Exabyte Mammoth-2 Tape Drive

Integration Reference

Preliminary

This manual contains preliminary information that is subject to change without notice.

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1002965-000

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Revision History

Revision	Date	Description
000	September 2000	Preliminary release

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1002965-000

Note: The most current information about this product is available at Exabyte's World Wide Web site (www.exabyte.com).

Product Warranty Caution

The Exabyte® Mammoth-2 (M2™) Tape Drive is warranted to be free from defects in materials, parts, and workmanship and will conform to the current product specification upon delivery. For the specific details of your warranty, refer to your sales contract or contact the company from which the tape drive was purchased.

The warranty for the tape drive shall not apply to failures caused by:

- Physical abuse or use not consistent with the operating instructions or product specifications provided by Exabyte's personnel or agent for the applicable equipment.
- Use of any type of cleaning material other than an Exabyte Mammoth Cleaning Cartridge (or a cleaning cartridge approved by Exabyte for the Mammoth tape drive).
- Modifications by other than Exabyte's personnel or agent in any way other than those approved by Exabyte, provided the warranty shall not be voided by the repair or replacement of parts or the attachment of items in the manner described in maintenance or installation instructions provided by Exabyte.
- Repair by other than Exabyte's personnel or agent in a manner contrary to the maintenance instructions provided by Exabyte.
- Removal of the Exabyte serial number tag.
- Physical abuse due to improper packaging of returns.

CAUTION

Returning the tape drive in unauthorized packaging may damage the unit and void the warranty.

If you are returning the tape drive for repair, package it in its original packaging (or in replacement packaging obtained from your vendor). Refer to the packing instructions in the *Exabyte Mammoth-2 Product Specification*.

If problems with the tape drive occur, contact your maintenance organization; do not void the product warranty by allowing untrained or unauthorized personnel to attempt repairs.

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About This Reference

This reference provides information to assist and guide you in the integration of the Exabyte® Mammoth-2 (M2™) tape drive into an enclosure, a library, or a computer or server bay.

➤ **PRELIMINARY** This manual contains preliminary information that may be changed without notice. Information that has not yet been determined is indicated by the notation: ***//TBD//***.

Related Publications

Exabyte Mammoth-2 Tape Drive

- *Exabyte Mammoth-2 Tape Drive Installation and Operation*, 330875
- *Exabyte Mammoth-2 Tape Drive Product Specification*, 330874
- *Exabyte Mammoth-2 Tape Drive SCSI Reference*, 330876
- *Mammoth-2 Fibre Channel Interface Supplement*, 1003790
- *75m and 150m AME Hybrid 8mm Data Cartridge Specification for Mammoth-2*, 1003157
- *225m AME Hybrid 8mm Data Cartridge Specification for Mammoth-2*, 341391

Standards

- *ANSI Small Computer System Interface-2 (SCSI-2)*, X3.131 – 1994
- *ANSI SCSI-3 Fast20 Parallel Interface (Fast-20)*, X3.277 – 1996
- *ANSI SCSI Parallel Interface-2 (SPI-2)*, X3T10/1142D, Rev. 11
- *ANSI SCSI Parallel Interface-3 (SPI-3)*, ANSI X3T11
- *TapeAlert Specification, Version 2.0*, November, 1997
- *ANSI Information Technology Fibre Channel Protocol for SCSI (FCP)*, X3.269-1996
- *Fibre Channel Protocol for SCSI, Second Revision 2* (FCP-2), T10/Project 1144-D/Rev 4, December 1999
- *ANSI Information Technology Fibre Channel Physical and Signaling Standard (FC-PH)*, X3.230-1994

- *ANSI Information Technology Fibre Channel 2nd Generation Physical and Signaling Standard (FC-PH-2)*, X3.303-1998
- *ANSI Information Technology Fibre Channel Arbitrated Loop (FC-AL)*, X3.272-1996
- *ANSI Information Technology Fibre Channel Arbitrated Loop (FC-AL-2)*, NCITS 332-1999
- *Information Technology Fibre Channel Fabric Loop Attachment (FC-FLA)*, T11/Project 1235-DT/Rev 2.7
- *40-pin SCA-2 Connector w/Bidirectional ESI*, SFF-8067
- *40-pin SCA-2 Connector w/Parallel Selection*, SFF-8045
- *SCA-2 Unshielded connections*, EIA-700A0AE (Sff-8451)
- *Standard ECMA-249, 8mm Wide Magnetic Tape Cartridge for Information Interchange – Helical Scan Recording – DA-2 Format*, June 1998
- *Standard ECMA-293, 8 mm Wide Magnetic Tape Cartridge for Information Interchange – Helical Scan Recording – MammothTape-2 Format*, December 1999

Conventions Used in This Reference

This guide uses the following conventions:

Note: Notes provide additional information or suggestions about the topic or procedure being discussed.

➤ **Important** Information next to the word "Important" helps you complete a procedure or avoid additional steps.

CAUTION

Boxed text under the word "CAUTION" provides information you must know to avoid losing data, or damaging the tape drive.

1 Welcome

This chapter provides an overview of the tape drive's components, drive status indicators, data cartridges, and drive cleaning.

For additional information about the Fibre Channel version of the tape drive, refer to the *Exabyte Mammoth-2 Fibre Channel Interface Supplement*.

1.1 Tape Drive Components

The following sections describe the major components of the tape drive.

Front Panel

Figure 1-1 shows the components of the tape drive's faceplate. The M2 tape drive includes three LEDs and an LCD that display provide information about the tape drive's operational status (non-LCD bezels are available for integrating the tape drive into a library).

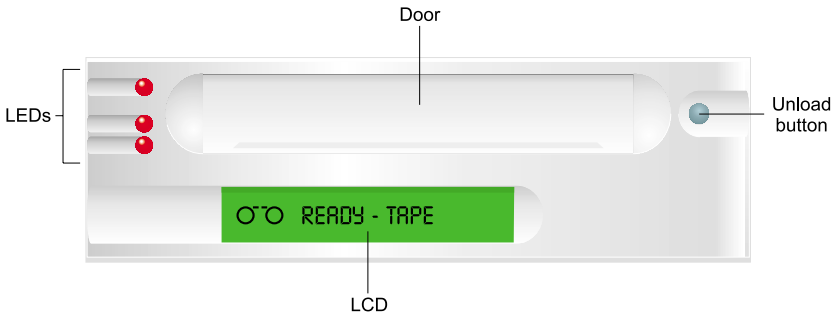

Figure 1-1 Front-panel components

Back Panel

Figure 1-2 shows the location of the SCSI tape drive's back-panel components.

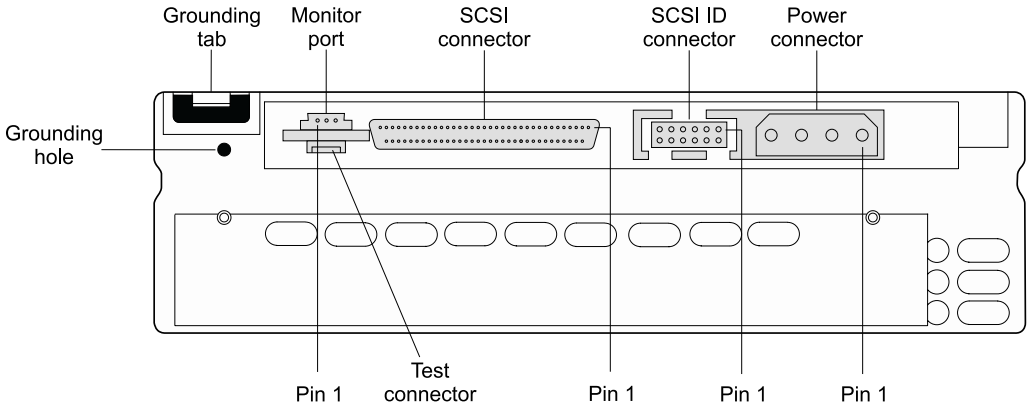

Figure 1-2 SCSI tape drive back-panel components

Figure 1-3 shows the location of the Fibre Channel tape drive's back-panel components.

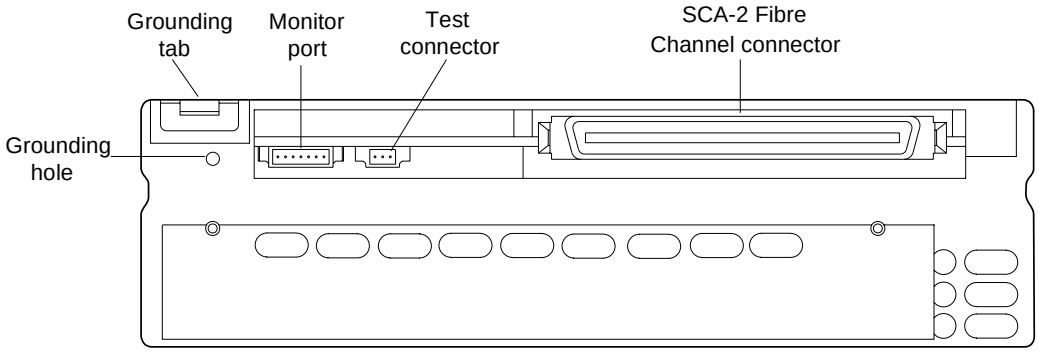

Figure 1-3 Fibre Channel tape drive back-panel components

1.2 Drive Status Indicators

The tape drive's front panel offers LEDs and an optional LCD for monitoring its operational status.

LEDs

The light emitting diodes (LEDs) have the following, general meanings:

- **Top LED (amber)**. When this LED is flashing, an error has occurred. After extensive use of standard AME media, this LED may light solidly, indicating that the tape drive needs to be cleaned using an Exabyte Mammoth Cleaning Cartridge. This LED also lights when the tape drive is performing a cleaning operation.
- **Middle LED (green)**. When this LED is on, tape is loaded and the tape drive is ready to begin operations.
- **Bottom LED (green)**. When this LED is flashing, tape motion is occurring. When this LED is on, the tape drive is performing a reset.

Table 1-1 describes the LED combinations that may occur during normal tape drive operation.

Table 1-1 LED combinations during normal tape drive operation

	Tape Drive State								
	POST[a] or reset	Error or failed POST	Ready (no tape loaded)	Ready (tape loaded)	Normal tape motion	High speed motion	Time to clean	Clean in progress	Code load in progress
Top LED (Error/ Clean)	●	✳	n/a	n/a	n/a	n/a	●	●	❍
Middle LED (Tape Ready)	●	❍	❍	●	●	●	n/a	●	●
Bottom LED (Tape Motion)	●	❍	❍	❍	✳	✳ fast	n/a	✳	●

[a] POST = power-on self-test

Legend: ❍ = off ● = on ✳= flash n/a = not applicable (may be any state)

LCD

Table 1-2 lists the messages that may appear on the tape drive's LCD.

Table 1-2 Mammoth-2 LCD messages

LCD Message Description[a]	
Reset messages **(When the tape drive is reset, the LCD cycles through the following messages.)**	
*** RESETTING	The first message during the power-on sequence.
MODEL:	The model number of the tape drive.
SUBMOD:	The submodel number of the tape drive.
SN:	The serial number of the tape drive.
CODE:	The level of the tape drive's firmware.
LAST CLN: *nn* hrs	The number of hours since the tape drive has last been cleaned.
COMPRESS: ON *or* COMPRESS: OFF	Compression is enabled (the default) or compression is disabled.
LV DIFFERENTIAL *or* FIBRE CHANNEL	The tape drive has an LVD (low voltage differential) SCSI or Fibre Channel configuration.
SCSI ID: *or* FIBRE ID:	The SCSI ID or Fibre Channel ID of the tape drive.
LANGUAGE:	The available non-English languages for the LCD (French, German, Spanish, Italian, and Portuguese) appear when you perform the following steps: **1.** Press and hold the unload button during the reset sequence. After the ID message appears, the LCD cycles through the languages. **2.** When the desired language displays, release the button and the messages appear in that language. For a list of non-English language LCD messages, refer to the Exabyte web site (www.exabyte.com) or the *Exabyte Mammoth-2 Product Specification.*
Tape drive status messages	
READY–NOTAPE	The tape drive is ready to accept a cartridge.
○ ¯ ¯ ○ LOADING	The tape drive is loading the tape.
○ ¯ ¯ ○ READY–TAPE	The tape drive has successfully loaded the tape and is ready for read/write operations.
○/○ READY–TAPE	A write-protected tape is loaded and ready for read operations.
○ ¯ ¯ ○ EJECT ■■■= = =	The unload button was pressed. The tape drive ejects the cartridge as soon as it finishes its current operation. The icon to the left of the EJECT message indicates the current operation (write, erase, and so on).

Table 1-2 Mammoth-2 LCD messages (*continued*)

LCD Message Description[a]	
Tape drive status messages (*continued*)	
EJECT–PREVNT	The software has disabled the eject function with the PREVENT/ALLOW MEDIUM REMOVAL command. The tape drive will rewind and unload the tape, but will not eject the cartridge.
ILLEGAL TAPE	The tape drive detected an incompatible cartridge and ejected it.
Tape motion messages	
READ + ■■■= = =	The tape drive is reading or writing data. The + sign appears when the tape drive is in compression mode. The boxes show the amount of tape used.
WRITE+ ■■■= = =	
PROTECTED	The tape drive cannot write data because the data cartridge is write-protected.
ILLEGAL WRT	The tape drive cannot write to the type of data cartridge inserted. This message remains until an unload/eject operation is performed.
> > SEARCH ■■= = = = < < SEARCH ■■= = = =	High-speed search is in progress. The arrows indicate the direction of the search.
< < REWIND ■■= = = =	Rewind is in progress.
ERASE ■■= = = =	The tape drive is erasing data on the tape.
FORMAT ■■■■■■	The tape drive is repartitioning the tape to the requested format. The icon to the left of the message displays the current operation (write, erase, search, and so on).
WORN TAPE	The tape currently in the tape drive has exceeded the tape drive's maximum tape passes threshold and must be replaced.
Cleaning messages	
CLEAN SOON[b]	The tape drive should be cleaned at the next convenient time.
CLEANING . . .	Cleaning is in progress.
DEPLETED[b]	The cleaning tape in the cartridge is depleted and the tape drive will eject it. Use a new cleaning cartridge.
Error conditions **(When a hardware error occurs, the LCD cycles through the current error code and the previous two error codes.)**	
ERR 1: *xx yy zz* ERR 2: *xx yy zz* ERR 3: *xx yy zz*	In the error display, *xx* indicates the fault symptom code, and *yy* and *zz* indicate secondary errors (if any). If an error appears, contact Exabyte Technical Support (see "Contacting Exabyte" on the inside of the back cover).

Table 1-2 Mammoth-2 LCD messages (*continued*)

LCD Message Description[a]	
Diagnostics and loading code	
DIAG-LOAD TAPE	This message appears if the tape drive receives a SCSI SEND DIAGNOSTIC command or if a diagnostic tape is inserted.
DIAG-TESTING....	The tape drive is performing the diagnostic tests.
DIAG-PASSED	This message appears for 15 seconds when the test completes successfully.
DIAG-FAILED	The test failed. The LCD then cycles through three statistics messages: DIAG-WRITE, DIAG-READ, DIAG-ECC.
LOADING CODE....	This message displays when code is loading from a code load tape, through SCSI, or through the Monitor port. If the code load is successful, the tape drive automatically resets. If the code load fails, the LCD displays CODE LOAD FAIL.
CODE LOAD FAIL	These messages appear in sequence after the code load failed.
RETRY CODE LOAD	
MAKE CODELOAD TP	The tape drive is making a code load tape.

[a] These are the LCD messages as of June 2000. You can find updated LCD messages on Exabyte's web site (www.exabyte.com).

[b] These messages appear when non-SmartClean media is used extensively and the tape drive is cleaned using an Exabyte Mammoth Cleaning Cartridge.

1.3 Data Cartridges

The development of M2 brought about the creation of a new type of data cartridge – Exabyte Advanced Metal Evaporated (AME) with SmartClean™. Each Exabyte SmartClean data cartridge contains a two-meter length of cleaning material at the beginning of the tape. This cleaning material is separated from the AME media by a clear tape "window," allowing the drive to position the tape correctly at the beginning of the AME media and locate the cleaning material when needed. The tape drive uses an internal monitoring system that determines when cleaning is required and performs the cleaning automatically.

The M2 drive is backward compatible with media written by previous generations of MammothTape drives. Table 1-3 summarizes media compatibility for M2 and shows data capacity in gigabytes (GB).

Table 1-3 M2 media compatibility and capacity

	Data cartridge lengths	M2	Capacity	
			Compressed[a]	Uncompressed
AME with SmartClean	75 m	Read/Write	50 GB	20 GB
	150 m		100 GB	40 GB
	225 m		150 GB	60 GB
Standard AME	22 m	Read[b]	12.5 GB	5 GB
	45 m		25 GB	10 GB
	125 m		75 GB	30 GB
	170 m		112.5 GB	45 GB

[a] Assumes a 2.5:1 compression ratio.

[b] For the purposes of data interchange, M2 can read, but not write, standard AME tapes written in the original Mammoth format. M2 can read and write data on new or erased standard AME tapes. However, with extensive use of these cartridges, the tape drive will require regular cleaning with an Exabyte Mammoth Cleaning Cartridge.

Reusing Mammoth Cartridges

M2 can overwrite cartridges written in original Mammoth format after the data has been erased. Mammoth-2 and Mammoth formats cannot be mixed on the same tape.

SmartClean Data Cartridges

The tape drive's firmware controls the use of the cleaning tape at the beginning of the cartridge and invokes SmartClean when necessary.

1.4 Drive Cleaning

Regular cleaning of the tape drive removes debris from the heads and the tape path and helps maintain data integrity. Cleaning also improves the reliability of the tape drive.

The combination of SmartClean media and the integrated Dynamic Head Cleaner (cleaning wheel) make the M2 a self-cleaning tape drive. The cleaning wheel (see Figure 1-4) moves into contact with the scanner every time media is loaded and after a specified amount of operation. In addition, a sophisticated algorithm contained in the tape drive's firmware can invoke the cleaning wheel if needed during extended backup or restore operations.

Note: When M2 is used with non-SmartClean AME media, the self-cleaning action of the cleaning wheel extends the interval for required manual cleaning. When cleaning is required, the top LED on the tape drive faceplate illuminates and the LCD displays the message "CLEAN SOON." To help maintain data integrity and reliability, clean the tape drive as soon as possible after the LED illuminates and the message appears. Use a Exabyte Mammoth Cleaning Cartridge to clean the tape drive.

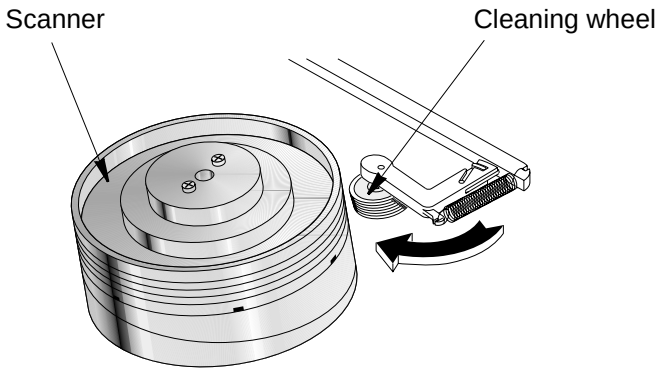

Figure 1-4 Self-cleaning action of the Dynamic Head Cleaner

1.5 Drive Code Upgrades

Microcode can be loaded into the tape drive in the following ways:

- Using the codeload tape. The header on the tape identifies the microcode tape, and sets up the tape drive to automatically load the microcode.
- Over the SCSI or Fibre Channel bus.
- Over the serial port, using the M2 Monitor, a software application available from the Exabyte web site.

2 Product Testing

Exabyte conducts extensive testing of all its products and makes a number of the test results available to you. This chapter describes the types of testing Exabyte performs and provides information about how to obtain test results that can help speed up your integration process.

2.1 Types of Tests

Table 2-1 is an overview of the testing that Exabyte performs on of all its tape drives.

Table 2-1 Standard Exabyte product tests

Test	Purpose	Description
Engineering verification testing (EVT)	To aid the product development process by testing all parts of the product to make sure they meet specifications and to identify and fix problems early in the development cycle.	All prototypes of the product are tested to the limits of functionality for performance specifications, environmental requirements, safety and regulation limits, and fail modes.
Design verification testing (DVT)	To verify that the product performs according to its product specifications and ANSI standards.	All phases of the product's functionality are tested, as described in Table 2-2. The test results are available to you to help in the integration process.
Process verification testing (PVT)	To determine whether existing manufacturing processes can produce the product in high volume while meeting reliability specifications.	Samples of the product are pulled from inventory and subjected to stress tests that are designed to replicate a broad range of user applications and to accumulate usage hours at a high rate. MTBF (mean time between failure) is determined and compared to specifications for the product.

Table 2-1 Standard Exabyte product tests (*continued*)

Test	Purpose	Description
Engineering change testing	To verify that the product continues to perform according to its product specifications after engineering changes are implemented.	Any time an engineering change is made, the product's functionality is reconfirmed. Depending on the type of change, any or all of the tests performed during DVT (described in Table 2-2) may be conducted.
On-going reliability testing (ORT)	To continually monitor the reliability of the product and determine the lifetime of its various components.	Samples of the product are pulled from inventory and subjected to long-term performance tests that determine the life of such components as the motors, recording heads, and electronics.

2.2 Design Verification Testing

Design verification testing (DVT) consists of a wide range of tests designed to verify the product's functionality. The individual tests performed on the tape drives are described in Table 2-2.

Table 2-2 Design verification testing

Test	Description
SCSI Specification Compliance	
SCSI Command Set	Verifies that the SCSI command set implemented in the tape drive complies with ANSI specifications.
SCSI Message Set	Verifies that the SCSI message set implemented in the tape drive complies with ANSI specifications.
Unit Attention and Reset Conditions	Verifies that the tape drive reports Unit Attention after the conditions specified in the *Exabyte Mammoth-2 Product Specification* or the *Exabyte Mammoth-2 SCSI Reference*, and that the drive can be reset under the conditions specified in the product specification or SCSI reference.
Performance Specifications	
Transfer Rate Benchmark	Verifies the data transfer rate of the tape drive, including synchronous and asynchronous data transfers, fixed-block and variable-block transfers, and transfers in all of the data formats supported by the drive.
Power Dissipation	Measures the current drawn by the tape drive on the + 5 and + 12 V power supply lines during various operations, including power-up, tape load, tape unload, read, write, high-speed search, and rewind.
Write/Read Access Times	Verifies the write and read access times of the tape drive in all of its supported data formats. Access time is the time that elapses after the drive receives the last byte of the command's descriptor block (CDB) until it signals REQ to transfer the first byte of data across the SCSI bus.

Table 2-2 Design verification testing (*continued*)

Test	Description
Power Supply Noise Injection	Verifies that the tape drive will accurately read and write data when certain noise levels are injected on its power supply lines.
Tape Drive Functionality	
Performance at Stress Conditions	See "Performance at Stress Conditions Test" on page 2-4.
Mixed Model Data Interchange	Verifies that the tape drive is able to write tapes that are readable by other compatible Exabyte products and read tapes that are written by other compatible Exabyte products.
Status Indicators	Verifies that the LEDs on the front panel of the tape drive accurately indicate the following states: power-on initialization, power-on self-test pass or fail, ready with tape loaded, SCSI activity, error, normal tape motion, compressed tape motion, and time to clean.
Environmental Specifications	
Electrostatic Discharge (ESD)	Verifies that the tape drive functions when subjected to the limits or levels specified in the *Exabyte Mammoth-2 Product Specification*.
Shock, non-operating	
Shock, operating	
Vibration, Non-operating	
Vibration, operating	
Acoustic Noise	
EMI (Electromagnetic Interference Susceptibility)	
VDE/FCC/DOC/CISPR	Verifies that the tape drive complies with the limits for radiated and conducted electrical energy defined by these standards.
Agency Approvals	
UL	Verifies that the tape drive is compliant as a component to the requirements of UL standard 1950, 3rd Edition, Information Technology Equipment.
CSA	Verifies that the tape drive is compliant as a component to the requirements of CSA standard 22, 950-M89, Information Technology Equipment.
TUV	Verifies that the tape drive is compliant as a component to the requirements of EN60950, 1990 and VDE 0805/05.90.

2.3 Performance at Stress Conditions Test

The Performance at Stress Conditions test is designed to simulate how a tape drive is likely to operate under a wide range of conditions. Tape drives are run through a series of tests representing typical operation under varying conditions of stress. Results from the Performance at Stress Conditions test generally provide all the information needed to predict the overall reliability of the tape drive in a wide range of operating environments.

The stress conditions include:

- Margined + 5V and + 12V power supply lines (± 5%)
- Noisy power supply
- Temperature and humidity extremes
- Thick tape and thin tape
- Fixed-length and variable-length logical block sizes
- Fixed and random data patterns
- Synchronous and asynchronous data transfers
- Horizontal and vertical mounting orientations
- Start/stop and streaming data transfer modes

During the Performance at Stress Conditions test, the tape drive is run through a series of trials in which all of the tests described in Table 2-3 are performed. During each trial, one or more stress conditions are varied to determine how the drive is affected.

Table 2-3 Tests conducted under stress conditions

Test	Description
Power-on Self-test, No Tape Installed	Verifies that the tape drive can successfully execute its power-on self-test.
Power-on Self-test, Tape Installed	Verifies that the tape drive can successfully execute its power-on self-test with a tape loaded and become “ready.”
Code Load Tape Functionality	Verifies that the tape drive can successfully recognize a codeload tape, download the code, and eject the tape.
Serial Port Functionality	Verifies that the tape drive can successfully perform a “monitor dump” and download code through its serial port.
Cleaning Tape Recognition	Verifies that the tape drive can successfully recognize the insertion of a cleaning cartridge and perform the required cleaning routine.
Tape Load Functionality	Verifies that the tape drive can successfully load a tape and become “ready.”
Voltage Margin Guard Band	Verifies that the tape drive will accurately perform read and write operation within ± 5% of specified voltage, and determines how far outside of this limit the drive will continue to operate.

Table 2-3 Tests conducted under stress conditions (*continued*)

Test	Description
Write/Read Error Rate Evaluation	Verifies the tape drive's write and read performances for random data patterns. All data formats supported by the drive are tested.
Read Interchange Error Rate Evaluation	Verifies that the tape drive is able to read tapes that are written by another compatible Exabyte tape drive.
Power Loss/Restore Data Integrity	Verifies that no recorded data will be lost as a result of a power loss during a read operation.
High-Speed Search Functionality	Verifies the tape drive's high-speed search capabilities by issuing searches to random locations on the tape.

2.4 Availability of Test Results

All DVT and Performance at Stress Conditions test results are available on request from Exabyte. Results from the individual tests described in Table 2-1 can provide further information if you have areas of particular concern. Contact your Exabyte Account Representative to request test results.

Notes

3 Changing an Existing Mammoth Driver

If you have been supporting the Mammoth or Mammoth-LT tape drive and want to convert an existing driver to provide support for the M2, you need to consider the changes described in the following sections. For detailed information about the SCSI implementation used by the tape drive, see the *Exabyte Mammoth-2 SCSI Reference*.

Note: For information about the Fibre Channel version of the tape drive, refer to the *Exabyte Mammoth-2 Fibre Channel Interface Supplement*.

3.1 SmartClean™ (Hybrid Clean)

SmartClean is a feature that uses specially formulated cleaning material at the beginning of a SmartClean AME data cartridge to clean the tape drive. This feature is invoked when the tape motion threshold is reached or as part of a write or read recovery. To ensure that your driver does not time out during a SmartClean operation, an EEImage is available for testing purposes. With this EEImage, the SmartClean operation is performed whenever the tape reaches logical end of partition (LEOP). Contact your Exabyte Account Representative to request this EEImage.

3.2 SCSI Message System and Burst Transfer Rate

For M2, the allowable REQ /ACK Offset in the SCSI message system has increased to 32 outstanding REQ pulses, compared to 16 for Mammoth.

3.3 Transfer Rates

For M2, the burst and sustained transfer rate have changed as follows:

- M2 is an Ultra2 SCSI device capable of burst transfer rates of up to 80 megabytes per second (MB/s) on a wide LVD bus. The transfer rate is established by the SCSI host adapter using the Synchronous Data Transfer Request message to set the Transfer Period to the desired time. M2 accepts Transfer Periods as short as 25 nanoseconds (ns). For Mammoth, which has a maximum burst transfer rate of 20 MB/s on a wide LVD bus, the shortest Transfer Period accepted is 100 ns.

- The sustained data transfer rate for M2 is 12 MB/s for uncompressed data. This data transfer rate means that the host needs to supply data to the M2 drive at a minimum of 12 MB/s to maintain streaming operation and prevent backhitching. M2's 32 MB data buffer compensates for variances in the host's data transfer rate.

  If the tape drive is compressing data, the host must supply the data at 30 MB/s to maintain streaming operation at the drive's transfer rate of 12 MB/s (assuming a 2.5:1 compression ratio).

3.4 INQUIRY Command

This section describes modifications to the information M2 returns when it receives an INQUIRY command, as follows:

- The value of the Wbus16 bit (byte 07, bit 5) of the Standard Inquiry data is always 1, indicating that the drive supports 16-bit wide transfers on the SCSI bus. In Mammoth, this bit is 0 if a narrow configuration is being used and 1 if a wide configuration is being used.
- The Product Identification field (bytes 16 through 31) in the Standard Inquiry Data has changed. The value returned by M2 is "Mammoth2," followed by eight ASCII spaces. In Mammoth, this value is "EXB-8900," followed by the 8-bit default configuration identifier.
- The Submodel ID field (bytes 36 through 43) has been added to the Standard Inquiry Data. This field contains the ASCII representation of the EEPROM image identifier (for example, MH000105). In Mammoth, these bytes are unused and contain blanks.
- The Device Identification Page (Page Code= 83h) has been added.

All Inquiry parameters not defined in this section are described in the *Exabyte Mammoth-2 SCSI Reference*.

Returning Inquiry Data

Table 3-1 summarizes the values you should specify in the INQUIRY CDB to return the different types of Inquiry data.

Table 3-1 Values to specify in the INQUIRY CDB to return the different types of Inquiry data

To return this inquiry data...	Set these fields to...		And specify this value for the Allocation Length...	Number of bytes returned (hex)
	EVPD	Page Code		
Standard Inquiry Data	0	00h	any value from 0 to FFh	0 to 106 bytes (0h to 6Ah)
Supported Vital Product Data Page	1	00h	07h	7 bytes (7h)
Unit Serial Number Page	1	80h	0Eh	14 bytes (0Eh)
Device Identification Page	1	83h	42h	66 bytes (42h)

Standard Inquiry Data

The tape drive returns the Standard Inquiry Data when the EVPD bit in the command CDB is 0h.

Bit / Byte	7	6	5	4	3	2	1	0
00	Peripheral Qualifier			Peripheral Device Type				
01	RMB	Device-Type Modifier						
02	ISO Version		ECMA Version			ANSI Version		
03	AENC	TrmIOP	Reserved		Response Data Format			
04	Additional Length							
05	Reserved							
06								
07	RelAdr	WBus32	WBus16	Sync	Linked	RSVD	CmdQue	SftRe
08 ⋮ 15	Vendor Identification							
16 ⋮ 31	Product Identification							
32 ⋮ 35	Product Revision Level							
36 ⋮ 43	Submodel ID							
44 ⋮ 55	Vendor Specific							
56 ⋮ 95	Reserved							
96 ⋮ 105	Unit Serial Number							

Bytes 16 through 31 – Product Identification

Contains the ASCII representation of the product name followed by sufficient spaces to fill the field (for example, Mammoth2_____, where each "_" represents an ASCII space character).

Bytes 36 through 43 – Submodel ID

Contains the ASCII representation of the EEPROM image identifier (for example, MH000105).

Supported Vital Product Data Page

The tape drive returns the Supported Vital Product Data page when the EVPD bit in the command CDB is 1h and the Page Code is 00h.

Bit / Byte	7	6	5	4	3	2	1	0
00	Peripheral Qualifier			Peripheral Device Type				
01	Page Code							
02	Reserved							
03	Page Length							
04	First Page Code Supported							
05	Second Page Code Supported							
06	Third Page Code Supported							

Byte 00, Bits 7 through 5 – Peripheral Qualifier

The value for this field is 0, indicating that this is a single LUN device.

Byte 00, Bits 4 through 0 – Peripheral Device Type

The value returned for this field is 01h, which identifies the tape drive as a sequential access device.

Byte 01 – Page Code

The Page Code for the Vital Product Data page is 00h.

Byte 03 – Page Length

The value returned for this field is 03h, which indicates that three additional bytes are available, excluding this byte.

Byte 04 – First Page Code Supported

The value for this field is 00h, which indicates support for the Vital Product Data page.

Byte 05 – Second Page Code Supported

The value returned for this field is 80h, which indicates support for the Unit Serial Number page.

Byte 06 – Third Page Code Supported

The value returned for this field is 83h, which indicates support for the Device Identification Page.

Device Identification Page (Page Code= 83h)

The Device Identification Page allows the tape drive to report device identification information. The tape drive returns the Device Identification page when the EVPD bit in the CDB is 1 and the Page Code is 83h.

Note: Bytes 42 through 65 of the Device Identification Page are not used by the SCSI tape drive. These bytes are used by the Fibre Channel tape drive for reporting the tape drive's world-wide names.

Bit Byte	7	6	5	4	3	2	1	0
00	Peripheral Qualifier			Peripheral Device Type				
01	Page Code							
02	Reserved							
03	Page Length (3E)							
04	Reserved				Code Set			
05	Reserved		Association		Identifier Type			
06	Reserved							
07	Identifier Length (22h)							
08 ⋮ **41**	(MSB) Device Identifier 1 (LSB)							
42	Reserved				Code Set			
43	Reserved		Association		Identifier Type			
44	Reserved							
45	Identifier Length (8h)							
46 ⋮ **53**	(MSB) Device Identifier 2 (LSB)							
54	Reserved				Code Set			
55	Reserved		Association		Identifier Type			
56	Reserved							
57	Identifier Length (8h)							
58 ⋮ **65**	(MSB) Device Identifier 3 (LSB)							

Byte 00, Bits 7 through 5 – Peripheral Qualifier

The value for this field is 0, indicating that this is a single LUN device.

Byte 00, Bits 4 through 0 – Peripheral Device Type

The value returned for this field is 01h, which identifies the tape drive as a sequential access device.

Byte 01 – Page Code

The Page Code for the Device Identification page is 83h.

Byte 03 – Page Length

The value returned for this field is 3Eh, which indicates that there are 62 additional bytes available, excluding this byte.

Byte 04, Bits 3 through 0 – Code Set

The value returned for this field is 02h, which indicates that the Device Identifier 1 field contains ASCII data.

Byte 05, Bits 5 and 4 – Association

The value returned for this field is 0h, indicating that Identifier 1 is associated with the tape drive.

Byte 05, Bits 3 through 0 – Identifier Type

The value returned for this field is 1h, indicating that the first eight bytes of the field contain the Vendor Identification returned for the Standard Inquiry Data.

Byte 07 – Identifier Length

The value returned for this field is 22h, which indicates that the length of the Device Identifier 1 field is 34 bytes, excluding this byte.

Byte 08 through Byte 41 – Device Identifier 1

This field contains the Device Identifier for the tape drive, as follows:

- **Bytes 08 through 15** contain the ASCII representation of "EXABYTE", followed by a single ASCII space character.
- **Bytes 16 through 32** contain the ASCII representation of Mammoth2 followed by eight ASCII space characters.
- **Bytes 33 through 41** contains the ASCII representation of the tape drive's ten-digit serial number in the format *ddddddddd*, where *d* is a decimal digit (0-9). For example, 0000000123 represents serial number 123.

Byte 42, Bits 3 through 0 – Code Set

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	01h	Device Identifier 2 field contains binary data.

Byte 43, Bits 5 and 4 – Association

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	0h	Device Identifier 2 is associated with the addressed physical device (the tape drive).

Byte 43, Bits 3 through 0 – Identifier Type

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	2h	Device Identifier 2 field contains a 64-bit IEEE Extended Unique Identifier (world-wide name).

Byte 45 – Identifier Length

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	8h	The length of the Device Identifier 2 field is 8 bytes, excluding this byte.

Byte 46 through Byte 53 – Device Identifier 2

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	8h	These bytes contain the binary representation of the 64-bit world-wide name for the tape drive node on the Fibre Channel fabric, formatted as shown in the following table.

Bit / Byte	7	6	5	4	3	2	1	0
46	(MSB)							
47	IEEE Company ID							
48								(LSB)
49	FFh							
50	FFh							
51	(MSB)							
52	Global Device ID							
53								(LSB)

Bytes 46 through 48 – IEEE Company ID The value returned for this field is 00D080, the IEEE Company ID for Exabyte Corporation.

Bytes 51 through 53 – Global Device ID The value returned for this field is the unique world-wide name associated with the tape drive as a node during Fabric Login.

Byte 54, Bits 3 through 0 – Code Set

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	01h	The Device Identifier 3 field contains binary data.

Byte 43, Bits 5 and 4 – Association

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	0h	Device Identifier 3 is associated with the addressed physical device (the tape drive).

Byte 55, Bits 3 through 0 – Identifier Type

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	2h	Device Identifier 3 field contains a 64-bit IEEE Extended Unique Identifier (world-wide name).

Byte 57 – Identifier Length

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	8h	The length of the Device Identifier 3 field is 8 bytes, excluding this byte.

Byte 58 through Byte 65 – Device Identifier 3

The value returned for this field depends on whether the tape drive uses a SCSI interface or a Fibre Channel interface, as follows:

Interface	Value returned	Definition
SCSI	Reserved	These bytes are not used by the SCSI tape drive.
Fibre Channel	8h	These bytes contain the binary representation of the 64-bit world-wide name for the tape drive port that received the INQUIRY request, formatted as shown in the following table.

Bit / Byte	7	6	5	4	3	2	1	0
58	(MSB)							
59				IEEE Company ID				
60								(LSB)
61	FFh							
62	FFh							
63	(MSB)							
64				Global Device ID				
65								(LSB)

Bytes 58 through 60 – IEEE Company ID The value returned for this field is 00D080, the IEEE Company ID for Exabyte Corporation.

Bytes 63 through 65 – Global Device ID The value returned for this field is the unique world-wide name associated with the fibre port that received the Inquiry request.

3.5 LOG SENSE Command – Tape History Log

A new parameter has been added to the Tape History Log (Page Code = 35h) for the LOG SENSE command. Parameter Code 27h – Lifetime SmartClean Cycles is a 4-byte counter that increments each time the tape drive executes an automatic cleaning cycle using an AME cartridge with SmartClean. This parameter was not reported by Mammoth.

3.6 MODE SELECT/ MODE SENSE Commands

The following changes have been made to the MODE SELECT/MODE SENSE pages:

- Additional Medium Type codes have been added to the MODE SENSE Parameter List Header. These type codes are defined in the following section.

- A new Density Code has been added to the Block Descriptor. A Density Code of 28h indicates that the tape drive uses the new Mammoth-2 format. A Density Code of 27h, indicating Mammoth format, is reported when a tape written in Mammoth format is inserted in the drive. Older MP cartridges written in 8200, 8200c, 8500, or 8500c formats are not reported and are automatically ejected.

- For the Vendor-Unique Parameters pages (Non-Page Format and Page Code = 20h), the 112M, CT, and NBE fields are ignored by M2. These fields were used by Mammoth when reading older MP cartridges. Also, Page 20h, the Read Tape Format field reports either M2 format (101b) or Mammoth format (100b). Older MP cartridges written in 8200, 8200c, 8500, or 8500c formats are not reported.

- On the Data Compression Page (Page Code = 0Fh), M2 reports 04h in the Compression Algorithm field (bytes 04 through 07), indicating that the drive uses Adaptive Lossless Data Compression (ALDC) compression.

  For the Decompression Algorithm field (bytes 08 through 11), M2 returns 04h if the inserted tape is written in Mammoth-2 format, indicating that the ALDC decompression algorithm will be used for decompressing data. If the inserted tape is written in Mammoth format, that tape drive returns 10h, indicating that the Improved Data Recording Capability (IRDC) decompression algorithm will be used for decompressing data.

  The ALDC algorithm is more efficient and provides a better compression ratio than the IRDC algorithm used by Mammoth.

- For the Medium Partition Page (Page Code = 11h), the size of the partitions specified in the SDP (Select Data Partitions) bit was increased to 250 MB. The partition size was 50 MB for Mammoth.

Byte 01 (6-Byte CDB) or Byte 02 (10-Byte CDB) – Medium Type

M2 accepts and uses all AME media tape lengths, including the new lengths of Exabyte AME with SmartClean media. The hex values of the new media for Medium Type returned to the host when a cartridge is loaded are listed in Table 3-2.

Note: If the tape has not yet been sized, the tape drive will report the shortest of the possible lengths.

Table 3-2 Values returned for the Medium Type field in MODE SENSE data

Value returned	Length of tape loaded
00h	No cartridge loaded, cleaning cartridge loaded, or tape is unknown, broken, or unreadable
D1h	22 meters (Exabyte AME 22m)[a]
D2h	170 meters (Exabyte AME 170m)[a]
D3h	125 meters (Exabyte AME 125m)[a]
D4h	48 meters (Exabyte AME 48m)[a]
D5h	225 meters (Exabyte AME with SmartClean 225m)
D6h	150 meter (Exabyte AME with SmartClean 150m)
D7h	75 meter (Exabyte AME with SmartClean 75m)

[a] Mammoth-2 can read, but not write data on this tape when it is recorded using the original Mammoth format. When these tapes are used extensively, the tape drive will require regular cleaning with an Exabyte Mammoth cleaning cartridge.

3.7 READ BLOCK LIMITS Command

The minimum block size (bytes 04 and 05 of the Read Block Limits data) has been changed to four bytes (0004h). For Mammoth, the minimum block size is 1 byte (0001h).

3.8 REQUEST SENSE Command

The following changes have been made to the Extended Sense bytes in the REQUEST SENSE command:

- Byte 20, bit 6, TMD (Tape Mark Detect Error) is no longer used. This bit applied to 8200 format only.
- Byte 21, bit 7, Cleaning Wheel Failure (CWF) has been added to inform the host that a test of the Cleaning Wheel mechanism has failed. The Cleaning Wheel test is performed once during the Power-On Self-Test (POST). If CWF equals 0, the test passes; if CWF equals 1, the test failed. The tape drive does not treat this condition as a hard failure. This bit is not used in Mammoth.
- Byte 29 of the Extended Sense bytes information (Cleaning Reason), is used to indicate the reason that the drive is currently requesting or requiring cleaning. This field was reserved for Mammoth. The possible values for the cleaning reason are shown in Table 3-3.

  Note: If the tape drive requests cleaning due to multiple reasons, the sum of the associated values is reported. For example, if the drive needs cleaning due to poor error statistics and > 100 hours of AME tape motion, the reported value would be 0Ah (02h + 08h).

Table 3-3 Values returned in the Cleaning Reason field for the REQUEST SENSE data

Value	Description
00h	Cleaning is not required.
01h	Reserved.
02h	Cleaning is requested due to poor error statistics on the current tape.
04h	Cleaning is requested due to an unrecoverable read or write error.
08h	Cleaning is requested because there have been > 100 hours of AME tape motion.

3.9 WRITE BUFFER Command

The size of the microcode for M2 is approximately 1 MB but can potentially grow as large as 2 MB. This is larger than Mammoth and should be taken into account if a microcode download function is being modified.

3.10 Fault Symptom Codes

Fault Symptom Codes 15h and 3Ah have been eliminated. These codes only applied to reading 8xxx format tapes.

Notes

4 Integrating the Hardware

This chapter describes the hardware considerations for installing the tape drive into an enclosure, a computer or server bay, or a library. This chapter also provides the pin assignment information for the tape drive SCSI or Fibre Channel connector.

4.1 Custom Faceplate Requirements

Exabyte offers three faceplates for the M2 drive: an LCD faceplate, a thick LED faceplate, and a thin LED faceplate. However, you may choose to design your own faceplate. A custom faceplate must meet the following requirements:

- The cartridge insertion opening must be located as shown in Figure 4-1.

  Note: The cartridge opening measurements are the same for the LCD and LED faceplates.

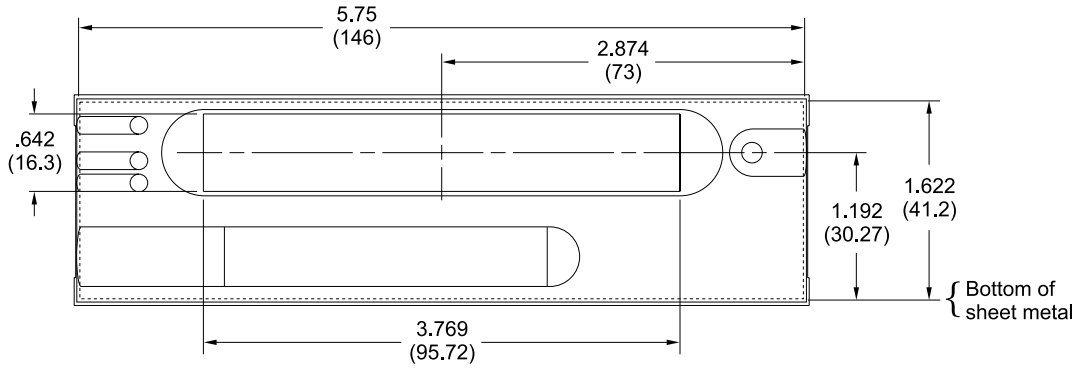

Figure 4-1 Dimensional location of the cartridge insertion opening in inches and millimeters

- The custom faceplate must be retained and located using the features shown in Figure 4-2. Use the ϕ8.05 mm holes for snap-in retention of the faceplate and the 9mm tabs to ensure proper location of the faceplate.

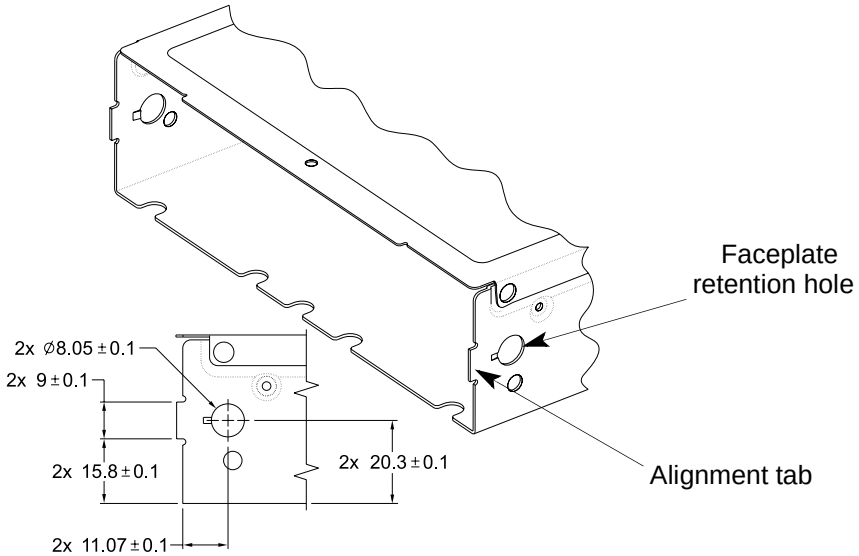

Figure 4-2 Dimensional locations of the faceplate features in millimeters (side view)

4.2 Back-Panel Connectors

You can design your own enclosure, or you can purchase the tape drive already integrated into an Exabyte tabletop enclosure. If you design your own enclosure or incorporate the tape drive into an existing enclosure, the design must provide access to the tape drive back panel connectors.

Figure 1-2 on page 1-2 shows the back-panel components of the SCSI tape drive. Figure 4-3 shows the dimensional locations of these components.

Figure 1-3 on page 1-2 and Figure 4-4 show the same information for the Fibre Channel tape drive.

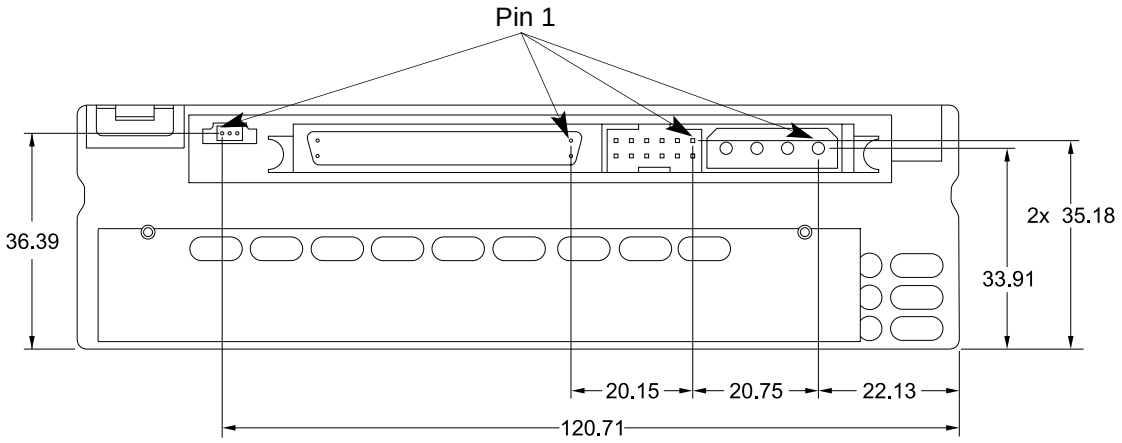

Figure 4-3 SCSI tape drive back-panel connector locations in millimeters

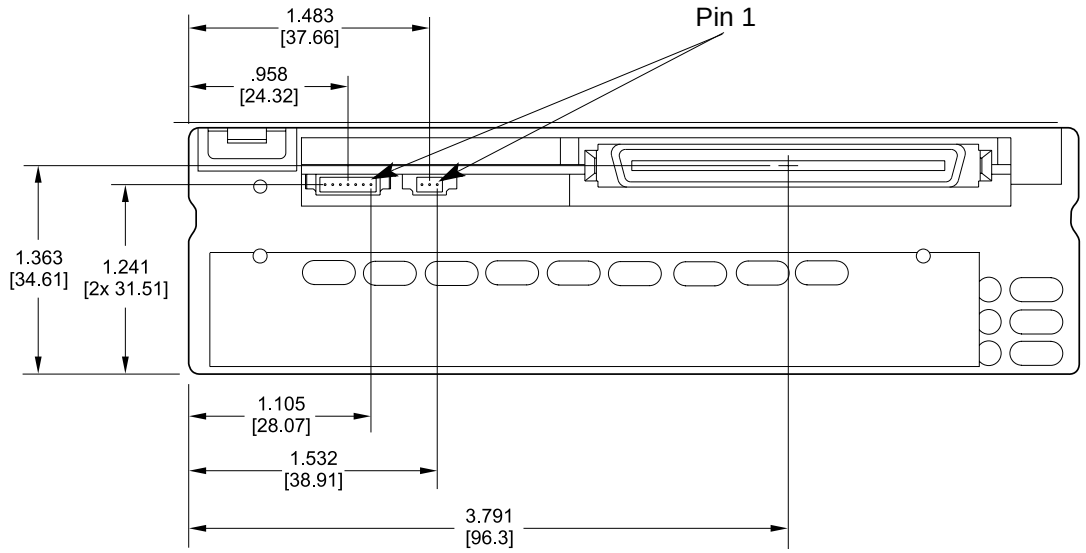

Figure 4-4 Fibre Channel tape drive back-panel connector locations in inches (millimeters)

SCSI Connector (SCSI Tape Drive Only)

The SCSI connector on the back of the tape drive is a 68-pin male, shielded, AMP 7860190-7. Table 4-1 and Table 4-2 show the connector pin assignments for the tape drive when attached to an LVD SCSI or single-ended wide SCSI bus, respectively.

➤ **Important** Although LVD SCSI is compatible with single-ended SCSI, connecting the tape drive to a single-ended SCSI bus will significantly reduce tape drive performance.

Table 4-1 LVD wide SCSI connector pin assignments

Signal	Pin number		Signal
+ DB (12)	1	35	–DB (12)
+ DB (13)	2	36	–DB (13)
+ DB (14)	3	37	–DB (14)
+ DB (15)	4	38	–DB (15)
+ DB (P1)	5	39	–DB (P1)
+ DB (0)	6	40	–DB (0)
+ DB (1)	7	41	–DB (1)
+ DB (2)	8	42	–DB (2)
+ DB (3)	9	43	–DB (3)
+ DB (4)	10	44	–DB (4)
+ DB (5)	11	45	–DB (5)
+ DB (6)	12	46	–DB (6)
+ DB (7)	13	47	–DB (7)
+ DB (P)	14	48	–DB (P)
GROUND	15	49	GROUND
DIFFSENS	16	50	GROUND
TERMPWR	17	51	TERMPWR
TERMPWR	18	52	TERMPWR
OPEN	19	53	OPEN
GROUND	20	54	GROUND
+ ATN	21	55	–ATN
GROUND	22	56	GROUND
+ BSY	23	57	–BSY
+ ACK	24	58	–ACK
+ RST	25	59	–RST
+ MSG	26	60	–MSG
+ SEL	27	61	–SEL
+ C/D	28	62	–C/D
+ REQ	29	63	–REQ
+ I/O	30	64	–I/O
+ DB (8)	31	65	–DB (8)
+ DB (9)	32	66	–DB (9)
+ DB (10)	33	67	–DB (10)
+ DB (11)	34	68	–DB (11)

Table 4-2 Single-ended wide SCSI connector pin assignments

Signal	Pin number		Signal
GROUND	1	35	–DB (12)
GROUND	2	36	–DB (13)
GROUND	3	37	–DB (14)
GROUND	4	38	–DB (15)
GROUND	5	39	–DB (P1)
GROUND	6	40	–DB (0)
GROUND	7	41	–DB (1)
GROUND	8	42	–DB (2)
GROUND	9	43	–DB (3)
GROUND	10	44	–DB (4)
GROUND	11	45	–DB (5)
GROUND	12	46	–DB (6)
GROUND	13	47	–DB (7)
GROUND	14	48	–DB (P)
GROUND	15	49	GROUND
GROUND	16	50	GROUND
TERMPWR	17	51	TERMPWR
TERMPWR	18	52	TERMPWR
OPEN	19	53	OPEN
GROUND	20	54	GROUND
GROUND	21	55	–ATN
GROUND	22	56	GROUND
GROUND	23	57	–BSY
GROUND	24	58	–ACK
GROUND	25	59	–RST
GROUND	26	60	–MSG
GROUND	27	61	–SEL
GROUND	28	62	–C/D
GROUND	29	63	–REQ
GROUND	30	64	–I/O
GROUND	31	65	–DB (8)
GROUND	32	66	–DB (9)
GROUND	33	67	–DB (10)
GROUND	34	68	–DB (11)

Terminating the SCSI Bus

If the tape drive is the last device on the SCSI bus, you must terminate the bus by installing a pass-through terminator on the tape drive's SCSI connector. Or, if there is an unused connector at the end of the SCSI cable, you can terminate the bus there. The drive does not supply terminator power.

➤ **Important** Exabyte recommends using active termination. Exabyte testing has shown that older passive termination does not provide rising edge transitions that are fast or clean enough at fast SCSI speeds.

Fibre Channel Connector (Fibre Channel Tape Drive Only)

The Fibre Channel connector on the back of the tape drive is an SCA 80-pin copper connector. Table 4-3 shows the connector pin assignments for the Fibre Channel tape drive. Unless otherwise noted, all signals are defined in the SFF-8067 specification. Pin lengths are as follows:

L – Long backplane pin length
S – Short backplane pin length

Note: Tape drive communications with the library do not occur through this connector. Use the RS-232 serial port connector for communication between the tape drive and the library.

Table 4-3 Pin assignments for the Fibre Channel SCA 80-pin connector

Pin #	80-pin Connector Contact and Signal Name	80-pin Connector Contact and Signal Name	Pin #
1	12 V CHARGE	GROUND (12 V)	41
2	12 V	GROUND (12 V)	42
3	12 V	GROUND (12 V)	43
4	12 V	MATED 2 (not connected)	44
5	12 V	OPT 12 V GROUND (not connected)	45
6	12 V	GROUND (12 V)	46
7	OPT 12 V (not connected)	– DRIVE_ATN (not connected)	47
8	OPT 12 V (not connected)	– LIB_RST (not connected)	48
9	OPT 12 V (not connected)	– LIB_SEN (not connected)	49

Table 4-3 Pin assignments for the Fibre Channel SCA 80-pin connector (*continued*)

Pin #	80-pin Connector Contact and Signal Name	80-pin Connector Contact and Signal Name	Pin #
10	Reserved	– LIB_DRV_SEN (not connected)	50
11		+ LIB_TX (not connected)	51
12		– LIB_TX (not connected)	52
13		– LIB_RX (not connected)	53
14		+ LIB_RX (not connected)	54
15		Reserved	55
16	–ENBL BYP CH1 (not connected)	OPT 12 V GROUND (not connected)	56
17	– PARALLEL ESI (not connected)	+ PORT 1_IN	57
18	READY LED (not connected)	– PORT 1_IN	58
19	POWER CONTROL (not connected)	GROUND (12 V)	59
20	–ENBL BYP CH2 (not connected)	+ PORT 2_IN	60
21	SEL_6	– PORT 2_IN	61
22	SEL_5	GROUND (12 V)	62
23	SEL_4	+ PORT 1_OUT	63
24	SEL_3	– PORT 1_OUT	64
25	FAULT LED (not connected)	GROUND (5 V)	65
26	DEVICE CONT 2 (not connected)	+ PORT 2_OUT	66
27	DEVICE CONT 1 (not connected)	– PORT 2_OUT	67
28	5 V	GROUND (5 V)	68
29	5 V	SEL_2	69
30	5 V	SEL_1	70
31	5 V	SEL_0	71
32	5 V	DEVICE CONT 0 (not connected)	72
33	5 V	GROUND (5 V)	73
34	5 V	MATED 1 (not connected)	74
35	5 V	GROUND (5 V)	75
36	5 V CHARGE	GROUND (5 V)	76
37	Reserved	Reserved	77
38	RMT_START (not connected)	DLYD_START (not connected)	78
39	GROUND (5 V)	GROUND (5 V)	79
40	GROUND (5 V)	GROUND (5 V)	80

Monitor Port

The monitor port, shown in Figure 1-2 on page 1-2, allows you to perform the following:

- Load code
- Upload a diagnostic listing (dump) from the tape drive's buffer
- Access the monitor program

Use a 3-pin header (Molex 53261-0310) connected to the active monitor cable (Exabyte 33-01-00015). The level translator is included in the cable.

The connector pin definitions are listed in Table 4-4. See Figure 4-3 and Figure 4-4 for the location of the monitor port pin 1.

Table 4-4 Monitor port pin assignments

Pin Number	Name	Level
1	Gnd	Gnd
2	– TXD	TTL
3	– RXD	TTL

Power Connector (SCSI Tape Drive Only)

Figure 1-2 on page 1-2 shows the power connector for the SCSI tape drive. The tape drive requires an AMP 1-480424-0 series or equivalent female power connector. Table 4-5 lists the pin assignments for the power connector. See Figure 4-3 for the location of pin 1.

Table 4-5 Power connector pin assignments

Pin Number	Assignment
1	+ 12 VDC
2	12 VDC return
3	5 VDC return
4	+ 5 VDC

Power for the internal Fibre Channel tape drive is supplied through the 80-pin SCA-2 connector, shown in Figure 1-3.

SCSI ID Jumpers (SCSI Tape Drive Only)

The SCSI tape drive uses six 2mm jumper posts on the back of the tape drive to set the SCSI ID. SCSI IDs of 0 through 15 are set using a binary value determined by the four right-most pins. The presence of a jumper represents a one; the absence of a jumper represents a zero. For replacement jumpers, use AMP 382575-2 or equivalent. Jumper 5 is reserved and jumper 6 is TERMPOWER. Figure 4-5 shows the SCSI ID jumper settings. See Figure 1-2 on page 1-2 for the location of pin 1.

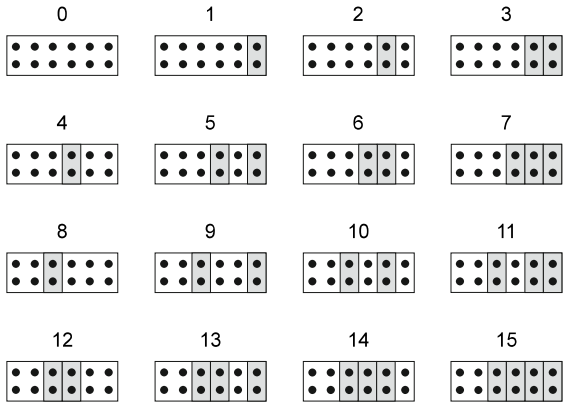

Figure 4-5 SCSI ID jumper settings

Remote Switch

If desired, you can set the SCSI ID by removing the jumpers and connecting a remote switch to the SCSI ID connector. Use an AMP part number 1-111623-7. This AMP part is used with a ribbon cable; AMP does not currently offer a discrete wire version. The connector mates to all of the pins on the connector; however, only the four right-most pins are used for the SCSI ID.

Fibre ID (Fibre Channel Tape Drive Only)

The Fibre ID for the internal Fibre Channel tape drive is set through the address bits on the 80-SCA-2 connector (see Figure 1-3). Addresses are selectable from 00h to FFh. However, within this range, the addresses 7Eh and 7Fh are reserved and should not be used. Using either of these addresses will immediately cause the tape drive to use soft addressing (see the *Exabyte Mammoth-2 Fibre Channel Supplement* for more information).

Tape Drive Ground

To ground the tape drive, use one of the following methods:

- Connect a 1/4-inch female spade connector to the ground tab (shown in Figure 4-6).
- Connect an M2 × 0.4 × 6 mm self-tapping screw to the ground hole (shown in Figure 4-6).

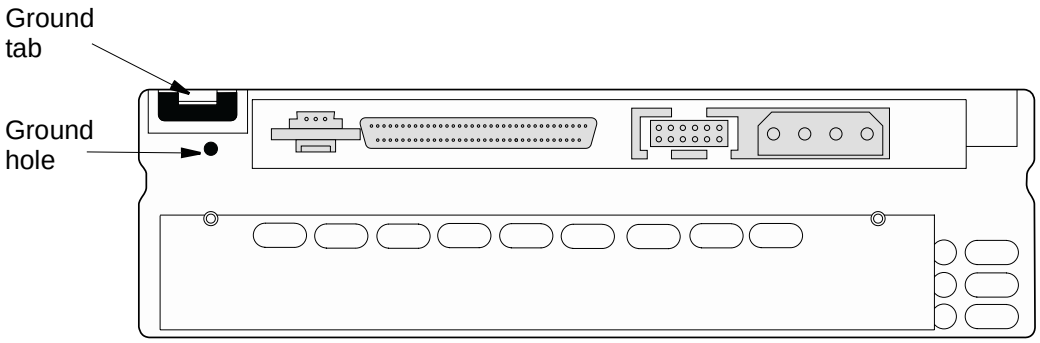

Figure 4-6 Ground tab and ground hole locations (SCSI drive shown)

4.3 Size and Weight

Table 4-6 shows the size and weight of the tape drive. Figure 4-7 shows the dimensions of the bare drive.

Table 4-6 Dimensions of the tape drive

Depth	
without faceplate	1.63 inches (4.13 cm)
with any Exabyte faceplate	1.68 inches (4.28 cm)
Width	
without faceplate	5.75 inches (14.61 cm)
with any Exabyte faceplate	5.87 inches (14.92 cm)
Length[a]	
without faceplate	8.00 inches (20.32 cm)
with LCD faceplate	A = 8.39 inches (21.31 cm)
with thick LED faceplate	A = 8.20 inches (20.83 cm)
with thin LED faceplate	A = 8.09 inches (20.55 cm)
Weight	2.9 pounds (1.3 kg)

[a] In some units, the LVD SCSI connector extends an additional 0.36 inches (9.2 mm) beyond the back edge of the tape drive chassis.

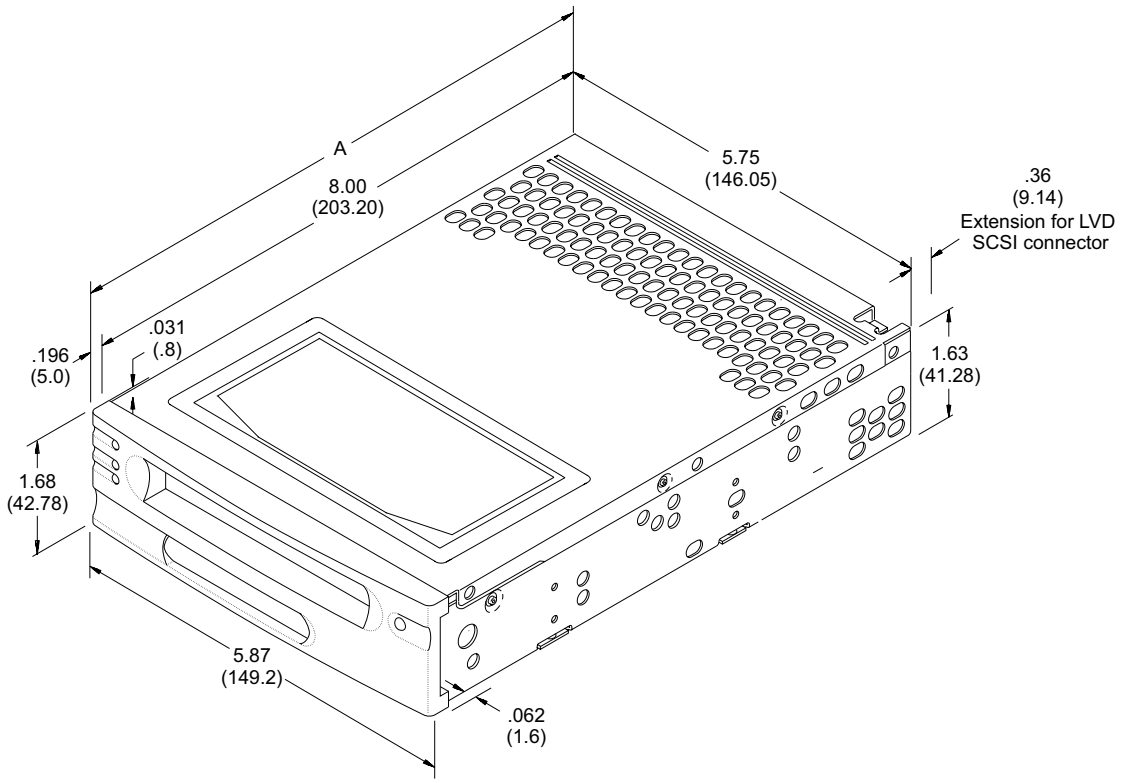

Figure 4-7 Dimensions of the bare drive in inches and millimeters (SCSI tape drive with an LCD faceplate shown)

4.4 Tape Drive Mounting Requirements

The tape drive can be mounted either horizontally or vertically and in a stationary or sliding position. The requirements are the same for the SCSI and Fibre Channel versions of the tape drive.

➤ **Important** In early versions of M2, the LVD SCSI connector extends approximately 0.36 inches (9.2 mm) beyond the industry-standard length for a 5.25-inch, half-high form factor.

Figure 4-8 shows three sets of four mounting holes in the main housing of the tape drive that allow for a number of mounting positions (two sets on the sides, set A and set B, and one set on the bottom, set C).

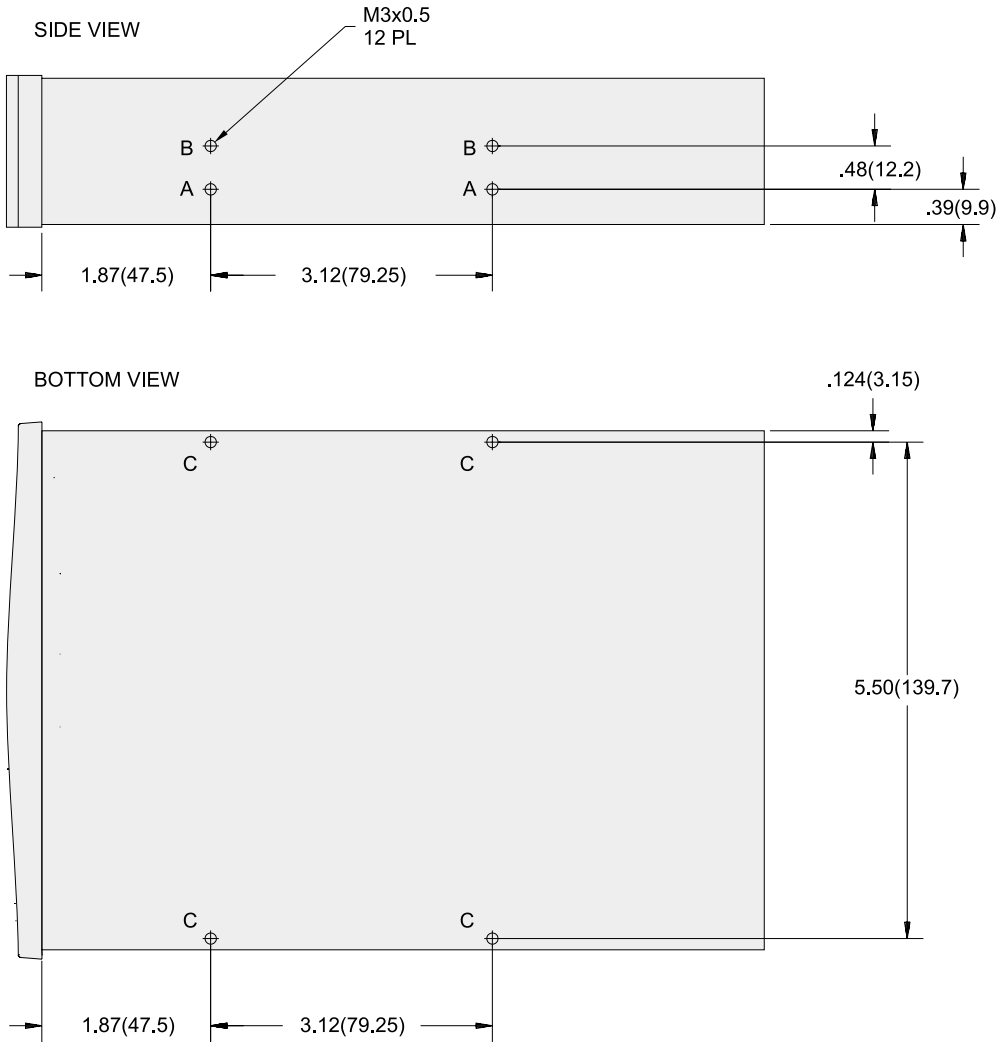

Figure 4-8 Mounting holes in inches and millimeters (three sets of four)

When mounting the tape drive, follow these guidelines:

- Use *one* set of mounting holes. (Use all four holes in whichever set you choose; do not use combinations of mounting holes from different sets.)
- Use M3 × 0.5 × 6 mm screws. **For proper mounting, use the correct screw length.**
- Ensure that no objects such as screw heads, cables, or adjacent devices are pressing against the frame.

- Do not obstruct the ventilation slots on the bottom and at the rear of the tape drive.
- Allow sufficient space for accessing the tape drive's front panel controls.

4.5 Tape Drive Enclosure Requirements

You can design your own enclosure, or you can purchase the tape drive already integrated into an Exabyte tabletop enclosure. If you design your own enclosure or incorporate the tape drive into an existing enclosure, the design must provide adequate air flow to dissipate the heat resulting from approximately 12 watts of power consumption. The air flow must be sufficient to keep the tape path temperature from exceeding 45° C (113° F), as measured near the scanner with a thermocouple.

Note: The onboard thermistor may be used to measure the tape path temperature. However, this device has an accuracy of ± 2° C.

The tape drive design optimizes the air flow from front to back. The flow impedance is such that a minimal negative pressure in the enclosure will draw sufficient air through the drive's front faceplate. This air is then directed through the drive and exhausted through the rear panel. The design minimizes air flow through the tape path and minimizes tape path contamination.

Figure 4-9 shows the temperature and humidity requirements for the tape drive path. The area within the dotted line represents the operating environment. Table 4-7 defines the points in the chart.

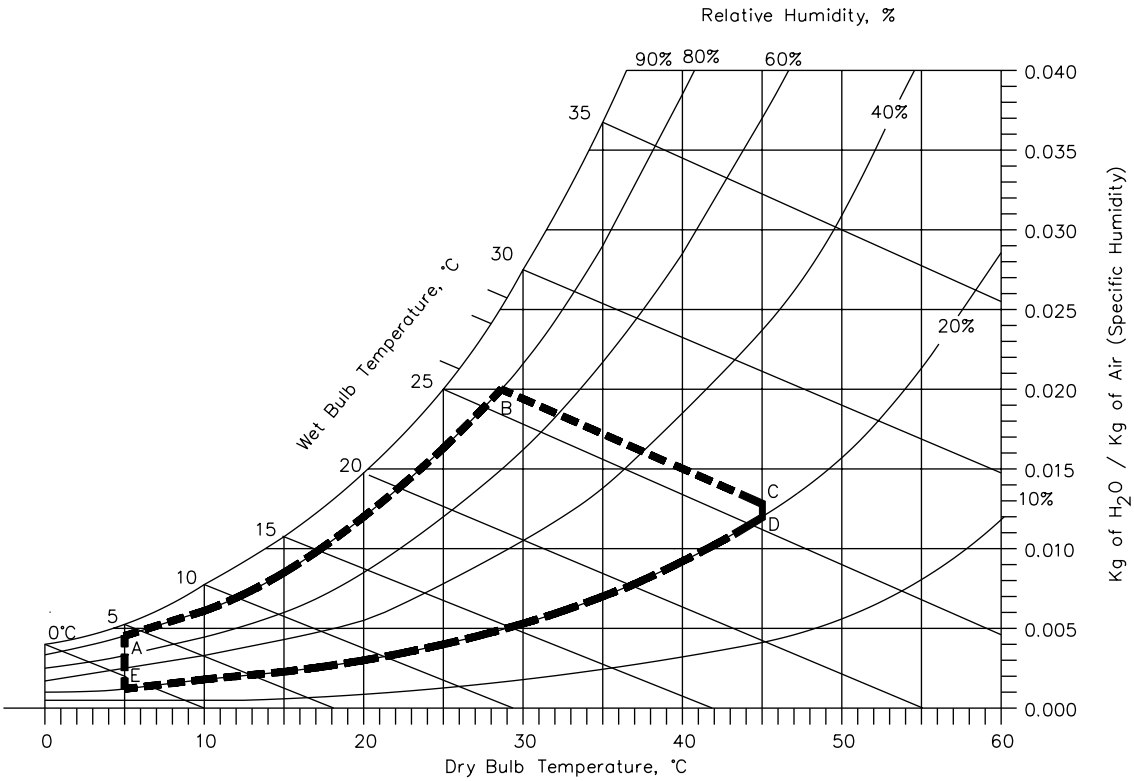

Figure 4-9 Tape path temperature and humidity ranges for operation

Table 4-7 Temperature and humidity points

Point	Temperature	Humidity
A	5° C	80%
B	29° C	80%
C	45° C	22%
D	45° C	20%
E	5° C	20%

➤ **Important** The operating temperature and humidity specifications are for the tape path. When the tape drive is in an enclosure, the ambient temperature typically must be lower than the maximum temperature to avoid exceeding the maximum at the tape path.

4.6 Power Requirements

If you design your own tape drive enclosure or incorporate the tape drive into an existing enclosure, the design must meet the power requirements described in the following sections.

Power Consumption

Table 4-8 shows the internal tape drive's power consumption when operating and when idle.

Table 4-8 Drive power consumption

	LVD SCSI	Fibre Channel
Power consumption when operating[a]	18 watts	//TBD//
Power consumption when idle[b]	7 watts	//TBD//

[a] Assumes that the tape drive is reading data 50% of the time and writing data 50% of the time.

[b] Sleep 2 state, see the *Exabyte Mammoth-2 Product Specification* for more information.

Power Supply Requirements

The internal tape drive operates from standard + 5 VDC and + 12 VDC supply voltages, as specified in Table 4-9 (all specified voltages are DC; no external AC power is used).

Note: The tape drive does not provide overvoltage or overcurrent protection. Safety agency certification requires that the supplied voltages be from a Safety Extra-Low Voltage source (per IEC 950).

Table 4-9 Drive power supply requirements

	LVD SCSI		Fibre Channel	
	+ 5 Volts	**+ 12 Volts**	**+ 5 Volts**	**+ 12 Volts**
Nominal tolerance[a] Ripple and noise[b] (60 Hz to 20 MHz)	± 5% 125 mVpp max	± 10% 125 mVpp max	± 5% 125 mVpp max	± 10% 125 mVpp max
Operating current (amps) Nominal[c] Peak[d]	 2.9 3.1	 0.3 1.2	 **//TBD//** **//TBD//**	 **//TBD//** **//TBD//**

[a] The tolerance is limited by some digital parts having a 5% tolerance specification.

[b] The ripple voltage is included in the total voltage tolerance.

[c] Nominal current occurs during streaming write or read.

[d] The peak current occurs during load, drum spin-up, unload, or at the start of search or rewind operations, and lasts for less than 5 seconds.

4.7 Environmental Specifications

Table 4-10 summarizes environmental specifications for the tape drive.

Table 4-10 Environmental specifications

	Operating[a]	**Storage**[b]**/ Non-operating**[c]	**Transportation**[d]
Tape path temperature range[e]	+ 5° C to + 45° C (+ 41° F to + 113°F)	–40° C to + 60° C (–40° F to + 140° F)	–40° C to + 60° C (–40° F to + 140° F)
Temperature change[f]	1° C per minute or 13° C per hour, max. (2° F per minute; 23° F per hour, max.)	1° C per minute or 20° C per hour, max. (2° F per minute; 36° F per hour, max.)	
Relative humidity	20% to 80% non-condensing	10% to 90% non-condensing	
Wet bulb	26° C Max (79° F Max)		
Altitude	–304.8 m to 3048 m (–1,000 ft to 10,000 ft)		–304.8 m to 12192 m (–1,000 ft to 40,000 ft)

[a] All operating measurements include the data cartridge.

[b] The tape drive has not been unpacked. The storage period does not exceed three years.

[c] The tape drive has been unpacked, but is not operating. Data cartridge not included.

[d] The tape drive has not been unpacked. The transportation period does not exceed 6 months.

[e] The drive contains a thermistor near the scanner to automatically make this measurement.

[f] The inserted data cartridge's temperature and humidity must be allowed to stabilize in the specified ambient environment for 24 hours.

4.8 Particulate Contamination Limits

The ambient operating environment should not exceed the particulate counts shown in Table 4-11.

Table 4-11 Particulate contamination limits

Particle size	Number of particles ≥ particle size per cubic meter	Number of particles ≥ particle size per cubic foot
0.1	8.8×10^7	2.5×10^6
0.5	3.5×10^7	1.0×10^6
5.0	2.5×10^5	7.0×10^3

4.9 Physical Size of Data Cartridge

For detailed information about the size of the data cartridges, refer to *75m and 150m AME Hybrid 8mm Data Cartridge Specification for Mammoth-2* or *225m AME Hybrid 8mm Data Cartridge Specification for Mammoth-2*.

4.10 Agency Compliance

When purchased from Exabyte Corporation, both the internal model of the tape drive and the tabletop model comply with domestic and international product safety standards. See the *Exabyte Mammoth-2 Product Specification* for more information.

Notes

5 Integrating into a Library

This chapter provides information pertaining specifically to integrating the tape drive into a library.

5.1 Setting the Tape Drive SCSI ID

If you are integrating the tape drive into a library, the library needs to communicate with the tape drive using a remote cable to set its SCSI ID. You can set the tape drive SCSI ID by connecting a cable to the SCSI ID connector. See page 1-2 for the location of the SCSI ID connector and page 4-9 for cable requirements.

5.2 Resetting the Tape Drive

If you are installing the tape drive into a library, the library must be able to reset the drive by power cycling it.

5.3 Resetting the Cartridge Loader

In the event that the library's robot must retry picking an ejected cartridge, the tape drive's cartridge loader can be reset. Resetting the cartridge loader re-establishes the cartridge eject distance, thus avoiding the need to reload the cartridge and then re-eject it from the tape drive.

To reset the cartridge loader for a robot pick retry, the library must use the SendMail Request (described on page 6-16) to send the following 36 bytes to the tape drive through the serial port (all values are hex):

1C,	0,	1,	*Channel ID*
1C,	0,	1,	E7
0,	0,	0,	8
0,	0,	0,	47
0,	0,	0,	4B
0,	0,	0,	48
0,	0,	0,	2
0,	0,	0,	1
0,	0,	0,	0

5.4 Cartridge Insertion Opening Location

When integrating the tape drive into a library using an Exabyte faceplate, you must accurately align your robot with the cartridge opening to ensure proper cartridge insertion. Figure 5-1 shows the measurements for the location and dimensions of the opening.

Note: The cartridge opening measurements are the same for the LCD and LED faceplates.

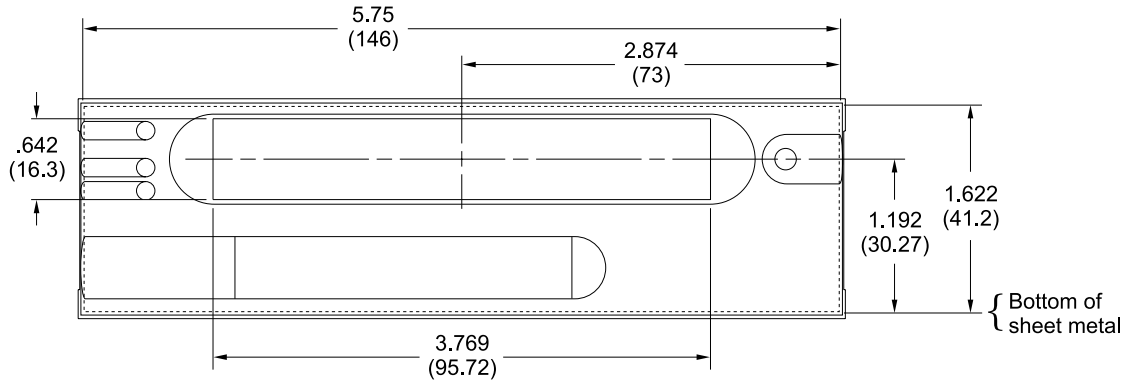

Figure 5-1 Dimensional location of the cartridge insertion opening in inches and millimeters

5.5 Cartridge Load/ Unload Specifications

This section provides information you need to properly load and unload cartridges with a robot.

Insertion Force

The insertion force required to insert a cartridge up to the soft load initiation point depends on the insertion velocity. Exabyte recommends a maximum insertion velocity of 15.25 millimeters per second (0.6 inches per second) which results in an insertion force of 700 grams (24.7 ounces). Higher insertion velocities result in higher insertion forces and are not recommended. The insertion force needs to be normal to the front of the tape drive, and uniformly distributed across the face of the cartridge. Also, to allow the soft load mechanism to properly take the cartridge away from the robot, it is important that the robot does not constrain the cartridge.

Soft Load Initiation Point

The soft load initiation point is where the tape drive takes over loading the cartridge. Figure 5-2 shows a cartridge inserted up to the soft load initiation point.

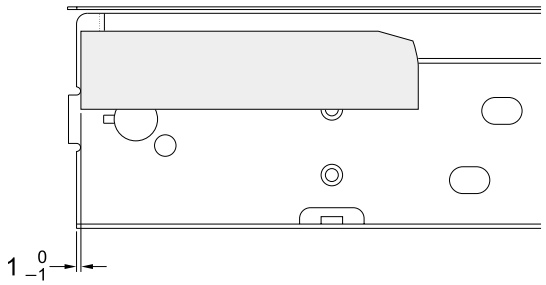

Figure 5-2 A cartridge inserted up to the soft load insertion point, the faceplate is removed for clarity (shown in millimeters)

Eject Distance

To ensure that the robot can properly pick an ejected cartridge, allow for the eject distance show in Figure 5-3 when installing the tape drive into the library.

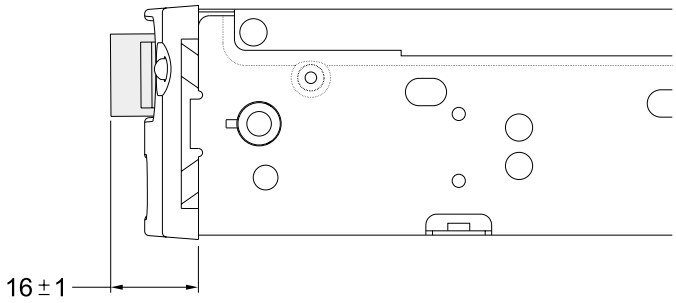

Figure 5-3 Eject distance in millimeters

Extraction Force

The extraction force is the force required to pick the cartridge from the ejected position. The maximum force is 400 grams (14 oz). This force needs to be normal to the front of the tape drive and distributed uniformly across the face of the cartridge.

6 Using the Firmware Interface

The Firmware Interface (ISOCOM) allows you to monitor various drive parameters and pass that information to the host, the system controller, or the system operator panel/LCD display.

ISOCOM is Exabyte's name for the protocol used by the Exabyte M2 drive to communicate with the host or library. ISOCOM is loosely based on the layered communications model promoted by the International Standards Organization (ISO). The protocol is token-based where the host or tape drive can initiate communications. However, the host is usually the token initiator with the tape drive becoming the initiator when it sends multiple packets to fulfill the host's request.

ISOCOM uses serial communications only. You must connect the host's serial port to the tape drive's monitor port with a special 3-pin serial cable (available from Exabyte, see "Contacting Exabyte" on the inside of the back cover).

Exabyte's M2 Monitor Software for Windows, which runs on a host, uses ISOCOM to get information from the tape drive during communication over the serial port. The M2 Monitor Software is available from Exabyte's web site (www.exabyte.com).

Libraries that have implemented the ISOCOM protocol can use it to obtain diagnostic information through the tape drive's monitor port.

6.1 Token-Based Protocol

A token-based protocol is based on the exchange of tokens, optionally followed by a packet (see page 6-3). The tokens may be BEL (0×07), SYN (0×16), or NAK (0×15). Table 6-1 shows the action taken in response to a token exchange.

Note: The listener must respond to the initiator within 5 seconds of receiving a token. If the initiator is the host, then the host must perform a recovery sequence.

Table 6-1 Token exchange actions

Initiator	Listener	Action
BEL	BEL	Initiator declares it wants to send a new packet. The listener overrides this by declaring it wants to send a packet. The listener becomes the initiator and sends a packet.
BEL	SYN	Initiator sends new packet.
BEL	NAK	Initiator resends last packet.
SYN	BEL	Initiator received BEL from listener and now sends SYN to allow the listener the chance to send a packet.
SYN	SYN	Initiator received BEL from listener and now sends SYN to allow the listener the chance to send a packet. Listener does not require the initiator role to send a packet and no one is initiator.
SYN	NAK	Initiator received BEL from listener and now sends SYN to allow the listener the chance to send a packet. Listener does not accept initiator role and sends NAK to force the initiator to resend the last packet before giving up the initiator role.
NAK	NAK	Severe communications problems. Try to reconnect at 9600 Baud.

Serial Break Condition

Serial break condition detection is an integral part of the ISOCOM protocol. Both the host and the tape drive can initiate a break condition and both host and drive must detect break conditions. Table 6-2 compares the definition of a break condition based on which device initiates the break condition.

Table 6-2 Break conditions

Initiator	Definition
Host	The host is alerting the drive that it is sending a token at 9600 baud.
Tape Drive	The tape drive is alerting the host that it is ready to communicate, has a problem, or is sending the host a token at 9600 baud.

Packet Description

ISOCOM communications consist of packets. These packets contain binary (not ASCII) data. The host initiates a request packet and the tape drive satisfies the request by responding with a reply packet. Packets can be up to 260 bytes in length. The first 8 bytes of the packet are always reserved for Packet Header information.

Note: All multi-byte values are sent using Big-Endian, most significant byte to least significant byte, format. (Little-Endian is least significant byte to most significant byte.)

General Packet Structure

Table 6-3 shows the general form of a packet composed of the 8-byte header and a variable length data section.

Note: The left column of the table is a byte index and the top row shows the increment. For example, Packet type is byte 2 in the packet (0 + 2 = 0).

Table 6-3 General packet structure

Byte	0	1	2	3
0	Length	Reserved	Packet Type	Channel ID
4	CheckSum			
8 - 259	Packet Data			

Byte 0 – Length The Length field specifies the number of bytes in the data section of this packet only. The 8-byte header is not included in the length. Maximum length is 252 bytes.

Byte 1 – Reserved This byte is reserved. The value returned should be zero.

Byte 2 – Packet Type The Packet Type field specifies how this packet should be processed by the tape drive. Packet types are shown in Table 6-4.

Table 6-4 Packet types

Packet Type	Hex Value	Description
NULL_PKT	00h	Not used.
REQUEST	01h	Used as the packet type for requests that are processed by request functions.
REPLY	02h	Used as the packet type for all but the last packet in a reply stream.
EOD	03h	Used as the packet type for the last packet in a stream of packets.
ILL_REQ	04h	Used to indicate that the preceding request was illegal. This is most likely because incorrect parameters were sent to a request function.
Reserved	05h	Reserved.
CANCEL	06h	Used to abort a reply stream on a particular channel.
Reserved	07h	Reserved.
CONNECT	08h	Used to establish a connection between the tape drive and the host.
DISCONNECT	09h	Used to dismantle a connection between the tape drive and the host.
NOT_CONNECT	0Ah	Used to indicate that a valid connection does not exist.
ILL_CONNECT	0Bh	Used to indicate that a connect request has been denied.
STOP	0Ch	Used to stop the operating system.
BAUD_RATE	0Dh	Used to negotiate a different baud rate.
CODE_LOAD	0Eh	Used to load code into the tape drive.
PARA_LOAD	0Fh	Used to load code over the parallel port.
LOAD_FAIL	10h	Used to indicate that a code load failure has occurred.
Reserved	11h	Reserved.
LAST_PKT_TYPE	FFh	Not used.

Byte 3 – Channel ID Shows the ID of the channel being used by the tape drive and host to carry on multiple virtual "conversations" at the same time. The host keeps track of open channels and uses a free channel when initiating a new conversation with the drive. Once a channel connection is established, all requests and responses in the conversation use the same channel. For example, If the tape drive receives a request on channel 4, it responds with a reply on channel 4.

Channels 0 through 2 are reserved. Channel 3 is reserved for library communications. If you are implementing a host application, use only channels 4 though 8 for tape drive communications. In addition, avoid carrying on multiple virtual conversations at the same time.

Byte 4 through 7 – CheckSum The CheckSum field is the 4-byte sum of all bytes in the header and data section of the packet, excluding the checksum field of the header.

The checksum is calculated using 4-byte unsigned arithmetic. The calculation is done by adding the 4-byte values starting at each 4-byte boundary (not including byte 4, which is the CheckSum value). If the length of mod 4 is non-zero, the remainder of the 4-byte values is masked out (zeroed).

Bytes 8 through 259 – Packet Data These bytes contain the data in the packet.

ISOCOM Communications Dialogs

This section provides examples of the communication dialogs that occur between the host and the tape drive. Table 6-5 shows example dialogs to illustrate how dialogs are used.

Table 6-5 Examples of communication dialogs

Connection/Reset Sequence	
Host	**Tape Drive**
< break>	
BEL	
	SYN
< Disconnect Request>	
	BEL
SYN	
	< Disconnect Reply>
BEL	
	SYN
< Connect Request>	
	BEL
SYN	
	< Connect Reply>
BEL	
	SYN
< Baud Rate Request>	
	BEL
SYN	
	< Baud Rate Reply>
SYN	
	SYN

Load Code Sequence[a]	
Host	**Tape Drive**
BEL	
	SYN
< Load Code Request>	
	< break>
Performs Connection/Reset Sequence	
BEL	
	SYN
< Load Data>	
BEL	
	SYN
< Load Data>	
BEL	
	SYN

Write Dump Sequence[b]	
Host	**Tape Drive**
BEL	
	SYN
< Take Dump Request>	
	BEL
SYN	
	< Dump Data>
	BEL
BEL	
< Read Variable Request>	
	BEL
SYN	
	< Dump Data>
	BEL
SYN	
	< Read Variable Reply>
SYN	
	SYN
	BEL
SYN	
	< Dump Data>
	BEL
SYN	
	< Dump Data>

[a] The Load Code Sequence for pre-release version 13 of the Mammoth 29200 boot code does not include the Baud Rate Request/Reply negotiations of the Connection/Reset sequence.

[b] Write Dump Sequence uses Read Variable Request to find out the total number of bytes to expect from the drive. This example illustrates how multiple requests can be serviced at the same time as long as they are on different channels.

Recovery Sequence

Table 6-6 shows how the host restores communications with the tape drive after a timeout. Timeouts typically occur when the host is expecting to receive a certain number of bytes from the tape drive and does not receive them within an allotted time.

Timeouts often occur when the tape drive is transmitting a dump file to the host at a baud rate of 115,200. Because the tape drive sends the file to the host in 260-byte data packets, CE_OVERRUN errors can occur on the host's serial port. A timeout results when the host cannot move the received bytes from its hardware buffer to the secondary buffer used by the communication application quickly enough. You can induce timeouts by making a lengthy request and then running another computer-intensive application on your host.

Note: When either the PC or the tape drive issues a serial break, communications on both sides are reset to a default baud rate of 9600 (or, occasionally, 19200).

Table 6-6 Recovery sequence examples

Write Dump Recovery, 29200 Only	
Host	**Tape Drive**
< CE_OVERRUN occurs>	
< Timeout expires>	
< break>	
NAK	
	SYN
	< Resends last pkt>
	BEL
BEL	
< Baud rate request>	
	BEL
SYN	
	< Dump data pkt>
	BEL
SYN	
	< Baud rate reply>
SYN	
	SYN
	BEL
SYN	
	< Dump data pkt>
	BEL
SYN	
	< Dump data pkt>

Write Dump Recovery, Power PC, only	
Host	**Tape Drive**
< CE_OVERRUN occurs>	
< Timeout expires>	
< break>	
	BEL
NAK	
	< Resends last pkt>
	BEL
BEL	
< Baud rate request>	
	BEL
SYN	
	< Dump data pkt>
	BEL
SYN	
	< Baud rate reply>
SYN	
	SYN
	BEL
SYN	
	< Dump data pkt>
	BEL
SYN	
	< Dump data pkt>

Load Code Recovery	
Host	**Tape Drive**
< CE_OVERRUN occurs>	
< Timeout expires>	
< break>	
NAK	
	NAK
BEL	
	SYN
< Resends last pkt>	
BEL	
	SYN
< Load data pkt>	
BEL	
	SYN
< Baud rate request>	
BEL	
	BEL
< Load data pkt>	
	BEL
BEL	
< Load data pkt>	
	BEL
SYN	
	< Baud rate reply>
SYN	
	SYN
BEL	
	SYN
< Load Data Pkt>	

Connect Request

The Connect Request is used by the host to establish a channel connection to the tape drive.

Byte	0	1	2	3
0	0	0	Connect (8h)	Channel ID
4	CheckSum			

Connect Reply

The Connect Reply is used by the tape drive to tell the host the name of its symbol-table file, the monitor type, and other information the host needs to communicate with the tape drive. Code should be written to handle the currently defined data bytes and ignore additional bytes.

Note: If you are developing host code be aware that the length of the connect reply packet may increase in the future.

Byte	0	1	2	3
0	54h	0	Connect (8h)	Channel ID
4	CheckSum			
8	Monitor Type	Reserved	Frequency	Trace Mode
12	Boot Version [0-3]			
16	Boot Version [4-7]			
20	Boot Ver [8]	Byte 0-2 of Flash Version		
24	Byte 3-6 of Flash Version			
28	Byte 7-8 of Flash Version		Byte 0-1 of Date	
32	Byte 2-5 of Date			
36	Byte 6-9 of Date			
40	Byte 10-13 of Date			
44	Byte 14-17 of Date			
48	Byte 18-21 of Date			
52	Byte 22-25 of Date			
56	Byte 26-29 of Date			
60	Max Buffer Blocks		EEPROM Version [0-1]	

Byte	0	1	2	3
64	EEPROM Version [2-5]			
68	EEPROM Version [6-9]			
72	Max Index Value		SCSI ID	Product ID
76	Serial Number [0-3]			
80	Serial Number [4-7]			
84	Serial Number [8-10]			Reserved
88	Default Symbol Table Address			

Byte 8 – Monitor Type The Monitor Type field indicates the type of tape drive to which the host is connected. Table 6-7 describes the types of monitors.

Table 6-7 Monitor types

Types	Value	Description
Boot	Bh	Indicates that the drive is a single channel polling packet driver. Only boot operations are available.
Flash	Fh	Indicates that the drive is a multi-channel event driven packet driver. Full flash monitor operations are available.

Byte 9 – Frequency The Frequency field indicates the speed of the microprocessor, as follows:

10h – The microprocessor operates at 16 Mhz
14h – The microprocessor operates at 20 Mhz

Byte 10 – Trace Mode (obsolete) The Trace Mode field indicates the form of the task trace partitions, as follows:

00h – Main and background
01h – Main, high frequency, and background

Byte 12 through Byte 20 – Boot Version The Boot Version field is a null terminated ASCII string.

Byte 21 through Byte 29 – Flash Version The Flash Version is a null terminated ASCII string that specifies the name of the symbol table file without the extensions.

Byte 30 through Byte 59 – Flash Date The Flash Date contains the date and time of the code that is currently inside the flash EEPROM. It is used to prevent symbol table mismatches caused by users renaming the symbol table files.

Byte 60 and Byte 61 – Max Buffer Blocks The Max Buffer Blocks fields contain information needed by the host to properly size the buffer viewer. For M2, 1 buffer block unit equals 1,048,576 (100080h) bytes.

Byte 62 through Byte 71 – EEPROM Version The EEPROM Version is a null terminated ASCII string that specifies the name of the EEPROM configuration file without the extension.

Byte 72 and Byte 73 – Max Index Value The Max Index Value field specifies the maximum legal value for a default symbol table lookup index.

Byte 74 – SCSI ID The SCSI ID field contains a number from 0 to 15 which corresponds to the SCSI ID jumper setting on the back of the M2 tape drive.

Byte 75 – Product ID The following Product IDs are possible:

00h = Mammoth
01h = Mammoth, PowerPC experimental
02h = Mammoth-2
03h = Mammoth LT
04h = M2 Fibre Channel

Byte 76 through Byte 86 – Serial Number The Serial Number field contains a null terminated ASCII string representing the drive's serial number as contained in the EEPROM.

Byte 88 through 91 – Default Symbol Table Address This address is the entry point that allows a host to manually read the Default Symbol Table. "Max Index Value" is one less than the number of entries in the Default Symbol Table. Each entry is a 32-bit (4 byte) unsigned long word. See SendMail Request on page 6-16 for more information about when to use the address of the Default Symbol Table.

Illegal Connect Reply

The Illegal Connect Reply is used by the tape drive to tell the host about errors in the Connect Request. If the connection request is denied, then the tape drive returns an Illegal Connect reply to the host. A connection can be denied because the packet driver is already connected, a higher priority connection already exists, or if any requirement of the Advanced Connect request can not be met (for example, if the password is incorrect).

Byte	0	1	2	3
0	0	0	Ill_Connect (Bh)	Channel ID
4	CheckSum			

Disconnect Request

The Disconnect Request is used by the host to tell the tape drive to disconnect. It should be sent when the host has no further requests for the tape drive. Use of the Disconnect Request has significant effects on the state of the tape drive channel being used for communication. For example, a Disconnect Request causes all registered Cancel functions to be invoked, essentially resetting the entire drive channel.

Byte	0	1	2	3
0	0	0	Disconnect (9h)	Channel ID
4	CheckSum			

Disconnect Reply

The Disconnect Reply is used by the tape drive to tell the host that all operations required to perform a disconnect have completed. The Disconnect Reply is used to indicate a forced disconnect or a “cannot connect”.

Byte	0	1	2	3
0	0	0	Disconnect (9h)	Channel ID
4	CheckSum			

Not Connected Reply

The Not Connected Reply is used by the tape drive to tell the host that it is not currently connected or that the current connection has been preempted by a higher priority connection.

Byte	0	1	2	3
0	0	0	Not_Connect (Ah)	Channel ID
4	CheckSum			

Cancel Request

The Cancel Request is used by the host to tell the tape drive to stop a stream of replies. The tape drive returns an EOD message as soon as all tape drive threads of execution have terminated. The Cancel Request affects only the channel on which the request was sent.

Byte	0	1	2	3
0	0	0	Cancel (6h)	Channel ID
4	CheckSum			

6.2 Code Load Requests

Code Load Requests are used by the host to tell the tape drive to get ready for a code load operation.

Serial Code Load Request

The Serial Code Load Request, called CODE_LOAD, is used by the host to tell the drive to jump to boot and get ready to receive a serial code load. This packet type is also used for each packet in a serial code load packet stream. The last packet in the serial code load has packet type EOD.

Byte	0	1	2	3
0	0	0	Code_Load (Eh)	Channel ID
4	CheckSum			

Parallel Load Request

The PARA_LOAD Request is used by the host to tell the tape drive to jump to boot and get ready to receive a parallel code load.

Byte	0	1	2	3
0	0	0	Para_Load (Fh)	Channel ID
4	CheckSum			

Load Fail Reply

The LOAD_FAIL Reply is used by the tape drive to tell the host that the code load failed. The actual reason for the code load failure is contained in the data section of the LOAD_FAIL packet.

Byte	0	1	2	3
0	1	0	Load_Fail (10h)	0
4	CheckSum			
8	Failure Code	Not used		

Byte 8 – Failure Code The Failure Code can be any one of the following:

1h – Hardware failure
2h – Cycle redundancy check (CRC) failure
3h – Load failure
4h – Serial failure
5h – Parallel failure

6.3 DPrintf

DPrintf replies are used by the tape drive to transmit ASCII text information to the host for display by its monitor software. The tape drive can send a DPrintf reply to the host at any time using communications channel 2, which is reserved for this purpose. The host should handle a reply on channel 2 as an “auto-reply” since it asks for this information by default.

Although the ISOCOM specification defines a request for disabling these automatic replies, the request is not available in the M2 Monitor for Windows software and cannot be used by libraries. The only way a library can disable these messages is to set the nv.cfg.library_mode value of the EEPROM to GE_EXB_LIBRARY. The firmware used by libraries to communicate with the tape drive should make use of this option because it simplifies communications a great deal. Instead of monitoring multiple virtual conversations, your communications implementation can consist of simple request/reply matching pairs.

The following table shows the tape drive’s replies to implied DPrintf requests.

Byte	0	1	2	3
0	4h + *N*	0	Reply (2h)	2h (Dedicated to Dprintf)
4	CheckSum			
8...*N*	ASCII Text			

Byte 8...*N* ASCII text to display for tracing and can include line-feed (0Ah) characters. This text is not null-terminated.

6.4 Request Functions

The 4-byte function address for a Request function comes directly after the Packet Header's CheckSum bytes. The M2 Monitor for Windows software and libraries do not have direct access to the function addresses. The tape drive firmware includes a Default Symbol Table that maps the values shown Table 6-8 to the correct function addresses. Libraries substitute the values in Table 6-8 for the function addresses.

Table 6-8 Default addresses for Request functions

Request function	Default value
_dCoreReadBlock	00000006h
_dCoreSendMail	00000008h
_dCoreStatusRequest	00000016h

SendMail Request

The SendMail Request is used by the host to schedule a task for execution on the tape drive. When the task is dispatched the mail parameters are passed.

Byte	0	1	2	3
0	8h	Reserved	Request (1h)	Channel ID
4	CheckSum			
8	_dCoreSendMail			
12	Task			
16	Mail			
20	Link			
24	Parameters			
28	Iterations			
32	Expected Status			

Byte 8 through 11 – _dCoreSendMail The request function is called _dCoreSendMail() and its job is to send mail to a mail entry point. This function is also known as scheduling a task.

Byte 12 through 15 – Task The Task field is the address or index of a mail entry point.

Note: Not all mail entry points can be invoked by the host.

Byte 16 through 19 – Mail The Mail field is a command in the form *n*C_*. In this form, C means command and *n* is one of the following:

S – servo
L – logical
P – physical
D – diagnostics

Byte 20 through 23 – Link The Link is the address or index of _dSchedlink or of _sDummy. If the address is _dSchedLink, the host receives the status of the sent mail. Otherwise, if the address is _sDummy, the host receives a simple EOD reply when the task is scheduled, not when the task is dispatched or completed.

Byte 24 through 23 – Parameters The value for the Parameters field is zero unless the mail function's description specifies some other value.

Byte 28 through 31 – Iterations The Iterations field indicates the number of times the drive-based sequencer should repeat the mail command if the status matches the expected status. This field should be zero.

Byte 32 through 35 – Expected Status The Expected Status field indicates the expected mail status of the mail entry point and is checked by the drive-based sequencer before each iteration.

Simple SendMail Reply

The tape drive uses the Simple SendMail Reply to inform the host that mail has been sent. The Simple SendMail Reply does not report the status of the mail. The following table shows what the reply looks like if you use _sDummy rather than _dSchedLink.

Byte	0	1	2	3
0	0	Reserved	EOD (3h)	Channel ID
4	CheckSum			

Advanced SendMail Reply

The tape drive uses the Advanced SendMail Reply to send the status of a mail function to the host. The status also contains the results of the mail function. Most mail functions can indicate results in ways other than the Advanced SendMail reply. For example, results can be indicated by updating the test results structure. However, Advanced SendMail reply is immediate and is in a simple form for a host-based sequencer to act on.

Byte	0	1	2	3
0	0	0	EOD (Eh)	Channel ID
4	CheckSum			
8	Actual status			
12	Link			
16	Parameter			
20	Successful iterations			

Byte 8 through 11 – Actual Status The Actual Status field is the result of the mail function expressed in the form *n*S_*. In this form, S means status and *n* is one of the following:

S – servo
L – logical
P – physical
D – diagnostics

Byte 12 through 15 – Link The Link field is the address/name of the mail function that finally responded to the initial mail command. This may not be the same as the specified mail function because once a mail function is executed the sequence of mail commands can end up anywhere in the mail entry point space.

Byte 16 through 19 – Parameter The Parameter field is used to further distinguish the mail status.

Byte 20 through 23 – Successful Iterations The Successful Iterations field indicates the number of consecutive times the actual status matched the expected status.

Library SendMail

The tape drive uses SendMail to allow a host to initiate tasks within the drive. However, if the tape drive is in a library, the library does not have full access to the tape drive's firmware symbol table information. Instead, the library must use the default symbol table information shown in Table 6-9 to initiate a SendMail request and then decode the returned status. The numbers represent the default symbol table index.

Table 6-9 Default symbol table for use by a library

	Eject a cartridge	Soft load a cartridge
Task	E9h (mcAsynch)	E9h (mcAsynch)
Mail	EAh (XE_ASYNCH_EVENT)	EAh (XE_ASYNCH_EVENT)
Link	48h (sDummy)	48h (sDummy)
Parameter	08h (SI_UNLOADBTTN) Symbol index: EBh	04h (SI_AUTOLOAD) Symbol index: ECh
Iterations	01h	01h
Good Status	0h (always returns zero)	0h (always returns zero)

Example of a Library Using SendMail

In this example, the library uses SendMail to eject a cartridge from the tape drive.

1. The library saves the "Max Index Value" and "Address of Default Symbol Table" values from the connect reply and verifies that the desired default symbols are within the range of the "Max Index Value."

2. The library confirms that the necessary parameter is listed in Table 6-9. In this case, the firmware number for SI_UNLOADBTTN is the parameter that the library needs to send to the tape drive in order to eject the cartridge.

   The library reads the value of SI_UNLOADBTTN from the tape drive's firmware and determines the address of the default symbol as described in Step 1. The firmware address of SI_UNLOADBTTN = (Address of the default symbol table) + ((EBh) * (4 bytes/entry)). For example, if the default symbol table's address is 0x1DF32C, then the address of SI_UNLOADBTTN is 0x1DF6D8.

3. The library constructs a Read Block Request to get the required hexadecimal value to send to the tape drive, as follows:

0C	00	01	04
Checksum (calculated by the host)			
00000006 (_dCoreReadBlock)			
001DF6D8 (Address)			
00000004 (Length)			

The tape drive replies with a status similar to the following:

04	00	03	04
Checksum (calculated by the drive)			
00000006 (Requested bytes – value of SI_UNLOADBTTN)			

4. The library issues a SendMail request to eject the cartridge, as follows:

1C	00	01	04
Checksum (calculated by the host)			
00000008 (_dCoreSendMail)			
000000E9 (Task)			
00000048 (Link)			
00000008 (Parameter)			
00000001 (Iterations)			
0000000 (Expected status. If iterations equals 1, this may be zero.)			

After the tape drive ejects the cartridge, it sends the library a reply similar to the following:

10	00	03	04
Checksum (calculated by the drive)			
0000000 (Actual status), ignored			
0000000 (Link), ignored			
0000000 (Parameter), ignored			
0000000 (Successful Iterations), ignored			

Read Block Request

The host uses the Read Block Request to request a specified number of bytes of data from a specified address in the tape drive memory.

Byte	0	1	2	3
0	16	Reserved	Request (1h)	Channel ID
4	CheckSum			
8	_dCoreReadBlock			
12	Address			
16	Length			

Byte 3 – Channel ID The Channel ID field indicates the channel identification number.

Byte 8 through 11 – _dCoreReadBlock The read function is called _dCoreReadBlock and it takes an address and length.

Byte 12 through15 – Address The starting address of the requested block. It is typically the address of a C data structure.

Byte 16 through 19 – Length The number of bytes in the requested block. It is limited to 64 bytes.

Read Block Reply

The tape drive uses Read Block Reply to send a block of data from its memory to the host.

Byte	0	1	2	3
0	4N	Reserved	EOD (3h)	Channel ID
4	CheckSum			
8	Word 1			
⋮	...			
8 + 4*n*	Word N			

Byte 3 – Channel ID The Channel ID field indicates the channel identification number.

Byte 8 through 8+ 4*n* These are the bytes contained in the data block.

6.5 Status Request

The Status Request is used to ask the tape drive for a drive status.

Byte	0	1	2	3
0	5h	Reserved	Request (1h)	Channel ID
4	CheckSum			
8	_dCoreStatusRequest			
12	Reply Page	Not used		

Byte 3 – Channel ID The Channel ID field indicates the channel identification number.

Bytes 8 through 11 – _dCoreStatusRequest The _dCoreStatusRequest takes a single parameter as described in byte 12.

Byte 12 – Reply Page The Reply Page byte contains a code that identifies the type of status the host is requesting. Currently, there are three types:

0 – Returns the same information as the Connect Reply. See page 6-9 for a description of the Connect Reply format.

1 – Returns LCD and Cart Status reply (library use). See page 6-22.

2 – Returns the Read/Write statistics (library use). See page 6-24.

Status Reply Page 1

The tape drive uses Status Reply Page 1 to provide the host with information about the drive's current state. The host then displays that information as it would appear on M2's LCD. The Cart Status byte on this page provides additional cartridge status information to allow a library application to determine when a cartridge has been loaded or ejected.

Byte	0	1	2	3
0	Length (16h)	Reserved	EOD (3h)	Channel ID
4	CheckSum			
8	Pkt Version	Reserved	Cart Status	Clean status
12	LCD String (characters 0-3)			
16	LCD String (characters 4-7)			
20	LCD String (characters 8-11)			
24	LCD String (characters 12-15)			
28	NULL (0×0)	Reserved	Temperature	Not used

Byte 8 – Pkt Version The Pkt Version field identifies the format of the data within this reply packet. Any changes to the length or content of this packet will cause this number to increment so that the host can readily identify incompatibility issues. The current value is 0.

Byte 10 – Cart Status The Cart Status byte contains individual flag bits indicating the state of the cartridge and load mechanism. Table 6-10 explains each bit from most significant (bit 7) to least significant (bit 0).

Table 6-10 Cartridge status bits

Bit #	Description
7	Tape is present
6	Tape is loaded
5	Loading in process
4	Unloading in process
3	An AME cartridge type is present
2	The cartridge is write protected
1	Unused
0	Unused

Byte 11 – Cleaning Status The Cleaning Status byte is set to 01h when the drive has determined that a cleaning cartridge should be inserted. Normally this byte equals 00h, indicating that the tape drive does not need cleaning.

Bytes 12 through 24 – LCD String The LCD String field contains the same information as M2's front panel LCD display. The LCD string is a combination of ASCII and special icon characters. The ASCII string is null terminated in byte 28.

Byte 30 – Temperature The Temperature byte contains the value most recently read from the drive's internal tape path thermistor in degrees Celsius.

Status Reply Page 2

Status Reply Page 2 provides information about the tape drive's current read /write performance and lifetime accumulators.

Byte	0	1	2	3
0	Length	Reserved	EOD (3h)	Channel ID
4	CheckSum			
8	Pkt Version	Density Code	Reserved	Reserved
12	Blocks Written			
16	Blocks Rewritten			
20	Blocks Read			
24	Blocks Requiring ECC			
28	Tape Remaining			
32	Tape Size			
36	Power on Seconds			
40	Tension Seconds			
44	Last Clean Time			

Byte 8 – Pkt Version The Pkt Version field identifies the format of the data within this reply packet. Any changes to the length or content of this packet will cause this number to be incremented so that the host can readily identify incompatibility issues. The current value is 0.

Byte 9 – Density Code Specifies the format the tape drive used to read or write data.

Byte 12 through 15 – Blocks Written Specifies the number of blocks written to tape.

Byte 16 through 19 – Blocks Rewritten Specifies the number of blocks that were rewritten.

Byte 20 through 23 – Blocks Read Specifies the number of blocks read.

Byte 24 through 27 – Blocks Requiring ECC Specifies the number of blocks that required error correction.

Byte 28 through 31 – Tape Remaining Specifies the amount of tape remaining in 1 kilobyte blocks.

Byte 32 through 35 – Tape Size Specifies the total number of 1 kilobyte blocks on the tape.

Byte 36 through 39 – Power on Seconds Specifies how long the tape drive has been powered on in seconds.

Byte 40 through 43 – Tension Specifies how long the tape has been tensioned in seconds.

Byte 44 through 47 – Last Clean Time Indicates the time the tape drive was last cleaned.

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Contacting Exabyte

For specific integration issues, contact your Exabyte Account Representive. For other issues, contact Exabyte using any of the following methods:

For technical support	
Exabyte Technical Support	1-800-445-7736
	1-303-417-7792
	1-303-417-7160 (fax)
e-mail	support@exabyte.com
World Wide Web	www.exabyte.com www.mammothtape.com www.m2wins.com
To order supplies and accessories	
Exabyte	1-800-774-7172 or 1-800-392-8273
To return equipment for service	
Exabyte Service	1-800-445-7736
	Scotland: + 44-1-324-564564
e-mail	service@exabyte.com

Note: If it is more convenient to your location, contact Exabyte Technical Support in Europe at the following numbers:

Phone:+ 31-30-254-8890
Fax: + 31-30-258-1582