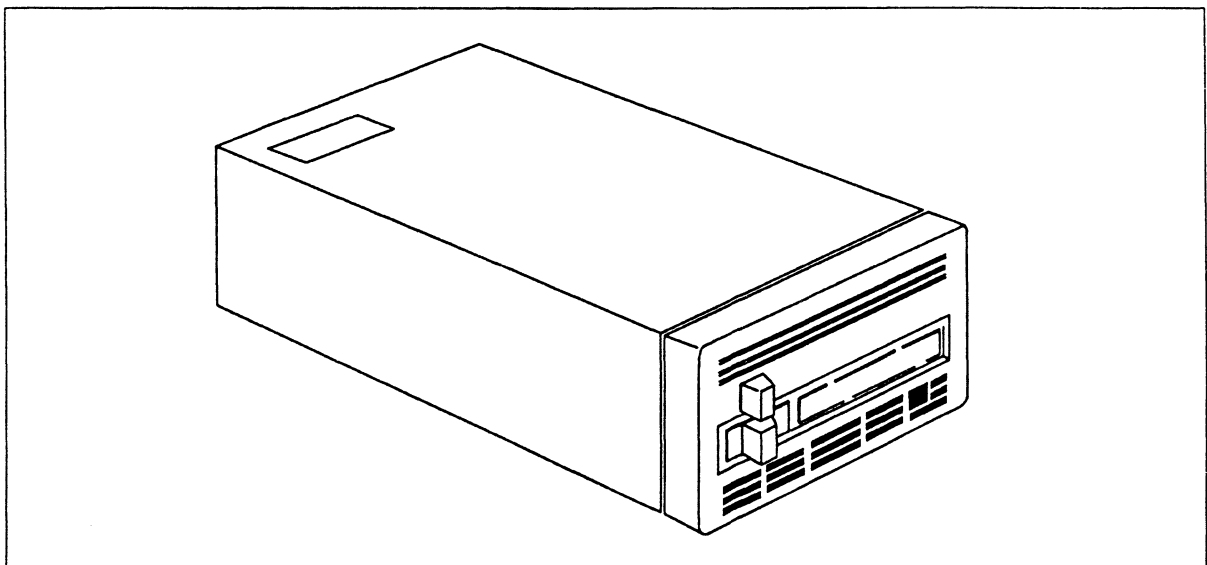


Figure 1-3. Front View of Viper External Drive

1.6 About This Manual

The remaining chapters in this manual are described briefly in the table below.

Table 1-2. Chapter Descriptions

CHAPTER NUMBER	CHAPTER TITLE	DESCRIPTION
2	Specifications	Contains the physical, performance, environmental, power, data and tape handling, tape cartridge specification tables, and SCSI conformance statement.
3	Installation	Contains guidelines, cautions, unpacking tips, and inspection information.
4	Interface	Describes the Viper SCSI interface including signals, pin assignments, and timing.
5	Viper SCSI Commands	Individually describes the SCSI sequential access device commands used in the Viper drive.
6	Theory of Operation	Details the functional operation of each assembly of the Viper drive with descriptions of the tape drive cartridge and media formats.
7	Maintenance and Reliability	Gives preventive maintenance schedule and procedures. Also included in this chapter is information about reporting problems.

CHAPTER 2 SPECIFICATIONS

2.1 Overview

Archive Viper SCSI drives provide reliable backup for microcomputer data. This chapter includes technical specifications for all Viper models. Information included describes the following specifications and requirements.

- Physical Specifications
- Power Requirements
- Drive Performance Specifications
- Environmental Requirements
- Data Cartridge Specifications
- Regulatory Compliance
- SCSI Conformance Statement

2.2 Physical Specifications

CONFIGURATION	SPECIFICATION	DIMENSION	
		US	METRIC
Internal	Height	1.625 in	41.27 mm
	Width	5.750 in	146.00 mm
	Depth	8.000 in	203.20 mm
	Weight	3.000 lb	1.36 kg
External	Height	3.500 in	89.00 mm
	Width	6.600 in	168.00 mm
	Depth	11.400 in	290.00 mm
	Weight	8.000 lb	3.65 kg

2.3 Power Requirements

SPECIFICATION	POWER SUPPLY VOLTAGE	
	+12 VOLTS	+5 VOLTS
Tolerance (incl. max. ripple of 100 mV)	±10%	±5%
Standby Current	0.2 Amps nominal	1.1 Amps nominal
Operational Current	0.8 Amps nominal 1.7 Amps maximum	1.1 Amps nominal 1.5 Amps maximum
Tape Start Surge (up to 300 msec)	2.5 Amps maximum	
Power Dissipation (operational)	9.6 Watts typical 22.4 Watts maximum 33 Watts maximum (tape start surge)	5.5 Watts typical 7.8 Watts maximum

2.3.1 Power Connector

FEATURE	SPECIFICATION
Input Connector	AMP 641737-1
Mating Connector	AMP 1-480424-0
Pins	AMP 60617-1
PIN	ASSIGNMENT
1	+12 VDC
2	+12 Return
3	+5 Return
4	+5 VDC

2.4 Drive Performance Specifications

FEATURE	SPECIFICATION		
	60SI	125SI	150SI
Capacity (formatted)	45 or 60 MB	125 MB	125MB or 150MB
Track Format	9-Track Serpentine	15-Track Serpentine	15 or 18-Track Serpentine
Flux Density	10,000 fpi	12,500 fpi	12,500 fpi
Data Density	8,000 bpi	10,000 bpi	10,000 bpi
Data Transfer Rate (average)	90 KB/Sec	112.5 KB/Sec	112.5 KB/Sec
Recording Format	QIC-24	QIC-120	QIC-120 or QIC-150
SCSI Burst Data Transfer Rate	1.88 MB/Sec		
Data Buffer Size	56 KB		
Tape Speed	90 ips		
Speed Variations	Short term $\pm 4\%$ Long term $\pm 7\%$		
Start/Stop Time	300 mSec (maximum)		
Head Configuration	Two-track, Read-after-write (1 track in each direction) separate full-width erase		
Recording Code	GCR (0,2) Run Length Limited		

2.5 Environmental Specifications

SPECIFICATION	REQUIREMENT	
	OPERATIONAL	NON-OPERATIONAL
Temperature	+5° to +45°C (+41° to +113° F)	-30° to +60°C (-22° to +140°F)
Thermal Gradient	1° C/minute	1° C/minute
Relative Humidity	20% to 80% non-condensing	5 % to 85% non-condensing
Maximum Wet Bulb Temperature	26° C	
Altitude	-1,000 to +15,000 ft.	-1,000 to +50,000 ft.
Shock	2.5 g maximum, 11 mSec	25 g maximum, 11 mSec
Vibration (1/2 sine wave) peak-peak displacement	0.005 in. maximum 5 Hz to 63 Hz	0.1 in. maximum 5 Hz to 17 Hz
peak acceleration	0.5 g maximum 63 Hz to 500 Hz	1.5 g maximum 17 Hz to 500 Hz

2.6 Data Cartridge Specifications

The Viper drives record to maximum capacity when Models 60S and 125S use DC600A type data cartridges and the Model 150S uses DC600XTD type data cartridges. To enable backward compatibility in all models, Viper drives can also recognize different types of data cartridges, and can write and read various QIC standard tape formats.

The following tables list data cartridges qualified for use in the Viper drives, plus the performance functions of each data cartridge with respect to the drive. The function column includes backward compatibility.

2.6.1 Model 60S

DATA CARTRIDGE SPECIFICATION	DATA CARTRIDGE	ARCHIVE MODEL	DRIVE FUNCTIONS	
			READ/WRITE	READ ONLY
ANSI BSR X3.127	DC300XLP	545 (450 ft)	QIC-24 format	QIC-11 format
ANSI X3B5/85-138	DC600A	560 (600 ft)	QIC-24 format	QIC-11 format
ANSI X3B5/87-217	DC600XTD	660 (600 ft)	QIC-24 format	QIC-11 format

2.6.2 Model 125S

DATA CARTRIDGE SPECIFICATION	DATA CARTRIDGE	ARCHIVE MODEL	DRIVE FUNCTIONS	
			READ/WRITE	READ ONLY
ANSI BSR X3.127	DC300XLP	545 (450 ft)		QIC-24 and QIC-11 format
ANSI X3B5/85-138	DC600A	560 (600 ft)	QIC-120 format	QIC-24 and QIC-11 format
ANSI X3B5/87-217	DC600XTD	660 (600 ft)	QIC-120 format	QIC-24 and QIC-11 format

2.6.3 Model 150S

DATA CARTRIDGE SPECIFICATION	DATA CARTRIDGE	ARCHIVE MODEL	DRIVE FUNCTIONS	
			READ/WRITE	READ ONLY
ANSI BSR X3.127	DC300XLP	545 (450 ft)		QIC-24 and QIC-11 format
ANSI X3B5/85-138	DC600A	560 (600 ft)	QIC-120 format	QIC-24 and QIC-11
ANSI X3B5/87-217	DC600XTD	660 (600 ft)	QIC-150 and QIC-120 format	QIC-24 and QIC-11 format

2.7 Regulatory Compliance

Archive Viper drives comply with the regulations listed in the following table.

AGENCY	CSA	IEC	UL	TUV	FCC
REGULATION	C22.2 No.220	435, 380	478	DIN IEC 380/VDE 0806	Class B

2.8 ANSI X3.131 Conformance Statement

GENERAL FEATURES

1. Supports Arbitration
2. Disconnect/Reconnect
3. Single-ended drivers
4. Termination power supplied to the cable (jumper option)
5. Supports both single and multi-initiator systems
6. Fixed block transfer lengths only
7. Hard reset
8. Parity implemented (enabled with jumper option)
9. Space blocks, filemarks, sequential filemarks, and EOD (forward and reverse)
10. Mode Select allows selection of explicit read/write format
11. Supports third-party reservation
12. Verify is Medium verification only

LEVEL

0, 1, and 2 of ANSI REV 17B

OPTIONAL COMMANDS

- | | |
|--------------------------|----------------------------|
| 1. Test Unit Ready | 8. Release Unit |
| 2. Send Diagnostic | 9. Erase |
| 3. Space | 10. Mode Sense |
| 4. Verify | 11. Load/Unload |
| 5. Recover Buffered Data | 12. Copy |
| 6. Mode Select | 13. Read/Write Data Buffer |
| 7. Reserve Unit | |

OPTIONAL MESSAGES

Send

- | | |
|----------------------|--------------------------------------|
| 1. Save Data Pointer | 4. Linked Command Complete |
| 2. Disconnect | 5. Linked Command Complete with flag |
| 3. Message Reject | 6. Identify |

Receive

- | | |
|-----------------------------|---------------------|
| 1. Initiator Detected Error | 4. No operation |
| 2. Abort | 5. Bus Device Busy |
| 3. Message Reject | 6. Identify |
| | 7. Restore Pointers |

VENDOR UNIQUE COMMANDS

- | | |
|---------------|--------------------------|
| 1. Seek block | 2. Request block address |
|---------------|--------------------------|

CHAPTER 3 INSTALLATION

3.1 Introduction

This chapter briefly describes installation procedures for internal and external Viper tape drives but does not contain detailed instructions.

The Archive external Viper requires an adapter card. The SC402 adapter for PC/AT compatible computers and the SC409 adapter for PS/2 and compatible computers are available from Archive Corporation.

3.2 Guidelines and Cautions

The following guidelines and cautions are industry standards and apply to handling and installing all Archive products.

- Archive drives contain components that are sensitive to static electricity. They are shipped in protective anti-static bags. Do not remove the drive from the anti-static bag until you are ready to install it.
- Before removing a circuit board or drive from the protective packaging, discharge static electricity from your body by touching the computers metal surface or any known grounded surface.
- Hold the drive by its edges only; touching the printed circuit board can cause component damage. Lay the drive only on top of the bag or return it to the bag.
- Clean the head at the recommended intervals. Failure to do this can cause excessive data errors.
- Maintain input power within specification limits to insure reliable operation.

3.3 Unpacking and Inspection

Archive products are inspected and carefully packaged at the factory; however, damage can occur during shipping. Follow these steps for inspecting and unpacking.

1. Visually inspect shipping containers; notify your carrier immediately of any damage.
2. Place shipping containers on a flat, clean, stable surface; carefully remove and verify contents. If parts are missing or equipment is damaged, notify your Archive representative.
3. Save containers and packing materials for any future reshipment.

3.4 Installation

Viper drives can be mounted inside a microcomputer and connected through the interface and power cables or installed externally and connected through the interface cable and power cable. The following sections briefly described important installation procedures.

3.5 Internal Viper Drives

The Viper drive can be installed horizontally or vertically as shown in Figure 3-1. Horizontal installation is recommended. When vertical mounting is preferred, install the drive with the head-loading lever at the top as shown.

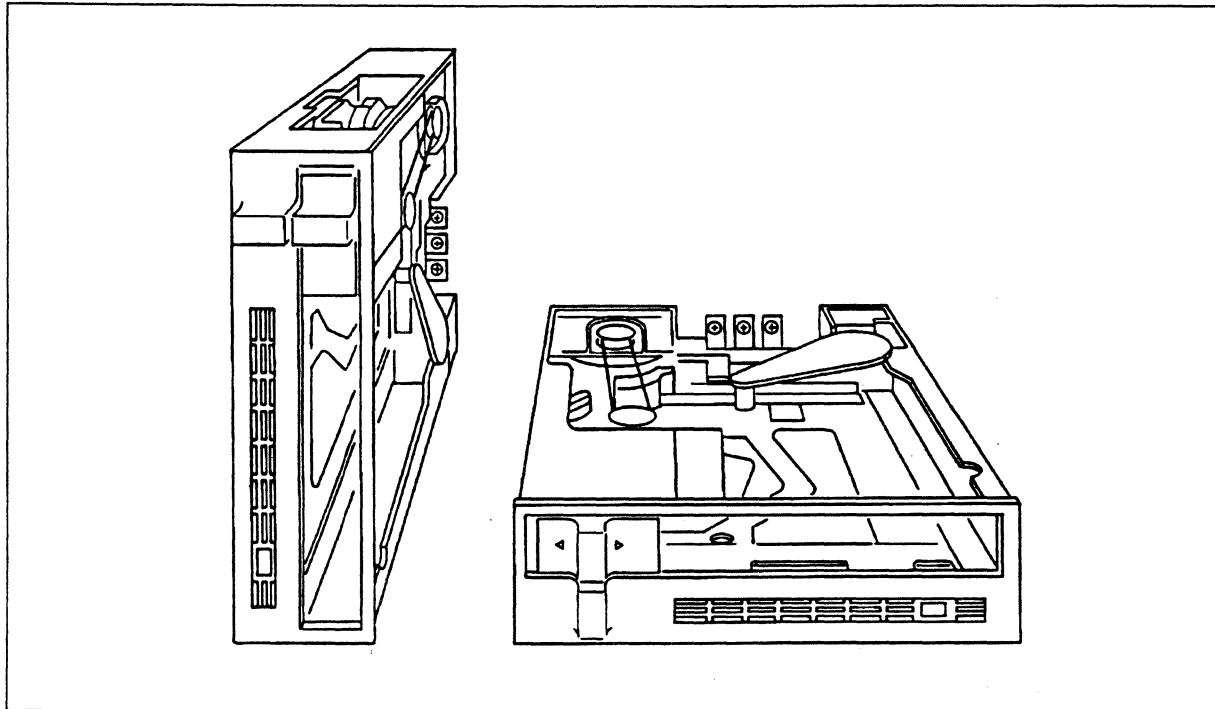


Figure 3-1. Internal Installation

3.5.1 Mounting Screws

The drive chassis contains threaded mounting holes for 6-32 screws. Four are located on the bottom and two are on each side of the frame. See Figure 3-2. When mounting vertically, use three of the four screw holes to fasten the drive. Tighten the screws 5.3 inch-pounds or 2-1/2 turns. Over tightening can cause excessive stress to the drive chassis.

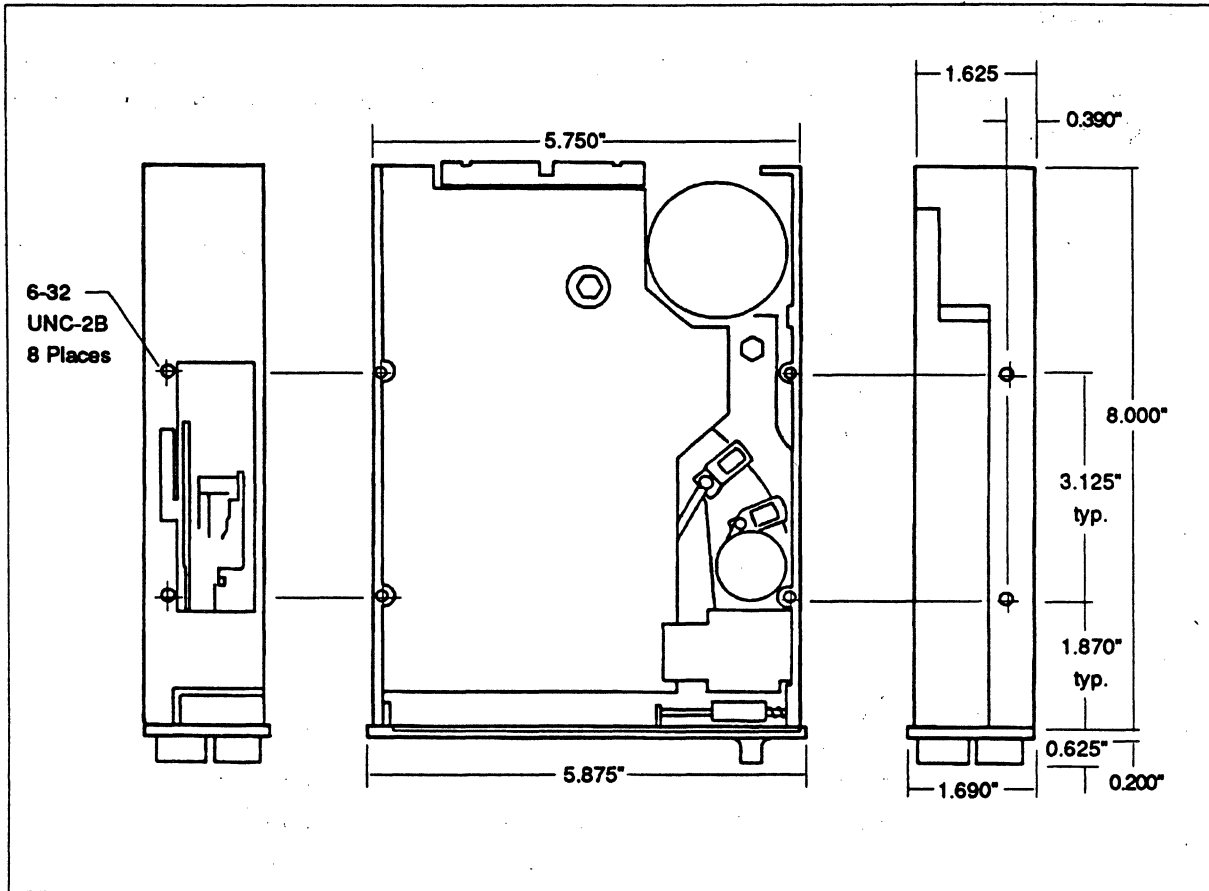


Figure 3-2. Mounting Hole Locations

3.5.2 Connectors

Power and interface connectors are located on the back of the drive as shown in Figure 3-3. The recommended interface mating connector is a 3M 3425-6600, Burndy FRE-50BF-1, KEL-AM RFM25-2852-0, or equivalent. The recommended power mating connector requires an AMP 1-48024-0 housing with AMP 60617-1 pins or equivalent.

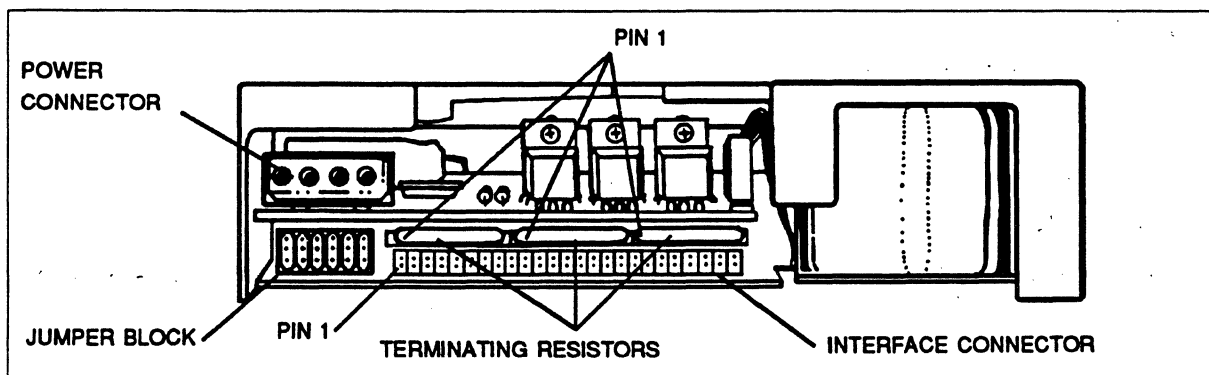


Figure 3-3. Viper Rear View

3.5.3 Jumper Configuration

The configuration jumper block is located on the rear assembly. Interface configuration or programming is accomplished on the configuration jumper block with jumper clips (Archive P/N 15864-001) as shown in Figure 3-4.

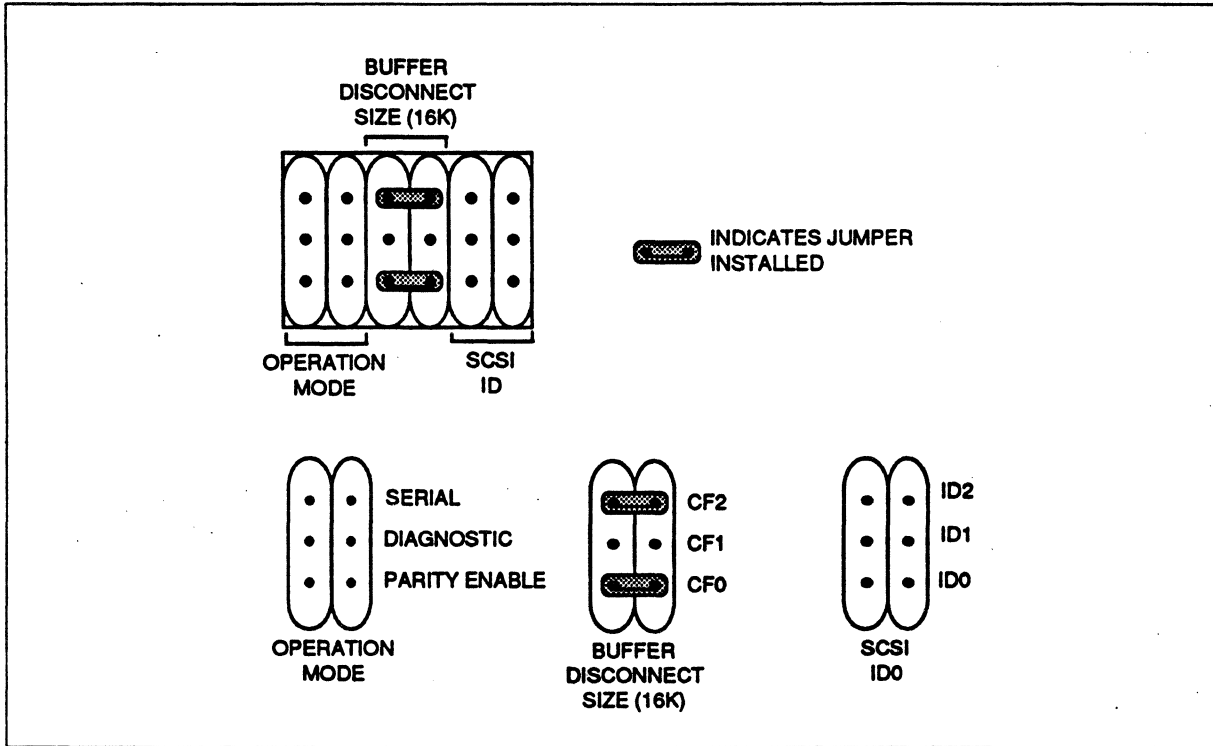


Figure 3-4. Configuration Jumper Block.

3.5.4 Operational Mode

In the Operational Mode, with no jumper clip in the Diagnostic position, the jumper pairs specify the following:

- Enable or disable parity check.
- Select buffer disconnect size.
- Specify Viper drives SCSI bus ID.

3.5.5 Parity Enable

Parity check is enabled by installing a single jumper pair clip in the Parity Enable location as shown in Figure 3-4.

3.5.6 Drive Identification

In multi-user and multi-initiator systems with more than two SCSI devices including the host, each device must have a unique ID. The ID determines controller arbitration priority, with ID0 the lowest priority. Viper ID jumpers are shown in Figure 3-4 and defined in Table 3-1.

Initiators should have high priority IDs. Standard configuration Viper drives are factory set to ID0.

Table 3-1. SCSI ID Selection

ID NO. JUMPER	0*	1	2	3	4	5	6	7
ID2					X	X	X	X
ID1			X	X			X	X
ID0		X		X		X		X
X = Jumper Installed * Standard Configuration, Factory Setting								

3.5.7 Selectable Buffer Disconnect

The buffer disconnect size sets the maximum number of bytes that can be sent over the SCSI bus during a single data transfer phase. During lengthy data transfers, this feature periodically frees the bus for other operations; thus, disconnect size can affect overall system performance where more than two SCSI devices must arbitrate for bus time. Optimum disconnect size is a function of both the number of devices and the speed at which they independently process data bursts.

Since all but the current Target and Initiator must wait for the bus to proceed with data transfers, disconnect size should be set to permit bus arbitration at intervals that optimize the off-bus processing multiple devices can perform in parallel.

Table 3-2. Buffer Disconnect Size Selection

BUFFER SIZE JUMPER	2K	4K	6K	8K	12K	16K*	24K	32K
CF2					X	X	X	X
CF1			X	X			X	X
CF0		X		X		X		X
X = Jumper Installed * Disconnect size setting of 16K is minimum for using the Copy command.								

3.6 Connecting External Vipers

The External Viper can be operated vertically or horizontally as shown in Figure 3-5.

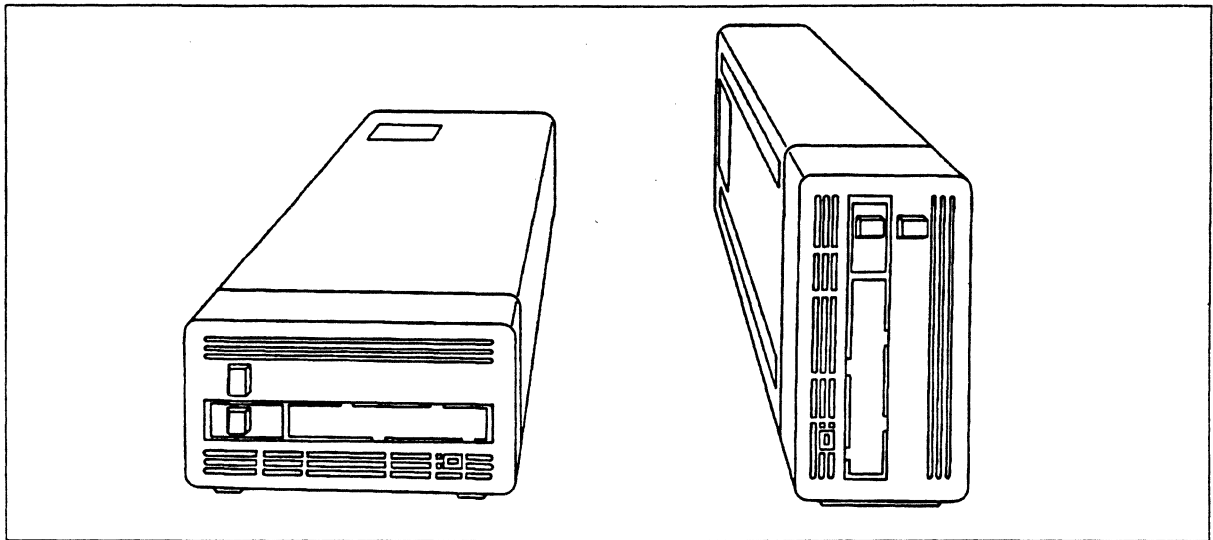


Figure 3-5. External Installation

The External Viper has two interface connectors to allow daisy chaining. See Figure 3-6.

- When the Viper is the last drive, a single interface cable is attached to one connector and a terminating plug is installed in the other.
- When the Viper is within the chain, interface cables from the preceding and following drives are connected. No termination is required. See Figure 3-7.

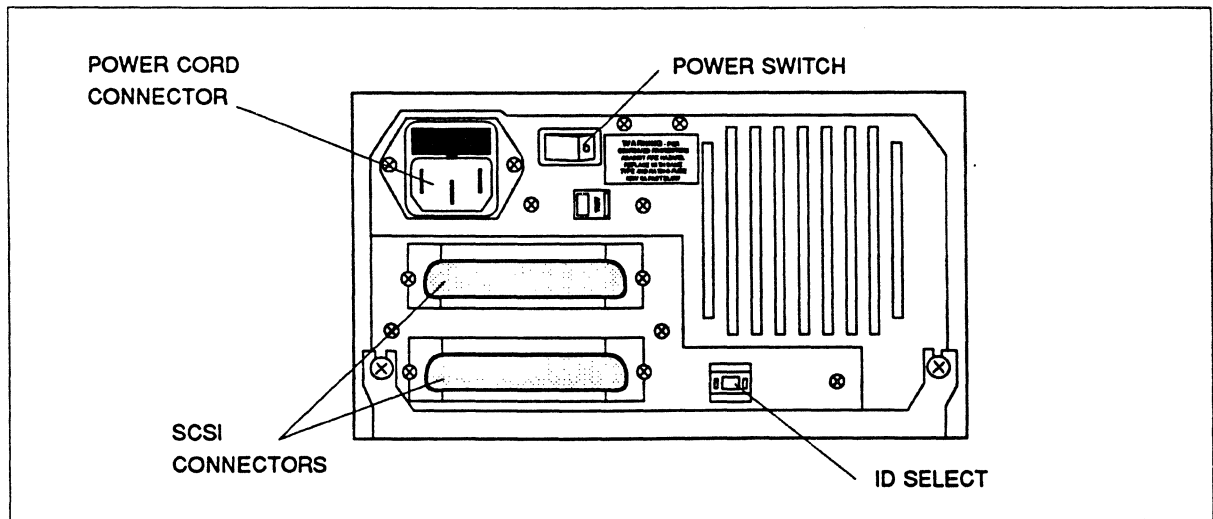


Figure 3-6. Viper External Interface Connectors and ID Switch

3.6.1 SCSI Drive Identification Switch

The ID select on the rear of the external Viper incorporates a digital display with a button on each side to change the display and set drive identification. See Figure 3-6.

- Push the left button to decrease the number.
- Push the right button to increase the number.
- Other usual features such as disconnect size and parity are selectable only by jumpers on the PCB.

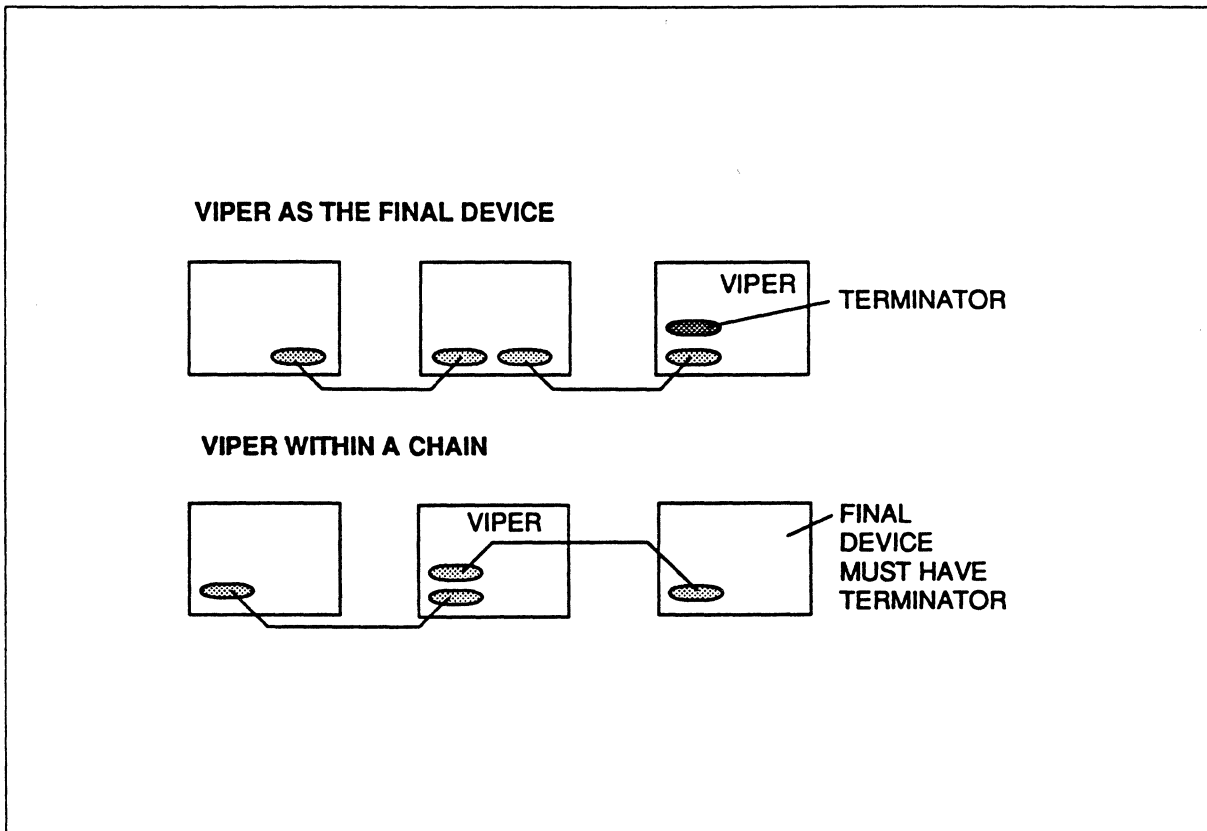


Figure 3-7. Viper SCSI Daisy-Chain Diagram

CHAPTER 4 INTERFACE

4.1 Overview

Viper streaming tape drives are designed to operate with the Small Computer System Interface (SCSI) bus. This chapter discusses SCSI bus operation as it pertains to Viper drive functions.

SCSI is a standard interface established to support peripheral equipment such as printers, tape drives, magnetic disks, optical disks for microcomputers and other computer systems. The SCSI bus can support up to eight IDs consisting of any multiple of host adaptors and peripheral devices.

The interface is an eight-port, daisy-chained bus using eighteen signal lines: nine data-bit signal lines and nine control lines. The nine data bit lines consist of eight signal lines and one parity-bit line. The remaining nine lines are for control and status signals to coordinate data transfer operations between the host controller and the selected drive.

The Viper drive has an internal SCSI controller integrated into the drive electronics. Each device ID on the SCSI bus may drive up to 8 logical units (LUN). The Viper drive addresses only LUN 0.

4.1.1 ANSI SCSI Bus Standards

Besides studying the information presented in this manual, we recommend you read ANSI X3.131 SCSI bus standard and QIC-104 (SCSI sequential storage device implementation standard) before writing host software drivers. See Archive's conformance statement in SPECIFICATIONS.

4.1.2 Signal Notation Conventions

All SCSI bus interface signals are active-low. The following conventions are used to describe SCSI interface signal notation.

- A signal name or abbreviation preceded by a minus sign (-) indicates the signal is active low.

Example: -MSG

4.2 SCSI Bus Connector Signals

The SCSI signal locations on the PCB connector and a description of each signal are shown in Table 4-1.

NOTE: All odd pins, except Pin 25, are connected to signal ground at the host. Pin 25 is left open.

Table 4-1. SCSI Signal Locations on Drive Connector

PIN	SIGNAL	DESCRIPTION	SIGNAL DRIVER
2	-DB(0)	Data Bus Bit 0 (LSB)	Target/Initiator
4	-DB(1)	Data Bus Bit 1	Target/Initiator
6	-DB(2)	Data Bus Bit 2	Target/Initiator
8	-DB(3)	Data Bus Bit 3	Target/Initiator
10	-DB(4)	Data Bus Bit 4	Target/Initiator
12	-DB(5)	Data Bus Bit 5	Target/Initiator
14	-DB(6)	Data Bus Bit 6	Target/Initiator
16	-DB(7)	Data Bus Bit 7 (MSB)	Target/Initiator
18	-DB(P)	Data Bus Parity	Target/Initiator
20	Ground		
22	Ground		
24	Ground		
25	Open		
26	Terminator Power	+5V (Optional) ¹	
28	Ground		
30	Ground		
32	-ATN	Attention	Initiator
34	Ground		
36	-BSY	Busy	Target/Initiator
38	-ACK	Acknowledge	Initiator
40	-RST ²	Reset	Initiator*
42	-MSG	Message	Target
44	-SEL	Select	Target/Initiator
46	-C/D	Control/Data	Target
48	-REQ	Request	Target
50	-I/O	Input/Output	Target

1 The +5V drive supply is available on the SCSI connector as a terminator power option. This pin is connected to the +5V through a 1N4001D diode and a 1-Amp fuse. The option is factory installed and is selected by an internal jumper on the PCB.

2 ANSI defines -RST as a bidirectional pin. On the Viper drive, -RST is input only.

4.3 Signal Descriptions

The Viper drive SCSI interface consists of eighteen signals. Nine are control lines and nine are data lines. Data lines include the parity signal option. These signals are described in Table 4-2.

Table 4-2. SCSI Interface Signals

SIGNAL	NAME	DESCRIPTION
-BSY	Busy	OR-tied signal used to indicate the data bus is in use.
-SEL	Select	Signal used by an Initiator to select a Target, or by a Target to re-select an Initiator. SEL is driven by the Initiator during the Selection Phase and driven by the Target during a Reselection-Phase.
-C/D	Control/Data	Target driven signal used to indicate whether Control or Data information is on the data bus. True (low) indicates Control, and false (high) indicates Data.
-I/O	Input/Output	Target driven signal used to control data movement direction on the data bus with respect to an Initiator. This signal is also used to distinguish between the Selection and Reselection Phases. True (low) indicates input to the Initiator, and false (high) indicates output from the Initiator.
-MSG	Message	Target driven signal used to indicate the presence of a Message Phase on the bus. True (low) indicates Message Phase, and false (high) indicates Data, Command, or Status Phase.
-REQ	Request	Target driven signal used to indicate a request for a REQ/ACK data transfer handshake.
-ACK	Acknowledge	Initiator driven signal used to indicate an acknowledgement for a REQ/ACK data transfer handshake.
-ATN	Attention	Initiator driven signal used to indicate the Initiator has a message to communicate to the Target.
-RST	Reset	OR-tied signal used to indicate a Reset condition.
DB(7-0)	Data Bus	Eight data-bit signals plus a parity-bit signal that form the data bus. DB (7) is the MSB and has the highest priority (ID 7) during the Arbitration Phase.
DB(P)	Data Bus	Data parity is odd and is a jumper-selectable option. Parity is not valid during the Arbitration Phase. DB (P) is not to be driven False (high) during the Arbitration Phase.
<p>NOTE: The BSY and RST signals are the only OR-tied signals. In ordinary bus operation, these signals may be simultaneously driven by two or more drivers. There is no operational problem in mixing OR-tied and three-state drivers on signals other than BSY and RST.</p>		

4.4 Command Set Description

Table 4-3 shows the SCSI X3.131 Group 0 commands for sequential access devices implemented by the Viper drive.

Table 4-3. Group 0 Commands for SCSI Bus Sequential Access Devices

CODE	TYPE	COMMAND NAME
00h	O	Test Unit Ready
01h	M	Rewind
02h	V	Request Block Address
03h	M	Request Sense
05h	E	Read Block Limits
08h	M	Read
0Ah	M	Write
0Ch	V	Seek Block
10h	M	Write File marks
11h	O	Space
12h	E	Inquiry
13h	O	Verify
14h	O	Recovered Buffered Data
15h	O	Mode Select
16h	O	Reserve Unit
17h	O	Release Unit
18h	O	Copy
19h	O	Erase
1Ah	O	Mode Sense
1Bh	O	Load/Unload
1Dh	O	Send Diagnostic
1Eh	O	Prevent/Allow Medium Removal
3Bh	O	Write Data Buffer
3Ch	O	Read Data Buffer
M = mandatory command		O = optional command
E = extended command		V = vendor unique

4.5 SCSI Bus Protocol

Communication on the SCSI bus occurs between a host computer SCSI controller and a peripheral controller. The host controller is the Initiator and the peripheral device is the Target.

Some SCSI bus functions are assigned to the Initiator and others to the Target. The Initiator arbitrates (enters the Arbitration Phase of operation) for control of the SCSI bus and enters the Selection Phase to select a specific Target such as a Viper drive.

The Target drive can request transfer of command, data, status, information, or disconnect from the bus. While the Viper drive is disconnected, the bus is free to accomplish other tasks. While disconnected, the Target drive can process information obtained from the bus. If the Target wants to reconnect, it arbitrates for bus control. For example, a Target can reselect an Initiator or another Target to continue an operation.

The Target at times actually becomes an Initiator and arbitrates for control of the SCSI bus. For the Viper drive this occurs only during a Copy operation.

SCSI bus data transfer operations are asynchronous as defined in the ANSI SCSI specification and follow a defined request/acknowledge (REQ/ACK) handshake protocol. One eight-bit byte of information can be transferred with each REQ/ACK handshake.

The SCSI bus protocol is divided into three modes of operation: Waiting Phases, Control Phases, and Information Transfer Phases. These are subdivided into the eight operational phases listed in Table 4-4. Information on these operational phases is contained in the following paragraphs.

Table 4-4. Operational Phases

OPERATIONAL PHASES		
WAITING PHASES	CONTROL PHASES	INFORMATION TRANSFER
1. Bus free	2. Arbitration 3. Selection 4. Reselection	5. Command 6. Data (Data In/Data Out) 7. Status 8. Message (Message In/Message Out)

4.6 Waiting and Control Phases

The status of the SCSI bus is a function of the control signals. These signals define the SCSI as in the Waiting Phase (Bus Free Phase), the Control Phases (Arbitration, Selection, or Reselection), or the Information Transfer Phases (Command, Data, Status, or Message). Viper drives support both a SCSI system with Arbitration Phase and a SCSI system without Arbitration Phase.

4.6.1 Nonarbitrating Systems

In systems where the Arbitration Phase is not implemented, the allowable sequences are shown in Figure 4-1. The normal progression is from the Bus Free Phase to the Selection Phase and from the Selection Phase to one or more of the Information Transfer Phases. See ANSI SCSI X1.31 for detailed discussions of bus timing.

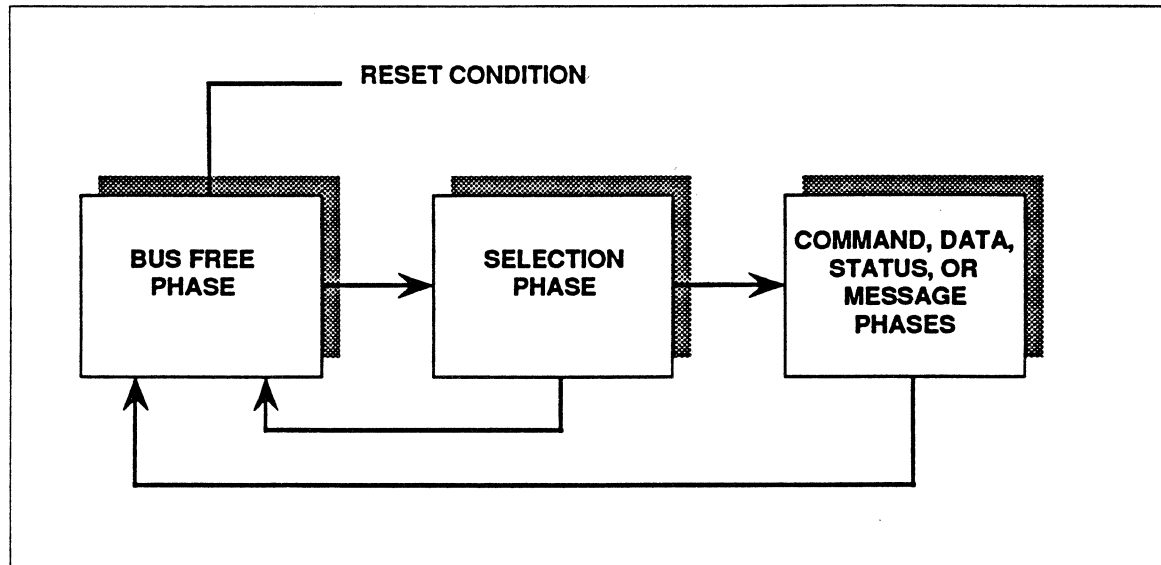


Figure 4-1. Phase Sequencing with Nonarbitration

4.6.2 Arbitrating Systems

In arbitration systems, the sequence of SCSI bus phases follows the sequence shown in Figure 4-2. Operation begins with the Bus Free Phase. Normal progression is from the Bus Free to the Arbitration Phase. During Arbitration, Initiators and Targets assert for control of the SCSI bus. The bus is awarded to the device with the highest priority SCSI bus address (DB7).

Arbitration is won by the highest priority SCSI device when both BSY and SEL are asserted and a delay of at least 1200 nSec (1 bus clear delay + 1 bus settle delay) occurs before the Arbitration Phase ends and the Selection Phase begins. Signal timing is shown in Figure 4-3 and complete Arbitration Phase protocol is described in Table 4-5.

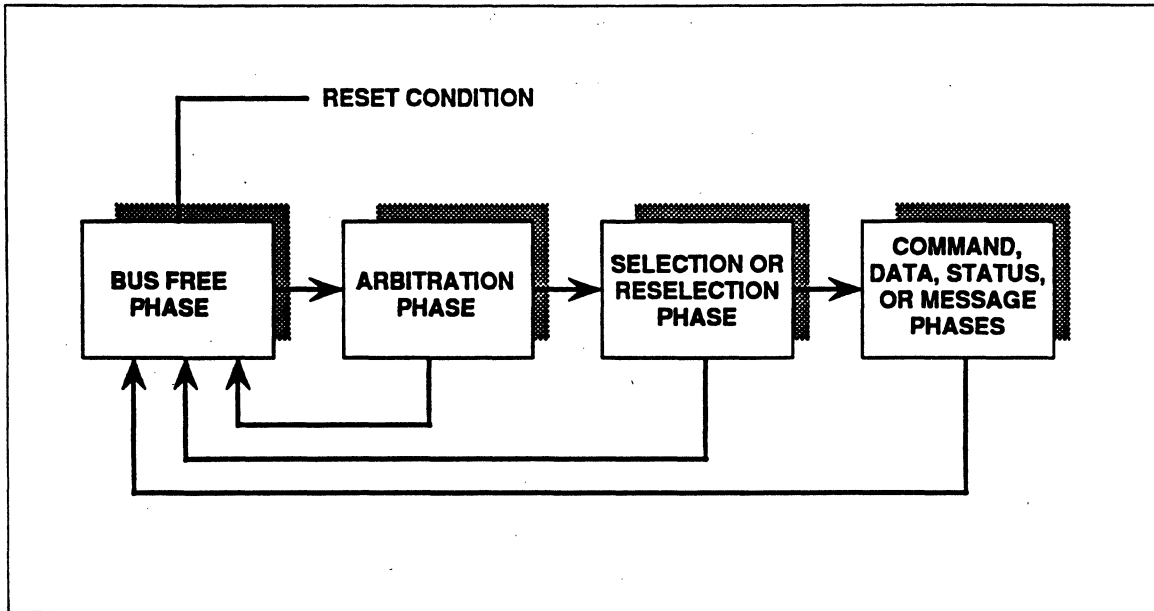


Figure 4-2. Phase Sequencing with Arbitration

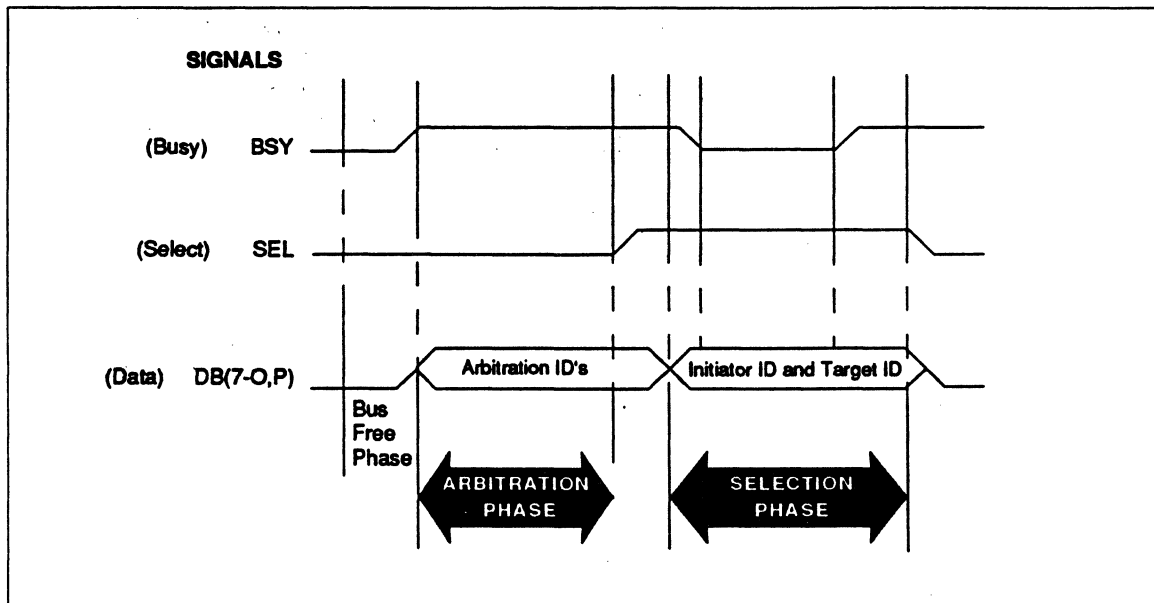


Figure 4-3. Arbitration and Selection Phase Signal Timing

Table 4-5. Arbitration Phase Protocol

STEP	PROCEDURE
1.	The SCSI device first waits for a Bus Free Phase to occur. The Bus Free Phase is detected when both the BSY and SEL signals are simultaneously and continuously false for a minimum of a bus settle delay of 400 nSec.
2.	The SCSI device waits a minimum of one bus free delay of 800 nSec after detection of a Bus Free Phase before driving any signal. The Bus Free Phase occurs after BSY and SEL are both false for a bus settle delay of 400 nSec.
3.	Following the 800 nSec Bus Free Delay in Step 2, the SCSI device Arbitrates for the SCSI bus by asserting both BSY and its own SCSI ID; however, the SCSI device does not assert a BSY and its SCSI ID if more than a bus settledelay (1.8 μ Sec) has passed since the Bus Free Phase was last observed.
4.	After waiting at least an Arbitration delay (2.2 μ Sec) measured after asserting a BSY signal, the SCSI device examines the data bus. If a higher priority SCSI ID bit is true then the SCSI device loses the Arbitration and the SCSI device releases its signals and returns to Step 1. If no higher priority SCSI ID bit is true on the bus, then the SCSI drive wins the Arbitration and it asserts the SEL signal. Any other device that participated in the Arbitration Phase and lost Arbitration releases BSY and its SCSI ID bit within a bus clear delay after SEL becomes true. A SCSI device that loses Arbitration returns to Step 1.
5.	The SCSI device that wins Arbitration waits at least one bus clear delay plus a bus settle delay of 1,200 nSec after asserting the SEL signal and changing the condition of other signals.
<p>NOTE: The single SCSI ID bit on the data bus corresponds to the unique ID code of the SCSI device. All other SCSI data bus bits are released by the SCSI device. Parity is not valid during the Arbitration Phase. During the Arbitration Phase, DB(P) may be undriven or driven true, but not false.</p>	

4.7 Selection and Reselection Phases

The Selection and Reselection Phases provide a method for establishing a link between the Initiator and Target. When selected by the Initiator (read or write data), the Target has the option of disconnecting from the SCSI bus. When the Target needs to again establish the link to its original Initiator, the Target reselects that Initiator.

When selection is made, there are no restrictions on the sequences between information transfer phases. A phase type may be followed by the same phase type. For example, a data phase followed by another data phase.

A device that wins Arbitration assumes the roll of Initiator by releasing the I/O signal. The Initiator sets the data bus to a value that is the OR of its SCSI ID bit and the Target's ID bit. The Initiator waits at least two deskew delays (90 nSec) before releasing the BSY signal and an additional bus settle delay (400 nSec) before looking for a response from the Target.

A device that loses Arbitration must release the Select ID and BSY.

Operation enters the Selection or Reselection Phases when a particular device wins a request in Arbitration and gains control of the SCSI bus. These phases allow the device in control of the bus to select another specific device connected to the SCSI bus for communication.

As an example the Initiator can select a Viper drive to begin an operation, or the Viper drive can re-select an Initiator to continue an operation previously disconnected.

For the Copy function, the Viper drive can act as an Initiator and select another controller as a Target source or destination for the Copy operation.

The Selection and Reselection Phases can be terminated for either of the following reasons:

- A Selection/Reselection time-out occurs. A Target or Initiator did not respond to a Selection or Reselection Phase within a maximum abort time of 200 μ Sec.
- A reset signal occurs on the SCSI bus, and all sequences are terminated and signals released by all Targets and Initiators.

The Initiator can use the ATN signal to notify the Viper drive that an ID message from the Initiator is ready. To ensure the Target recognizes the Attention condition before the Command Phase is entered, the ATN signal must be low before the SEL is asserted and BSY de-asserted.

4.8 Information Transfer Phases

The Command, Data, Status, and Message Phases are grouped together as the Information Transfer Phases (Table 4-6) because they are all used to transfer data or control information on the SCSI bus.

Table 4-6 shows the Control Data (C/D), Input/Output (I/O), and Message (MSG) signals used to distinguish between the various Information Transfer Phases. The Target drives these three signals and thereby controls all changes from one phase to another.

Table 4-6 Information Transfer Phases

SIGNALS	-MSG	-C/D	-I/O	PHASES	DIRECTION OF TRANSFER
-I/O	1	1	1	Data	Initiator to Target
	1	1	0	Data	Target to Initiator
-C/D	1	0	1	Command	Initiator to Target
	1	0	0	Status	Target to Initiator
-MSG	0	0	1	Message	Initiator to Target
	0	0	0	Message	Target to Initiator
Key: 1 = False 0 = True					

Information Transfer Phases use one or more REQ/ACK handshakes to control the information transfer. Each REQ/ACK handshake allows the transfer of one byte of information. During the information transfer phases, BSY remains true and SEL remains false. C/D, I/O, and MSG control signals are valid for a bus settle delay of 400 nSec before assertion of REQ signal at the first handshake and remain valid until negation of ACK at the end of the last handshake.

4.8.1 Asynchronous Data Transfer

The Target controls the direction of information transfer with the I/O signal. When I/O is asserted (low), information is transferred from the Target to the Initiator. When I/O is deasserted (high), information is transferred from the Initiator to the Target. Figure 4-4 shows the data transfer signals for information transfer from Target to Initiator, and Figure 4-5 shows the data transfer signals for information transfer from Initiator to Target. Each direction of information transfer is discussed in detail in the following paragraphs.

4.8.1.1 Transfer from Target to Initiator

The transfer from Target to Initiator is described in the following table and illustrated in Figure 4-4.

TIMING POINT	ACTION
t_1	The I/O signal is asserted, the Target drives the data (DB7-0) and parity signals to their desired values.
t_2	The Target then asserts the REQ signal.
t_3	The Initiator reads the data and parity signals after REQ is asserted, then signals its acceptance of the data by asserting the ACK.
t_4	ACK goes low at the Target, and the Target deasserts REQ
t_5	REQ signal is false. The Initiator deasserts ACK. After the ACK signal is high, the Target can continue the transfer by repeating these steps from t_1 .

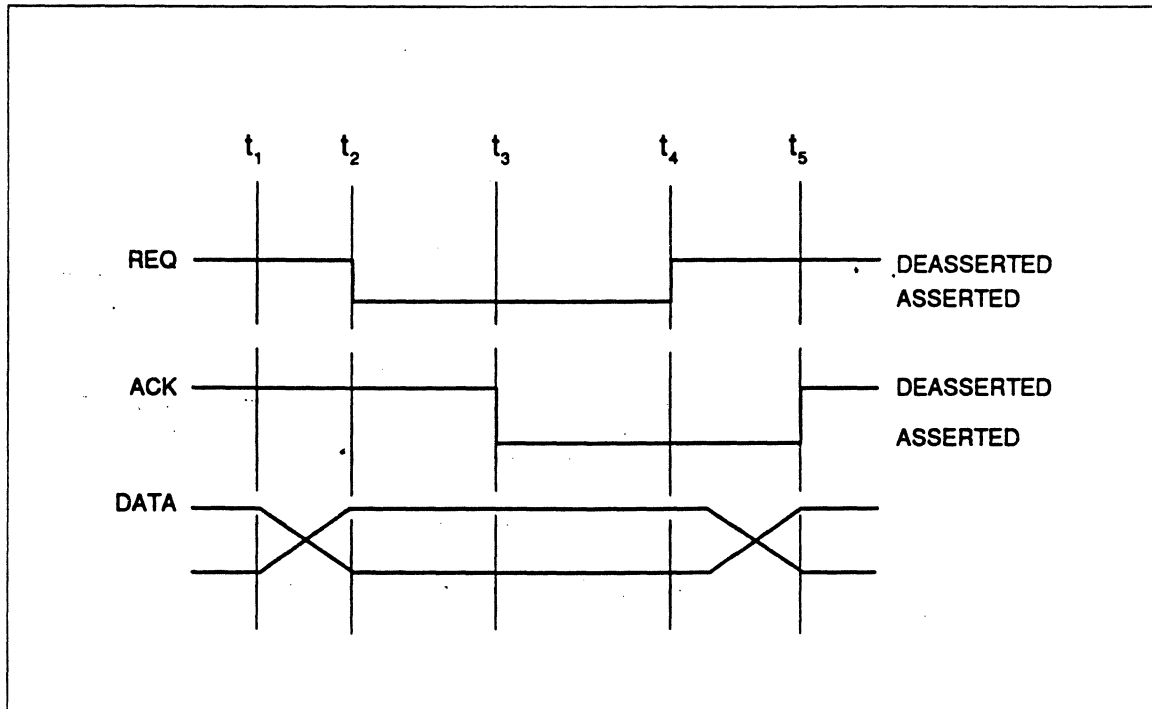


Figure 4-4. Signals Used In Transfer from Target to Initiator

4.8.1.2 Transfer from Initiator to Target

Transfer from Initiator to Target is described in the following table and illustrated in Figure 4-5.

TIMING POINT	ACTION
t_1	The I/O signal is deasserted, and the Target asserts REQ to request information.
t_2	The Initiator drives the data and parity signals to their desired values.
t_3	The Initiator asserts the ACK.
t_4	The Target deasserts REQ signaling its acceptance of data and the Initiator releases the data and parity signals, and deasserts the ACK signal.
t_5	The Initiator deasserts ACK. The Target can then continue to transfer by asserting the REQ signal.

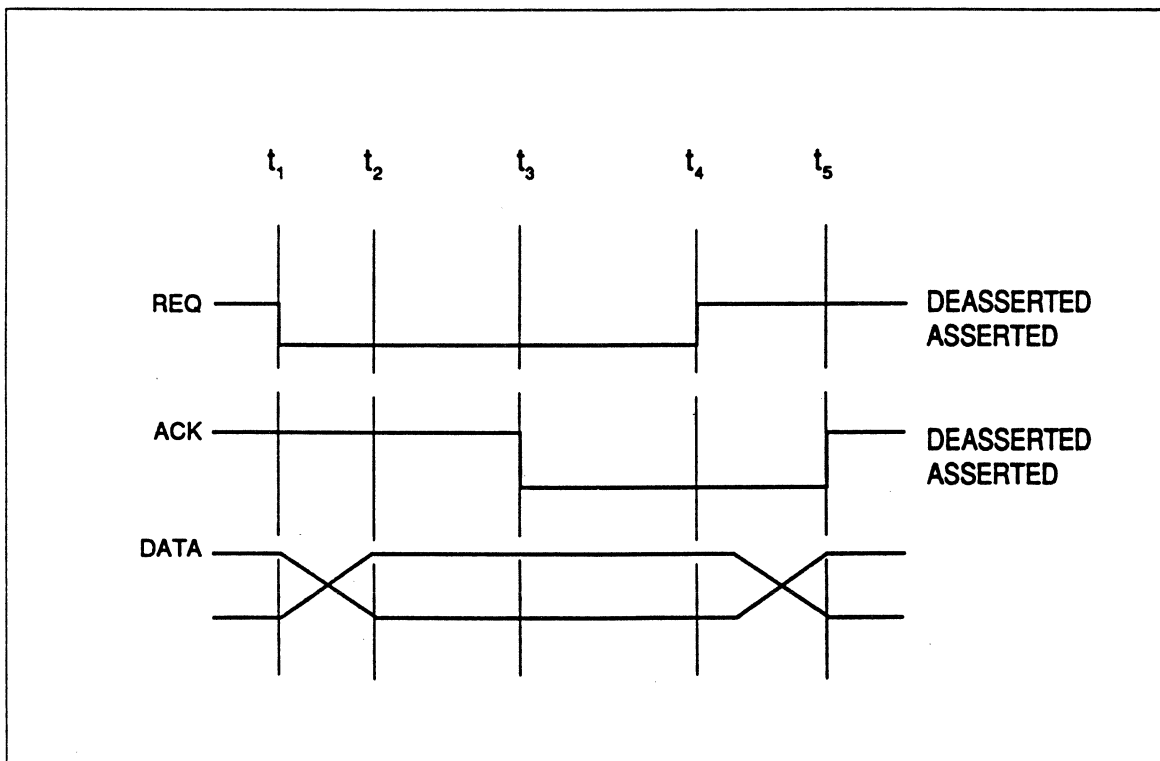


Figure 4-5. Signals Used In Transfer from Initiator to Target

4.9 Command Phase

During Command Phase, the Target requests command information from the Initiator. The Target asserts the C/D signal and deasserts the I/O and MSG signals thus denoting the Command Phase. The REQ/ACK then handshakes the command bytes across the SCSI bus (Figure 4-5). The command bytes are also called the Command Descriptor Block (CDB).

4.10 Data Phase

The Data Phase is subdivided into the Data-In and Data-Out Phases.

4.10.1 Data-In Phase

During Data-In phase, the Target requests that data be sent to the Initiator from the Target. The Target asserts the I/O signal and deasserts the C/D and MSG signals thus denoting the Data-In Phase. The REQ/ACK handshakes (Figure 4-4) then transfers the requested byte count.

4.10.2 Data-Out Phase

During a Data-Out phase, the Target requests that data be sent from the Initiator to the Target. The Target deasserts the C/D, I/O, and MSG signals thus denoting the Data-Out Phase. The REQ/ACK handshakes (Figure 4-5) then transfers the requested byte count across the SCSI bus.

4.11 Status Phase

During a Status Phase, the Target requests that status information be sent to the Initiator from the Target. The Target asserts the C/D and I/O signals and deasserts the MSG signal thus denoting the Status Phase. The REQ/ACK handshakes the one byte status code across the SCSI bus (refer to Figure 4-4).

4.12 Message Phase

The Message Phase consists of either the Message-In or Message-Out Phases. The messages the Viper drive supports are all one byte messages.

4.12.1 Message-In Phase

During Message-In Phase, the Target requests that messages be sent to the Initiator from the Target. The Target asserts the C/D, I/O, MSG signals thus denoting the Message-In Phase. The REQ/ACK handshakes the one byte message across the SCSI bus.

4.12.2 Message-Out Phase

During Message-Out Phase, the Target requests that messages be sent from the Initiator to the Target. The Target invokes this phase in response to the Attention (ATTN) signal asserted by the Initiator. The Viper drive responds to the ATTN signal at every phase change. The Target asserts the C/D and MSG signals and deasserts the I/O signal, denoting the Message-Out Phase. The REQ/ACK handshakes the one byte message across the SCSI bus. The Target uses REQ/ACQ handshakes (Figure 4-5) until the ATN signal becomes false, unless an error occurs and the message is rejected.

4.13 Command Descriptor Block

A request to a peripheral device is performed by sending a Command Descriptor Block (CDB) to the Target. For several commands, the request is accompanied by a list of parameters sent during a Data Out Phase. If an invalid parameter is contained in the CDB, Viper drive terminates the command without altering the medium. A typical Group 0, six-byte, Command Descriptor Block is shown in Table 4-7.

Note that the CDB contains both reserved bit fields and defined bit fields. Defined bit fields are: Group Code, Command Code, Logical Unit Number, Vendor Unique, Flag, and Link, whereas reserved bit fields are defined by zeros such as those appearing on the last line of Table 4-7. Table 4-8 describes the CDB fields common to all Group 0 commands.

Table 4-7. Command Descriptor Block Format

BITS BYTE	7	6	5	4	3	2	1	0
0	Group Code			Command Code				
1	Logical Unit Number			Command Dependent				
2	Command Dependent							
3	Command Dependent							
4	Command Dependent							
5	Vendor Unique	0	0	0	0	0	Flag	Link

Table 4-8. CDB Fields Common to Group 0 and 1 Commands

COMMAND DESCRIPTOR BLOCK FIELD	DESCRIPTION
Group Code ¹	This field indicates which of eight possible SCSI command groups is specified. Viper drive supports Group 0.
Command Code ¹	This field indicates which of 32 possible command codes for a particular group code is specified.
Logical Unit Number ²	The LUN must be set to zero.
Vendor Unique	When set, these bits select vendor unique functions in specified commands.
Flag bit	The Flag bit is used only in conjunction with the Link bit and must be set to zero if the Link bit is zero. When the Link bit is set, the value of the Flag bit determines the appropriate message to send to the Initiator when a linked command completes successfully; value zero indicates the Linked Command Complete message is required, value one indicates the Linked Command Complete with Flag message is required. Typically, the Flag bit is used to cause an interrupt in the Initiator at the end of or at logical intervals in linked command processing.
Link bit ³	The Link bit is used to indicate that the Initiator desires automatic linking to the next command upon successful completion of the current command. When the Link bit is one, upon successful termination of the command, Viper drive returns Intermediate Status followed by one of the two Command Complete messages as determined by the Flag bit. (Refer to description of Flag bit above).
<ol style="list-style-type: none"> 1. Together, group code and command code make up the op code. 2. If a non-zero logical unit number is received in a CDB, a Check Condition status is returned and Extended Sense Key is set to Illegal Request. 3. If the Link bit is used, all applicable commands must have the Immed bit set to zero or a Check Condition status is returned and Extended Sense Key is set to Illegal Request. 	

4.14 SCSI Message Descriptions and Definitions

The SCSI message codes, descriptions, and directions are given in Table 4-9. SCSI message definitions are given in Table 4-10. Each of these SCSI messages are supported by the Viper drive.

Table 4-9. SCSI Message Codes

CODE	DESCRIPTION	DIRECTION
00h	Command Complete	In
02h	Save Data Pointer	In
03h	Restore Data Pointer	Out
04h	Disconnect	In
05h	Initiator Detected Error	Out
06h	Abort	Out
07h	Message Reject	In/Out
08h	No Operation	Out
0Ah	Linked Command Complete	In
0Bh	Linked Command Complete With Flag	In
0Ch	Bus Device Reset	Out
80h-87h	Identify (No Disconnect/Reconnect)	In/Out
C0h-07h	Identify (Disconnect/Reconnect)	Out

Table 4-10. SCSI Message Definitions

MESSAGE	HEX CODE	DEFINITION
ABORT	(06h)	This message is sent from an Initiator to clear present drive operation. All pending data and status for the issuing Initiator is cleared and the drive goes back to Bus Free Phase. No status or ending message is sent for the operation. Any previously set modules will not be changed.
BUS DEVICE RESET	(0Ch)	This message is sent from an Initiator to direct the drive to clear all current commands, and forces the drive to an initial state with no operations pending for any initiator. Upon recognizing this message, the drive moves to the Bus Free Phase. All modes will be reset to the default state.
COMMAND COMPLETE	(00h)	This message is sent from the Viper drive to an Initiator to indicate that execution of a command has terminated and that valid status has been sent to the Initiator. After successfully sending this message, the drive goes to the Bus Free Phase by releasing BSY. <i>NOTE: The command may have been executed successfully or unsuccessfully as indicated in the status.</i>
DISCONNECT	(04h)	This message is sent from the Viper drive to inform an Initiator that the present physical path is going to be broken (Viper drive plans to disconnect by releasing BSY), and that a later reconnect will be required to complete the current operation. If the Initiator detects the Bus Free Phase, other than as the result of a Reset condition, without first receiving a Disconnect or Command Complete message, the Initiator considers this as a catastrophic error condition. The Disconnect message does not cause the Initiator to save the data pointer. If Disconnect messages are used to break a long data transfer into two or more shorter transfers, then a Save Data Pointer message is issued by the Viper drive before each Disconnect. <i>NOTE: Configuration jumpers are used to select the disconnect size (refer to Chapter 6 , Theory of Operation).</i>

Table 4-10. SCSI Message Definitions Continued

MESSAGE	HEX CODE	DEFINITION
IDENTIFY (80h - 87h) No Disconnect/Reconnect) (C0h-C7h Disconnect/Reconnect)		These messages are sent by either the Initiator or Viper drive to establish the physical path connection between them. The physical path connection indicates both the Initiator and Viper drive have message passing capability. Bit 7 is set to one to distinguish these messages from other messages. Bit 6 is set to one by the Initiator indicating the Initiator has the ability to accommodate disconnection and reconnection. Bits 5 through 3 are reserved (set to zero). Bits 2 through 0 specify the logical unit number that must be 0 for the Viper drive. When Identify is sent from the drive to an Initiator during reconnection, an implied Restore Pointers message is performed by the Initiator prior to completion of this message.
INITIATOR DETECTED ERROR (05h)		This message is sent from an Initiator to inform Viper drive an error, such as a parity error, has occurred.
LINKED COMMAND COMPLETE (0Ah)		This message is sent from Viper drive to an Initiator to indicate that execution of a linked command is completed and that status was sent. The Initiator can then set the pointers to the initial state for the next linked command.
LINKED COMMAND COMPLETE WITH FLAG (0Bh)		This message is sent from Viper drive to an Initiator to indicate that execution of a linked command with the Flag bit set to one, is completed and that status was sent. The Initiator then sets the current pointers to the initial state of the next linked command. Typically this message is used to cause an interrupt in the Initiator between two linked commands.
MESSAGE REJECT (07h)		This message is sent from Viper drive to indicate the last message it received was inappropriate or was not implemented. The Viper drive sends Message Reject and then goes to the Message-In phase prior to requesting additional message bytes from the Initiator. This provides an interlock so the Initiator can determine which message was rejected.
NO OPERATION (08h)		This message is sent from an Initiator in response to a Viper drive request for a message, when the Initiator does not currently have any other valid message to send.
SAVE DATA POINTER (02h)		This message is sent from Viper drive to direct the Initiator to save a copy of the present active data pointer for Viper drive.

An Initiator that accommodates disconnect/reconnect can indicate this to the Viper drive during the Selection phase by asserting ATN before bus condition SEL true and BSY false. This causes the drive to enter the Message-Out phase when the Selection phase completes.

The first message sent by the host after the Selection phase is an Identify message. Under normal conditions, the first message sent by the Viper drive after a Reselection phase is also Identify. Under certain exceptional conditions the host may send the Abort message or the Bus Device Reset message instead of Identify as the first message.

The purpose of the Identify message is to establish a physical path between an Initiator and Target for a particular logical unit. The Identify message contains the LUN. The Viper drive must be identified by the Initiator as LUN 0. The Viper drive always addresses LUN 0 of the Initiator.

When the ID message is completed, the Viper drive establishes the Message-Out phase in response to Attention being asserted by the Initiator. The Viper drive responds to Attention at all phase changes, and all messages are serviced except when the drive is Disconnected or Busy. At these times the Viper drive accepts Identify, Bus Device Reset, and No-op messages. Abort and Initiator detected error messages are responded to with a Reject Message. During a Disconnect or Busy state, the Viper drive can not process an Abort or Initiator detected error message. Abort or Initiator detected error messages would essentially cause a drive reset, and all data normally maintained for these messages would be lost.

4.15 SCSI Status Code Descriptions and Definitions

The Viper drive uses the following 4-bit status codes as shown in Table 4-11.

Table 4-11. Status Code Definitions

4-BIT STATUS CODE						DEFINITION
BITS	4	3	2	1	0	
	0	0	0	0	X	Good Status
	0	0	0	1	X	Check Condition
	0	1	0	0	X	Busy
	1	0	0	0	X	Intermediate Status
	1	1	0	0	X	Reservation Conflict
Note: X = Reserved, must be set to 0						

The status code format is shown in Table 4-12. A status byte is sent from the Viper drive to the Initiator during the Status phase at the termination of each command unless the command is cleared by an Abort message, by a Bus Device Reset message, or by a Reset condition.

Table 4-12. Status Code Block Format

BITS	7	6	5	4	3	2	1	0
CONTENT	0	0	0	Status Code				0

Descriptions of the five supported SCSI status codes is given in Table 4-13.

Table 4-13. SCSI Status Code Descriptions

STATUS	CODE	BYTE ZERO STATUS PHASE	DESCRIPTION
BUSY	4h	08h	The status (Viper drive busy) is returned when the drive is unable to accept a command from the Initiator, such as during an intermediate disconnect or after an immediate command has completed and the request function is not done. The normal Initiator recovery action is to issue the command at a later time.
CHECK CONDITION	1h	02h	Any error, exception, or abnormal condition that causes the sense data to be set, causes a Check Condition status. A Request Sense command should be issued following a Check Condition status, to determine the nature of the condition.
GOOD STATUS	0h	00h	This status indicates the Viper drive has successfully completed the command.
INTERMEDIATE STATUS	8h	10h	This status is returned for every command in a series of linked commands except the last command unless an error, exception, or abnormal condition causes either Check Condition or Reservation Conflict status to be set. If this status is not returned, the chain of linked commands is broken and no further commands in the series are executed.
RESERVATION CONFLICT	Ch	18h	This status is returned when a device attempts to access a Viper drive when it is reserved for access to another device.

4.16 Attention Condition

The Attention Condition allows an Initiator to inform a Target the Initiator has a message to be sent. The Viper drive may read this message at its convenience by performing a Message-Out phase. The Initiator creates the Attention Condition by asserting the ATN signal at any time except during the Arbitration or Bus Free phases. The Viper drive checks to see if ATTN is set at every phase change. If ATTN is set, the drive goes into the message phase. The Initiator may deassert the ATN signal at any time. Normally, the Initiator deasserts ATN during or before the last REQ/ACK handshake of the Message-Out phase. The Attention signal must be present prior to a phase change to allow the Viper drive time to respond with a Message-Out phase at the phase change.

4.17 Reset Condition

The Reset Condition takes precedence over all phases and conditions, and is used to immediately terminate operation and clear all SCSI devices from the bus. Any SCSI device can create a reset condition by asserting a RST signal for a minimum reset hold time of 25 μ Sec. The Viper drive never asserts reset. During the Reset Condition, all SCSI devices release all SCSI signals (except RST) within a Clear Reset Delay (800 nSec) of the transition of RST to low. The Bus Free phase always follows the Reset Condition.

When a reset is issued to the Viper drive, the SCSI bus clears all uncompleted commands, releases all SCSI device reservations, sets the Viper drive to default modes, and returns to the Bus Free phase.

4.18 Unit Attention Condition

The Unit Attention condition in the Viper drive results from the following conditions:

- A Reset was previously issued to the Viper drive.
- The Viper drive has just been powered on.
- The tape cartridge was removed when the tape is positioned away from BOT.
- The tape cartridge was removed when the tape is positioned at BOT following a Prevent or a Load command.

The Unit Attention Condition persists for each Initiator until that Initiator issues a command other than Inquiry for which the Viper drive returns with a Check Condition Status. If the next command from that Initiator following the Check Condition Status is Request Sense, then the unit attention sense key is returned.

If the Inquiry Command is received from an Initiator with a pending Unit Attention Condition before the Viper drive reports Check Condition Status, the Viper drive performs the Inquiry Command and does not clear the Unit Attention Condition.

If the Request Sense Command is received from an Initiator with a pending Unit Attention Condition before the Viper drive reports Check Condition Status, the Viper drive reports unit attention sense key and clears the Unit Attention Condition for that Initiator.

4.19 Buffered Mode

The Buffered Mode allows maximum streaming operation. In this mode, the drive signals Command Complete when all requested data for a Write of Verify Command has been transferred from the host to the Viper buffer. This provides data to maintain streaming while the host readies a new Write Command.

If an error occurs in writing data to the tape after the Viper drive signals Command Complete, an error status is sent on the next Command issued.

4.20 Immediate Function

For Initiators that do not support the disconnect feature, the Immediate bit provides a means of releasing the bus while the drive is busy completing a function such as repositioning the tape. If a command is sent by the Initiator after a previous Immediate Command was accepted, the drive continues the Immediate Function it is currently performing, accepts the new command CDB, and immediately completes the new command with Busy Status.

An immediate bit of zero means the status is returned to the Initiator when the tape has been repositioned. An Immediate bit of one means the status is returned to the Initiator as soon as the function is started.

4.21 Residual Length Function

When performing a Write Command in the Buffered Mode, the drive returns a Good Status and Command Completion Message when the last byte requested by the command is placed in the Data Buffer, rather than when it is written onto tape. If an unrecoverable error occurs while data is being written onto tape, the drive calculates the Residual Length and places this value in the information bytes of the Sense Data Block. 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 is issued:

In the Non-buffered Mode, the first command in a sequence of commands terminates at the time of the error and returns a Check Condition. The Initiator then issues a Request Sense Command and receives a Residual Length in the Request Sense Extended Sense bytes 3-6.

The Viper drive calculates the Residual Length for write functions the same way in Buffered Mode as in Non-buffered Mode. Residual Length is calculated by:

$$RC = AL - (TL - RL)$$

Where :

RC (Residual Count) = The amount of data trapped in the Viper drive buffer, not written to tape. This is the same quantity as RL.

AL (Actual Length) = Blocks transferred from the host to the Viper drive across the SCSI bus.

TL (Transfer Length) = The Transfer Length from bytes 2-4 of the Write Command (Request Transfer Length).

RL (Residual Length) = The Residual Length from bytes 3-6 of the Request Sense Extended Sense. (The amount of blocks not written to tape.)

4.22 Disconnect/Reconnect Function

When the drive is performing a task not requiring communication with the Initiator or when the Viper drive determines there is long time with no bus activity, it disconnects from the bus. For example, when repositioning the tape or when writing to tape from a full buffer or when a SCSI disconnect boundary is reached (see Configuration Jumpers). During the time the Target is disconnected for one of these functions, the bus is free for use by other devices. Both disconnect and reconnect are initiated by the Target.

When the Initiator first selects the drive, it sends an Identify Message indicating that it is allowing the drive to disconnect and reconnect and be capable of supporting messages other than Command Complete. To disconnect from the bus, the Viper drive performs the following procedure:

1. The drive can send a Save Data Pointers Message if the disconnecting function was a data transfer.
2. The drive sends a Disconnect Message indicating it is going to disconnect.
3. The drive disconnects from the bus by deasserting BSY and releasing control of all bus signals.

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

- The Viper drive accepts the command and immediately returns Busy Status. The Viper drive does not queue commands.
- Immediately following the selection, the Initiator may send the Identify, No Message, or Bus Device Reset messages to the drive.

When the disconnected drive is ready to reconnect with the Initiator, it does the following:

1. Monitors the bus waiting for a Bus Free Phase to occur. When a Bus Free Phase is sensed, the Viper drive Arbitrates for the bus.
2. Wins arbitration. The Viper drive then attempts to reselect the Initiator. If the Initiator fails to respond in 250 mSec, the drive drops all bus signals and allows the bus to again enter the Bus Free Phase. The drive then repeats the attempted Arbitration.
3. When the Viper drive has successfully reselected the Initiator, it sends an identify message to reestablish the path between the drive and the Initiator. This message is always 80h since the Viper drive is initiating the reselection and is always LUN 0. If the reconnecting function is a data transfer, a Restore Pointers Message is implied when the Viper drive sends an identify message to the Initiator and the Initiator responds accordingly.

4.23 SCSI Memory Address Pointers

SCSI provides for two sets of three pointers within each Initiator. When a physical path is established with a host, and this path can accommodate disconnection and reconnection, the host must ensure that its Current Pointers for the path are equal to the Saved Pointers in the Viper drive. An implied Restore Pointers Operation occurs in the host as a result of a connect or reconnect.

4.23.1 Current Data Pointers

Also known as Active Pointers, these pointers are used to represent the state of the interface and point to the next Command, Status or Data byte to be transferred between the memory of the Initiator and the Target. There is only one set of Current Pointers in each Initiator. The Current Pointers are used by the Target currently connected to the Initiator.

4.23.2 Saved Data Pointers

There is one set of these pointers for each currently active device whether or not it is currently connected. The set includes Command, Status and Data Pointers that point to the Command Descriptor Block, Status Area and Data Area, respectively, for that device.

The Saved Pointer continues to point to the start of the Data Area until the Target reconnects to the Initiator. In response to the implied Save Data Pointer message, the Initiator replaces the Current (active) Data Pointer with the value of the Saved Data Pointer.

4.24 Early Warning Function

Early Warning on the Viper drive is a logical warning given when one megabyte of storage space remains on the tape. The position is calculated by the drive based on the amount of data the drive was able to store on a track. When this physical position is reached on a tape, the following occurs.

1. Data transfers from the host are terminated at the next disconnect boundary.
2. All data remaining in the drive buffer is written to the tape.
3. The command completes with 40h Sense data meaning EOM and no Sense Key.
4. Subsequent Write commands will write data and complete with check condition with EOM Status and No Sense Key until the physical tape holes are encountered. See Write Command for a description.

4.25 Error Reporting

4.25.1 Soft Errors

A soft error is not considered an error, but more a reliability data indicator. Most soft errors are tape-quality related, and will occur more frequently during write operations than during read operations. Soft errors indicate repeated attempts (less than 16) by the drive to read or write data on the tape. Some soft errors are normal, but an increase in the usual count can indicate deteriorating tape quality. Retensioning the tape can lower the soft error count. If the soft error count remains higher than normal, clean the read/write heads. If this procedure does not clear the problem, change to a new tape cartridge.

4.25.2 Hard Errors

If a hard error (unrecoverable error) occurs during operation, the drive terminates operation immediately and returns a Check Condition. The Initiator ceases any further read or write functions and issues 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 attempt, the error is considered unrecoverable and the operation terminates. When a hard error is encountered, retention the tape then repeat the function. If successful ignore the hard error. If not successful, replace the tape with a new tape cartridge and repeat the function.

4.26 SCSI Bus Phase Timing

Table 4-14 shows the SCSI Bus sequence timing. Except where noted, the delay time measurements for each SCSI device is calculated from signal conditions existing at the SCSI bus connection for that device. Normally these measurements do not consider delays in the SCSI bus cable.

Table 4-14. SCSI Bus Sequence Timing

TIMING	DURATION	DESCRIPTION
Arbitration Delay	2.2 μ Sec	The minimum time (no maximum time) an Initiator or Viper drive needs from the time the BSY signal is asserted for Arbitration until the Viper drive can examine the Data Bus to determine if Arbitration has been won.
Bus Clear Delay	*800 nSec	The minimum time an Initiator or Viper requires to stop driving all SCSI bus signals after either (1) a Bus Free Phase is detected, or (2) the SEL signal is received from another SCSI bus Initiator during the Arbitration Phase.
Bus FreeDelay	*800 nSec	The minimum time an Initiator or Viper waits after it has detected the Bus Free Phase until it asserts the BSY signal when going to the Arbitration Phase.
Bus Set Delay	1.8 μ Sec	The minimum time an Initiator or Viper is allowed after it detects a Bus Free Phase to assert the BSY signal and the SCSI ID bit on the databus as a requirement for entering the Arbitration Phase.
Bus Settle Delay	400 nSec	The time the SCSI bus needs to settle after changing certain control signals.
Cable Skew Delay	10 nSec	The maximum difference allowed in propagation time between any two SCSI bus signals when measured between any two SCSI bus devices.
Deskew Delay	45 nSec	This time is used to calculate the minimum time required for deskew delay of certain signals.
Reset Hold Time	25 μ Sec	The minimum time (no maximum time) for which the RST signal is to be asserted.
Selection Abort Time	200 μ Sec	The maximum time-out duration before asserting a BSY signal that the drive or Initiator takes after the most recent detection of Select or Reselect. This timeout is required to ensure that a drive or Initiator does not assert the BSY signal after a Selection or Reselection Phase has been aborted. This timeout is not the same thing as the Selection Timeout Delay.
Selection Time-out Delay	250 mSec	The minimum recommended time during the Selection or Reselection Phase that an Initiator or drive should wait for a BSY response before starting the time-out procedure.
*In the Bus Clear Delay for condition (1), the maximum time allowed for a SCSI device to clear the SCSI bus is 1200 nSec from the time the BSY and SEL signals both first become false. If a SCSI device requires more than a Bus Settle Delay to detect the Bus Free Phase, it clears the SCSI bus within the time duration of a Bus Clear Delay minus the excess time.		

CHAPTER 5 VIPER SCSI COMMANDS

5.1 Introduction

This chapter describes Archive Viper tape drive SCSI commands. Each command is described, its Command Descriptor Block illustrated, and Completion Status given. The SCSI X3.131 Group 0 commands for sequential access devices implemented by the Viper drive are listed numerically by code in Table 5-1.

Table 5-1. SCSI Commands for Bus Sequential Access Devices

CODE	COMMAND	SECTION
00h	TEST UNIT READY	5.3
01h	REWIND	5.4
02h	REQUEST BLOCK ADDRESS	5.5
03h	REQUEST SENSE	5.6
05h	READ BLOCK LIMITS	5.7
08h	READ	5.8
0Ah	WRITE	5.9
0Ch	SEEK BLOCK	5.10
10h	WRITE FILEMARKS	5.11
11h	SPACE	5.12
12h	INQUIRY	5.13
13h	VERIFY	5.14
14h	RECOVER BUFFERED DATA	5.15
15h	MODE SELECT	5.16
16h	RESERVE UNIT	5.17
17h	RELEASE UNIT	5.18
18h	COPY	5.19
19h	ERASE	5.20
1Ah	MODE SENSE	5.21
1Bh	LOAD/UNLOAD	5.22
1Dh	SEND DIAGNOSTIC	5.23
1Eh	PREVENT/ALLOW Medium Removal	5.24
3Bh	WRITE DATA BUFFER	5.25
3Ch	READ DATA BUFFER	5.26

5.2 Descriptor Block

Viper drives send a request to a peripheral device by sending a command descriptor block (CDB) with some commands also requiring a parameter list. If the CDB or the parameter list contains an invalid parameter, the drive terminates the command without altering the medium.

5.2.1 Command Descriptor Block Format

Archive Viper command descriptor blocks are six-byte blocks in the following format.

BITS BYTE	7	6	5	4	3	2	1	0
0	Group Code			Command Code				
1	Logical Unit No.			Command Dependent				
2	Command Dependent							
3	Command Dependent							
4	Command Dependent							
5	Vendor Unique	0	0	0	0	0	Flag	Link

5.2.2 Command Descriptor Block Field Descriptions

The command block descriptor fields are described in the following table.

FIELD	BYTE	BITS	DESCRIPTION
Group Code	0	5-7	This field indicates the SCSI command group used. Viper drives use only Group 0 commands.
Command Code	0	0-4	This field indicates which of the 32 command codes is sent. <i>NOTE: The Group Code and Command Code are used together to indicate the operation code.</i>
Logical Unit Number 1		5-7	Must be set to 0.
Command Dependent	1 2-4	0-4 0-7	See specific command.
Vendor Unique	5	6-7	These bits are ignored.
Flag and Link Bits	5	0 and 1	These bits are used by all commands. The meaning is described in the following table.

5.2.3 Flag and Link Bit Descriptions

The Link bit enables a chain of commands to execute sequentially without individually initiating the commands. When each command completes, a linked command complete message is sent.

The Flag bit allows the initiator to track milestones in the linked command process by requesting a linked command complete (with flag) message from the Viper.

The Flag and Link bits are used by all commands. These bits are defined according to the following.

IF THE LINK BIT IS ...	AND THE FLAG BIT IS ...	THE RESULT IS ...
1	0	The Target sends a linked command complete message, then processes the next command.
1	1	The Initiator desires an automatic link to the next command upon successful completion of the current command. The Target sends a Linked command complete (with flag) message and returns Immediate Status and the message defined by the Flag bit.
0	0	The Flag bit is always set to 0. The Target terminates action and goes bus free on completion of the current command.

5.3 TEST UNIT READY (00h)

The TEST UNIT READY command determines if the Viper drive is ready to accept a medium access command. If access is accepted, the Viper drive returns Good Status. This command does not initiate a diagnostic routine.

5.3.1 TEST UNIT READY Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	X	X	0	0	0	0	Flag	Link

5.3.2 Completion Status

CODE	MESSAGE	DESCRIPTION															
00h	Good Status	<ul style="list-style-type: none"> • The tape is not moved • Viper drive is ready to accept any legal command • Viper drive remains in any previously set mode. 															
02h	Check Condition	<p>Extended Sense Byte 02h</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not Ready</td> <td>• No cartridge in the drive.</td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td>• Parity error on SCSI Bus or the Viper</td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td>• The CDB contains an invalid bit</td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> • Cartridge was changed prior to accepting this command • Viper was reset prior to accepting this command. </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not Ready	• No cartridge in the drive.	04h	Hardware Error	• Parity error on SCSI Bus or the Viper	05h	Illegal Request	• The CDB contains an invalid bit	06h	Unit Attention	<ul style="list-style-type: none"> • Cartridge was changed prior to accepting this command • Viper was reset prior to accepting this command.
CODE	MESSAGE	DESCRIPTION															
02h	Not Ready	• No cartridge in the drive.															
04h	Hardware Error	• Parity error on SCSI Bus or the Viper															
05h	Illegal Request	• The CDB contains an invalid bit															
06h	Unit Attention	<ul style="list-style-type: none"> • Cartridge was changed prior to accepting this command • Viper was reset prior to accepting this command. 															

5.4 REWIND (01h)

The REWIND command causes the Viper drive to rewind to Beginning of Tape (BOT).

5.4.1 REWIND Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	IMMED
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	X	X	0	0	0	0	Flag	Link

5.4.2 Command Descriptor Block Field Description

The immediate (IMMED) Bit, Byte 1, Bit 0, can be used to specify that status be returned as soon as the operation is initiated.

5.4.3 Completion Status

CODE	MESSAGE	DESCRIPTION															
00h	Good Status	<ul style="list-style-type: none"> Viper drive is ready to accept any legal command Viper drive remains in any previously set mode. The Tape is positioned to BOT. 															
02h	Check Condition	<p>Extended Sense Byte 02h</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not Ready</td> <td> <ul style="list-style-type: none"> No cartridge in the drive </td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> Parity error on SCSI Bus or the Viper </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> The Link bit and IMMED bit were both set to a 1 The CDB contains an invalid bit </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> Cartridge was changed prior to accepting this command Viper was reset prior to accepting this command </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not Ready	<ul style="list-style-type: none"> No cartridge in the drive 	04h	Hardware Error	<ul style="list-style-type: none"> Parity error on SCSI Bus or the Viper 	05h	Illegal Request	<ul style="list-style-type: none"> The Link bit and IMMED bit were both set to a 1 The CDB contains an invalid bit 	06h	Unit Attention	<ul style="list-style-type: none"> Cartridge was changed prior to accepting this command Viper was reset prior to accepting this command
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06h	Unit Attention	<ul style="list-style-type: none"> Cartridge was changed prior to accepting this command Viper was reset prior to accepting this command 															

5.5 REQUEST BLOCK ADDRESS (02h)

The REQUEST BLOCK ADDRESS command requests the drive to transfer the current data block address to the Initiator. This command returns the actual block address number on tape.

For QIC-24 or QIC-120 mode, the first data block is Block 1. For QIC-150 mode, the first block on tape is a control block as defined by the QIC-150 specification, and the first data block on tape is Block 2. If a REWIND and a REQUEST BLOCK ADDRESS is issued to a QIC-150 tape, Block Address 2 is returned.

5.5.1 REQUEST BLOCK ADDRESS Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	X	X	0	0	0	0	Flag	Link

5.5.2 Command Descriptor Block Field Description

If the Allocation Length, Byte 4, field is zero, the default data Transfer Length (3) is used. When non-zero, the number of bytes specified in Allocation Length (up to a maximum of 3 bytes) is transferred.

5.5.3 REQUEST BLOCK ADDRESS Data Format

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	Block Address - MSB			
1	Block Address							
2	Block Address - LSB							

5.5.4 REQUEST BLOCK ADDRESS Data Field Description

The Block Address, Bytes 0 through 2, fields report the current tape position block number.

5.5.5 Completion Status

CODE	MESSAGE	DESCRIPTION												
00h	Good Status	<ul style="list-style-type: none"> • The tape is not moved • Viper drive is ready to accept any legal command • Viper drive remains in any previously set mode 												
02h	Check Condition	Extended Sense byte 02 <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> • Parity error on either the SCSI Bus or Viper drive </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> • The CDB contains an invalid bit </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • The Viper drive was Reset prior to accepting this command </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	04h	Hardware Error	<ul style="list-style-type: none"> • Parity error on either the SCSI Bus or Viper drive 	05h	Illegal Request	<ul style="list-style-type: none"> • The CDB contains an invalid bit 	06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • The Viper drive was Reset prior to accepting this command
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5.6 REQUEST SENSE (03h)

The REQUEST SENSE command causes the Viper drive to transfer status data to the Initiator pertaining to the last command. The Viper drive uses extended sense format only.

5.6.1 REQUEST SENSE Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	1
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	X	X	0	0	0	0	Flag	Link

Sense Data is updated with each command; therefore, the sense data only reports the status of the immediately previous command. If there is a Check Condition Status, a REQUEST SENSE should be issued to recover the information from the Sense Data.

The REQUEST SENSE command returns Check Condition Status only if a fatal error occurs during execution of the REQUEST SENSE command. If non-fatal errors occur during REQUEST SENSE execution, Good Status is returned. Sense data may be invalid following a fatal error on a REQUEST SENSE command.

5.6.2 Command Descriptor Block Field Description

A Byte 4 of zero in the Allocation Length field indicates that 14 bytes of extended sense data are transferred. When non-zero, the number of bytes specified in Allocation Length (up to a maximum of 14 bytes) are transferred.

5.6.3 Extended Sense Data Format

BITS BYTE	7	6	5	4	3	2	1	0
0	Valid	Error Class (7h)			Error Code			
1	Segment Number							
2	FM	EOT	ILI	0	Sense Key			
3	Residual Length - MSB (0)							
4	Residual Length- - - (0)							
5	Residual Length- - - (0)							
6	Residual Length - LSB (0)							
7	Additional Sense Length							
8	COPY Source Sense Data Pointer							
9	COPY Destination Data Pointer							
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	Number of Recoverable Errors - MSB							
13	Number of Recoverable Errors - LSB							
14	COPY Target Status							
15-22	COPY Target Sense Data Bytes 0 - 7							

5.6.4 Extended Sense Data Field Descriptions

FIELD NAME	BYTES	BITS	DESCRIPTION
Valid Bit	0	7	<p>The Valid Bit indicates the Residual Length, Bytes 3 to 6, field is defined. If the Valid Bit is set to one, Residual Length is the requested length minus the actual length in blocks. For example,</p> <p>If: WRITE Transfer Length = 1000 blocks Residual Length = 896 blocks Blocks transferred to Viper = 192 blocks</p> <p>Then: Transfer Length - Residual Length = Data written to tape $1000 - 896 = 108$</p> <p>And: Blocks transferred to Viper - Data to tape = Data trapped in buffer $192 - 108 = 84$</p> <p><i>Note: To recover data trapped in the Viper buffer, issue a Recover Buffer Data command with Requested Length of 84.</i></p>
Error Class	0	4-6	The Error Class field indicates Extended Sense. It is set to 7h.
Error Code	0	0-3	The Error Code field indicates standard extended sense data format.
Segment Number		1	The Segment Number field is set to zero.
FM Bit	2	7	The FM Bit indicates that the current command has read a Filemark.
EOT Bit	2	6	<p>This bit indicates one of the following:</p> <ol style="list-style-type: none"> 1. Early-warning has been reached or passed in the forward direction 2. The command could not be completed because beginning-of tape (BOT) was encountered in a space reverse command.
Incorrect Length Indicator (ILI)	2	5	ILI is not used. Viper supports only fixed-length blocks ILI is always set to 0.
Sense Key	2	0-3	This field indicates the status of the last command.

5.6.4 Extended Sense Data Field Descriptions Continued

FIELD NAME	BYTES	BITS	DESCRIPTION
Additional Sense Length	7		<p>A number greater than zero in this field indicates that bytes 8 through N contain information.</p> <p>If the copy target was the source device, Byte 8 contains 06h for the Sense Key or OAh, COPY Aborted.</p> <p>If the copy target was the destination device, Byte 9 contains 05h for the Sense Key or OAh, COPY Aborted.</p>
Number of Recoverable Errors	12 -13		These fields contain the number of recoverable errors (Soft Errors). The 16-bit value is the accumulated soft error count of a series of commands. The value in this field is reset to zero when the command is switched from write to read or read to write.
Copy Target Status	14		Copy Target Status field reports the Copy Target Sense Key
Copy	15 -22	0 -7	Copy Target Sense Data fields report the bytes from the REQUEST SENSE Extended Sense of the Copy Target.
<p>NOTE: Because the ANSI X3.131, 1986, specification makes no provisions for multiple error reporting, a Viper drive priority code is assigned to each of the possible Sense Keys. In the case of multiple errors, the Sense Key with highest priority is reported. The priorities are numbered one through eleven, with one being the highest priority. The following table describes priority.</p>			

5.6.5 Priority and Definition of Sense Keys

KEY	PRIORITY	MESSAGE	DEFINITION
00h	11	No Sense	The Check Condition occurred in conjunction with detection of FM or EOT or status was not available.
01h	10	Recovered Error	The last command completed successfully following recovery actions by Viper drive. A Check Condition was not issued.
02h	8	Not ready	The Viper drive cannot be accessed. Operator intervention may be required to correct this condition.
03h	3	Media Error	The command terminated with a non-recoverable error that was probably caused by a flaw in the medium or an error in the recorded data.
04h	2	Hardware Error	The Viper drive detected a non-recoverable hardware failure (parity, etc.) while performing the command.
05h	7	Illegal Request	The CDB contained an illegal parameter.
06h	1	Unit Attention	The cartridge was changed or the Viper has been reset.
07h	9	Data Protect	The cartridge is write-protected, the operation was not performed.
08h	6	Bland Check	A no-data condition was encountered on the tape or wrong data format was encountered on tape .
0Ah	N/A	Copy Aborted	The Copytarget reported a Check Condition. Error information is reported in bytes 8, 9, 11-22.
0Bh	4	Aborted Command	The Viper drive aborted the command. The Initiator may be able to recover by trying the command again.
0Dh	5	Volume Overflow	The Viper reached the physical EOT and data remains in the buffer. A Recover buffered data command may be issued to read unwritten data not written to tape from the buffer.

5.6.6 Completion Status

CODE	MESSAGE	DESCRIPTION						
00h	Good Status	<ul style="list-style-type: none"> • Media Position is not changed • Viper drive is ready to perform any appropriate command • Viper drive remains in any previously set modes 						
02h	Check Condition	Extended Sense byte 02						
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">CODE</th> <th style="width: 25%;">MESSAGE</th> <th style="width: 60%;">DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>04h</td> <td>Hardware Error</td> <td>• Parity error either on the SCSI Bus or the Viper drive.</td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	04h	Hardware Error	• Parity error either on the SCSI Bus or the Viper drive.
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04h	Hardware Error	• Parity error either on the SCSI Bus or the Viper drive.						

5.7 READ BLOCK LIMITS (05h)

The READ BLOCK LIMITS command causes the Viper drive to transfer the block length limits to the Initiator. Both the maximum and minimum block lengths are set to 512 (200h) since Viper drive supports only one block length.

5.7.1 READ BLOCK LIMITS Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0	1
1	1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	X	X	0	0	0	0	Flag	Link

5.7.2 Command Descriptor Block Field Descriptions

There are no command dependent fields in the Command Descriptor Block.

The values of the individual bytes in the Block Length fields are shown below in hexadecimal notation.

5.7.3 READ BLOCK LIMITS Data Format

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	Maximum Block Length MSB (00h)							
2	Maximum Block Length (02h)							
3	Maximum Block Length LSB (00h)							
4	Minimum Block Length MSB (02h)							
5	Minimum Block Length LSB (00h)							

5.7.4 Completion Status

CODE	MESSAGE	DESCRIPTION												
00h	Good Status	<ul style="list-style-type: none"> • The position of the Media is not changed • Viper drive is ready to accept any appropriate command • Viper drive remains in previously set mode. 												
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> • Parity error on either the SCSI Bus or Viper drive </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> • The CDB contains an invalid bit </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • The Viper drive was reset prior to accepting this command. </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	04h	Hardware Error	<ul style="list-style-type: none"> • Parity error on either the SCSI Bus or Viper drive 	05h	Illegal Request	<ul style="list-style-type: none"> • The CDB contains an invalid bit 	06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • The Viper drive was reset prior to accepting this command.
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06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • The Viper drive was reset prior to accepting this command. 												

5.8 READ (08h)

The READ command transfers one or more blocks from the Viper drive to the Initiator beginning with the next block on tape. Only 512-byte blocks are supported. Upon successful termination of the READ command, the tape is logically positioned after the last block transferred on the EOT side of the tape.

5.8.1 READ Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	1
2	Transfer Length - MSB							
3	Transfer Length							
4	Transfer Length - LSB							
5	X	X	0	0	0	0	Flag	Link

5.8.2 Command Descriptor Block Field Descriptions

BIT NAME	BYTES	BITS	DESCRIPTION
Fixed Block Size Bit	1	0	This bit must be a one, indicating that the size of the blocks are fixed.
Transfer Length	2 - 4		The Transfer Length field specifies the number of blocks to be read. When a transfer length is zero, no data is transferred. This condition is not considered an error.

5.8.3 READ command Description

The READ command is complete when one of the following conditions is encountered on tape:

- End of data (EOD)
- A file mark (FM)
- Transfer length satisfied
- End of tape (EOT)
- Unrecoverable data error

5.8.3.1 End of Data

If EOD is encountered, the command terminates with a Check Condition status and a Sense Key of 08h. The tape is then positioned to allow an Append Data operation.

5.8.3.2 Filemark

If a filemark is encountered, the command is completed with a Check Condition, and in a REQUEST SENSE command, byte 02 returns with the filemark bit 40h. If the Valid bit is set indicating a residual count, the Residual Length field equals the difference between the requested transfer length and the actual blocks read. Upon termination, the tape is positioned after the filemark on the EOT side of tape.

5.8.3.3 Transfer Length Satisfied

If the Transfer Length is satisfied, the command completes successfully with a Good Status, and the tape is positioned on EOT side of the last block read.

5.8.3.4 End of Tape (EOT)

When EOT is encountered during a Read command, the command terminates with a Check Condition and Sense Key 48h, indicating EOT and Blank Check. If the Valid bit is set, the Residual Length equals the difference between the requested length and number of actual blocks read.

5.8.3.5 Unrecoverable Data Error

If an Unrecoverable Data Error is encountered, the READ command terminates with Check Condition and an 03h Sense Key. If the Valid bit is set, Residual Length equals the difference between the requested Transfer Length and the actual number of blocks read. For an error to be defined as an Unrecoverable Data Error, it must be retried 16 times. This is accomplished as follows using an offtrack stepping algorithm.

1. When an error is encountered, the drive retries 4 times at the nominal position.
2. If unable to recover the data, it steps the head up and retries 4 times at that position.
3. If still unsuccessful, it steps below the nominal position and retries 4 times.
4. If unsuccessful again, it steps back to the nominal position, and retries 4 more times.
5. When the drive is unable to recover the data in any of these 16 retries, the error is reported as unrecoverable.
6. If the drive recovers the data in any of these retries, the Recoverable Error Counter in bytes 13 and 14 is incremented to reflect a Recoverable Error.

5.8.4 Completion Status

CODE	MESSAGE	DESCRIPTION																														
00h	Good Status	<ul style="list-style-type: none"> • Media is positioned on the EOT side of the last block read • The Viper drive is ready to perform any legal command • The Viper drive remains in any previously set mode. 																														
02h	Check Condition	<p>Extended Sense Byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not Ready</td> <td>• No cartridge in drive</td> </tr> <tr> <td>03h</td> <td>Media Error</td> <td>• Unrecoverable Data Error encountered</td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td>• Parity error either on the SCSI bus or the Viper drive</td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td>• The CDB contains an invalid bit</td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> • The cartridge was changed prior to issuing the READ command • The Viper drive has previously received a Reset </td> </tr> <tr> <td>08h</td> <td>Blank Check</td> <td> <ul style="list-style-type: none"> • Drive encountered End of Data • Density code previously set by a MODE SELECT command does not match the same density as was previously written onto the tape </td> </tr> <tr> <td>43h</td> <td>End of Media and Media Error</td> <td>• Physical End of Media is encountered and Media Error</td> </tr> <tr> <td>48h</td> <td>End of Media and Blank Check</td> <td>• End of Media is encountered and Blank Check</td> </tr> <tr> <td>80h</td> <td>Filemark and No Sense</td> <td>• A file mark was read</td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not Ready	• No cartridge in drive	03h	Media Error	• Unrecoverable Data Error encountered	04h	Hardware Error	• Parity error either on the SCSI bus or the Viper drive	05h	Illegal Request	• The CDB contains an invalid bit	06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to issuing the READ command • The Viper drive has previously received a Reset 	08h	Blank Check	<ul style="list-style-type: none"> • Drive encountered End of Data • Density code previously set by a MODE SELECT command does not match the same density as was previously written onto the tape 	43h	End of Media and Media Error	• Physical End of Media is encountered and Media Error	48h	End of Media and Blank Check	• End of Media is encountered and Blank Check	80h	Filemark and No Sense	• A file mark was read
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5.9 WRITE (0Ah)

WRITE command transfers one or more data blocks from the Initiator to the Viper drive. Only fixed-length blocks, 512-byte blocks are supported. If the Transfer Length is zero, no data is transferred, and the current position of the tape is not changed. This condition is not considered an error.

5.9.1 WRITE Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	0
1	0	0	0	0	0	0	0	1
2	Transfer Length - MSB							
3	Transfer Length							
4	Transfer Length - LSB							
5	X	X	0	0	0	0	Flag	Link

Before issuing a WRITE command, the tape must be positioned at BOT or at the end of recorded data either by issuing a SPACE EOD or a READ command.

QIC data can only be written over erased tape; therefore, when the Viper drive writes to track zero, the erase head is turned on to condition the entire tape.

Two operation modes are established before writing either by a MODE SELECT command or by a default after a Reset. The Buffered Mode determines whether Good Status is returned as soon as data is successfully written to the Viper drive buffer or when the data is written to tape. The default after a Reset is the Buffered Mode. The Density Code determines the format for writing to or reading from the tape.

If the tape is written from BOT and the Density Code is default 00h, the density is set to the maximum allowable capacity for the tape installed. If a MODE SELECT command was issued for a specific density, that density is written to tape if the tape can support it. Multiple densities cannot be written to a tape.

The Viper calculates the logical Early Warning based on the amount of data written to the drive before the last track. As a write begins on the last track, the remaining data is divided by the previous number of tracks to determine how much data can be written on that track before Early Warning is issued. Early Warning is calculated as one megabyte before the EOT. This insures that when Early Warning is encountered, enough space remains to successfully write any unwritten blocks up to one megabyte.

At Early Warning, the Viper completes the current block transfer and terminates the command with a Check Condition and a 40h Sense Key. The data in the Viper buffer is written to tape.

If writing the buffer to tape is unsuccessful a volume overflow is reported. Residual count in the Request Sense reports the amount of data not transferred. Writing can continue in the Early Warning region until EOT is encountered. Any WRITE command issued within Early Warning and successfully completed, finishes with a Check Condition and a 40h Sense Key.

When EOT is encountered, the command completes with a Check Condition and a 43h Sense Key meaning EOT and media error. This is considered a catastrophic error, and no data can be written beyond this point. The residual count in the Request Sense Status reports the amount of data not written to tape.

QIC-24, QIC-120, and QIC-150 specify that every file be terminated with a filemark. Although the Viper does not consider no filemark an error condition, the QIC specification considers the tape as an illegal tape. Writing a filemark at the end of each file prevents this occurrence.

If an error is encountered while writing, 16 attempts are made to rewrite the block. If none of the 16 rewrites are successful, the error is considered unrecoverable and reported as such. If during the 16 retries the block is successfully written, the write process continues and a recoverable error is reported in the Request Sense data, bytes 13 and 14. This is not considered an error condition. The soft error count accumulates as soft errors are encountered.

5.9.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTES	BITS	DESCRIPTION
Fixed	1	0	This bit must be a one to indicate that blocks are fixed sized.
Transfer Length	2 - 4	0 - 7	These fields specify the number of blocks to be written at the current tape position.

5.9.3 Completion Status

CODE	MESSAGE	DESCRIPTION				
00h	Good Status	<ul style="list-style-type: none"> The tape is positioned on the EOT side of the last block written The tape is prepared for an append operation Viper drive remains in any previously set modes 				
02h	Check Condition	Extended Sense Byte 02h				
		<table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>01h</td> <td>Recoverable Error</td> <td> <ul style="list-style-type: none"> Tape encountered soft errors that are reported in Status bytes 13 and 14 of the Request Sense Command All data is successfully written to tape </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	01h
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01h	Recoverable Error	<ul style="list-style-type: none"> Tape encountered soft errors that are reported in Status bytes 13 and 14 of the Request Sense Command All data is successfully written to tape 				

5.9.3 Completion Status Continued

CODE	MESSAGE	DESCRIPTION
02h	Not ready	• No cartridge in drive
03h	Media Error	• Unrecoverable data error encountered
04h	Hardware error	• Parity error on SCSI bus or the Viper
05h	Illegal request	<ul style="list-style-type: none"> • CDB contains an illegal bit • The tape is not positioned to EOD • A DC300XLP is installed; the drive cannot write to this media • QIC-11 or QIC-24 was sent by Mode Select; the drive does not support writing that density code
06h	Unit attention	<ul style="list-style-type: none"> • The cartridge was changed prior to sending this command • The Viper was Reset prior to this command
07h	Write Protect	<ul style="list-style-type: none"> • Tape is write protected; check the cartridge before continuing. • Cartridge in the drive cannot support the selected density code
0Dh	Volume overflow	• Write command completed with data in the buffer. Use Recover Buffer Data to recover the data
40h	End of Media and No Sense	<ul style="list-style-type: none"> • Write command encountered early warning • Write command completed a successful write in the early warning zone
41h	End of Media and Recoverable Error Sense Key	<ul style="list-style-type: none"> • Write command encountered early warning with soft errors reported • Write command completed within the early warning zone with soft errors reported.
43h	End of Media and Media Error Sense Key	• EOT was encountered

5.10 SEEK BLOCK (0Ch)

The SEEK BLOCK command is used to position the tape at the specified block address. No data is transferred. SEEK BLOCK positions the tape to block locations greater or less than the current block position. Positioning is done with a direct block addressing algorithm and does not require a serpentine search through all tracks for the requested block. The Viper drive head steps directly to the track the requested block is on, and the tape streams to the block on that track only.

The Initiator may obtain block addresses through the REQUEST BLOCK ADDRESS command as part of its tape write procedures. The block addresses can, in turn, be recorded in a user-defined directory. Typically, this directory is located at the end of recorded data and is used to rapidly position to the beginning of specific files on the tape.

When there is no exception condition during a SEEK BLOCK command, the tape is logically positioned before the block specified in the block address. The first data block on tape is block 1, therefore, a zero in the block address is considered an error.

5.10.1 SEEK BLOCK Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	0	0
1	0	0	0	0	0	0	0	IMMED
2	0	0	0	0	Block Address - MSB			
3	Block Address							
4	Block Address - LSB							
5	X	X	0	0	0	0	Flag	Link

5.10.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTES	BITS	DESCRIPTION
IMMED Bit	1	0	The IMMED bit is used to request that status be returned as soon as the operation is initiated. When the IMMED bit is not set, status is returned after the tape is positioned at the specified block.
Block Address	2 3 - 4	0 - 3 0 - 7	These fields indicate the address of the block to which the tape is to be positioned.

5.10.3 Completion Status

CODE	MESSAGE	DESCRIPTION																								
00h	Good Status	<ul style="list-style-type: none"> • Viper drive is ready to accept any appropriate command • Viper drive remains in any previously set mode • Media is positioned before the requested Block 																								
02h	Check Condition	Extended Sense Byte 02																								
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5.11 WRITE FILEMARKS (10h)

The WRITE FILEMARKS command causes the specified number of filemarks to be written to tape beginning at the current block position or following the last buffered data block when buffered data remains to be written.

This command can be used to force all remaining buffered data blocks to be written to tape without appending filemarks by specifying zero filemarks unless immediate mode is selected.

The command does not return Good Status to the Initiator unless all buffered data blocks and filemarks are written correctly on the tape unless immediate mode is selected.

5.11.1 Write Filemark Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	0	IMMED
2	Number of Filemarks - MSB							
3	Number of Filemarks							
4	Number of Filemarks - LSB							
5	X	X	0	0	0	0	Flag	Link

5.11.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTES	BITS	DESCRIPTION
Immediate Bit	1	0	In the current code this bit defines the Immediate Mode. It causes the Write Filemarks command to execute without an under run.
Number of Filemarks	2-4	0-7	The Number of Filemarks fields that contain data for writing Filemarks.

5.11.3 Completion Status

CODE	MESSAGE	DESCRIPTION																																				
00h	Good Status	<ul style="list-style-type: none"> • Tape is positioned on the EOT side of the last Filemark written. • The tape is prepared for an append operation. • Viper remains in any previously set modes. 																																				
02h	Check Condition	<p>Extended Sense Byte 02h</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>01h</td> <td>Recoverable Error</td> <td> <ul style="list-style-type: none"> • The tape encountered soft errors that are reported in bytes 13 and 14 of the RequestSense Data. • All data is successfully written to tape. </td> </tr> <tr> <td>02h</td> <td>Check condition</td> <td>• No cartridge in drive</td> </tr> <tr> <td>03h</td> <td>Media Error</td> <td>• Unrecoverable data error encountered</td> </tr> <tr> <td>04h</td> <td>Hardware error</td> <td>• Parity error on SCSI bus or the Viper</td> </tr> <tr> <td>05h</td> <td>Illegal request</td> <td> <ul style="list-style-type: none"> • CDB contains an illegal bit • The tape is not positioned to EOD • A DC300XLP is installed; the drive cannot write to this media • QIC-11 or QIC-24 sent by MODE SELECT; the drive does not support writing that density code </td> </tr> <tr> <td>06h</td> <td>Unit attention</td> <td> <ul style="list-style-type: none"> • The cartridge was changed before the Write Command was issued • Reset occurred prior to this command </td> </tr> <tr> <td>07h</td> <td>Write Protect</td> <td> <ul style="list-style-type: none"> • The tape is write protected • Cartridge cannot support selected density </td> </tr> <tr> <td>0Dh</td> <td>Volume Overflow</td> <td>• Write command completed with data remaining in the buffer. Recover data with a recover buffer data command</td> </tr> <tr> <td>40h</td> <td>EOT and No Sense</td> <td> <ul style="list-style-type: none"> • Write Filemark encountered early warning • Write Filemark successful in EW zone </td> </tr> <tr> <td>41h</td> <td>End of Media and Sense Key</td> <td> <ul style="list-style-type: none"> • Write Filemark encountered EW with soft errors reported • Write Filemark completed in early warning zone with soft errors reported </td> </tr> <tr> <td>43h</td> <td>EOT and Media Error</td> <td>• End of tape encountered</td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	01h	Recoverable Error	<ul style="list-style-type: none"> • The tape encountered soft errors that are reported in bytes 13 and 14 of the RequestSense Data. • All data is successfully written to tape. 	02h	Check condition	• No cartridge in drive	03h	Media Error	• Unrecoverable data error encountered	04h	Hardware error	• Parity error on SCSI bus or the Viper	05h	Illegal request	<ul style="list-style-type: none"> • CDB contains an illegal bit • The tape is not positioned to EOD • A DC300XLP is installed; the drive cannot write to this media • QIC-11 or QIC-24 sent by MODE SELECT; the drive does not support writing that density code 	06h	Unit attention	<ul style="list-style-type: none"> • The cartridge was changed before the Write Command was issued • Reset occurred prior to this command 	07h	Write Protect	<ul style="list-style-type: none"> • The tape is write protected • Cartridge cannot support selected density 	0Dh	Volume Overflow	• Write command completed with data remaining in the buffer. Recover data with a recover buffer data command	40h	EOT and No Sense	<ul style="list-style-type: none"> • Write Filemark encountered early warning • Write Filemark successful in EW zone 	41h	End of Media and Sense Key	<ul style="list-style-type: none"> • Write Filemark encountered EW with soft errors reported • Write Filemark completed in early warning zone with soft errors reported 	43h	EOT and Media Error	• End of tape encountered
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5.12 SPACE (11h)

The SPACE Command uses two methods to move the tape. SPACE Filemarks counts individual marks and SPACE Sequential Filemarks searches for a contiguously grouped set of filemarks equal to the specified count. This command moves the tape:

- Forward or backward a specified number of blocks.
- Forward or backward a specified number of Filemarks.
- Forward or backward a specified number of sequential (contiguously grouped) Filemarks.
- Forward to the end of recorded data.

A file example is shown below.

Block	1	2	3	4	5	6	7	8	9	10	11	12	13
BOT	Data	Data	Data	Data	F/M	Data	Data	F/M	Data	Data	F/M	F/M	F/M
Position	1				2				3				

- When SPACE Block count is 4 from BOT, SPACE positions the tape to the beginning of the 4th block.
- When SPACE Sequential Filemarks count is 2 from BOT, SPACE positions the tape to the next occurrence of a double filemark (position # 2).
- When SPACE Filemarks count is 5 from BOT, SPACE positions the tape to position #3.

5.12.1 SPACE Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	0	1
1	0	0	0	0	0	0	Code	
2	Count - MSB							
3	Count							
4	Count - LSB							
5	X	X	0	0	0	0	Flag	Link

5.12.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTES	BITS	DESCRIPTION										
Code	1	0-1	<p>The Code Field designates the desired function as shown below.</p> <table> <thead> <tr> <th>CODE</th> <th>FUNCTION</th> </tr> </thead> <tbody> <tr> <td>00h</td> <td>SPACE Blocks</td> </tr> <tr> <td>1Ch</td> <td>SPACE Filemarks</td> </tr> <tr> <td>2Ch</td> <td>SPACE Sequential Filemarks</td> </tr> <tr> <td>3Ch</td> <td>SPACE to end of recorded data</td> </tr> </tbody> </table>	CODE	FUNCTION	00h	SPACE Blocks	1Ch	SPACE Filemarks	2Ch	SPACE Sequential Filemarks	3Ch	SPACE to end of recorded data
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3Ch	SPACE to end of recorded data												
Count	2-4		<p>This field specifies the number of blocks, file marks, or file marks to space over. A zero value in the count field causes no media movement and is not considered an error.</p>										

5.12.3 Space-by-Count Functions

The Count field indicates both direction and distance. A positive value N in the Count field moves the tape forward over N blocks, Filemarks, or contiguous Filemarks with Space Sequential. A negative value -N (2's complement) in the Count field moves the tape backward over N blocks, Filemarks, or contiguous Filemarks. Zero in the count field causes no tape movement and is not considered an error.

When there are no exception conditions during space functions, forward tape motion ends on the EOT side of the last block or Filemark and reverse motion ends on the BOT side of the last block or Filemark.

- If a Filemark is encountered while spacing over blocks, a Check Condition Status is returned. Extended Sense FM bit is set. Extended Sense Valid bit is set, indicating Residual Length is non-zero. The Residual Length equals the difference in the requested count and the actual number of blocks spaced over not including the Filemark. The tape is positioned on the logical EOT side of the filemark if movement was forward or on the logical BOT side of the Filemark if movement was reverse.
- If EOD is encountered while spacing forward over blocks or Filemarks, Check Condition is returned with 08h Sense Key. Extended Sense Valid bit is set, indicating Residual Length is non-zero.
- If BOT is encountered while spacing in reverse over blocks or filemarks, Check Condition is returned with 40h Sense Key. Extended sense Valid bit is set, indicating a non-zero Residual Length.
- If Early Warning is encountered while spacing over blocks or Filemarks, Check Condition Status is returned with 08h Sense Key. Extended Sense Valid Bit is set, indicating a non-zero Residual Length.

- If EOT is encountered while spacing forward over blocks or Filemarks, Check Condition is returned with 40h or 43h Sense Key. Extended Sense Valid bit is set, indicating a non-zero Residual Length.
- If an unrecoverable data error is encountered, Check Condition Status is returned, Extended Sense Key is set to Medium Error, and Extended Sense Valid bit is set, indicating Residual Length is non-zero.

5.12.4 Space by Position Functions

The Count field is not applicable in space-by-position functions.

In the space to EOD function, the tape is positioned such that a subsequent WRITE Command appends data to the last recorded information on the tape.

The space to EOD function is useful in support of user-defined directories.

- If physical EOT is encountered while spacing to end of data, Check Condition Status is returned and Extended Sense is set to Medium Error.
- If unrecoverable data error is encountered, Check Condition Status is returned, Extended Sense Key is set to Medium Error, and Extended Sense Valid bit is set, indicating Residual Length is non-zero.

5.12.5 Completion Status

CODE	MESSAGE	DESCRIPTION												
00h	Good Status	<ul style="list-style-type: none"> • Viper drive is ready to accept any appropriate command • Viper drive remains in any previously set mode. • The Tape position is on the EOT side if space forward and on the BOT side if space reverse. 												
02h	Check Condition	Extended Sense byte 02h												
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03h	Media Error	• An unrecoverable data error was encountered while performing a Space command												
04h	Hardware	• Parity error on either the SCSI Bus or the Viper drive												

5.12.5 Completion Status Continued

Extended Sense byte 02h		
CODE	MESSAGE	DESCRIPTION
05h	Illegal Request	• The CDB contains an invalid bit
06h	Unit Attention	• The cartridge was changed prior to accepting this command • The Viper drive was reset prior to accepting this command.
08h	Blank Check	• End of Data was encountered while executing a space forward
40h	EOT bit and No Sense	• BOT was encountered while executing a Space Reverse.
43h	EOT bit and Media Error	• Physical EOT was encountered.
48h	EOT Bit and Blank Check	• Logical EOT was encountered.
80h	Filemark Bit No Sense	• A Filemark was encountered while performing a SPACE Command forward or reverse.

5.13 INQUIRY (12h)

The INQUIRY command requests that Viper drive parameter information be returned. If an INQUIRY command is received from an Initiator with a pending Unit Attention Condition (before the Viper drive reports Check Condition status), the Viper drive performs the INQUIRY command and does not clear the Unit Attention Condition.

5.13.1 INQUIRY command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	1	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	X	X	0	0	0	0	Flag	Link

5.13.2 Command Descriptor Block Field Description

FIELD NAME	BYTES	DESCRIPTION
Allocation Length	4	Specifies the number of bytes that the Initiator has allocated for the response data. The Viper drive transfers the number of bytes specified up to a maximum of 36. An Allocation Length of zero indicates that no data can be transferred. This is not considered an error.

5.13.3 INQUIRY Command Data Format

BITS BYTE	7	6	5	4	3	2	1	0
0	Peripheral Device Type							
1	RM(1)	Device Type Qualifier (0)						
2	0	0	ECMA Version (0)			ANSI Version (1)		
3	0	0	0	0	0	0	0	0
4	Additional Length (1Fh)							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8 : : : 15	Vendor ID - MSB Vendor ID - LSB							
16 : : : 31	Product ID - MSB Product ID - LSB							
32 : : : 35	Product Revision Level - MSB Product Revision Level - LSB							

5.13.4 INQUIRY Command Data Field Descriptions

FIELD NAME	BYTE	BIT	DESCRIPTION
Peripheral Device Type	0	0-7	This field indicates a sequential access device. Value 7Fh indicates that a logical unit is not present. This is reflected only in the case where a non-zero LUN was contained in the last Identify message sent by the Initiator.
RM	1	7	When set to 1, this field indicates the medium is removable.

5.13.4 INQUIRY Command Data Field Descriptions Continued

FIELD NAME	BYTE	BIT	DESCRIPTION
ECMA	2	3-5	This field indicates no claim to compliance with the European Manufacturers Computer Association (Version 3-3).
ANSI Version	2	0-2	This field indicate compliance with standard X3.131-1986.
Additional	4		This field indicates that 31 bytes of additional INQUIRY command parameters follow (beginning in Byte 05h). This value is not modified if the Allocation Length in the CDB is too small to accommodate the entire response.
Vendor ID	8 - 15		These fields contain eight bytes of ASCII data: "ARCHIVE (followed by a space)"
Product ID	16 - 31		These fields contain sixteen bytes of ASCII data: VIPER 150 XXXXX for the Viper firmware 150S VIPER 125 XXXXX for the Viper firmware 125S VIPER 60 XXXXX for the Viper firmware 60S The XXXXX is the first five digits of the Archive Part Number.
Product Revision Level	32 - 35		These fields contain four bytes of ASCII data: "-xxx" The xxx is the 3-digit firmware revision number; for example: "-001".

5.13.5 Completion Status

CODE	MESSAGE	DESCRIPTION									
00h	Good Status	<ul style="list-style-type: none"> • Media is not moved, current position is maintained • Viper drive remains in any previously set modes • Viper drive is ready to perform any appropriate commands 									
02h	Check Condition	Extended Sense byte 02									
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05h	Illegal Request	• The CDB contained an invalid bit									

5.14 VERIFY (13h)

The VERIFY Command verifies one or more blocks of data beginning with the next block on the logical unit. This command verifies the Cyclic Redundancy Check (CRC) on the medium and does not support byte-by-byte comparison of tape data with Initiator-supplied data. No data is transferred between the Initiator and Viper drive during the VERIFY operation and no data is written to the medium.

The command terminates after the specified number of blocks are verified or when Viper drive encounters a Filemark, the EOT, or an unrecoverable error including an invalid CRC. Upon completion the medium is positioned after the last block verified or Filemark.

If a VERIFY with a zero verification length is issued, no data is verified, and the current position on the tape does not change. This condition is not considered an error.

5.14.1 VERIFY Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	1	1
1	0	0	0	0	0	0	0	1
2	VERIFY Length - MSB							
3	VERIFY Length							
4	VERIFY Length - LSB							
5	X	X	0	0	0	0	Flag	Link

5.14.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTE	BIT	DESCRIPTION
Byte Compare Bit	1	1	This bit must be zero, indicating CRC verification is requested. The byte comparison option is not supported.
Fixed Block Size Bit	1	0	This bit must be one, indicating blocks are fixed-size. The variable length block option is not supported.
VERIFY	2-4		These fields specify the number of contiguous blocks to be verified.

5.14.3 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION																																	
00h	Good Status	<ul style="list-style-type: none"> Viper drive is ready to accept any appropriate command Viper drive remains in any previously set mode The Tape is positioned to the EOT side of the last block verified 																																	
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>01h</td> <td>Recoverable Errors</td> <td> <ul style="list-style-type: none"> Tape encountered soft errors that are reported in bytes 13 and 14 of the Request Sense Data. All data is successfully written to tape </td> </tr> <tr> <td>02h</td> <td>Not Ready</td> <td> <ul style="list-style-type: none"> A cartridge is not installed in the drive </td> </tr> <tr> <td>03h</td> <td>Media Error</td> <td> <ul style="list-style-type: none"> An unrecoverable data error was encountered </td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> Parity error on either the SCSI Bus or the Viper drive </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> The CDB contains an invalid bit </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> Cartridge changed prior to accepting this command Viper drive reset prior to accepting this command </td> </tr> <tr> <td>40h</td> <td>EOT Bit and No Sense</td> <td> <ul style="list-style-type: none"> End of recorded data was encountered </td> </tr> <tr> <td>43h</td> <td>EOT Bit and Media Error</td> <td> <ul style="list-style-type: none"> Physical End-of-Media was encountered </td> </tr> <tr> <td>48h</td> <td>EOT bit and Blank Check</td> <td> <ul style="list-style-type: none"> Logical End-of-Media was encountered </td> </tr> <tr> <td>80h</td> <td>Filemark Bit and No Sense</td> <td> <ul style="list-style-type: none"> A Filemark encountered </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	01h	Recoverable Errors	<ul style="list-style-type: none"> Tape encountered soft errors that are reported in bytes 13 and 14 of the Request Sense Data. All data is successfully written to tape 	02h	Not Ready	<ul style="list-style-type: none"> A cartridge is not installed in the drive 	03h	Media Error	<ul style="list-style-type: none"> An unrecoverable data error was encountered 	04h	Hardware Error	<ul style="list-style-type: none"> Parity error on either the SCSI Bus or the Viper drive 	05h	Illegal Request	<ul style="list-style-type: none"> The CDB contains an invalid bit 	06h	Unit Attention	<ul style="list-style-type: none"> Cartridge changed prior to accepting this command Viper drive reset prior to accepting this command 	40h	EOT Bit and No Sense	<ul style="list-style-type: none"> End of recorded data was encountered 	43h	EOT Bit and Media Error	<ul style="list-style-type: none"> Physical End-of-Media was encountered 	48h	EOT bit and Blank Check	<ul style="list-style-type: none"> Logical End-of-Media was encountered 	80h	Filemark Bit and No Sense	<ul style="list-style-type: none"> A Filemark encountered
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5.15 RECOVER BUFFERED DATA (14h)

The RECOVER BUFFERED DATA command is used to read data transferred to the Viper drive buffer but not written on tape. It is normally used only to recover from error conditions which make it impossible to write on tape.

5.15.1 RECOVER BUFFERED DATA Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	0	0
1	0	0	0	0	0	0	0	1
2	Transfer Length - MSB							
3	Transfer Length							
4	Transfer Length - LSB							
5	X	X	0	0	0	0	Flag	Link

This command functions similarly to the READ command, except that the data originates from the Viper drive buffer instead of from the media.

Blocks are transferred in the same order as if written to the tape. One or more RECOVER BUFFERED DATA commands may be used to read the unwritten buffered data.

5.15.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTE	BIT	DESCRIPTION
Fixed Block Size Bit	1	0	To indicate that blocks are fixed size, the Fixed Block Size bit must be one.
Transfer Length	2-4	0-7	The Transfer Length specifies the number of contiguous blocks to be recovered. When a Transfer Length of zero is specified, no data is transferred. This is not considered an error. If the Transfer Length exceeds the number of blocks in the Viper drive buffer, the command transfers the blocks available and completes with Check Condition Status. Extended Sense of 40h is set, and the residual length is equal to the difference between the Transfer Length and the actual number of blocks transferred.

5.15.3 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION																		
00h	Good Status	<ul style="list-style-type: none"> • The position of the Media is not changed • Viper drive is ready to accept any appropriate command • Viper drive remains in previously set mode 																		
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not Ready</td> <td>• A cartridge is not installed in the drive</td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td>• Parity error on either the SCSI Bus or the Viper drive</td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td>• The CDB contains an invalid bit</td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • Viper drive reset prior to accepting this command </td> </tr> <tr> <td>40h</td> <td>EOT and No Sense</td> <td>• The number of blocks specified in the transfer length exceeds the number of blocks remaining in the buffer</td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not Ready	• A cartridge is not installed in the drive	04h	Hardware Error	• Parity error on either the SCSI Bus or the Viper drive	05h	Illegal Request	• The CDB contains an invalid bit	06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • Viper drive reset prior to accepting this command 	40h	EOT and No Sense	• The number of blocks specified in the transfer length exceeds the number of blocks remaining in the buffer
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5.16 MODE SELECT (15h)

The MODE SELECT command allows the Initiator to place the Viper drive in either buffered or unbuffered mode and select a specific tape format. It is illegal to issue a MODE SELECT command without a cartridge installed or when positioned away from BOT with a cartridge installed.

5.16.1 MODE SELECT Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	0	1
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Parameter List Length							
5	X	X	0	0	0	0	Flag	Link

5.16.2 Command Descriptor Block Field Description

FIELD NAME	BYTES	DESCRIPTION
Parameter List Length	4	This field designates the number of bytes in the MODE SELECT that are transferred during the Data-Out Phase. A Parameter List Length of zero specifies that no data will be transferred. This is not considered an error.

5.16.3 Parameter List Header Format

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	Buffered Mode			Speed (0)			
3	Block Descriptor Length							

5.16.4 Parameter List Header Field Descriptions

MODE	BYTES	BITS	DESCRIPTION
Buffered	2	4-6	In Buffered Mode the Viper drive reports Good Status on Write command as soon as the data has been written to the Viper drive buffer. In the Unbuffered Mode Viper drive does not report Good Status on a Write command until the data is successfully written to Tape.
Speed	2	0-3	The Speed Field must be set to zero to indicate the default speed of 90 ips.
Block Descriptor Length	3		The Block Descriptor Length field is set to either 00h or 08h Descriptor Length indicating that there is either zero or one, 8-byte Block Descriptor to follow.

5.16.5 Parameter List—Block Descriptor

BITS BYTE	7	6	5	4	3	2	1	0
0	Density Code							
1	Number in Blocks - MSB (0)							
2	Number of Blocks (0)							
3	Number of Blocks - LSB (0)							
4	0	0	0	0	0	0	0	0
5	Block Length - MSB (00h)							
6	Block Length (02h)							
7	Block Length - LSB (00h)							

5.16.6 Parameter List—Block Descriptor Field Descriptions

NAME	BYTES	DESCRIPTION																																		
Density Code	0	<p>The density code field defines the tape format the Viper drive either writes or recognizes in a read command. Density codes and interpretations are shown in the following table.</p> <table border="1"> <thead> <tr> <th>Density Codes</th> <th>Interpretations</th> </tr> </thead> <tbody> <tr> <td>00h</td> <td>Implicit</td> </tr> <tr> <td>04h</td> <td>QIC-11</td> </tr> <tr> <td>05h</td> <td>QIC-24</td> </tr> <tr> <td>0Fh</td> <td>QIC-120</td> </tr> <tr> <td>10h</td> <td>QIC-150</td> </tr> </tbody> </table>	Density Codes	Interpretations	00h	Implicit	04h	QIC-11	05h	QIC-24	0Fh	QIC-120	10h	QIC-150																						
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Implicit Mode		<p>In a READ operation, the drive does a format search at BOT to determine the format on the installed tape. The search order is:</p> <table border="1"> <thead> <tr> <th>Search Sequence</th> <th>Format</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>QIC-150</td> </tr> <tr> <td>2</td> <td>QIC-120</td> </tr> <tr> <td>3</td> <td>QIC-24</td> </tr> <tr> <td>4</td> <td>QIC-11</td> </tr> </tbody> </table> <p>In a WRITE Operation, the drive determines the cartridge type and selects the highest appropriate capacity as shown below:</p> <table border="1"> <thead> <tr> <th>Drive</th> <th>Cartridge</th> <th>Selected Capacity</th> </tr> </thead> <tbody> <tr> <td rowspan="3">150S</td> <td>DC 600XTD</td> <td>QIC-150</td> </tr> <tr> <td>DC 600 A</td> <td>QIC-120</td> </tr> <tr> <td>DC 300 XLP</td> <td>Illegal</td> </tr> <tr> <td rowspan="3">125S</td> <td>DC 600XTD</td> <td>QIC-120</td> </tr> <tr> <td>DC 600 A</td> <td>QIC-120</td> </tr> <tr> <td>DC 300 XLP</td> <td>Illegal</td> </tr> <tr> <td rowspan="3">60S</td> <td>DC 600XTD</td> <td>QIC-24</td> </tr> <tr> <td>DC 600 A</td> <td>QIC-24</td> </tr> <tr> <td>DC 300 XLP</td> <td>QIC-24</td> </tr> </tbody> </table>	Search Sequence	Format	1	QIC-150	2	QIC-120	3	QIC-24	4	QIC-11	Drive	Cartridge	Selected Capacity	150S	DC 600XTD	QIC-150	DC 600 A	QIC-120	DC 300 XLP	Illegal	125S	DC 600XTD	QIC-120	DC 600 A	QIC-120	DC 300 XLP	Illegal	60S	DC 600XTD	QIC-24	DC 600 A	QIC-24	DC 300 XLP	QIC-24
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	DC 600 A	QIC-24																																		
	DC 300 XLP	QIC-24																																		

5.16.7 Parameter List—Block Descriptor Field Descriptions Continued

NAME	BYTES	DESCRIPTION
Explicit Mode		<p>The Viper drive enters the explicit mode by:</p> <ol style="list-style-type: none"> 1. Reading a tape 2. Writing a tape 3. With density code field set to non-zero in the Mode Select command. If the drive is operating in the QIC-11, QIC-24, QIC-120, or QIC-150 format, the drive is in the explicit format mode. <p>READ</p> <p>In Read Operation, the drive only recognizes the selected Explicit Mode. READ commands on all other formats are terminated with a Check Condition and a Sense Key of Blank Check.</p> <p>WRITE</p> <p>In Write Operation, the drive only writes in the selected Explicit Mode. If the installed cartridge does not support the selected Explicit Mode, the Write command terminates with a Check Condition and a Write Protect.</p> <p>If the Selected Density Mode is an 04h or 05h in a 125S or 150S, the write operation terminates with 05h Illegal Request.</p> <p>If Mode Select is issued to change the Density Code, the change is not reported in Mode Sense until a write or read operation is completed.</p>
Number of Blocks	1-3	This field is set to all zeros indicating that all logical blocks have the format specified in the Density Code field.
Block Length	5-7	This field is set to 00h, 02h, 00h indicating a fixed-block length of 512 bytes.

5.16.8 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION								
00h	Good Status *	<ul style="list-style-type: none"> • The Media is not moved. • The defined mode is set and remain set until another MODE SELECT or a Reset is issued • Viper drive is ready to perform any appropriate command. 								
02h	Check Condition	<p data-bbox="857 632 1114 657">Extended Sense byte 02</p> <table border="1" data-bbox="813 688 1365 1455"> <thead> <tr> <th data-bbox="821 699 1045 772">CODE</th> <th data-bbox="1053 699 1357 772">MESSAGE DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td data-bbox="821 783 1045 863">04h</td> <td data-bbox="1053 783 1357 863"> Hardware Error • Parity error on either the SCSI Bus or the Viper drive </td> </tr> <tr> <td data-bbox="821 873 1045 1220">05h</td> <td data-bbox="1053 873 1357 1220"> Illegal Request • The CDB or Parameter List contained an invalid bit • The Buffered Mode field or the Density Code field contains an illegal Mode Code • The cartridge was not at BOT when the command was issued </td> </tr> <tr> <td data-bbox="821 1230 1045 1455">06h</td> <td data-bbox="1053 1230 1357 1455"> Unit Attention • The cartridge was previously changed when away from BOT or at BOT following a Preventor Load command • Viper drive has previously received a Reset </td> </tr> </tbody> </table>	CODE	MESSAGE DESCRIPTION	04h	Hardware Error • Parity error on either the SCSI Bus or the Viper drive	05h	Illegal Request • The CDB or Parameter List contained an invalid bit • The Buffered Mode field or the Density Code field contains an illegal Mode Code • The cartridge was not at BOT when the command was issued	06h	Unit Attention • The cartridge was previously changed when away from BOT or at BOT following a Preventor Load command • Viper drive has previously received a Reset
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06h	Unit Attention • The cartridge was previously changed when away from BOT or at BOT following a Preventor Load command • Viper drive has previously received a Reset									

5.17 RESERVE UNIT (16h)

The RESERVE UNIT command reserves the Viper drive for the exclusive use of the requesting Initiator or for the exclusive use of third party specified SCSI device. The third party reservation option is provided for multi-initiator systems that use the COPY command.

Viper drive reservation, once established, remain in effect until the occurrence of one of the following:

- Another RESERVE UNIT command arrives from the same Initiator that requested the current reservation (for itself or for a third party). The new reservation supercedes the current one and may be the same as the current one. Redundant use of the command is not considered an error.
- A RELEASE UNIT command arrives from the same Initiator that requested the current reservation. The Viper drive returns to un-reserved mode.
- A Bus Device Reset Message arrives from any Initiator.
- A Reset condition occurs.

When the Viper drive is reserved, it returns Reservation Conflict Status in response to any and all commands received from excluded Initiators. An exception to this is in response to the RELEASE UNIT command and in response to a subsequent RESERVE UNIT command from the original reservation requestor (refer to RELEASE UNIT command).

5.17.1 RESERVE UNIT Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	1	0
1	0	0	0	3rd Pty	3rd Party ID			0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	X	X	0	0	0	0	Flag	Link

5.17.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTES	BITS	DESCRIPTION
3rd Pty Bit	1	4	The Third Party Bit indicates whether or not the reservation is for a third party.
3rd Party ID	1	1 to 3	The 3rd Party ID specifies an Initiator ID for which the release was intended. It is meaningful only when the 3rd Pty bit is set to 1. Viper drive does not release a third party reservation if this field does not identify the Initiator currently in control of the Viper drive.

5.17.3 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION															
00h	Good Status	<ul style="list-style-type: none"> The position of the Media is not changed Viper drive is ready to accept any appropriate command Viper drive remains in any previously set mode. Viper drive is reserved for the use of the specified ID. 															
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not Ready</td> <td> <ul style="list-style-type: none"> A cartridge is not installed in the drive. </td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> Parity error on either the SCSI Bus the Viper drive </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> The CDB contains an invalid bit </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> The cartridge was changed prior to accepting this command The Viper drive was Reset prior to accepting this command. </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not Ready	<ul style="list-style-type: none"> A cartridge is not installed in the drive. 	04h	Hardware Error	<ul style="list-style-type: none"> Parity error on either the SCSI Bus the Viper drive 	05h	Illegal Request	<ul style="list-style-type: none"> The CDB contains an invalid bit 	06h	Unit Attention	<ul style="list-style-type: none"> The cartridge was changed prior to accepting this command The Viper drive was Reset prior to accepting this command.
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5.18 RELEASE UNIT (17h)

The RELEASE UNIT command releases a current Viper drive reservation, if the command is received from the Initiator that originally established the reservation. If the original reservation was made for a third party, the RELEASE UNIT command Descriptor Block must also carry the third party data. Any RELEASE UNIT command that arrives from other than the originating requestor (including one that arrives from the third party currently in command of the Viper drive) is ignored and Good Status is returned in response to the command.

Additional events and conditions that can cause a reservation to be released are discussed under the RESERVE UNIT command.

NOTE: It is not an error to attempt to release an ID that is not currently reserved to the requesting Initiator. A reservation cannot be released, if it is reserved by another Initiator.

5.18.1 RELEASE UNIT Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	1	1
1	0	0	0	3rd Pty	3rd Party ID			0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	X	X	0	0	0	0	Flag	Link

5.18.2 Command Descriptor Block Field Descriptions

FIELD NAME	BYTES	BITS	DESCRIPTION
3rd Pty Bit	1	4	The 3rd Party bit is used to indicate when a release is for a third-party.
3rd Pty ID	1	1 to 3	The 3rd Party ID specifies an Initiator ID for which the release was intended. It is meaningful only when the 3rdPty bit is set to 1. Viper drive does not release a third party reservation if this field does not identify the Initiator currently in control of the Viper drive.

5.18.3 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION			
00h	Good Status	<ul style="list-style-type: none"> • The position of the Media is not changed • Viper drive is ready to accept any appropriate command • Viper drive remains in any previously set mode • Viper drive accepts commands from any Initiator 			
02h	Check Condition	Extended Sense byte 02			
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th data-bbox="805 758 899 814">CODE</th> <th data-bbox="899 758 1050 814">MESSAGE</th> <th data-bbox="1050 758 1370 814">DESCRIPTION</th> </tr> </thead> </table>	CODE	MESSAGE	DESCRIPTION
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		04h	Hardware Error	<ul style="list-style-type: none"> • Parity error on either the SCSI Bus or the Viper drive 	
05h	Illegal Request	<ul style="list-style-type: none"> • The CDB contains an invalid bit 			
06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • The Viper drive was Reset prior to accepting this command 			

5.19 COPY (18h)

The COPY command copies data blocks between a Viper drive and other SCSI Sequential or Direct Access devices. Viper drives manage data transfers by assuming the role of Initiator to establish a logical connection with another device. Viper drives do not support third party copying or managing transfers between two remote devices. The drive manages transfers only between itself and another device.

5.19.1 Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	0	0
1	0	0	0	0	0	0	0	0
2	Parameter List Length — MSB							
3	Parameter List Length							
4	Parameter List Length — LSB							
5	X	X	0	0	0	0	Flag	Link

5.19.2 Command Descriptor Block Field Description

The Parameter List Length field, Bytes 2 to 4, contains the total number of bytes in the trailing parameter list, including the 4-byte Header plus all 12-byte Segment Descriptors.

The Parameter List Length must be divisible by the 12-byte Segment Descriptor plus 4-byte header. Examples of valid quantities are: 0, 4, 16, 28, 40. If the Parameter List Length does not meet the above criteria, it is terminated with Check Condition and Illegal REQUEST SENSE Key.

5.19.3 COPY Command Description

The COPY command can include up to 256 Segment Descriptors, each identifying a different device or, for Direct Access devices, starting block address. The Viper drive processes one Segment Descriptor at a time. The Viper drive tape is not rewound between processing of each Segment Descriptor.

A copy to or from a Direct Access (D/A) device can be disk, image, or individual file. Each Segment Descriptor only transfers contiguous files from the D/A device. File transfers that are not contiguous blocks on the D/A device can be accomplished by using multiple Segment Descriptors to a maximum of 256.

The COPY command does not write Filemarks between Segment descriptors. The data appears as one file on tape if multiple segment descriptors are used.

The Viper drive issues READ or WRITE type commands to the other device, depending on whether the remote device is the source or destination for the data. Each command has a data length equivalent to the remote device block size.

The block sizes of Sequential (SEQ) devices are specified in the Segment Descriptors. To determine the block size of remote D/A devices, the Viper drive issues a MODE SENSE command each time a new Segment Descriptor is processed. Viper drives accommodate devices with a block sizes of 256, 512, 1024, 2048, and 4096 bytes.

Viper drives use only 512-byte blocks. When the other device has a block size of 256, the number of blocks to be copied must be an even number, and the Residual is reported in sectors. The Viper does not disconnect during a data transfer when transferring 256-byte blocks.

Prior to issuing a WRITE or READ command, the Viper determines the block size of the D/A device and the number of blocks to be transferred and converts this to 512 byte block intervals for the Viper drive to complete the requested transfer correctly.

Bus transfer length relates to the Viper drives selectable buffer disconnect feature. This is configured by placing jumper clips across pairs of pins in the disconnect size area of the configuration jumper block. The disconnect size selected must be 16K or greater for the copy command to work. See Chapter 3, INSTALLATION.

The Initiator issuing the COPY command is responsible for any applicable device reservations (see RESERVE UNIT command description). Also the Initiator is responsible for positioning the tape to the starting source/destination positions on sequential devices, and for insuring that the device which is logically connected to the managing Viper drive is properly initialized.

The Initiator must support the Disconnect/Reconnect option. If it does not, when the COPY command is received by the drive, it immediately terminates the command and returns Check Condition and an Illegal REQUEST SENSE Key.

5.19.4 COPY Parameter List Header Block

BIT BYTE	7	6	5	4	3	2	1	0
0	COPY					PRIORITY		
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0

5.19.5 Parameter List Header Block Field Descriptions

BIT NAME	BYTES	BITS	DESCRIPTION
Priority	0	0 - 2	This field is ignored since Viper drives do not queue commands. The COPY command must complete before a subsequent command is accepted.
COPY	0	3 - 7	In this field the Parameter List Header specifies the format Function of the subsequent Segment Descriptors. Viper drives use a Code subset of the COPY command functions defined in ANSI X3.131, restricted by the Viper requirement that the drive be considered a sequential device when participating in a COPY command.

The following shows Copy functions supported in terms of standard copy function Codes.

COPY FUNCTION CODE	USE	RESTRICTION
00h	D/A to SEQ	Source device cannot be a Viper drive.
08h	SEQ to D/A	Destination cannot be a Viper drive.
18h	SEQ to SEQ	Device cannot copy to itself.
D/A = Direct Access Device SEQ = Sequential Device		

In the following Segment Descriptors, designation of SCSI ID for a Viper drive must match the SCSI ID configured on the Viper drives Configuration Jumper Block.

5.19.6 D/A to SEQ Segment Descriptor

The Segment Descriptor for COPY Function Code 00h initiates a READ from the D/A device and a WRITE to the SEQ device (Viper drive). The Viper drive must be the destination device in a D/A to SEQ copy. Destination LUN, Byte 1, Bits 0-2, has a value of 0, referencing the controllers single drive.

When the D/A device block size is 256, the 24-bit count in D/A Device Number of Blocks must be an even number, indicating a whole number of 512 byte transfers. A block count of zero is permitted and causes a READ to be issued to the D/A device with a Transfer Length of zero. This is not considered an error.

This type of READ is a function of the value in D/A Device Logical Block Address. If the value of the Logical Block Address is equal to or greater than 221, a READ Extended (28h) is used. When the READ Extended is required, the Rel Adr Bit, Byte 1, Bit 1, is not used.

5.19.6.1 D/A to SEQ Segment Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	Source SCSI ID			0	0	Source LUN		
1	Destination SCSI ID			0	0	Destination LUN		
2	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	0	0
4	D/A Device Number of Blocks — MSB							
5	D/A Device Number of Blocks							
6	D/A Device Number of Blocks							
7	D/A Device Number of Blocks — LSB							
8	D/A Device Logical Block Address — MSB							
9	D/A Device Logical Block Address							
10	D/A Device Logical Block Address							
11	D/A Device Logical Block Address — LSB							

5.19.6.2 D/A to SEQ Segment Descriptor Field Descriptions

FEATURE	BYTES	BITS	DESCRIPTION
Source SCSI ID	0	5-7	This field specifies the source SCSI ID of the D/A device from which the data is read.
Source Drive	0	0-2	This field specifies the source LUN number of the D/A device
SCSI ID Destination Device	1	5-7	This field specifies the SCSI ID of the Viper drive
Number of Blocks	4-7		These fields specify the number of blocks from the D/A device to be transferred
D/A Device Address	8 - 11		These fields specify the logical block in the D/A device from Logical Block which the read starts.

5.19.7 SEQ to D/A Segment Descriptor

The Segment Descriptor for COPY Function Code 01h initiates a WRITE command from the SEQ device (Viper drive) to the D/A device.

The Viper drive must be the source device in a SEQ to D/A copy. Byte 0, bits 0 to 2 (Source LUN) have value 0, referencing the controllers single drive. Bytes 2 to 3 (SEQ Device Block Length) have value 512 (200 Hex), according to the Viper drive recording format.

In the case where the D/A device block size is 256, the 24-bit count in D/A Device Number of Blocks must be an even number.

A block count of zero is permitted and causes a WRITE type command to be issued to the D/A device with a Transfer Length of zero. This is not considered an error.

This type of WRITE command is a function of the value in D/A Device Logical Block Address. If the value of the Logical Block Address is equal to or greater than 221, a WRITE Extended (2Ah) is used. When the READ Extended is required, the Rel Adr Bit, Byte 1, Bit 1, is not used.

5.19.7.1 SEQ to D/A Segment Descriptor Block

BITS BYTES	7	6	5	4	3	2	1	0
0	Source SCSI ID			0	0	Source LUN		
1	Destination SCSI ID			0	0	Dest. LUN		
2	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	0	0
4	D/A Device Number of Blocks — MSB							
5	D/A Device Number of Blocks							
6	D/A Device Number of Blocks							
7	D/A Device Number of Blocks — LSB							
8	D/A Device Logical Block Address — MSB							
9	D/A Device Logical Block Address							
10	D/A Device Logical Block Address							
11	D/A Device Logical Block Address — LSB							

5.19.7.2 SEQ to D/A Segment Descriptor Field Descriptions

FEATURE	BYTES	BITS	DESCRIPTION
Drive SCSI ID	0	5 - 7	This field specifies the Viper drive SCSI ID number.
Destination SCSI ID	1	5 - 7	This field specifies the D/A device destination SCSI ID number.
Destination LUN	1	0 to 2	This field specifies the D/A device destination LUN number.
D/A Device Number of Blocks	4 to 7		These fields specify the number of blocks to be transferred from the SEQ device to the D/A device.
D/A Device Address	8 to 11		These fields specify the logical block of the D/A Logical Block device from which write starts.

5.19.8 SEQ to SEQ Segment Descriptor

In a Segment Descriptor for COPY Function Code 03h, the managing Viper drive may be either the source or destination device. The LUN associated with a Viper drive must always have value 0, referencing the controller's single drive. The Block Length associated with a Viper drive must always have a value of 512 (200h), according to the Viper drive recording format.

In the case where the remote device block size is 256, the 24-bit count in Source Number of Blocks must be an even number.

5.19.8.1 SEQ to SEQ Segment Descriptor Block

BITS BYTES	7	6	5	4	3	2	1	0
0	Source SCSI ID			0	0	Source LUN		
1	Dest. SCSI ID			0	0	Dest. LUN		
2	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	0	0
4	Source Block Length — MSB							
5	Source Block Length — LSB							
6	Destination Block Length — MSB							
7	Destination Block Length — LSB							
8	Source Number of Blocks — MSB							
9	Source Number of Blocks							
10	Source Number of Blocks							
11	Source Number of Blocks — LSB							

5.19.8.2 SEQ to SEQ Segment Descriptor Field Descriptions

FEATURE	BYTES	BITS	DESCRIPTION
Source SCSI ID	0	5-7	This field specifies the source SCSI ID of the SEQ device from which the data is read.
Source LUN	0	0-2	This field specifies the source LUN number of the SEQ device.
Destination SCSI ID	1	5-7	This field specifies the destination SCSI ID of the destination device.
Destination LUN	0-2		This field specifies the LUN of the destination device.
Source Block Length	4 and 5		These fields specify the length of the source block for a SEQ device.
Destination Block Length	6 and 7		These fields specify length of the destination block for a SEQ device.
Source Number of Blocks	8 to 11		These fields specify the number of blocks of the source for a SEQ device.

5.19.9 Completion Status

HEX CODE	MESSAGE	DESCRIPTION																					
00h	Good Status	<ul style="list-style-type: none"> The drive is positioned to the last block of the COPY command. 																					
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not ready</td> <td> <ul style="list-style-type: none"> A cartridge is not installed in the drive </td> </tr> <tr> <td>03h</td> <td>Media Error</td> <td> <ul style="list-style-type: none"> An unrecoverable data error has been encountered. </td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> Parity error on either the SCSI Bus or the Viper drive </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> The CDB contains an invalid bit The Parameter List Length is not divisible by 12 + 4 Viper drive buffer size is not configured for the minimum 16K Host does not support Disconnect/Reconnect The Viper drive is not LUN 0 Segment descriptor has a bit incorrectly set Target block size is 256K; Segment Descriptor defines an odd block count The COPY Function Code is not supported The drive ID is not in the correct Segment Descriptor field The Viper drive is not set to End of Media for a WRITE </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> The cartridge was changed prior to accepting this command Viper drive was Reset prior to accepting this command An implied Rewind is performed for a Read </td> </tr> <tr> <td>07h</td> <td>Data Protect</td> <td> <ul style="list-style-type: none"> The cartridge installed in the Viper drive is WRITE Protected The cartridge cannot support the selected Density Code </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not ready	<ul style="list-style-type: none"> A cartridge is not installed in the drive 	03h	Media Error	<ul style="list-style-type: none"> An unrecoverable data error has been encountered. 	04h	Hardware Error	<ul style="list-style-type: none"> Parity error on either the SCSI Bus or the Viper drive 	05h	Illegal Request	<ul style="list-style-type: none"> The CDB contains an invalid bit The Parameter List Length is not divisible by 12 + 4 Viper drive buffer size is not configured for the minimum 16K Host does not support Disconnect/Reconnect The Viper drive is not LUN 0 Segment descriptor has a bit incorrectly set Target block size is 256K; Segment Descriptor defines an odd block count The COPY Function Code is not supported The drive ID is not in the correct Segment Descriptor field The Viper drive is not set to End of Media for a WRITE 	06h	Unit Attention	<ul style="list-style-type: none"> The cartridge was changed prior to accepting this command Viper drive was Reset prior to accepting this command An implied Rewind is performed for a Read 	07h	Data Protect	<ul style="list-style-type: none"> The cartridge installed in the Viper drive is WRITE Protected The cartridge cannot support the selected Density Code
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5.19.9 Completion Status Continued

CODE	MESSAGE	DESCRIPTION
08h	Blank Check	• The Viper drive has encountered the End of Data
0A	Copy Aborted	<ul style="list-style-type: none"> • The target detects an exception condition; Check Condition Status is sent to the managing Viper. The drive generates a Check Condition Status for the initiator that issued the command. The Extended Sense Data returned by the managing Viper drive has a Sense Key set to COPY Abort, indicating a target error. Includes Sense Data from the target when available. • The target terminates the command sent from the Viper drive with a Check Condition. If the target was the source, byte 8 of the Request Sense Extended Sense is set to 06h, and byte 9 is set to 00h. If the target was the destination, byte 9 of the Request Sense Extended Sense is set to 05h, byte 8 is set to 00h. Byte 14 of the Request Sense Extended Sense contains the Status byte from the target. Byte 15 to 22 contains bytes 0 to 7 of the target Request Sense Extended Sense. • A Selection Timeout occurred on the remote device • The Direct Access device utilized an unsupported block size
40h	EOT bit and No Sense	<ul style="list-style-type: none"> • Early Warning was encountered during a WRITE to the drive. • A WRITE to the Viper drive in the Early Warning region was successfully completed
43h	EOM bit and Media Error	• EOT was encountered during a WRITE to the Viper drive
48h	EOT bit and Blank Check	• Logical EOT was encountered during a READ from the drive

5.20 ERASE (19h)

The ERASE command erases the tape. To begin erasing, the tape must be positioned at BOT when the command is issued. Upon completion of the operation, the tape repositions to BOT.

5.20.1 ERASE Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	0	1
1	0	0	0	0	0	0	IMMED	Long
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	X	X	0	0	0	0	Flag	Link

5.20.2 Command Descriptor Block Field Descriptions

BIT NAME	BYTES	BITS	DESCRIPTION
Long	1	0	The Long Bit specifies that the entire tape is to be erased. This bit must be set to one. Viper drive does not support the short erase option.
IMMED	1	1	The Immediate Bit specifies that status is to be returned as soon as the ERASE command is accepted and verified. When this bit is zero, status is not returned until the tape is Positioned at BOT.

5.20.3 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION																		
00h	Good Status	<ul style="list-style-type: none"> • Media is positioned at BOT • Drive is ready to perform any appropriate command • Drive remains in any previously set modes 																		
02h	Check Condition	Extended Sense Byte 02																		
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07h	WRITE Protect	• The cartridge in the Viper drive is WRITE Protected																		

5.21 MODE SENSE (1Ah)

The MODE SENSE command provides a means for Viper drive to report its current mode settings to the Initiator.

5.21.1 MODE SENSE Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	1	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	X	X	0	0	0	0	Flag	Link

5.21.2 Command Descriptor Block Field Description

BIT NAME	BYTES	BITS	DESCRIPTION
Allocation	4		This byte specifies the number of bytes the Viper drive returns in the Data-In Phase. An Allocation Length of zero means no MODE SENSE data is transferred. This condition is not considered to be an error. When non-zero, the number of bytes specified in Allocation Length is transferred up to a maximum of 12 bytes.

5.21.3 MODE SENSE Header Data Format

The MODE SENSE response data consists of a four-byte header followed by an eight-byte block descriptor.

BITS BYTE	7	6	5	4	3	2	1	0
0	ModeSense Data Length (0Bh)							
1	Medium Type (0)							
2	WP	Buffered Mode			Speed (0)			
3	Block Descriptor Length (08h)							

5.21.4 MODE SENSE Header Data Field Descriptions

BIT NAME	BYTES	BITS	DESCRIPTION								
Sense Data Length	0		This field specifies the number of bytes in the following MODE SENSE data. The Sense Data Length does include itself and is always set to 08h.								
Medium Type	1		This field is always set to zero indicating default media.								
WP Bit	2	7	This bit indicates whether or not the tape is write protected; a one indicates write protected, a zero indicates write enabled.								
Buffered	2	4 to 6	<p>In Unbuffered Mode the Viper drive does not report Good Status on a WRITE command until the data has been successfully written to tape.</p> <p>In Buffered Mode, the drive reports Good Status on a WRITE command as soon as the data has been written to the Viper buffer. The following table describes the buffered mode field status and interpretation.</p> <table border="1" data-bbox="841 1165 1346 1333"> <thead> <tr> <th>Buffer Mode</th> <th>Field Status Interpretation</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Unbuffered</td> </tr> <tr> <td>1</td> <td>Buffered (default)</td> </tr> <tr> <td>2-7</td> <td>Invalid</td> </tr> </tbody> </table>	Buffer Mode	Field Status Interpretation	0	Unbuffered	1	Buffered (default)	2-7	Invalid
Buffer Mode	Field Status Interpretation										
0	Unbuffered										
1	Buffered (default)										
2-7	Invalid										
Speed	2	0 to 3	The Speed Field is always be set to zero to indicate that the default speed of 90 ips is selected.								
Block Descriptor Length	3		Block Descriptor Length field is always set to 08h indicating that there is one 8 byte Block Descriptor to follow.								

BITS BYTE	7	6	5	4	3	2	1	0
0	Density Code							
1	Number in Blocks - MSB (00h)							
2	Number of Blocks (02h)							
3	Number of Blocks - LSB (00h)							
4	0	0	0	0	0	0	0	0
5	Block Length - MSB (0)							
6	Block Length (2)							
7	Block Length - LSB (0)							

5.21.5 Block Length Descriptor Field Descriptions

5.21.5.1 Density Code, Byte 0

The Density Code field defines the tape format the Viper drive either writes or recognizes in a READ command. Density Codes and Interpretations are shown.

DENSITY CODE	INTERPRETATION
00h	Implicit
04h	QIC-11
05h	QIC-24
0Fh	QIC-120
10h	QIC-150

5.21.5.2 Implicit Mode - Default Density Code Mode

In READ Operation, the drive does a format search at BOT to determine the format of the installed tape. The search sequence proceeds as follows:

1. QIC-150
2. QIC-120
3. QIC-24
4. QIC-11

In WRITE Operation, the drive determines the cartridge type and selects the highest appropriate capacity as shown.

DRIVE	CARTRIDGE SELECTED	CAPACITY
2150 S	DC 600XTD	QIC - 150
	DC 600 A	QIC - 120
	DC 300 XLP	Illegal
2125 S	DC 600XTD	QIC - 120
	DC 600 A	QIC - 120
	DC 300 XLP	Illegal
2060 S	DC 600XTD	QIC - 24
	DC 600 A	QIC - 24
	DC 300 XLP	QIC - 24

5.21.5.3 Explicit Mode

The Viper drive enters the explicit mode either by (1) reading a tape, (2) writing a tape, or (3) with density code field set to non-zero in the MODE SENSE command.

If the Viper drive is operating in the QIC-11, QIC-24, QIC-120, or QIC-150 format, the drive is in the explicit format mode.

In READ Operation, the drive only recognizes the selected Explicit Mode. READ commands on all other formats are terminated with a Check Condition and a Sense Key of Blank Check.

In WRITE Operation, the drive only writes in the selected Explicit Mode. If the installed cartridge does not support the selected Explicit Mode, the WRITE command terminates with a Check Condition and a Sense Key of 05h Illegal Request or 07h WRITE Protect. If the Selected Density Mode is a 04h or 05h in a 125S or a 150S, the write operation terminates with 05h Illegal Request. If the cartridge cannot support the selected Density Code, 07h WRITE Protect is set.

The reason for a WRITE Protect Sense Key is that this error code directs the user to remove the cartridge to find that the wrong cartridge was used.

If a MODE SELECT is issued to change the Density Code, this change is not reported in a MODE SENSE until a write or read operation is completed.

5.21.5.4 Number of Blocks, Bytes 1 to 3

This field is set to all zeros indicating that all logical blocks have the format specified in the Density Code field.

5.21.5.5 Block Length, Bytes 5 to 7

This field is set to 00h, 02h, 00h indicating a fixed block length of 512 bytes.

5.21.6 Completion Status

HEX CODE	MESSAGE	DESCRIPTION												
00h	Good Status	<ul style="list-style-type: none"> • The Media is not moved. It remains at the previous position • Viper drive remains in a previously set mode, MODE SENSE does not set or change any modes • Viper drive is ready to perform any appropriate command 												
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> • Parity error on either the SCSI Bus the Viper drive </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> • The CDB contained an invalid bit </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> • The cartridge was changed when away from BOT or at BOT following a PREVENT or LOAD command • Viper drive has received a Reset </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	04h	Hardware Error	<ul style="list-style-type: none"> • Parity error on either the SCSI Bus the Viper drive 	05h	Illegal Request	<ul style="list-style-type: none"> • The CDB contained an invalid bit 	06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed when away from BOT or at BOT following a PREVENT or LOAD command • Viper drive has received a Reset
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5.22 LOAD/UNLOAD (1Bh)

The LOAD/UNLOAD command requests that the Viper drive enable or disable the logical unit for further operations. In either case, the tape is positioned to BOT before loading or unloading. Since loading and unloading of the read/write head and the tape are performed mechanically by the operator, the command is logically equivalent to the REWIND command, depending on whether the RETEN bit is set, except for the following:

- When a LOAD command is executed, the LED on the front panel is ON. If the cartridge is removed (even at BOT), a Unit Attention Condition is set.
- When an UNLOAD command is executed (front bezel LED is turned off when at BOT), the tape positions at BOT and the cartridge may be removed at BOT without an error condition.

5.22.1 LOAD/UNLOAD Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	1	1
1	0	0	0	0	0	0	0	IMMED
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	RETEN	Load
5	X	X	0	0	0	0	Flag	Link

5.22.2 Command Descriptor Block Field Descriptions

BIT NAME	BYTE	BIT	DESCRIPTION
IMMED Bit	1	0	This bit specifies that status is to be returned as soon as the operation is initiated. When this bit is zero, status is not returned until the tape is positioned.
Load Bit	4	0	This bit specifies whether the cartridge is to be loaded or unloaded. If set to 1, the tape moves to BOT and the LED comes ON enabling further logical unit operation. If the tape is removed following a load (even at BOT), Unit Attention is set. If set to 0, the tape repositions to BOT and the LED goes OFF. The tape can be removed at BOT without setting Unit Attention. Following an Unload, the drive accepts and executes any valid commands.
RETEN Bit	1	1	This bit specifies the tape be retensioned before the LOAD UNLOAD command is completed. The tape moves from the current position to BOT, then EOT, and back to BOT.

5.22.3 Completion Status

HEX CODE	MESSAGE	DESCRIPTION															
00h	Good Status LOAD = 1 (Load)	<ul style="list-style-type: none"> • Media is positioned to BOT • Front Panel Light comes ON • Unit Attention is set if a cartridge is removed at BOT • Viper drive remains in any previously set modes, with the exception of Unload • Viper drive is ready to perform any appropriate commands 															
	LOAD = 0 (Unload)	<ul style="list-style-type: none"> • Media is positioned to BOT • Front Panel Light goes OFF at BOT • Unit Attention is not set if a cartridge is removed at BOT • Viper drive remains in any previously set modes, with the exception of Load • Viper drive is ready to perform any appropriate commands 															
	RETEN = 1	<ul style="list-style-type: none"> • Media is positioned to BOT, then to EOT, then back to BOT. After this action, the tension on the tape is equalized from BOT to EOT and any errors caused by poor tape tension should be corrected. 															
	IMMED = 1	<ul style="list-style-type: none"> • Good Status is returned once the command is transferred and verified. The requested action may still be in progress, such as a Retention. If another command is issued during this time, the Viper drive immediately completes the new command and returns Busy Status. 															
02h	Check Condition	Extended Sense Byte 02															
		<table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not Ready</td> <td>• No cartridge in drive</td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td>• Parity error either on the SCSI Bus or the Viper drive</td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td>• Both IMMED bit and Link bit were set to 1. • The CDB contained an invalid bit</td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td>• The cartridge was changed prior to BOT or at BOT following a PREVENT or LOAD command</td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not Ready	• No cartridge in drive	04h	Hardware Error	• Parity error either on the SCSI Bus or the Viper drive	05h	Illegal Request	• Both IMMED bit and Link bit were set to 1. • The CDB contained an invalid bit	06h	Unit Attention	• The cartridge was changed prior to BOT or at BOT following a PREVENT or LOAD command
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06h	Unit Attention	• The cartridge was changed prior to BOT or at BOT following a PREVENT or LOAD command															

5.23 SEND DIAGNOSTIC (1Dh)

The SEND DIAGNOSTIC Command causes Viper drive to perform diagnostic self-tests on the buffer memory. The tests are part of the Viper drive resident firmware. No data is transferred between the Viper drive and the Initiator during this command.

Good Status is returned if the tests ran successfully.

5.23.1 SEND DIAGNOSTIC Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	1	1	0	1
1	0	0	0	0	0	1	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	X	X	0	0	0	0	Flag	Link

5.23.2 Command Descriptor Block Field Descriptions

BIT NAME	BYTE	BIT	DESCRIPTION
Self Test Bit	1	2	This bit must be set to one. It indicates that Viper drive is to perform its self-test procedures and that a parameter list is not used.
UnitOff and DevOff Bits	1	0 to 1	These bits must be set to zero. They are inapplicable since the Viper drive self-test does not use the medium during testing.
Parameter List Length	3-4		These fields must be set to zero. They are inapplicable when the Self Test bit is set to one.

5.23.3 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION															
00h	Good Status	<ul style="list-style-type: none"> The position of the Media is not changed Viper drive is ready to accept any appropriate command Viper drive remains in any previously set mode 															
02h	Check Condition	Extended Sense byte 02															
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<p>NOTE: The LED signals three long, three short, and three long flashes. This sequence repeats until the condition is cleared.</p>																	

5.24 PREVENT/ALLOW Media Removal (1Eh)

Because the Viper drive does not physically prevent the removal of the cartridge during those times when the tape is moving in the drive, the front panel LED indicates when removal is allowable.

If the LED is ON (PREVENT command), cartridge removal is not allowed. If the media is removed when the LED is ON, the Unit Attention Condition is set. If the LED is OFF (ALLOW command), media removal is allowed. If the cartridge is removed while the LED is OFF, no Unit Attention is set. If the PREVENT command is issued, the LED is always ON even at BOT, and then media removal even at BOT causes the Unit Attention Condition to be set. After a Reset, the default state of the drive is in the ALLOW command mode.

NOTE: *The Prevent/Allow command can only be issued at BOT.*

5.24.1 PREVENT/ALLOW MEDIA REMOVAL Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	1	1	1	1	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	PRVNT
5	X	X	0	0	0	0	Flag	Link

5.24.2 Command Descriptor Block Field Description

The PRVNT (prevent) bit, Byte 4, Bit 0, specifies whether the front panel LED should be turned on (1) or turned off (0) when at BOT.

5.24.3 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION												
00h	Good Status	<ul style="list-style-type: none"> • The media position is not changed • The Viper is ready to accept appropriate command • The drive remains in any previously set mode • If a PREVENT command was issued, the LED is always on and the Unit Attention Condition is set upon media removal • If an ALLOW command was sent, the LED goes out at BOT. This allows media removal at BOT without setting Unit Attention Condition 												
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>04h</td> <td>Hardware Error</td> <td>• Parity error either on SCSI bus or the Viper drive</td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td>• The CDB contained an invalid bit</td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> • The cartridge was changed prior to issuing the PREVENT/ALLOW command • Viper drive has received a Reset prior to the PREVENT/ALLOW command </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	04h	Hardware Error	• Parity error either on SCSI bus or the Viper drive	05h	Illegal Request	• The CDB contained an invalid bit	06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to issuing the PREVENT/ALLOW command • Viper drive has received a Reset prior to the PREVENT/ALLOW command
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04h	Hardware Error	• Parity error either on SCSI bus or the Viper drive												
05h	Illegal Request	• The CDB contained an invalid bit												
06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to issuing the PREVENT/ALLOW command • Viper drive has received a Reset prior to the PREVENT/ALLOW command 												

5.25 WRITE DATA BUFFER (3Bh)

The WRITE DATA BUFFER Command is used in conjunction with the READ DATA BUFFER Command as a diagnostic function for testing the data buffer memory of the Viper drive and confirming the SCSI bus integrity. There is no access to the medium during the execution of this command.

5.25.1 WRITE DATA BUFFER Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	1	1	1	0	1	1
1	0	0	0	0	0	0	0	BCV
2	Buffer ID							
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Byte Transfer Length (MSB)							
8	Byte Transfer Length (LSB)							
9	X	X	0	0	0	0	Flag	Link

5.25.2 Command Descriptor Block Field Descriptions

BIT NAME	BYTE	BIT	DESCRIPTION
BCV Bit	1	0	The BCV bit set to 1 indicates that Byte 2 contains the number of the buffer at which writing is to begin. Buffers are numbered from 0 to 113 (71h).
Byte Transfer	7 and 8		<p>Byte Transfer Length specifies the maximum number of bytes transferred to the Target and retained in the buffer. It contains a four-byte header followed by the Write Data Buffer data. All transactions must be in multiples of 512 bytes (fixed block length), plus a 4 byte header.</p> <p>A Byte Transfer Length of zero indicates that no WRITE DATA BUFFER header and no WRITE DATA BUFFER data are transferred. This condition is not an error. It is also not an error to request a Byte Transfer Length less than the Available Length plus 4 (reported by the READ DATA BUFFER Command); however, if the Byte Transfer Length is greater than the Available Length plus 4 (E204h), the drive returns Check Condition Status with a Sense Key of Illegal Request.</p>

5.25.3 WRITE DATA BUFFER Data Header

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0

5.25.4 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION															
00h	Good Status	<ul style="list-style-type: none"> The position of the Media is not changed Viper drive is ready to accept any appropriate command Viper drive remains in any previously set mode 															
02h	Check Condition	<p>Extended Sense byte 02</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>MESSAGE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>02h</td> <td>Not ready</td> <td> <ul style="list-style-type: none"> A cartridge is not installed in the drive </td> </tr> <tr> <td>04h</td> <td>Hardware Error</td> <td> <ul style="list-style-type: none"> Parity error on either the SCSI Bus or the Viper drive </td> </tr> <tr> <td>05h</td> <td>Illegal Request</td> <td> <ul style="list-style-type: none"> The CDB contains an invalid bit Allocation length exceeds the E204h Allocation length is not modulo 512 plus 4 </td> </tr> <tr> <td>06h</td> <td>Unit Attention</td> <td> <ul style="list-style-type: none"> The cartridge was changed prior to accepting this command Viper drive was Reset prior to accepting this command </td> </tr> </tbody> </table>	CODE	MESSAGE	DESCRIPTION	02h	Not ready	<ul style="list-style-type: none"> A cartridge is not installed in the drive 	04h	Hardware Error	<ul style="list-style-type: none"> Parity error on either the SCSI Bus or the Viper drive 	05h	Illegal Request	<ul style="list-style-type: none"> The CDB contains an invalid bit Allocation length exceeds the E204h Allocation length is not modulo 512 plus 4 	06h	Unit Attention	<ul style="list-style-type: none"> The cartridge was changed prior to accepting this command Viper drive was Reset prior to accepting this command
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05h	Illegal Request	<ul style="list-style-type: none"> The CDB contains an invalid bit Allocation length exceeds the E204h Allocation length is not modulo 512 plus 4 															
06h	Unit Attention	<ul style="list-style-type: none"> The cartridge was changed prior to accepting this command Viper drive was Reset prior to accepting this command 															

5.26 READ DATA BUFFER (3Ch)

The READ DATA BUFFER command returns the 4-byte READ DATA BUFFER header plus the number of bytes specified by the Allocation Length field. This command is used in conjunction with the WRITE DATA BUFFER command as a diagnostic function for testing the drive buffer memory and confirming the SCSI bus integrity. During performance of this command, there is no access to the tape.

5.26.1 READ DATA BUFFER Command Descriptor Block

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	1	1	1	1	0	0
1	0	0	0	0	0	0	0	BCV
2	Buffer ID							
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Allocation Length (MSB)							
8	Allocation Length (LSB)							
9	X	X	0	0	0	0	Flag	Link

5.26.2 Command Descriptor Block Field Description

BIT NAME	BYTE	BIT	DESCRIPTION
BCV bit	1	0	If this bit is set to 1, Byte 2 contains the number of the buffer where the reading begins. Buffers are numbered from 0 to 113 (71h), and each buffer contains 512 bytes of data.
Allocation Length	7 and 8		These fields specify the maximum number of bytes the Initiator allocated for returned data. It includes a four-byte header, which is transferred first, followed by the READ DATA BUFFER data. All transactions must be in multiples of 512 bytes (fixed-block length), plus the 4 byte header.

5.26.3 READ DATA BUFFER Header

BITS BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	Available Length (MSB)							
3	Available Length (LSB)							

5.26.4 READ DATA BUFFER Header Field Descriptions

The READ DATA BUFFER Header contains four bytes.

- The first two bytes are reserved and set to zero.
- Bytes two and three contain the Available Length or the space available in the drive buffer. The Available Length for the drive is 56.5 kilobytes.

An Allocation Length of zero indicates a non-transference of READ DATA BUFFER header and READ DATA BUFFER data. This is not an error condition. It is likewise, not an error to request an Allocation Length less than Viper drives Available Length plus four (for the header). In that case, the drive returns the requested length, including the four byte header. If the number of bytes specified in the Allocation Length exceeds the Available Length plus 4 (or is not modulo 512 plus 4), it is treated as an Illegal Request.

5.26.5 Completion Status

COMPLETION CODE	MESSAGE	DESCRIPTION
00h	Good Status	<ul style="list-style-type: none"> • The position of the Media is not changed • Viper drive is ready to accept any appropriate command • Viper drive remains in any previously set mode.
02h	Check Condition	Extended Sense byte 02
02h	Not ready	• A cartridge is not installed in the drive
04h	Hardware Error	• Parity error on either the SCSI Bus or Viper drive
05h	Illegal Request	<ul style="list-style-type: none"> • The CDB contains an invalid bit • Allocation Length exceeds the E204h • Allocation Length is not modulo 512 plus 4.
06h	Unit Attention	<ul style="list-style-type: none"> • The cartridge was changed prior to accepting this command • Viper drive was Reset prior to accepting this command.

CHAPTER 6

THEORY OF OPERATION

6.1 Overview

Viper SCSI drives feature LSI circuitry and surface-mount technology and conform to ANSI X3.131 and QIC-02 standards. The Viper drive consists of multiple mechanical subassemblies, two electrical assemblies (PCBs), and a front bezel. All are assembled in a half-high, 5 1/4-inch drive chassis configured to fit inside a standard half-high floppy disk slot. Figure 6-1 is a simplified block diagram of the Viper drive. Drive electronics are located on the Main PCB and the Motor Driver PCB.

The Viper drive main PCB contains electronics for drive operations and interface. This single multilayer PCB offers advanced LSI circuitry and surface mount technology to provide high data reliability and low power consumption.

The motor driver PCB is mounted in the back of the drive behind the cartridge loading area and contains LSI circuits to control the speed and direction of the capstan drive motor.

SCSI control signals are transmitted to and from the Viper via the host interface connector at the rear of the drive. Power is received through a 4-pin connector located at the rear of the drive.

6.2 Printed Circuit Board

Under firmware program direction by the 64 Kbyte EPROM, the Intel 8-bit 8031 microprocessor provides complete control over the operation of the Viper drive. The microprocessor together with the VLSI automatically formats the data as it is written onto tape.

All read/write registers for transfer of data blocks within the drive electronics reside in VLSI and a 64 kilobyte buffer with parity. The data blocks are extracted from the formatted data as they are read from tape and sent to the host through the SCSI interface. Circuits for writing data to and reading data from tape are provided on the SCSI bus controller with all addressing control processed on the VLSI. The microprocessor and VLSI perform all error recovery operations.

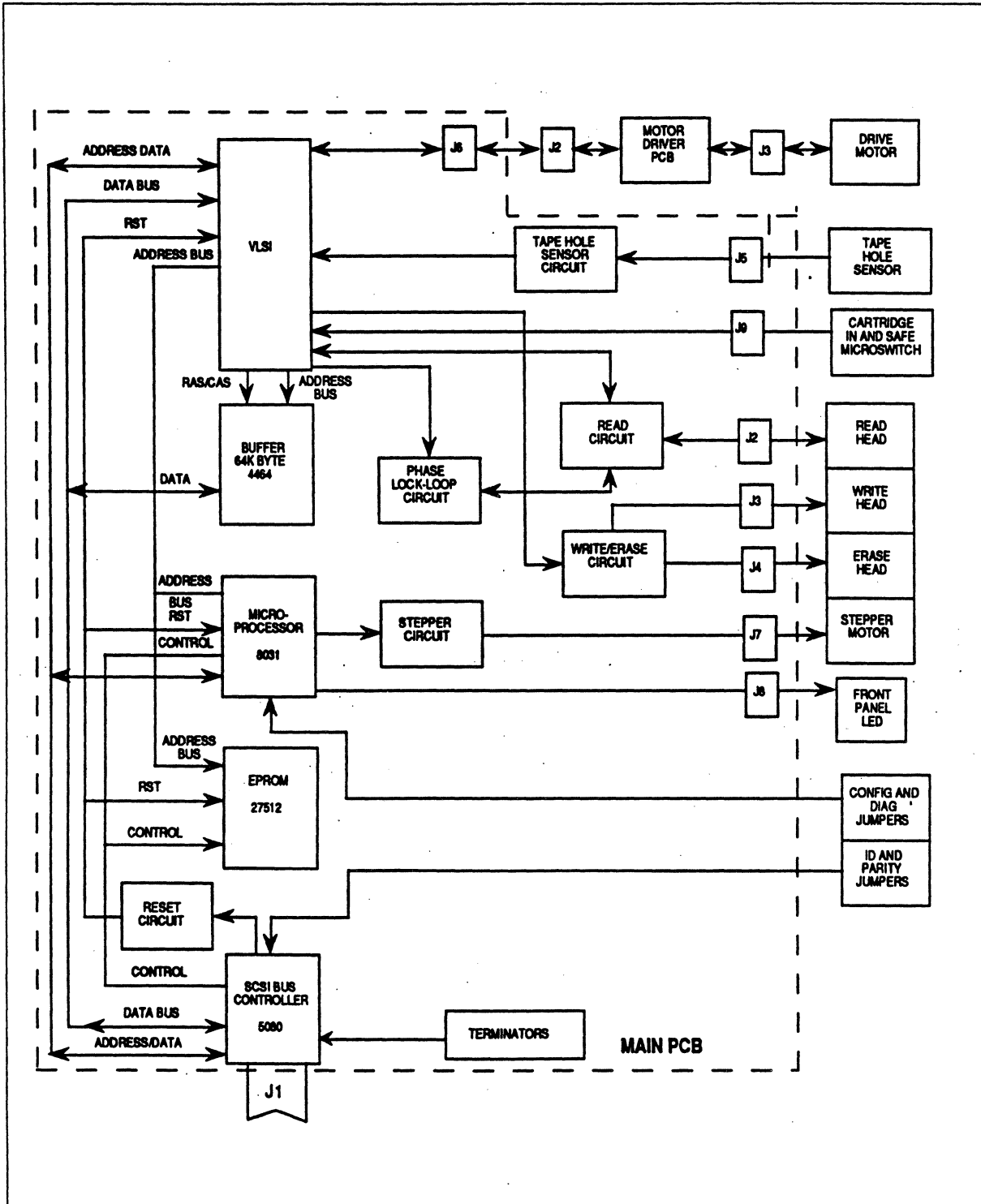


Figure 6-1. Viper Drive Functional Block Diagram

6.2.1 Basic VLSI Controller

The basic VLSI controller consists of the motor control register, motor status register, tape status register, tape hole latches and cartridge in/out detector. The -USF, -CIN, -UTH and -LTH signals all have the internal wrap-around signals at pads to the motor status register for ease of testing. It includes the circuits and features described in Table 6- 1.

Table 6-1. VLSI Features

CIRCUIT OR FEATURE	DESCRIPTION
DMA Controller	The DMA controller handles the host (SCSI) data transfer with minimum interventions by the microprocessor. It can perform any combination of either an Initiator role or a Target role.
Interrupt Controller	The interrupt controller consists of two maskable registers and two status registers and generates two interrupts to the microprocessor. The maskable registers are not initialized with a reset signal. The status bits can be read by the microprocessor at any time regardless of mask bit settings.
Memory Access Controller	The memory access controller consists of the arbiter, memory address multiplexer, memory bus transceiver, parity checker/generator, refresh control and dynamic RAM interface. This controls all the internal data bus and memory data bus activities.
Read/Write Controller	<p>This circuit consists of the write controller, read controller and read/write interface that is shared by both the write controller and read controller. The read/write controller basically operates in the following two modes:</p> <p>Read-After-Write Mode: The write controller controls the read/write interface. The write controller gets data and control bytes from the buffer memory. The read controller is only used as the read verifier it does NOT read the data back into the buffer memory.</p> <p>Read Mode: The write controller is not used and should be shut off. The read controller controls the read/write interface. The data and control bytes are put into the buffer memory.</p>
Clock Generator	The clock generator consists of the crystal oscillator, phase clock generator, microprocessor clock generator, and SCSI chip clock generator.

Table 6-1. VLSI Features Continued

CIRCUIT OR FEATURE	DESCRIPTION								
Configurations	The configuration registers configure the operation of this device and are set for both application and diagnostic programs.								
Power On Reset (POR)	Indicates status only. The POR bit is set by upon power-up and the bit is cleared by reading the Test cell register. It is important to distinguish between two reset conditions: a power-on reset occurring because of a condition where voltage values are low and a system reset.								
Data Separator	<p>The data separator consists of the frequency comparator, phase comparator, gray code counter, data separator and VCO logic.</p> <p>A phase-locked condition occurs when the falling edge of the clock signal coincides with the rising edge of a reference signal. A bit cell window is between two rising edges of the clock signal.</p> <p>The separated data and clock signals applied to the read controller. The read-after-write signal controls the data window size. It narrows down the data window to 75% during the read-after-write mode.</p> <p>Acquisition Advance (-AQA) and Track Advance (-TRKA) signals are used for VCO steering. They cause the following:</p> <table border="1" data-bbox="594 1150 1278 1356"> <thead> <tr> <th data-bbox="594 1150 894 1234">When these signals are driven to this state . . .</th> <th data-bbox="894 1150 1278 1234">the VCO frequency . . .</th> </tr> </thead> <tbody> <tr> <td data-bbox="594 1234 894 1272">low</td> <td data-bbox="894 1234 1278 1272">increases</td> </tr> <tr> <td data-bbox="594 1272 894 1310">high</td> <td data-bbox="894 1272 1278 1310">decreases</td> </tr> <tr> <td data-bbox="594 1310 894 1356">high-Z</td> <td data-bbox="894 1310 1278 1356">no change</td> </tr> </tbody> </table> <p>-AQA is controlled by the frequency comparator. The function of this signal is to lock on to a frequency as fast as possible and to lock-on to the gap frequency.</p> <p>-TRKA is controlled by the phase comparator. This signal provides tracking of a phase variations. The lock signal (originated in the read controller) switches between two comparators.</p>	When these signals are driven to this state . . .	the VCO frequency . . .	low	increases	high	decreases	high-Z	no change
When these signals are driven to this state . . .	the VCO frequency . . .								
low	increases								
high	decreases								
high-Z	no change								
Byte Counter	The Byte Counter counts the number of bytes independent of recording density.								
Test Points Multiplexer	The programmable test points output the various signals for checking the phase-lock loop (PLL) performance and margins.								

6.2.2 Write and Erase Circuits

The write circuits provide signals to the tape drive recording heads. Signals applied cause flux transitions on the tape corresponding to the data being recorded.

- Accurate write current control is achieved through a feed-back circuit.
- Current flow direction to the write heads is determined and write data signals (WD and -WD) from the LSI are directed to either head 1 or head 0 depending on which one is selected for recording.
- Head selection is determined by -REV. When -REV is low (TTL) and WEN (write enable) is high (TTL), 12 volts is applied to head 1. When -REV goes high and WEN is high, 12 volts is applied to Head 0.
- When recording to track 0, an erase current at 2.8 megahertz is applied to the full-width erase head through gates and signals ERA and ERB. Erase current is toggled back and forth so the maximum 25% duty cycle of the erase head is not exceeded by either of the erase circuits.
- A write switch actuation lever on the cartridge prevents writing data on the tape. When this lever is placed in the safe position, a switch is activated in the write circuits turning off removing the 12 volts and disabling the write circuit. The reset signal (-SRST) also provides a safeguard against writing invalid data by being assured that proper voltages are applied to the tape drive. This signal can also be activated through the drive interface.

6.2.3 Read Circuits

The read chain circuits condition the signal being read from the tape. A dual input preamplifier and multiplexer is provided for each read heads 0 and 1.

- Gain of the preamplifier is determined and a variable resistor adjusts the head inputs so that the output is properly balanced.
- Head selection is determined by a forward/reverse signal and the output of the dual preamplifier/multiplexer is conditioned by a seven-pole differentiating low-pass filter. This filter changes amplitude peaks into zero-crossings and also filters unwanted noise frequencies out of the data frequency range.
- The conditioned read signals are applied to a circuit consisting of a post amplifier and data pulse detector. Gain of the post amplifier is determined by the gain adjust resistor. The channel-to-channel equalization is achieved by adjusting a resistor. DC Balance is adjusted to correct for the differential offset voltage of the post amplifier.
- The output of the post amplifier is AC coupled and attenuated into the read comparator (zero-crossing detector) and write comparator (threshold detector) circuits. The threshold detector is triggered with 25% amplitude or 4% amplitude, depending upon whether the drive is in read-after-write or read only mode of operation. By qualifying data at 25% threshold during read-after-write, sufficient margin is provided to insure that the data will be recovered using a 4% threshold during read only.
- The thresholds are selected by a voltage divider network. When the controlling transistor is on, the network provides 4% read only threshold. When it is off, the network provides a 25% read-after-write threshold.
- Data pulse timing is accomplished by a one-shot multivibrator time-domain filter. The multivibrator is triggered by the zero-crossing detector on every zero crossing. As the multivibrator times out, the threshold detector is sampled to determine if it too has been triggered. If it has, then a second one-shot multivibrator is triggered, which is the read data pulse. The time constant for the time-domain filter is carefully selected to insure that unwanted zero crossings do not become false data transitions. The time constant for the read data pulse is not critical but it is maintained so it does not exceed 50% of the data window.

6.2.4 Tape Hole Sensor

This circuit consists largely of a two hole sensor circuit and a comparator circuits. These circuits eliminate the need for various potentiometer adjustments due to changes in tape transmissivity and sensor characteristics.

6.2.5 Phase Lock Loop

This circuit consists of a loop filter and a voltage controlled oscillator. The loop filter consists of several operational amplifier stages followed by the VCO and corresponding circuits. Total phase-lock-loop operation makes use of these circuits and phase and frequency comparison circuits located in the VLSI.

The phase-lock-loop operation makes use of two signals: -AQA and -TRKA. These signals represent the two modes of operation: frequency lock acquire and frequency phase-lock-tracking.

When operation begins, the system is in the frequency lock acquire mode. This mode of operation makes sure that signals are within range of an actual frequency and do not represent an unwanted harmonic. As soon as a fundamental frequency signal is obtained, operation moves to the frequency phase-lock-tracking mode. Two potentiometers are provided for phase lock offset adjustment and for VCO Range Adjustment.

6.2.6 Reset Circuits

A system reset is generated if the power supply voltage drops below a predetermined level. This reset function is accomplished by two monolithic integrated circuits. These reset controllers generate the SRST and -SRST signals. The SCSI bus reset also generates a -SRST signal output.

6.3 Data Transfer

To write data to tape, a number of conditions must be satisfied. The drive must be selected at the SCSI interface, the write enable signal must be active, and the cartridge write protect lever must be positioned to close the safe switch. Differential write data signals must be available at the VLSI interface. These signals are sent to the drive from the supplied controller through the SCSI interface and VLSI.

Unlike the write data circuits, the read circuits are operational during both write and read operations. As a tape is recorded the read head operates to read each block of data as it is written.

The difference between only reading data or reading after writing is controlled by the VLSI, microprocessor, and the host. The read after write data is qualified by the read and write thresholds. This ensures that the tape contains high-quality data.

During the read mode, the following read/write threshold percentages are applied allowing efficient retrieval of data:

VIPER DRIVE FORMAT	WRITE THRESHOLD	READ
60 M bytes	25 %	5 %
125 M bytes	25%	4 %
150 M bytes	25%	4 %

6.3.1 Erase Operation

When track 0 is selected, all tracks are erased. As a signal is applied to track 0 by the full-width erase head, the entire tape is erased. Erasing the entire tape ensures that new data is not written over old data. To enable the erase/write circuit, the tape cartridge must not have the write protect lever in the safe position, and the write enable signal must be true.

6.3.2 Write Data (Backup) Operation

Each formatted block of data is written immediately after the preceding block. Assuming the proper control signal protocol is in progress, write can be commanded by the host under certain conditions. In any case, Viper circuits verify that the cartridge is in place and not write protected.

If the host has not issued a tape position command to begin recording, the drive defaults to the beginning of tape (BOT) before writing begins.

Writing to tape can begin following a read operation. In this case, the last file written on tape is found, and the drive waits in the vicinity where the last data was recorded. When a write command is received, data blocks supplied are written after the previously recorded block of data.

Writing data to a streaming tape means that the tape should be in constant motion. For the tape to remain in constant motion, the flow of data from the host must be sufficient to keep the tape drive buffers full of data.

If data transfers from the host are interrupted, an underrun occurs. If data transfers from the host are under 90 kilobytes per second, the tape will not stop but the drive may, at intervals, write a duplicate of the preceding data block. The duplicate block is transparent to the host.

If the data falls below 45 kilobytes per second, the drive responds by writing a second copy of the last block and then writes a large postamble, stops tape motion, changes direction, and positions head over already written data. When the data transfers resume, the drive searches for the end of the last block and begins writing.

Underruns should be avoided since they consume tape, and the repositioning increases write time and reduces data throughput.

During a write operation, the early warning hole for the last track is sensed, the drive stops accepting data from the host at the next block boundary. The drive completes writing all data blocks contained in the buffers and raises the -EXCPT signal to the host.

In response, the host can command one block of data or a filemark written. The drive reports that the tape is at the end of media again and then writes another data block. This block, or blocks of data can be used to describe the file as incomplete.

6.3.3 Read Data (Restore) Operation

To restore data, a read command is given at the beginning of the tape, the drive starts tape motion in search of data. When the first block is successfully read, a ready signal is inserted and transfer of data blocks to the host begins. The drive continues to read and transmit data to the host until the end of data on tape is found or the end of a specified block of data to be restored is completed.

As long as the host can maintain the required data transfer rate, the drive keeps the tape in motion. If data transfer is interrupted, the drive stops tape motion, reverses tape direction, and positions over previously read data. This is called a read underrun. When the host can again transfer data, the drive starts tape motion and continues to read data.

The repositioning routine generated by read underruns reduces the average data throughput.

6.4 Drive Mechanics

6.4.1 Loading Mechanism

The Viper drive loading mechanism provides endwise cartridge loading. The head is moved from the cartridge path during insertion so the cartridge door can be opened for head penetration. The head is then moved back into penetration position for operation.

The head support and stepper assembly are mounted on a separate, pivoted subframe. The subframe is linked to the front panel latch lever so the assembly is pivoted in and out of position as the cartridge is latched or unlatched. A leaf spring stop provides accurate and precise location of the cartridge as it is moved into operating position.

Viper drives use a damped torsion spring to apply an outward force to the cartridge for cartridge removal. As a cartridge is inserted into the unit this spring is compressed until the tape is latched into the drive. When the tape is unlatched by sliding the front panel latch lever to the left, spring compression is released and ejects the cartridge partially out of the cartridge slot. A damping system in the eject lever controls cartridge ejection speed.

6.4.2 Cartridge Loading

The cartridge is inserted into the drive as shown in Figure 6-2. The latch lever slides toward the center of the drive engaging the latch roller and moving the head assembly into operating position.

1. To load the cartridge move the front panel latch lever to the left detent position and insert the cartridge. The front panel latch insures the head assembly and front latch roller are moved out of the way in preparation for cartridge insertion.

As the cartridge is inserted, the cartridge door is opened by a cam in the tape guide.

2. With the cartridge fully inserted, move the front panel latch lever to the right. Moving the lever to the right swings the head assembly into operating position and the latch rollers are moved into position, forcing the cartridge against the reference planes.

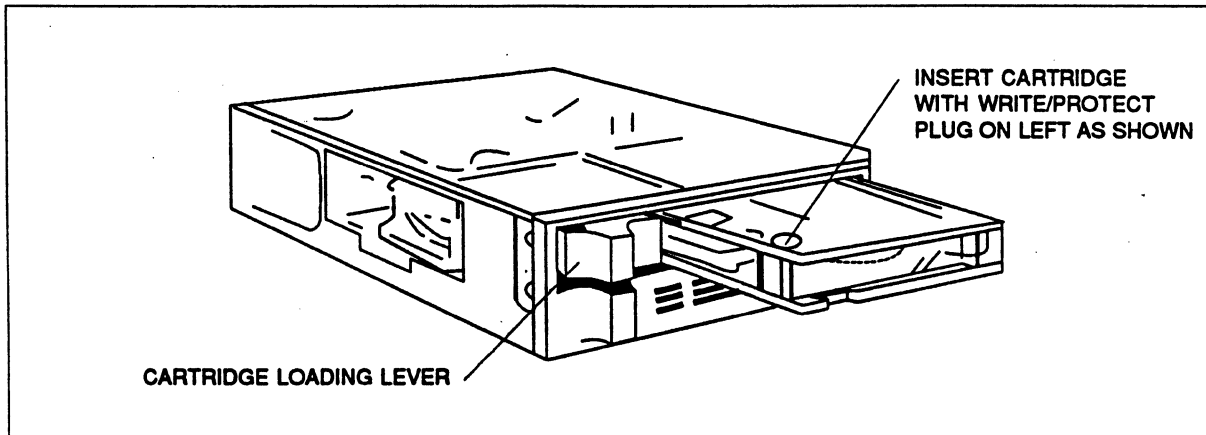


Figure 6-2. Cartridge Loading

6.4.3 Cartridge Removal

Move the front panel latch lever to the left to unlatch and partially eject the cartridge.

6.4.4 Tape Motion

The tape drive capstan is powered by a three-phase brushless DC motor. The motor consists of an inter-rotor design for low inertia and low starting current. The system includes a tachometer which provides a TTL level square wave output at a rate of eight cycles per revolution. The tachometer signal is derived by a Hall-effect generator which reads a magnetic pattern on the rotor. Three other Hall-effect elements in the motor provide commutation information to the drive circuitry for switching the motor driver transistors at the correct times to assure proper speed and rotational direction.

Capstan pressure is provided by mounting the capstan and bearings on a movable structure which is spring loaded against the cartridge drive roller. The capstan is constructed of a highly wear resistant urethane material with excellent friction characteristics for driving the cartridge roller. The capstan pulley and shaft ride on ball bearings.

6.5 Sensors/Interlocks

6.5.1 Cartridge Switch Assembly

The Viper uses two switches placed in ANSI-specified locations to sense the presence of a cartridge and write protect status. Because they must be removed from the path of the cartridge during cartridge insertion, they are mounted on the sliding latch lever. The cartridge-in-place switch is actuated by the cartridge sidewall when the cartridge is fully inserted in the drive.

6.5.2 Write Protect

The cartridge sidewall includes a rotating safe switch that is solid on one side and hollow on the other. When the safe switch is rotated so the solid side faces toward the write protect microswitch, this solid portion actuates the write protect switch and permits writing on the tape. When the safe switch is rotated so the hollow side faces the write protect microswitch, the switch is not actuated, and write or erase functions are not permitted.

6.5.3 Tape Hole Sensors

An optical end-of-tape sensor assembly is included in the Viper drive. This assembly consists of an infra-red LED placed near the edge of the cartridge.

- A light beam from the LED shines through a plastic window in the cartridge.
- The beam is reflected 90 degrees by a mirror back through the window in the cartridge onto two infra-red detectors adjacent to the LED. Normally the beam is blocked by the tape as it moves across the head. Near each end of the tape are small diameter holes. When these holes pass in front of the light beam, the beam can pass through the hole and be sensed by the infra red detectors.
- These holes are located to indicate an end of tape or beginning of tape condition. Tape holes are placed at different locations depending on end of the tape involved with two detectors used to determine the end of tape being sensed.

6.6 Motor Driver Printed Circuit Board

The Viper motor driver printed circuit board drives a three-phase, four-pole, brushless motor with eight-pole tachometer. All functions for controlling the speed and directions of this motor are contained on this circuit board, with the exception of certain control functions which are handled by the VLSI located on the Main PCB. A block diagram of the Motor Driver PCB is shown in Figure 6-3.

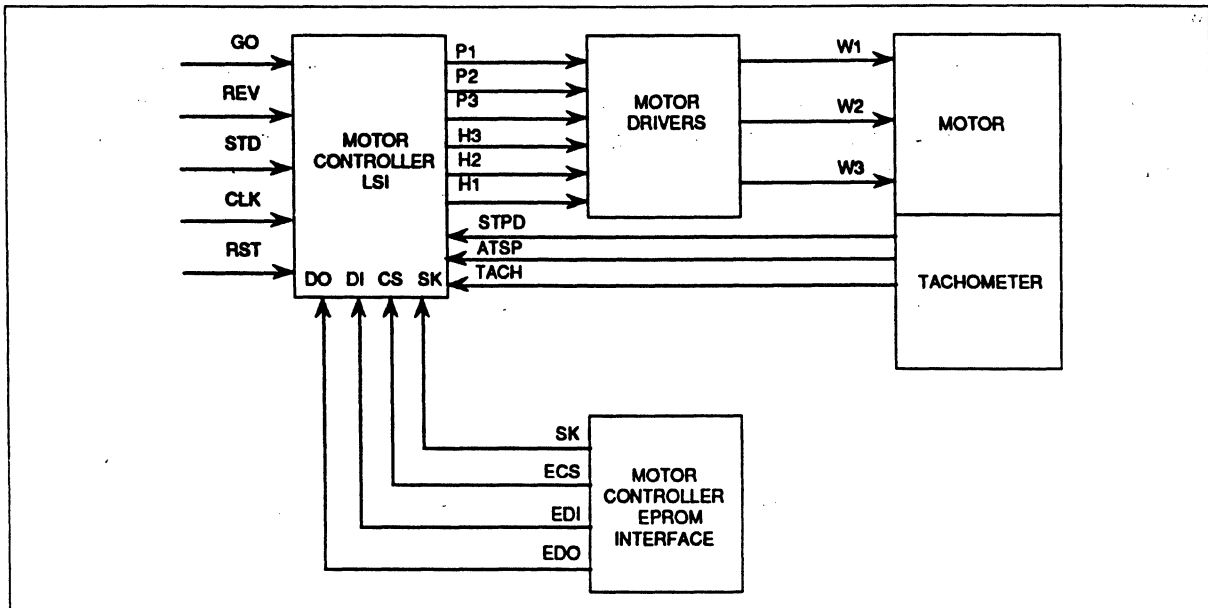


Figure 6-3. Motor Driver PCB Block Diagram

6.6.1 Interface

The motor driver-to-host interface contains three control lines (GO, REV, and SPD) and two status lines (STPD and ATSPD). The following table shows the conditions for both the STPD and ATSPD signals and their effects on motor operation.

STPD	ATSPD	STATUS
0	0	motor ramping up or braking
0	1	motor running at speed
1	0	motor stopped
1	1	motor stalled

When the host asserts the GO signal, the Viper drive controller deasserts the STPD signal and starts the motor in the direction specified by the REV signal at the speed specified by the SPD signal. When the motor achieves the correct speed, the controller asserts the ATSPD signal. When the host deasserts the GO signal, the controller deasserts the ATSPD signal to stop the motor. When the motor stops, the controller asserts the STPD signal. If the motor stalls during ramping or servoing, the controller asserts both the STPD and ATSPD signals and waits for the host to deassert the GO signal as an acknowledgement. At this time, the controller deasserts the ATSPD signal while leaving the STPD signal asserted.

6.6.2 Motor Controller LSI

The task of controlling the motor is handled by an LSI chip on the motor driver PCB. The motor controller LSI chip emulates a servoing algorithm placed on the drive firmware. While reading the following paragraphs, please refer to the motor controller LSI functional block diagram shown in Figure 6-4.

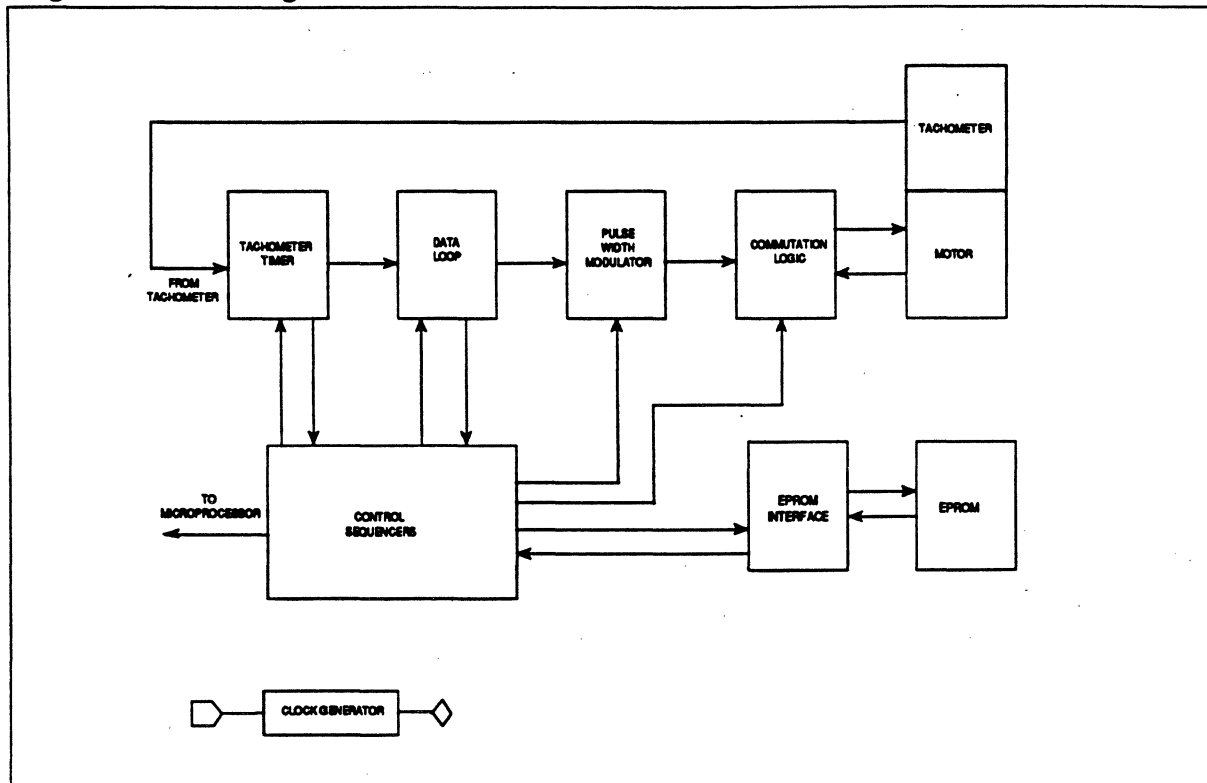


Figure 6-4. Motor Controller LSI Functional Block Diagram

Table 6-2. Motor Controller LSI Functions

FUNCTION	DESCRIPTION
Sequencers	Three sequencers control all activity within the motor driver LSI. The host sequencer is the main sequencer; it interprets control information from the host computer, reporting status to the host computer, and controlling all of the internal functions of the controller. The other two sequencers: the ramping sequencer and the servo sequencer are both slaves to the host sequencer and are responsible for the activities of ramping up and servoing the motor.
Clock Generator	The clock generator receives the master clock input and generates all clock pulse timing required for LSI operation. The clock generator logic within the LSI begins with the 11.25 MHz DLK clock signal input to the LSI. Other clock signals are derived from the basic DLK clock signal and are used by the sequencers, the data loop shift registers, and the pulse-width modulator.

Table 6-2. Motor Controller LSI Functions Continued

FUNCTION	DESCRIPTION
Tachometer Timer	The tachometer timer measures the elapsed time between tachometer pulses and uses this information to calculate motor speed. This information is also used to servo the motor and to detect when proper motor speed has been achieved. Overflow from the counter indicates when the motor is stalled, and when it is stopped during braking.
Data Loop	<p>The data loop (two, 16-bit shift registers and a serial adder) is used by the servo sequencer to translate tachometer period measurements from the tachometer timer into pulse width values for the pulse width modulator.</p> <p>One shift register holds the frequency error value, and the other holds the phase error value. Data flow through the loop is controlled by the sequencers. Serial addition is provided by a one-bit adder.</p>
Frequency Error Value	The frequency register can be shifted in either direction and may be parallel loaded from the tachometer timer. During pulse width computation, the frequency register operates as a general purpose register and also is used as a destination for program instructional data from the EPROM.
Phase Error Value	The phase register contains the current value of motor phase error, and the phase data can be shifted only to the right in this register .
Pulse Width Modulator	<p>The pulse width modulator generates pulses based on a value loaded by the sequencers. The pulse width modulator uses an 8-bit free running pulse width counter and an 8-bit presettable down-counter.</p> <p>During ramping, the pulse width is incremented from a 10% to 25% duty cycle over a 7 mSec period. The pulse width register receives data during servoing from the frequency register each time a computation is made (after each tach pulse). The frequency register value is compressed into a narrow range. Values larger than the top of the range produce the maximum pulse width, negative values produce the minimum.</p>
Commutation Logic	<p>Commutation logic controls current flow through the three windings of the motor based on the hall sensors, the current limit input, and the output of the pulse width modulator.</p> <p>Each of the six power transistors are switched on and off by the commutation logic, according to the encoded shaft-position information provided. In normal operation, the lower transistors are commutated directly and the upper transistors are modulated. In the braking mode all three upper transistors are turned on, and the lower transistors are turned off. This essentially shorts the motor winding together, allowing back-EMF braking.</p>
Shift Counter	The 4-bit shift counter is used for controlling arithmetic operations during servoing, and for loading data from the EPROM. The shift counter operates with two, 3-bit source registers which are loaded from the EPROM through the frequency registers.

6.6.3 EPROM Interface

The EPROM interface is a sequencer clocked at the EPROM data rate of 175 kilohertz. Operation of the EPROM interface is enabled by a signal from the ramp and host sequencers in the motor controller LSI.

6.7 Head Assembly

The magnetic read/write head contains four high performance magnetic heads (gaps) and a full-width erase head(gap). See Figure 6-5. Mounted on the head loading plate, the read/write head is positioned and aligned to produce precise and accurate serpentine track format recordings on a 1/4-inch cartridge tape.

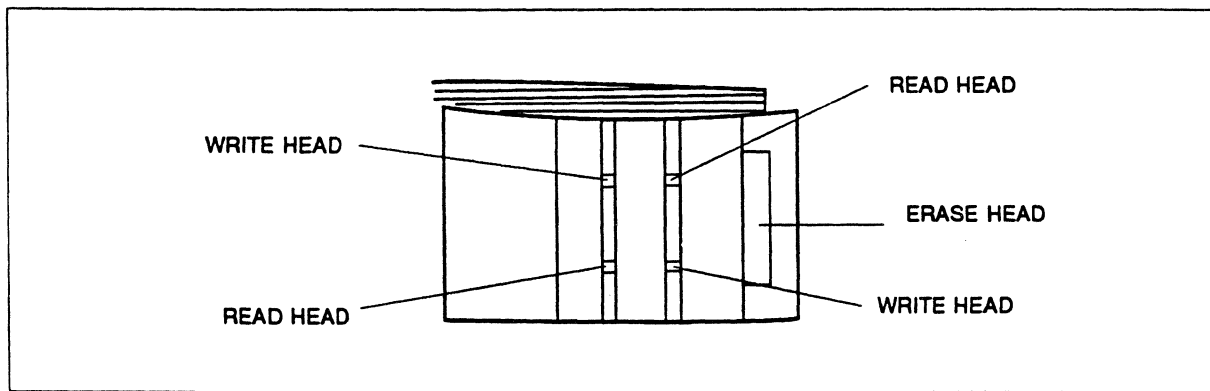


Figure 6-5. Read/Write/Erase Magnetic Head Configuration

In addition to reading data from and writing data to the tape media, the magnetic head provides a precision surface for tape interface. Constructed of carefully selected and matched materials and finished to a smoothness of a few millionths of an inch, the ceramic head provides optimum reliability and durability.

User servicing is not necessary with the exception of cleaning the head at the intervals recommended in *Maintenance and Reliability*.

CAUTION: Do not touch the magnetic head with any material or liquid not recommended in the cleaning procedures in *Maintenance and Reliability*, – Serious and permanent damage to the head can occur.

6.7.1 Read/Write Head Operation

The upper and lower read-after-write head pair construction permits read-after-write error detection and the bi-directional serpentine track pattern described in serpentine recording.

To the right of the head pairs is the full tape-width AC erase head. The erase head precedes the write head on Track 0. As Track 0 is written, the erase head erases the full width of the tape and is disabled at the end of Track 0. The drive command set also allows for a full erase pass prior to writing.

Table 6-3. Head Assembly Functions

FUNCTION	DESCRIPTION
Read/Write Head Positioning	<p>The Viper drive requires that the head be moved across the width of the tape for writing and reading various data tracks on the tape. To accomplish this, the read/write head is attached to a nut which rides on a threaded leadscrew shaft. This shaft is turned by a stepper motor which rotates in 15° increments. Each 15° increment advances the head, by 0.001 inch across the tape.</p> <p>The stepper motor provides precision data track positioning force, while additional head guidance is performed by low friction plastic bushings sliding on steel guide pins.</p>
Tape Track Sensing	<p>The stepper motor and associated control circuits move the head assembly the required number of electronically calculated steps to a designated track. Precise positioning of the head assembly is essential to assure media interchangeability from one drive to another.</p> <p>The Viper models 125S and 150S use edge of tape sensing to precisely locate the position for Track 0, and then use Track 0 as a reference point to step to the other track locations. Because Viper model 60S does not require this level of track-placement precision, Track 0 is located by positioning from the stepper end stop.</p>
Head Stepper Motor Interface	<p>Two stepper motor driver circuits control the unipolar stepper motor. The drivers have lines connected to the stepper motor in a full stepping mode of operation. This mode of operation requires that two stepper lines be in a low state when stepping and off when not stepping.</p> <p>The motor interface circuit consists of two drivers. The four stepper lines are connected to the microprocessor and are under microprocessor and EPROM program control.</p>

6.7.2 Serpentine Recording

Serpentine accurately describes the streaming tape drive pattern of recording serial data on tape. The recorded tape logically appears to consist of one long, winding track. The logically adjacent tracks are recorded, one track at a time, in opposite directions (even-numbered tracks in the forward direction and odd-numbered tracks in the reverse direction). This process takes advantage of the tape cartridge bi-directional capabilities and, thus, avoids time-consuming rewinds.

In operation, the tracks of data are written on the tape, but not written in parallel. Instead they are written in bit serial, one track at a time (Figure 6-6). When the load point hole is detected on the tape, the head is in the recording zone and writing begins on track 0. In addition to writing on track 0, the erase head is enabled, and full track erasing is accomplished just ahead of the write head.

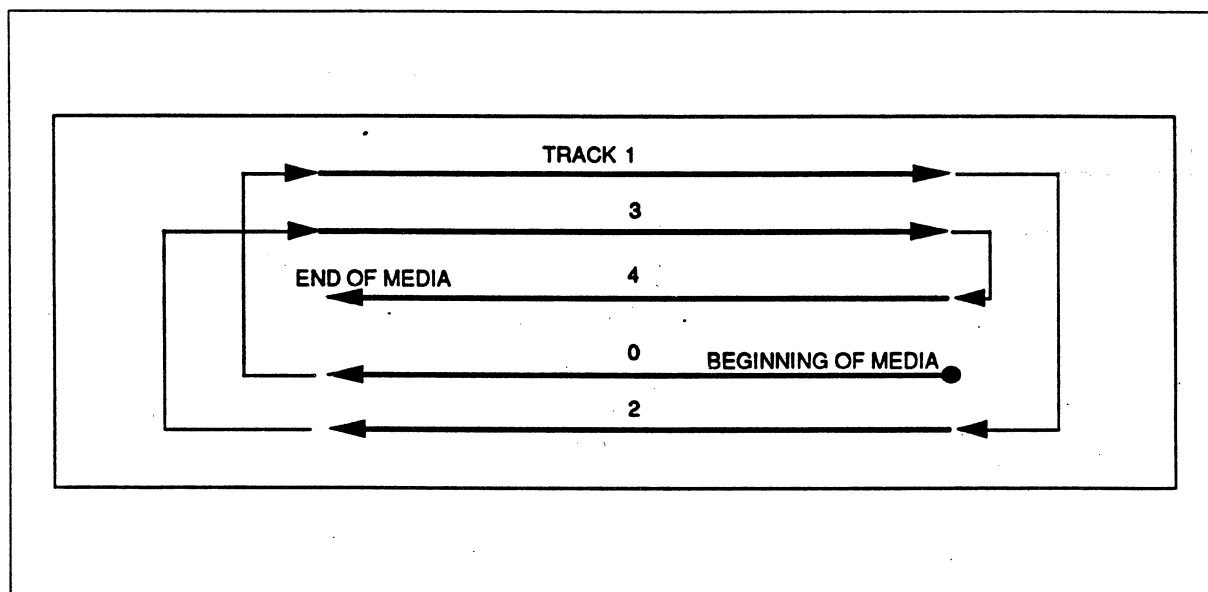


Figure 6-6. Typical Serpentine Recording

The write head continues writing data to the tape until the Early Warning hole is detected. At this time no more data is accepted from the SCSI bus on the next block boundary. Writing is continued until the buffers are empty.

Tape motion is continued until the end of tape hole is detected. Tape forward motion is stopped, the erase head is disabled, and the read/write gaps for track 1 are selected. Refer to Figure 6-7 for track positioning.

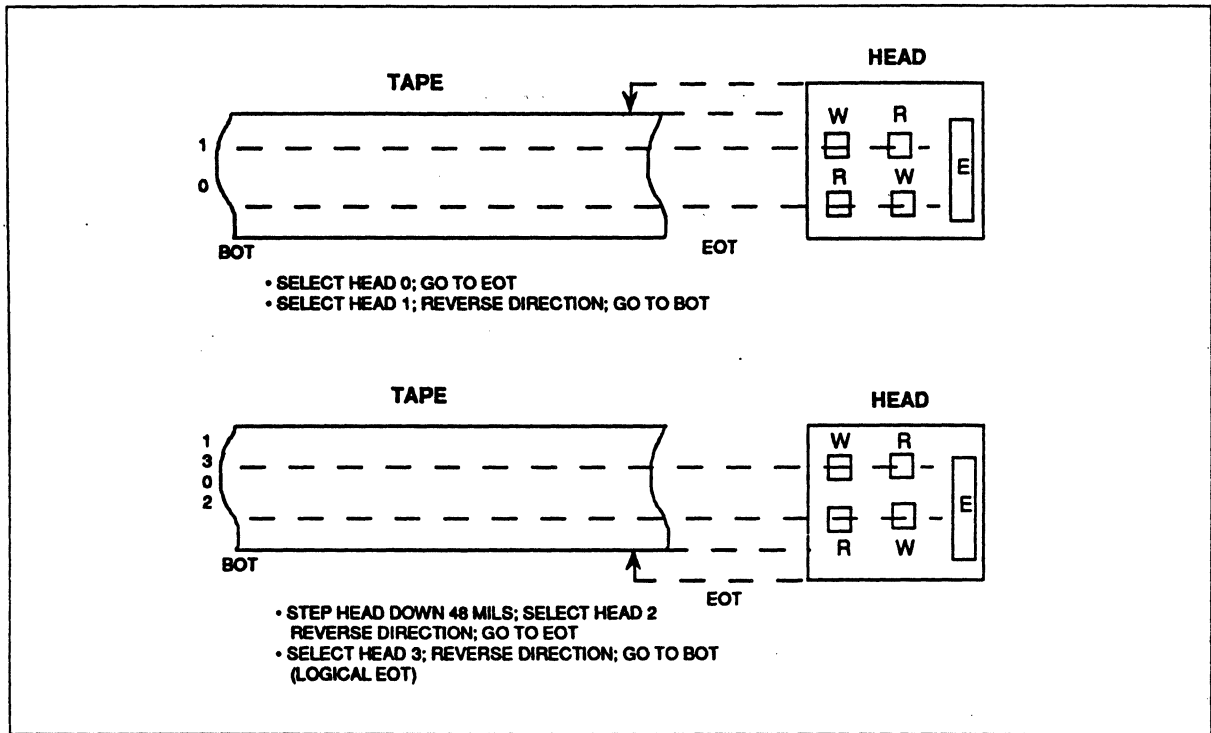


Figure 6-7. Track Positioning

Tape motion begins in the opposite direction in search for the end of tape Early Warning hole which now will be the load point for track 1. Writing is then enabled when the end of tape Early Warning hole is reached. When the beginning of tape Early Warning hole is detected the end of tape procedure is repeated and the drive writes on tracks 2, 3, etc. in the same way. Actual 9-track, 15-track, and 18-track serpentine patterns are shown in Figures 6-8, 6-9, and 6-10.

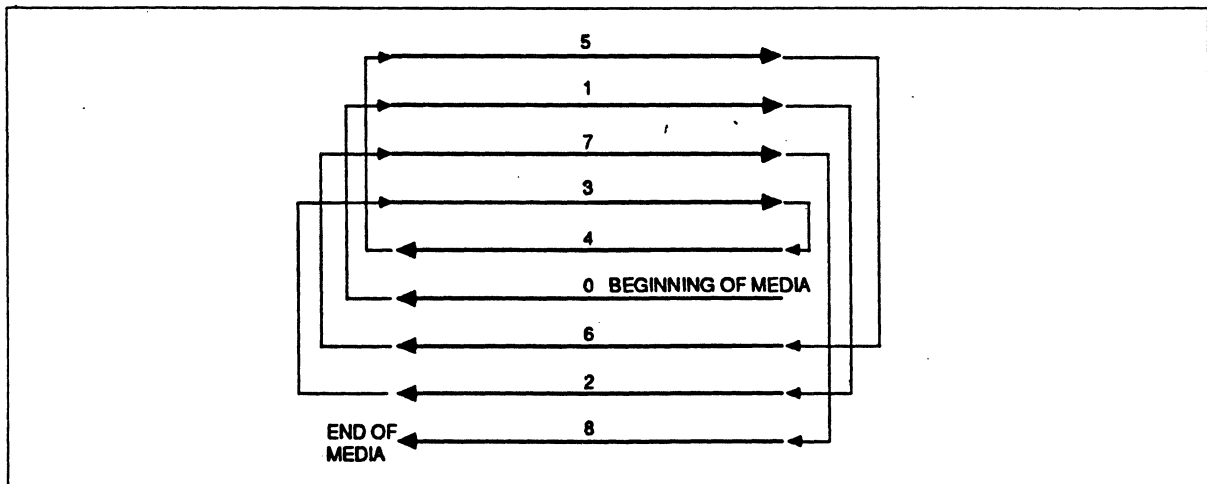


Figure 6-8. Serpentine Recording Pattern: 9-Track

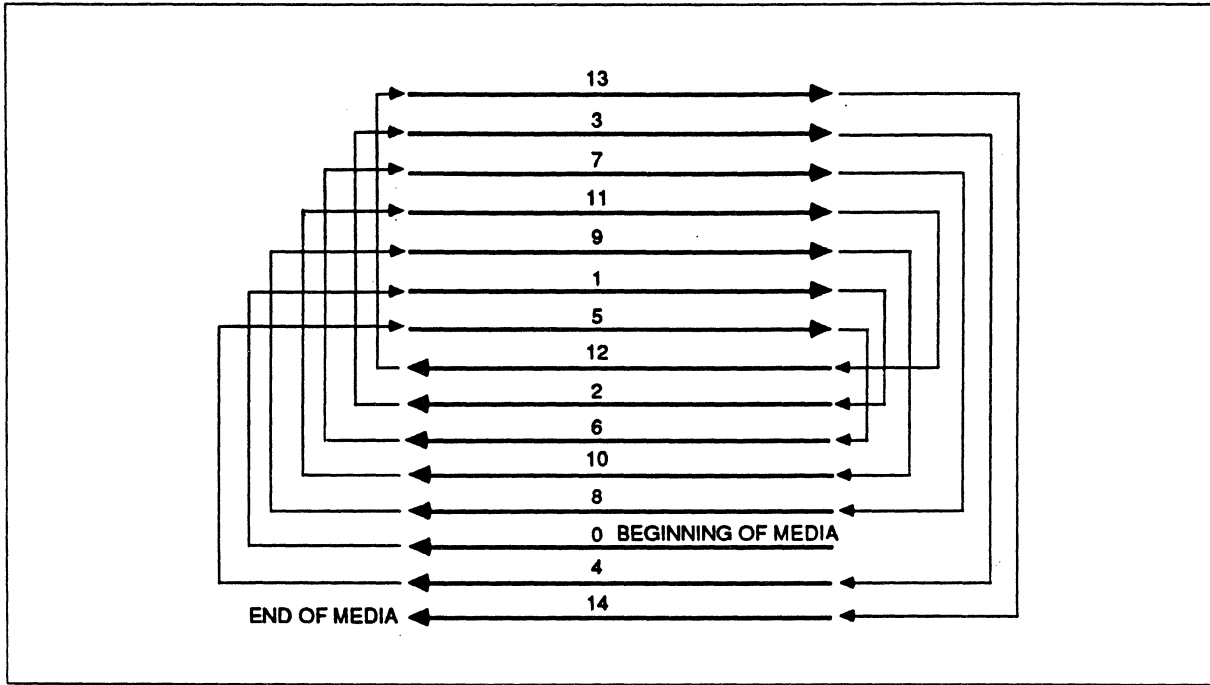


Figure 6-9. Serpentine Recording Pattern: 15-Track

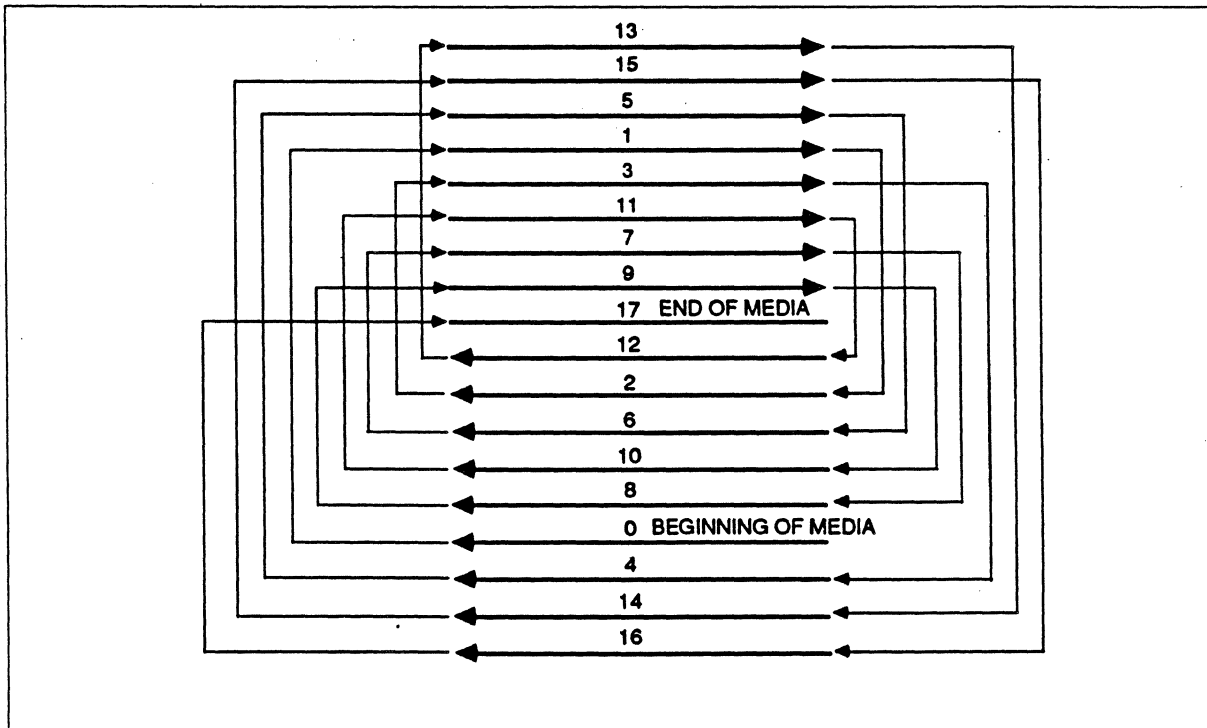


Figure 6-10. Serpentine Recording Pattern: 18-Track

6.8 Firmware

6.8.1 Write Error Recovery

The Viper drive has error processing and recovery routine software incorporated into the firmware. Although these routines are transparent to the host, it is important that the host is aware of the error rates in order to track tape media reliability. The drive issues a status report (in response to the Read Status Command) to the host containing the error rate status for the previous read or write operation.

Data errors due to contamination and imperfections in the tape are accommodated by the Viper drive. To ensure that the data has been written correctly, a read check is performed on each block of data as it is written. If a cyclical redundancy error (CRC) is found during the read check, that block is rewritten.

During the Write Command the three buffers are allocated as follows: one for the block being written; one for the block being read checked, so the data is available for rewriting; and one available for receiving the next data block from the host.

The tape drive head has two sets of gaps, one for each direction of tape motion. Each set comprises a read gap and a write gap. The write and read gaps are set 0.3 inches apart.

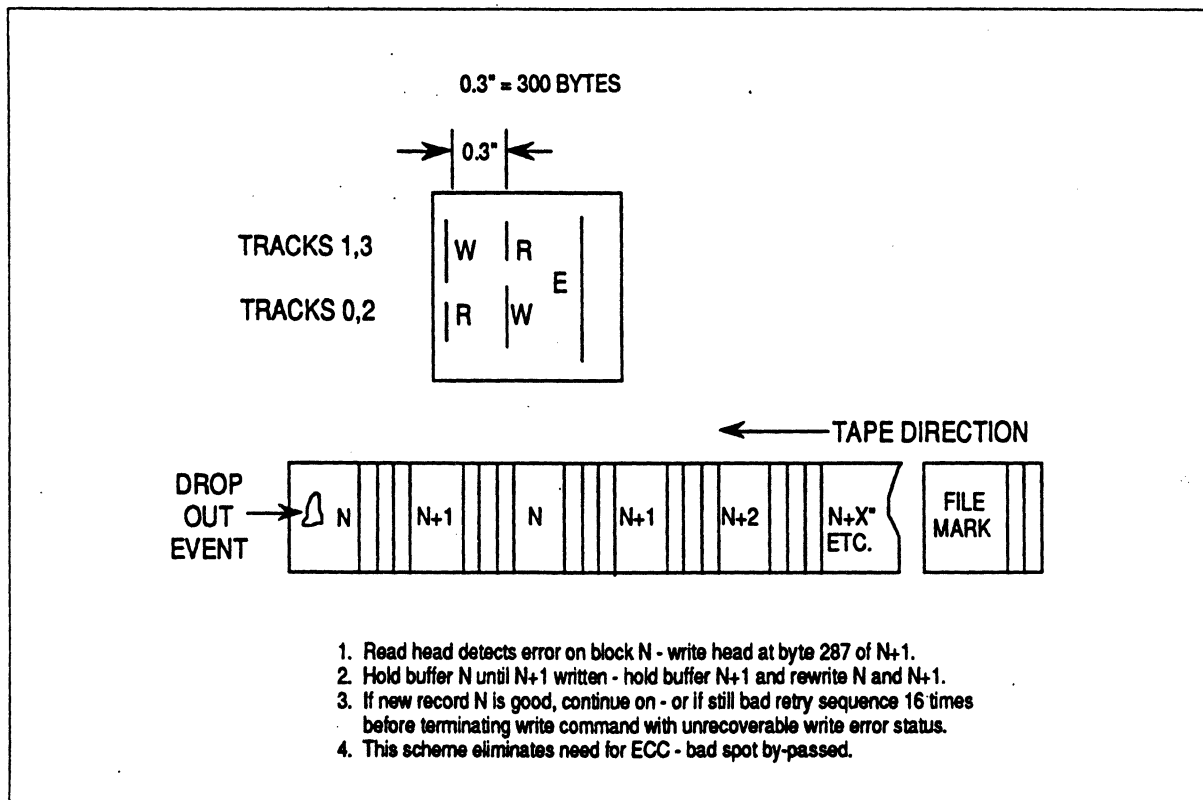


Figure 6-11. Read After Write Error Sequence

The read gap is used for read-after-write checking of new data as well as normal reading of data. Since the inter-record gap is only 0.013 inches, the controller begins writing block $n + 1$ before it finishes read-checking block N . By the time a CRC error can be found in Block N , block $N + 1$ is already half written. Because of this, the following protocol is followed:

1. Viper drive begins writing block N . Refer to Figure 6-16 while reading this protocol.
2. When block N reaches the read head (3000 flux reversals later), read checking begins.
3. The write function finishes writing block N by appending a block address and CRC.
4. A short resynchronization gap is generated and written.
5. The write channel begins writing block $N + 1$.
6. The read channel finds a CRC error in Block N .
7. Because a CRC error was found, block N must be rewritten. Block $N + 1$ is already half written.
8. The drive finishes writing block $N + 1$, then begins writing block N a second time.
9. If no errors are found in the second iteration of N during the read check, then the drive continues writing the second iteration of block $N + 1$ and proceed with its normal sequence.
10. If the second writing of block N still has a CRC error, then a third copy of N is written, and block $N + 1$ is also written. The drive repeats writing block N for a total of 16 attempts.

If a CRC error is still evident, the drive stops tape motion, sets the Exception Flag and rewinds the tape to BOT. The drive then informs the host of an unrecoverable or hard error.

This error recovery protocol is transparent to the host if no hard errors are discovered. To keep the host informed of the media quality, the drive can report the number of blocks rewritten in response to a Read Status Command. The total number of soft errors is cumulative.

6.8.2 Write Buffer Underrun

To write in the streaming mode, the tape must be in constant motion. For tape motion to be constant, the flow of data from the host must be sufficient to keep the drive buffers full of data.

If the drive has written block N and the next buffer of data N + 1 is not ready to be written, an underrun sequence begins. The drive begins writing block N a second time and continues the read-after-write check of the first copy of block N. If a buffer of data is still not ready when the drive completes the read check, the drive makes the decision to stop the tape if N was written successfully.

Before stopping the tape, the drive finishes the second copy of N and begins writing a gap. When the gap reaches the read head, the drive stops tape motion and repositions the tape in preparation for writing new data.

When the drive receives its next full block of data, it starts tape motion, reads correct tape speed, and begins writing new data after the gap. This underrun procedure allows about 3.33 mSec (at 90 ips) of delay for the host to catch up to the drive before tape motion is interrupted. It also ensures that the drive will wait for the host if something interrupts data flow.

6.8.3 Read Buffer Underrun

In a normal read operation, the drive reads a block of data from the tape into the buffer. It is then transferred via the bus, from the drive buffer to the host. The buffers are allocated so that one buffer is used for data being read in, a second buffer to transfer data to the host, and the third in reserve in case the host gets behind.

If the host fails to empty the drive buffers, a read buffer underrun may occur. An underrun occurs when the read channel has located the next block of data and none of the buffers are available.

To prevent the loss of this next block of data, the Viper drive controller stops the tape, reverses tape direction, then positions the tape in preparation for continuing reading. When the next buffer becomes available, the drive gets the tape up to speed and begins reading again.

6.8.4 Read Data Errors

During a read operation, a temporary read error may occur. If the drive encounters a block with a CRC error, it continues reading the next two blocks. If the second block has no CRC error and is the same block address as the original block in error, the drive knows that it was rewritten during the write operation.

This is the suspected condition and is invisible to the host. The drive continues reading without logging an error. If the drive reads the next two blocks and the block in error was not rewritten, the drive now performs a soft error retry.

First the drive stops the tape and repositions behind the block in error. The tape is then started and the block in error is reread and the CRC error rechecked. If necessary, the drive rereads the block in error 16 times. If after 16 attempts the data block still is read with an error, the read operation is terminated. If it is not the block in error, the host is informed. Successful soft error retries are invisible to the host. The Viper drive controller logs all soft error retries and passes the count to the host.

6.8.5 Streaming Termination

The tape streaming operation is terminated when an end-of-tape condition exists, and may be terminated when underrun or end-of-file conditions exist.

Table 6-4. Streaming Termination Description

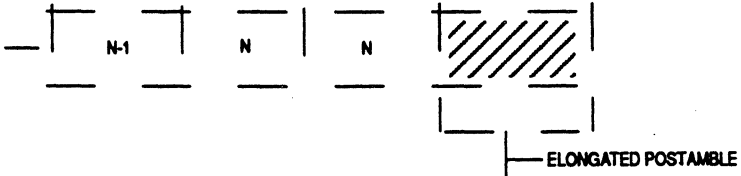
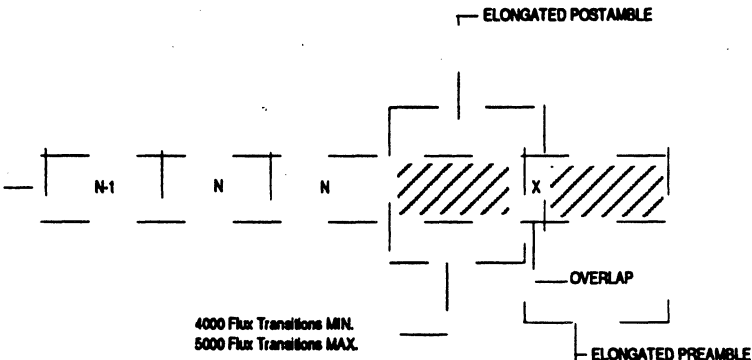
CONDITION	DESCRIPTION
End of Track	When an end-of-track condition is detected, the block currently being written is completed and followed by an elongated postamble to permit block verification. If the block does not meet the requirements for interchange, rewriting the block starts at the beginning of the next track following a long preamble.
Underrun or End-of-File	<p>When an underrun or end-of-file conditions exist, the normal sequence of recording block N, N + 1, etc., is replaced by the sequence of blocks N, N, etc., until the recording of block N meets the requirements for interchange. When block N is recorded such that the requirements for interchange are met, the associated rewriting of block N is completed or truncated. An elongated postamble is written as shown below.</p> 

Table 6-4. Streaming Termination Description Continued

CONDITION	DESCRIPTION
<p>Underrun or End-of-File</p>	<p>Writing an elongated preamble following the elongated postamble begins at 4,000 to 5,000 flux transitions from the end of the block preceding the elongated postamble. An elongated preamble is recorded before recording any other field in the block.</p> 
<p>Rewritten Blocks</p>	<p>When recording on tape, some blocks may have to be rewritten further down the tape. This is done to decrease the system error rate.</p> <p>A block N may be recognized as erroneous before or after block N + 1 is partly or completely written, but is always so recognized before the writing of block N + 2 is initiated.</p> <p>An erroneous block is not erased. Instead it is rewritten further down the tape. A correct block N is followed, although not necessarily immediately by a correct block N + 1. Rewritten blocks retain their block number. In addition, if applicable, file mark blocks retain their filemark block number.</p>

6.9 Data Cartridge

The data cartridge is an enclosed, self-contained mechanism that provides access to the tape surface by the drive heads and transports the tape across the head. The following are descriptions of the cartridge components shown in Figure 6-12.

Table 6-5. Data Cartridge Components

COMPONENT	DESCRIPTION OR FUNCTION
Baseplate	The baseplate provides the structure and stability for the data cartridge. It also is the mounting platform for all internal components of the drive and defines the mounting plane to locate the cartridge within the drive.
Tape Guides and Wrap Pins	Two tape guides located on each side of the door opening, control the wrap angle of the tape around the recording head. The wrap pins control the wrap angle of the tape to reduce tension variations as the tape moves from one end to the other.
Write Protect plug	The write protect plug is a capped, hollow cylinder with half of the wall removed. Depending upon the position of this cylinder the write head is either disabled or enabled so data on the tape cannot be overwritten.
Cover and Access Door	The tape and transport mechanism are protected by a clear plastic case which contains an access door that is automatically opened by the tape drive as the cartridge is inserted to allow access to the tape by the read/write heads.
Tape and Tape Hubs	The tape is wound (magnetic side out) onto two hubs that act alternately as supply or take up, depending on tape direction.
Tape Holes	A number of precisely located holes are found near each end of the tape. These holes are detected by the drive sensor assembly which generates hole-detect signals used to control tape motion. The tape holes are located as follows:
Beginning Of Tape (BOT) End Of Tape (EOT) Load Point (LP) Early Warning (EW)	Three upper and lower hole pairs, indicating the Beginning-Of-Tape position. three lower holes indicating the End-Of-Tape position. one upper hole near BOT indicating the start of recorded data. one upper hole near EOT indicating the end of the tape is near. Notice that the distance between BOT and LP holes is 36 inches for the DC300XLP cartridge, 48 inches for the DC600A cartridge, and 60 inches for the DC600XTD cartridge. The Viper tape drive differentiates between data cartridge types by recognizing these distances.
Mirror	The mirror is part of an optical sensing system. It reflects light through pre-punched holes toward the back of the drive to alert the drive when recording area limits are reached.

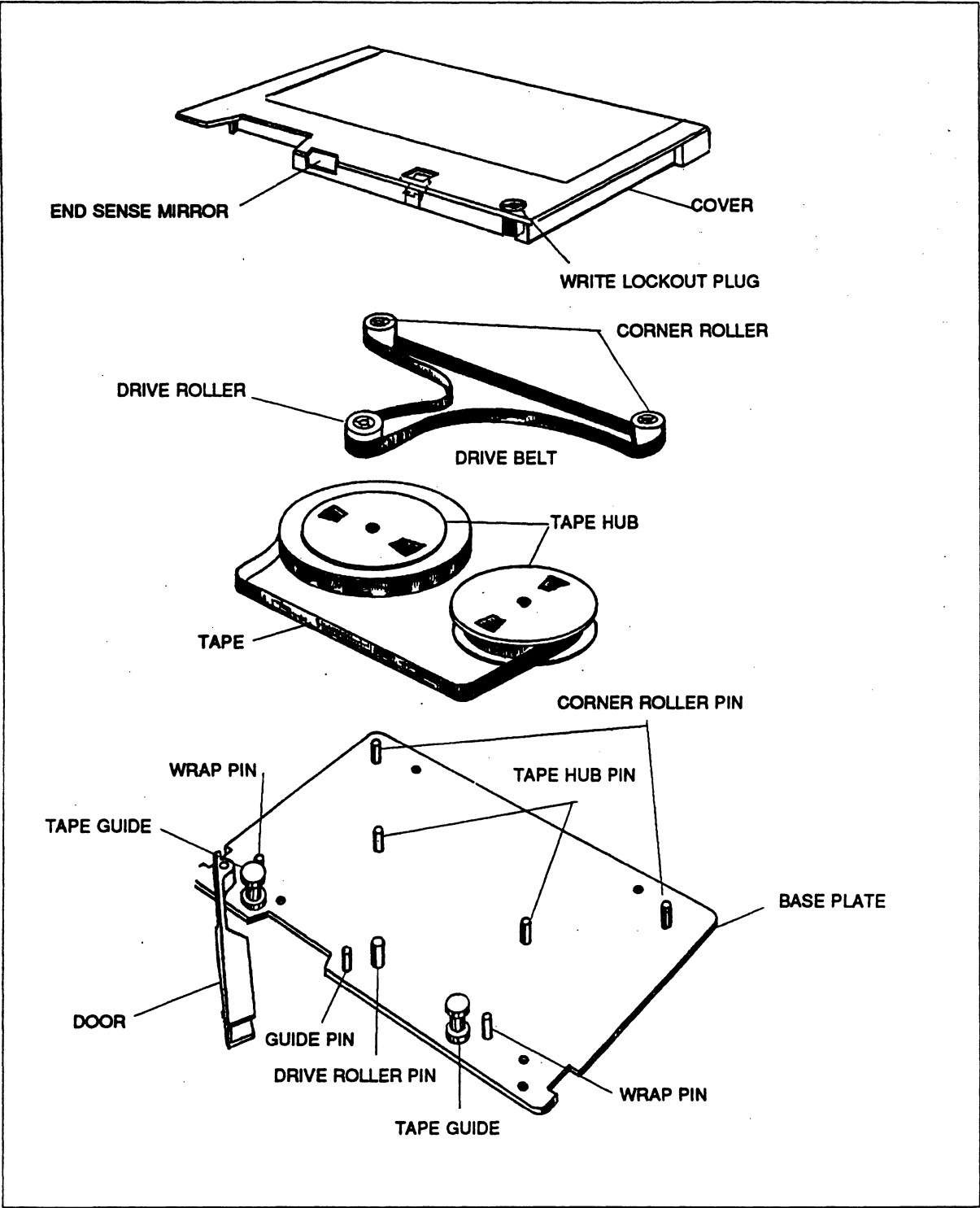


Figure 6-12. Data Cartridge, Exploded View

6.9.1 Tape Operation

Tape motion occurs when the drive motor and capstan cause the drive roller to rotate. This action transfers motion to the drive belt which is in contact with the tape on the tape hubs. Since the drive belt contacts the tape surface, constant tape speed is maintained regardless of tape pack diameter.

The cartridge also establishes and controls tape tension. Tape friction, drag torque, tape friction contribute to tape tension. Tension is not constant because tape tension factors vary as the tape moves from one hub to the other.

The Viper conforms to ANSI A and B reference plane specifications for cartridge positioning. Front and rear leaf-spring-loaded cartridge latch rollers to ensure proper seating against the A and B plane locators.

COMPONENT	DESCRIPTION
Capstan/Belt Drive	The drive motor is mounted near the rear of the drive and connected to the capstan by a belt. Belt tension is factory set with controlled pulley-to-pulley distances. One pulley has a crown on the belt contact surface to ensure more accurate belt tracking. Flanges on the pulleys prevent belt damage or loss during unusual events such as a stalled cartridge.
Tape Path	For proper tape-to-head contact, the tape path across the head is carefully controlled by precision mounting of the head during drive manufacture and by accurate alignment of the head and cartridge in the drive.

6.9.2 Recording

The recorded tape block format for recording data onto tape is shown in Figure 6-13. This illustration shows the locations of the preamble, the data block number, data block, block address, CRC, and postamble.

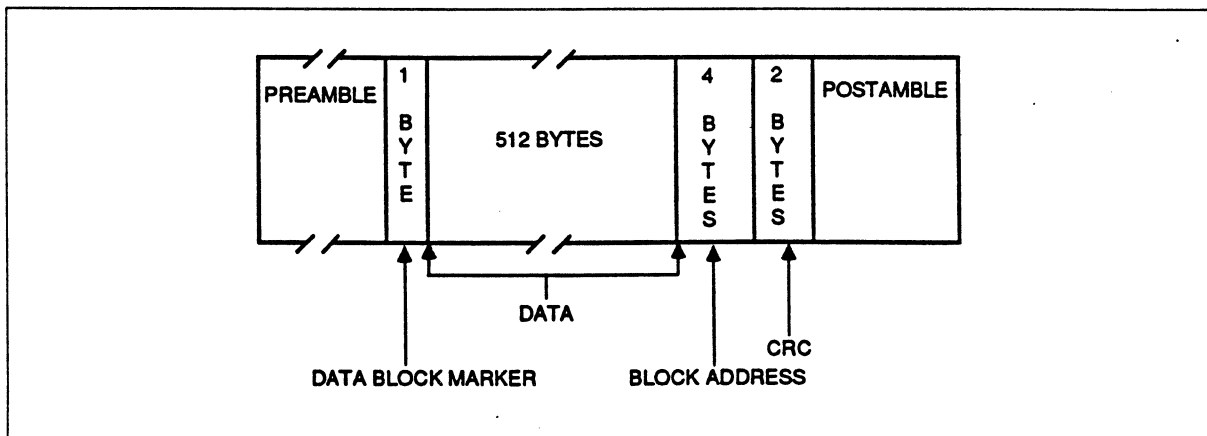


Figure 6-13. Recorded Block Format

6.9.2.1 Preamble

A preamble is generated in three configurations: Normal, Elongated, and Long. Each of these preamble configurations are shown below.

TYPE	DESCRIPTION
Normal Preamble	The normal preamble is used to synchronize the phase-locked-loop in read electronics to the data frequency. It is also used to measure the average signal amplitude.
Elongated Preamble	The elongated preamble precedes the first data block recorded after an underrun conditions occurs.
Long Preamble	The long preamble precedes the first data block for interchange recorded at the beginning of a track.

6.9.2.2 Data Block Marker

The data block marker identifies the start of data and consists of the following GCR pattern:

G4	G3	G2	G1	G0
1	1	1	1	1

MS nibble

G4	G3	G2	G1	G0
0	0	1	1	1

LS nibble

6.9.2.3 Data Block

The data block contains 512 bytes. Each 8-bit data byte is separated into two 4-bit groups called nibbles. Each 4-bit data nibble (B3 - B0) is encoded into a 5-bit GCR nibble (G4 - G0) for recording onto the tape. Data bytes are encoded into GCR bytes in accordance with the code translation shown in Table 6-2.

6.9.2.4 Block Address

The block address consists of 4 bytes that uniquely identify a block recorded on tape. The block address is encoded into GCR bytes as shown below, and defined in Figure 6-14. The first block number on track is block 1 and subsequent blocks are numbered sequentially. The block number is reset at the end of a track. The track number is recorded in Byte 0.

HEX	NIBBLE				GCR EQUIVALENT					
	B3	B2	B1	B0	G4	G3	G2	G1	G0	HEX
0h	0	0	0	0	1	1	0	0	1	19h
1h	0	0	0	1	1	1	0	1	1	1Bh
2h	0	0	1	0	1	0	0	1	0	12h
3h	0	0	1	1	1	0	0	1	1	13h
4h	0	1	0	0	1	1	1	0	1	1Dh
5h	0	1	0	1	1	0	1	0	1	15h
6h	0	1	1	0	1	0	1	1	0	16h
7h	0	1	1	1	1	0	1	1	1	17h
8h	1	0	0	0	1	1	0	1	0	1Ah
9h	1	0	0	1	0	1	0	0	1	09h
Ah	1	0	1	0	0	1	0	1	0	0Ah
Bh	1	0	1	1	0	1	0	1	1	0Bh
Ch	1	1	0	0	1	1	1	1	0	1Eh
Dh	1	1	0	1	0	1	1	0	1	0Dh
Eh	1	1	1	0	0	1	1	1	0	0Eh
Fh	1	1	1	1	0	1	1	1	1	0Fh

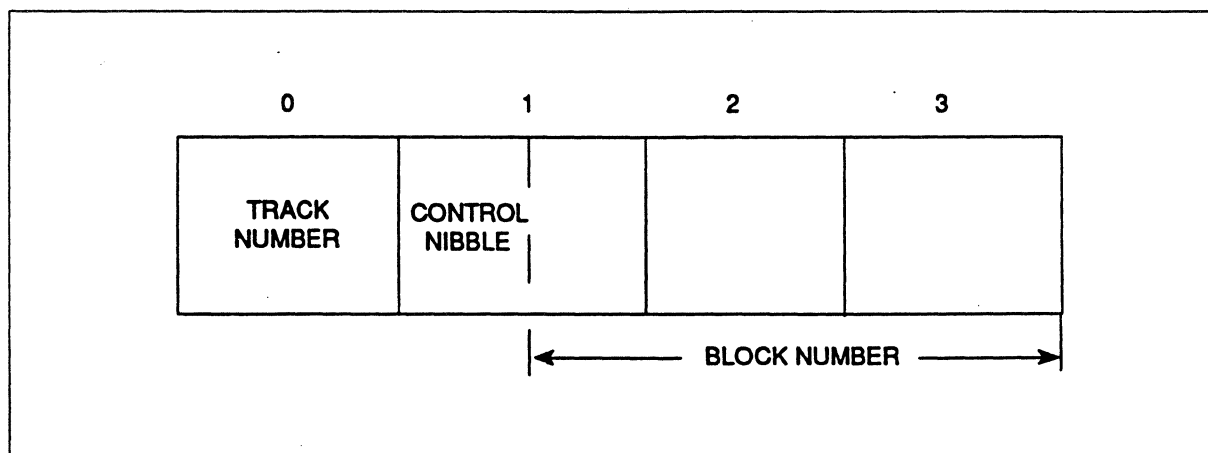


Figure 6-14. Block Address Definition

The control nibble (Byte 1, Bits 0-4) is defined as follows:

3	2	1	0	VALUE	DEFINITION
0	0	0	0	0	The current block contains user data or file mark.
0	0	0	1	1	Reserved for QIC-24/120 use.
0	0	1	0	2	The current block is a unique control block for use only on track format.
				3 -15	Reserved

6.9.2.5 Cyclical Redundancy Check

The cyclical redundancy check (CRC) consists of two bytes calculated over the 512 bytes of interchange data and the 4-byte block address starting with all ones CRC initial value. The CRC is encoded into GCR bytes in accordance with Table 6-2. The CRC is generated using the following polynomial:

$$\text{CRC} = X^{16} + X^{12} + X^5 + 1$$

6.9.2.6 Postamble

A postamble is generated in two configurations: Normal and Elongated. Each of these postamble configurations are shown below.

TYPE	DESCRIPTION
Normal Postamble	The normal postamble is recorded after the CRC as a guard band.
Elongated Postamble	The elongated postamble follows the first data block recorded after an underrun conditions occurs.

6.9.2.7 Format Differences

The differences in format between QIC-24, QIC-120, and QIC-150 are detailed below.

	QIC-24	QIC-120	QIC-150
Density (ftpi)	10,000	12,500	12,500
Bit Cell Width (uinch)	100	80	80
Tracks	9	15	18
Format: Preamble (Flux Trans):			
Normal	120-300	160-300	160-300
Elongated	3,500-7,000	3,500-8,500	3,500-8,500
Long	15,000-30,000	15,000-30,000	15,000-30,000
Postamble (Flux Trans):			
Normal	5-20	5-20	5-20
Elongated	3,500-7,000	5,500-8,500	5,500-8,500
Track Width (inches)	0.0135	0.0065	0.0056
Azimuth (minutes)	3	12	12
First Block	Data	Control	Control

CHAPTER 7

MAINTENANCE AND RELIABILITY

7.1 Maintenance

Archive tape drives require minimum operator maintenance. Preventive maintenance consists of cleaning the head assemblies and the tape hole sensor openings. To ensure reliable tape drive performance, a regular cleaning schedule should be established and the following precautions should be observed.

- Maintain a clean, dust-free environment within the temperature and humidity limits listed in the specifications.
- Keep all liquids away from drive and tapes to prevent spills into the equipment.
- Exercise reasonable care when using and storing cartridges. Do not place cartridges on the computer, monitor, or any peripheral device. When not in use, store a cartridge in its protective box away from heat sources and electromagnetic fields.
- When a stored tape is moved to an environment with a greatly different temperature, allow the tape to slowly achieve ambient temperature before using it.
- A tape stored for extended periods should always be retensioned before reuse. Retension a new tape before attempting to record onto it.
- Do not open the cartridge access door or touch the tape; fingerprints can cause data to be misread.

7.2 Tape Drive Cleaning

A small amount of dust or debris can affect tape drive performance, therefore the following tape head cleaning schedule is recommended:

- Clean the head assembly
 - after an initial pass with a new tape cartridge
 - after eight hours of normal use
- Clean the sensor hole and tape cartridge cavity
 - whenever dirt or dust is visible

7.2.1 Cleaning Supplies

- Low pressure aerosol air. Cans of low pressure air are available commercially at many hardware and appliance stores.

NOTE: *To avoid introducing contaminants into the tape drive, do not use shop air or air compressed in an oil lubricated compressor.*

- Archive head cleaning kit, Archive Part Number 14916-001
- Archive head cleaning fluid, Archive Part Number 14917-001, or Freon "TF" solution. Reagent grade chemically pure isopropol alcohol may be used if the head cleaning fluids are not available.
- Archive head cleaning pads, Archive Part Number 14918-001. If head cleaning pads are not available, you may use lint free cotton swabs or any industry acceptable head cleaning swab, 6 inches or longer.

7.2.2 Cleaning the Tape Drive Heads

1. Remove the tape cartridge and turn OFF power to the computer.
2. Push the head loading lever to LOAD position (toward the cartridge cavity opening) to position the heads into an accessible position for cleaning.
3. Carefully blow out dust from the sensor hole and tape cartridge cavity with aerosol air.
4. If you are using an Archive head cleaning kit, follow the directions in the kit. If you are using swabs for cleaning, follow the directions below:
 - a. Moisten a pad or swab in the head-cleaning fluid until it is saturated but not dripping.
 - b. Carefully clean the head by wiping only in the directions that the tape travels. Do not wipe perpendicularly to the tape movement direction or use a circular, scrubbing motion. See Figure 7-1.
 - c. Discard used pad or swab and repeat Steps *a* and *b* with new swabs until the swab shows no sign of dirt.
 - d. Use a new, dry swab to remove any remaining cleaning fluid from the head.
5. Push the head loading lever away from the cartridge cavity opening to remove the head assembly from operating position.
6. Turn on the computer.

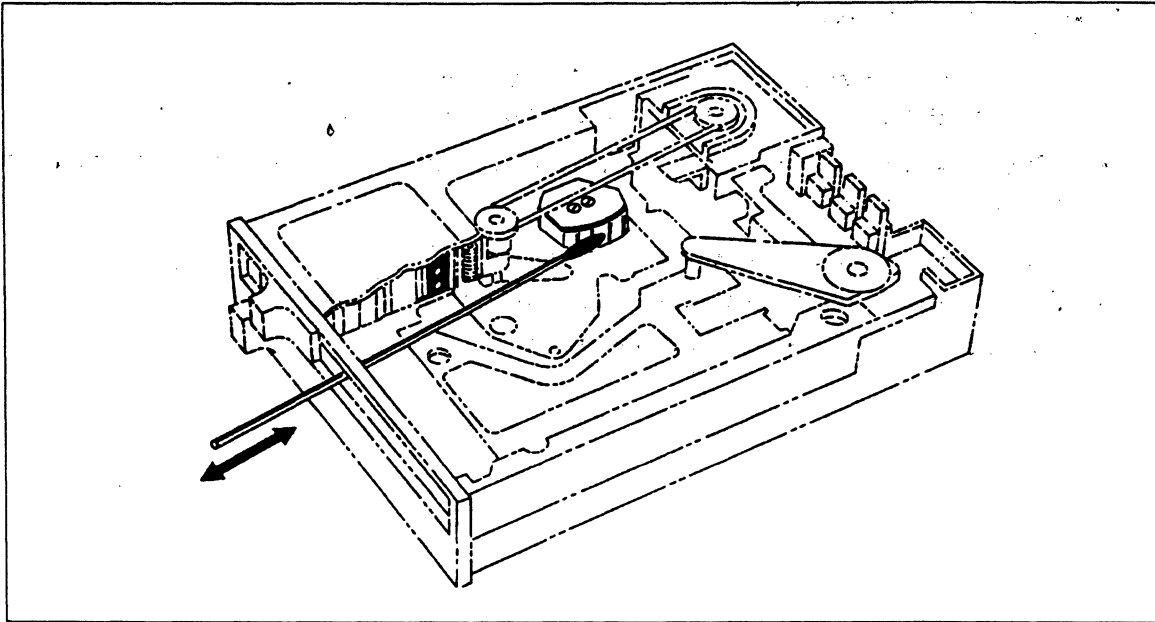


Figure 7-1. Head and Sensor Cleaning

7.3 Reliability

Mean-Time-Between-Failures (MTBF) includes all power-on and operational time, but excludes maintenance periods. Operational time (tape movement) is assumed to be 20% of the power-on time.

Mean-Time-To-Repair (MTTR) is the average time required by a qualified service technician to diagnose a defective drive and install a replacement drive.

Viper reliability specifications are listed in the following table:

FEATURE	SPECIFICATION
Non-Recoverable Error Rate	Less than 1 in 10^{10} bits
Recoverable Error Rate	Less than 1 in 10^8 bits
Error Recovery Techniques	Defect skipping, Write verify, Read retry and ECC
MTBF	More than 15,000 Hours at 20% Duty Cycle
MTTR	No more than 30 minutes

7.4 Reporting a Problem

- Call your supplier or your Archive Representative to report a problem. Be prepared to describe the problem by answering these questions.
- What function such as formatting, backup, or restoring was in progress when the problem occurred?
- What error message or messages were displayed?
- Did the problem occur with more than one tape cartridge?
- Did the drive make any abnormal noises?

GLOSSARY

- BEGINNING-OF-TAPE.** Tape position: the beginning of the tape.
- BLOCK.** Unit of data transfer used by the tape backup system; consists of 1024 bytes.
- BOT.** See Beginning-of-Tape.
- BUFFER.** An area of the memory used for temporary storage and manipulation of data.
- BYTE.** Eight bits of binary data acted upon as a unit.
- CRC.** Cyclical redundancy check.
- CDB.** See Command Descriptor Block.
- CLUSTER.** An integral number of disk sectors grouped together for the purpose of allocating space on a disk.
- COMMAND DESCRIPTOR BLOCK.** A group of bytes used to communicate commands between the host and the tape drive.
- CONNECT.** The action of an initiator when asserting control over the SCSI bus to select a target for an operation.
- CONTENTION.** Condition when two or more devices contend for the use of a processor or try to access the system bus at the same time.
- DEFAULT.** A preset value used by a program if no other value is specified.
- DISCONNECT.** The action of a target releasing control of the SCSI bus.
- DMA.** Direct Memory Access; direct transfer of data to or from RAM, bypassing the CPU and increasing speed of computing process.
- END-OF-DATA.** Tape position: the end of recorded data.
- END-OF-TAPE.** The end of the tape.
- EOT.** See end-of-tape.
- HEXADECIMAL NOTATION.** The base sixteen numbering system. Viper hexadecimal values are shown as 02h
- HOST.** The computer that issues commands to the tape drive over the SCSI bus.
- INITIATOR.** A SCSI device that requests an operation by another SCSI device (the target). Viewed from tape drive perspective, the Initiator is usually the host computer.
- LSB.** Least significant byte or least significant bit.
- LOGICAL UNIT NUMBER (LUN).** A three-bit device identifier for a logical unit. The Viper 150 is always addressed designated LUN0.

LUN. See Logical Unit Number.

MODE. Definition of parameters that control the method in which the Viper reads or writes data.

MSB. Most significant byte or most significant bit.

PARAMETER. An operational element, such as the number of buffers used, whose value varies depending on system applications.

POINTERS. SCSI provides two sets of three pointers, current and saved, to help maintain communication.

QIC. Quarter-Inch-Cartridge standard.

RECONNECT. The action of a target selecting an initiator to resume an operation after a disconnect has occurred.

scsi. Small Computer System Interface. A standard for communication between microcomputers and peripherals that allows multiple peripherals.

SCSI DEVICE. Any host computer or peripheral device that can be connected to a SCSI bus.

SCSI ID. A bitwise representation of the SCSI Address.

SCSI ADDRESS. A unique address value (range 0-7) that identifies a device connected to a SCSI bus. The Viper 150 SCSI address is set by jumpers prior to installation and connection.

SERPENTINE. The winding, logical pattern that results when the streaming tape drive records data on the tape.

SOFT ERROR. Is a repeated attempt by the tape drive firmware to read or write data on the tape to correct a problem area on the tape. Soft error is not a real error, but a reliability feature. No data is lost.

STATUS BYTE. One byte of information returned from a target to an initiator upon completion of a command.

STREAMING. Tape recording method designed for continuous tape motion with continuous recording of data on the tape.

TAPE POSITION. Where the tape is stopped with respect to the tape drive recording heads.

TARGET. Any SCSI device that performs operations requested by an initiator.

UNRECOVERABLE ERROR. An error that is not correctable. Usually the result of a soft error condition that cannot be corrected by retries. Data is lost.

UNDERRUN. A condition that occurs when data is transferred faster than it can be processed. The underrun tally is the number of times that the tape drive streaming action stops during a backup or a restore operation.

VENDOR-UNIQUE. Any bits, fields or command values that are not defined by the ANSI X3.131 standard.

WRITE-PROTECTED. Cannot be written (recorded) on.

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