Mammoth-LT Tape Drive

Product Specification

Exabyte®

340230-000

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Revision History

Revision	Date	Description
000	February 1999	Initial release.

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

Exabyte Corporation
1685 38th Street
Boulder, Colorado 80301
(303) 442-4333

340230-000

Product Warranty Caution

The Exabyte® Mammoth-LT 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-LT 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 this manual.

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 Specification

This product specification provides functional, performance, and environmental specifications for the Exabyte® Mammoth-LT Tape Drive. It is intended for engineering, marketing, or purchasing personnel who are evaluating the tape drive to determine the feasibility of integrating it into product lines.

How This Manual is Organized

Chapter 1 through Chapter 5 provide specifications and information about both the internal and tabletop models of the tape drive. Appendix A provides additional specifications for the tabletop model.

Related Publications

Exabyte Mammoth-LT Tape Drive

- *Exabyte Mammoth-LT Tape Drive Installation and Operation*, 326984-000
- *Exabyte Mammoth Tape Drive SCSI Reference*, 306483

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 *Helical-Scan Digital Computer Tape Cartridge*, X3B5/89-136, Rev. 6
- ANSI/ISO/IEC 11319-1993 and ECMA-145, *Information Technology – 8mm Wide Magnetic Tape Cartridge for Information Interchange*, July 1992
- Standard ECMA-169, *8mm Wide Magnetic Tape Cartridge Dual Azimuth Format for Information Interchange, Helical Scan Recording*, June 1992
- Standard ECMA-249, *8mm Wide Magnetic Tape Cartridge for Information Interchange – Helical Scan Recording – DA-2 Format*, June 1998

Conventions

This manual uses the conventions shown below to highlight notes, important information, and cautions. Take special note of boxed text. Failure to follow cautions can result in equipment damage.

Note: Read *Notes* for additional information or suggestions about the topic or procedure being discussed.

➤ **Important** Read the information in *Important* notices to learn crucial information about the topic being discussed.

CAUTION

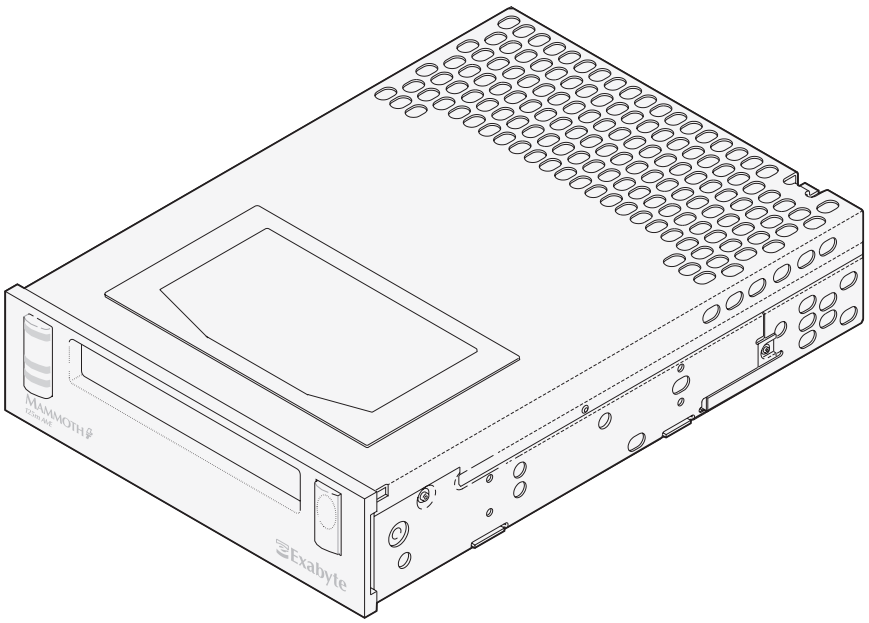
Read the information in *CAUTION* boxes to learn how to avoid damaging the library or tape drive or losing data.

1 Features

The Exabyte® Mammoth-LT Tape Drive is a high-speed, high-capacity tape drive designed to meet the growing demands for data storage in such areas as enterprise-wide networks, data acquisition, image processing, video-on-demand, and multimedia.

The tape drive transfers data at a rate of up to 4 megabytes per second with 2:1 compression, and can store up to 28 gigabytes of compressed data on a single data cartridge. The tape drive uses advanced metal evaporated (AME) tape, which provides a greater capacity than the metal particle (MP) tape used with previous generations of Exabyte products.

The tape drive supports the industry-standardized Tape Alert method for reporting errors and potential difficulties with the tape drive and media. The tape drive's internal Tape Alert firmware constantly monitors the tape drive and media for errors and potential difficulties that could have an impact on backup quality. It reports any problems using a standard set of messages.



Available Configurations

The tape drive is available in two SCSI configurations and as either an internal or tabletop model.

SCSI Configurations

The tape drive is available in the following configurations:

- Single-ended narrow
- Low-voltage differential (LVD) wide

The LVD tape drive uses an interface that is Ultra and Ultra2 SCSI compatible. The LVD interface allows the tape drive to be placed on the same bus as Ultra and Ultra2 SCSI devices without slowing the performance of these devices.

In a narrow SCSI configuration, up to eight devices (including one or more initiators) can be attached to a single SCSI bus. SCSI IDs can range from 0 to 7. In a wide SCSI configuration, up to 16 devices (including one or more initiators) can be attached to a single SCSI bus. SCSI IDs can range from 0 to 15 on a single bus.

The tape drive supports fast synchronous transfer mode. See Chapter 3 for more information about the SCSI interface.

Internal or Tabletop Model

The internal model of the tape drive conforms to a 5.25-inch, half-high form factor and can easily be integrated into your own system. The tabletop model is an external peripheral housed in an Exabyte enclosure, complete with power supply and cooling fan.

Note: See Appendix A for additional specifications that apply only to the tabletop model.

Figure 1-1 shows the internal and tabletop models.

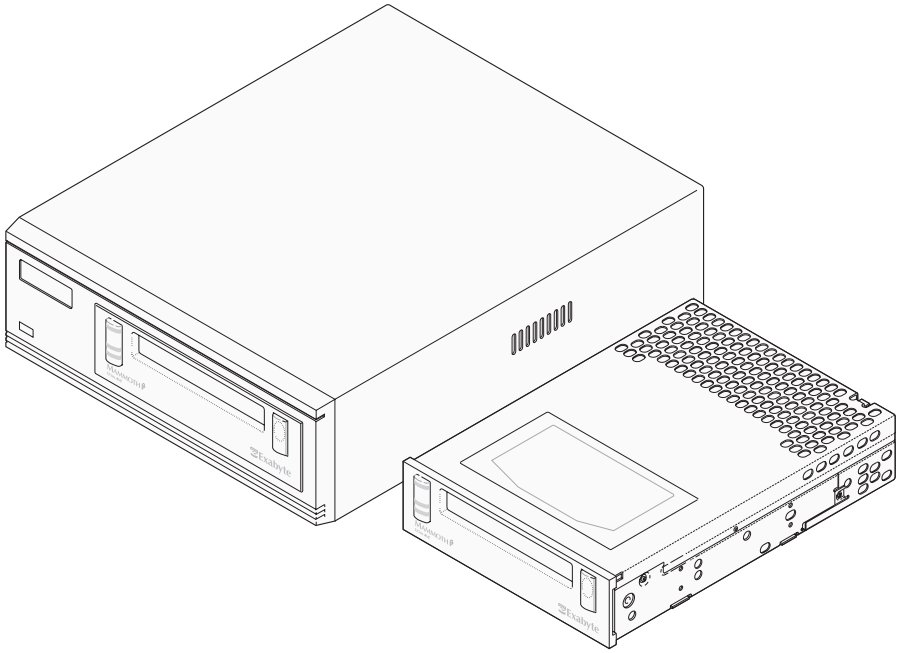


Figure 1-1 Tabletop and internal models of the tape drive

Size and Weight

Table 1-1 provides the dimensions and weight of the internal tape drive. Figure 1-2 shows the tape drive dimensions. See Appendix A for size and weight of the tabletop model.

Table 1-1 Dimensions and weight of the internal tape drive

Height **without faceplate** **with faceplate**	 1.62 inches (41.2 mm) 1.68 inches (42.7 mm)
Width **without faceplate** **with faceplate**	 5.75 inches (146.0 mm) 5.87 inches (149.1 mm)
Depth[a] **without faceplate** **with faceplate**	 8.00 inches (203.2 mm) 8.20 inches (208.2 mm)
Weight	2.9 pounds (1.3 kilograms)

[a] The LVD connector extends an additional 0.36 inches (9.1 mm) beyond the back edge of the tape drive chassis.

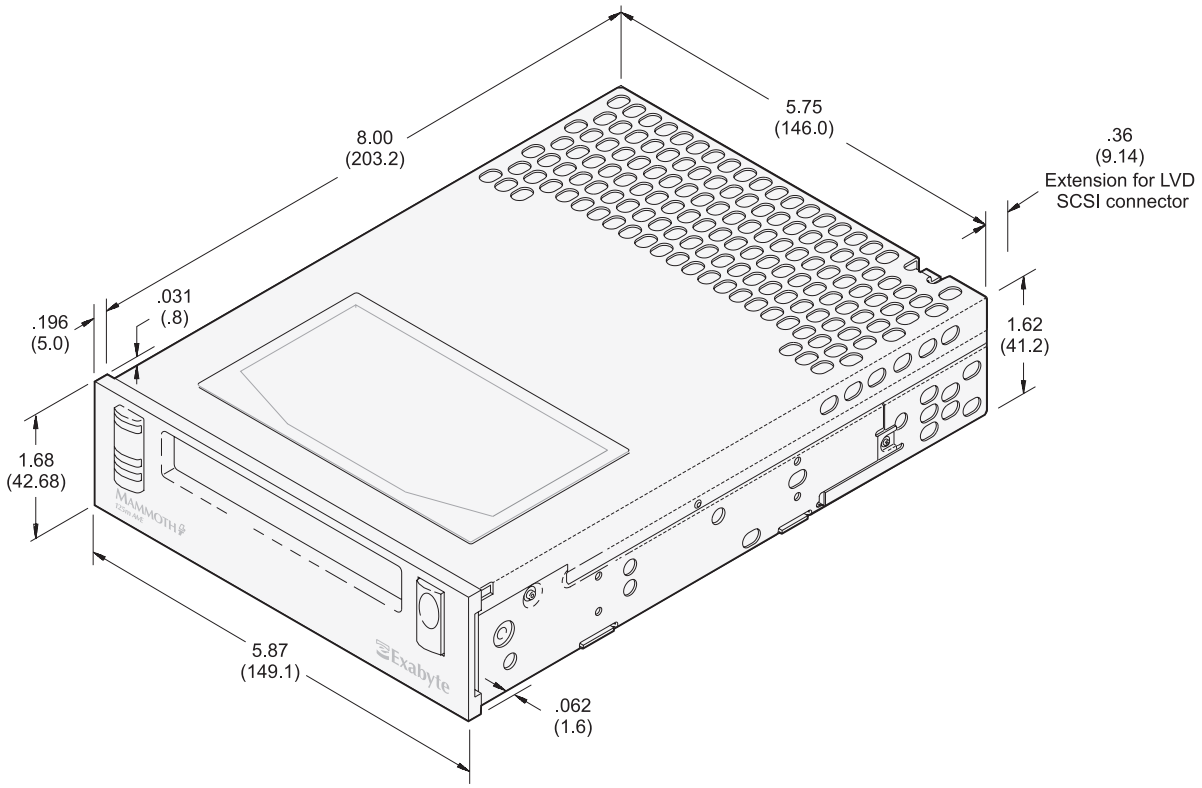


Figure 1-2 Dimensions of the tape drive in inches (and millimeters)

Components

This section describes the major components of the tape drive. For a description of the tabletop's additional components, see Appendix A.

Front Panel Controls and Indicators

Figure 1-3 shows the controls and indicators on the front panel of the tape drive. For more information about using these controls and indicators, see Chapter 2.

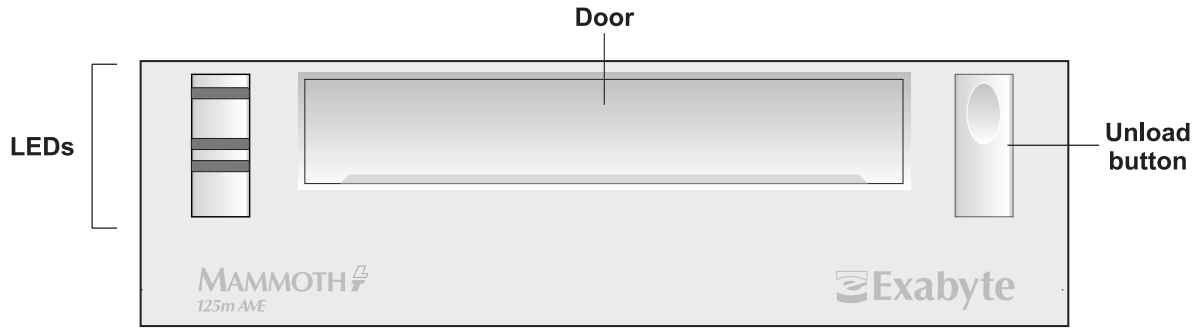


Figure 1-3 Front panel components

Door and faceplate The standard color for the door and faceplate is pearl white. Exabyte can provide custom colors at an additional cost.

Unload button Pushing the unload button causes the tape drive to unload the tape and eject the data cartridge. Pushing and holding this button for 10 seconds also causes the tape drive to initiate an internal reset.

LEDs Three light emitting diodes (LEDs) on the front panel give status information.

Back Panel Components

The location and appearance of the back panel components depend on whether the tape drive uses narrow SCSI (Figure 1-4) or wide SCSI (Figure 1-5).

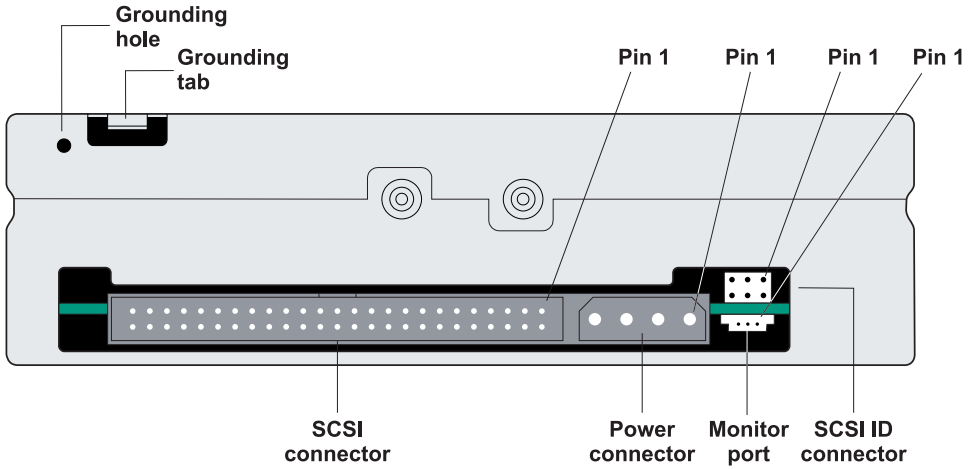


Figure 1-4 Narrow SCSI: back-panel components

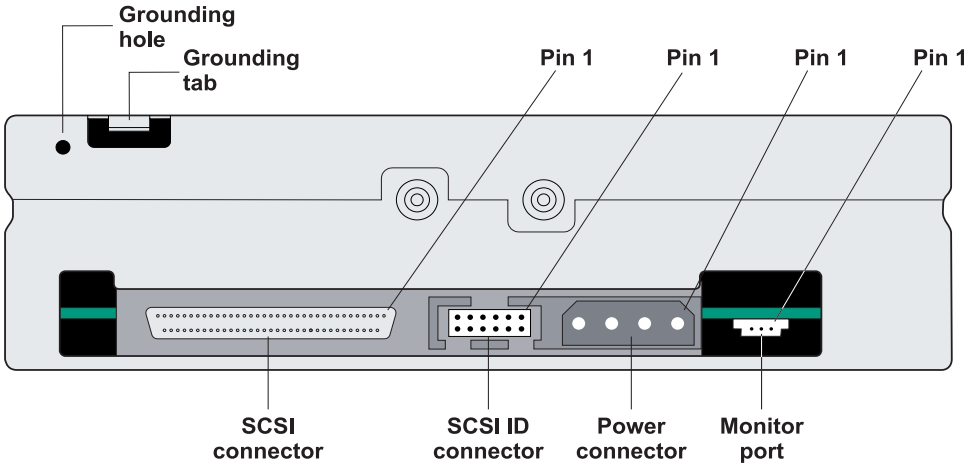


Figure 1-5 Wide SCSI: back-panel components

Grounding tab and grounding hole The tape drive includes a grounding tab and grounding hole for additional chassis grounding.

SCSI connector The SCSI connector allows you to connect the tape drive to the SCSI bus. The single-ended, narrow SCSI configuration uses a 50-pin connector; the LVD wide SCSI configuration uses a 68-pin connector.

> **CAUTION**
>
> All wide SCSI configurations use the same 68-pin connector. Do not connect a low-voltage differential (LVD) wide tape drive to a high-voltage differential (HVD) wide SCSI bus. Doing so may cause the SCSI bus to hang.

Power connector The 4-pin power connector is compatible with the power connector used for standard 5.25-inch half-high devices.

SCSI ID connector The SCSI ID connector enables you to set the SCSI ID by using jumpers or a remote switch.

Monitor port The Monitor port provides a serial interface to the tape drive's microprocessor. Using a diagnostic program, such as Exabyte's Mammoth Monitor, you can load code and perform diagnostics through a serial cable attached to this port.

Internal Components

Figure 1-6 shows the internal components of the tape drive.

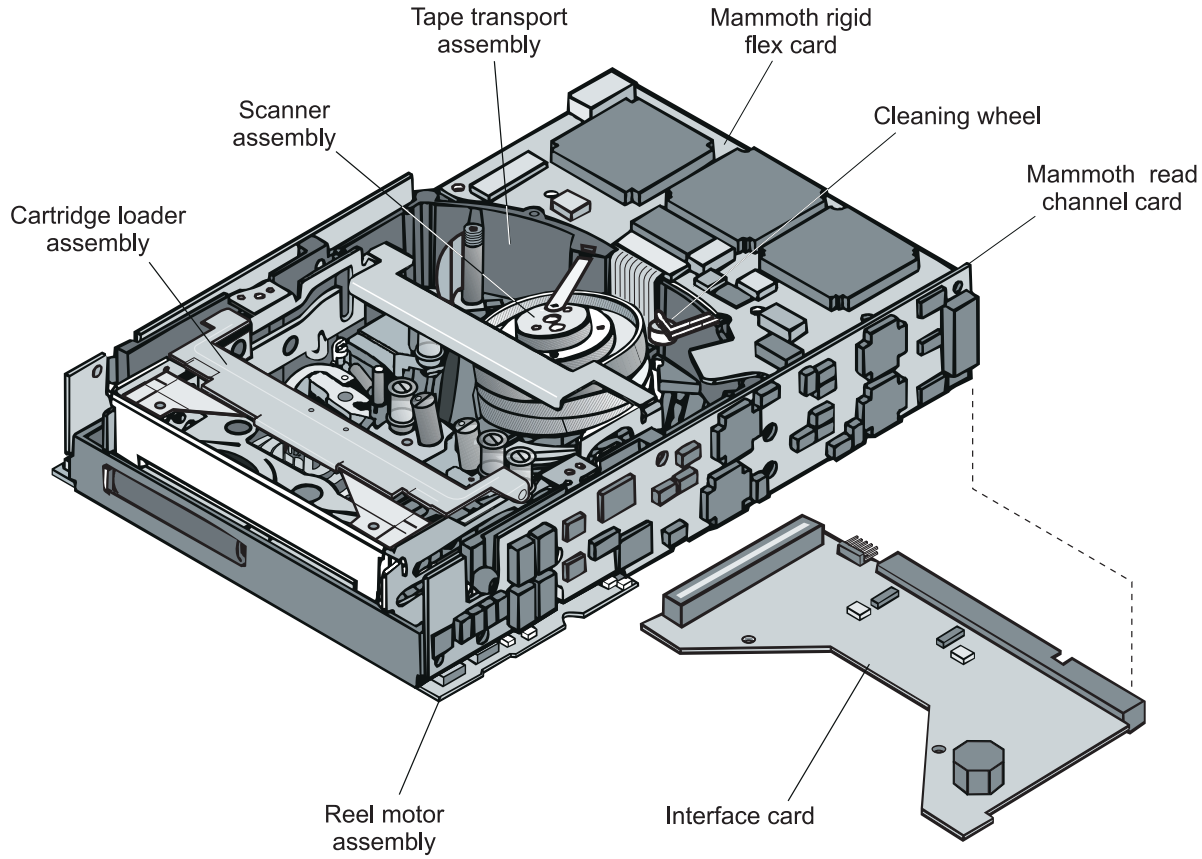


Figure 1-6 Internal components

Mammoth rigid flex (MRF) card The rigid flex card contains the microprocessor system that controls the data path, system interface, servo, and sensor functions. This card also contains the compression engine, buffer controller, ECC, and track formatting circuits.

Mammoth read channel (MRC) card The read channel card contains equalizer and data synchronizing circuits.

Interface card The interface card provides the communications interface to the SCSI bus. Two SCSI interface cards are available for the tape drive: single-ended narrow and LVD wide. You select the type of card when you order the tape drive.

Reel motor assembly The reel motor assembly contains the reel motors and the cartridge recognition sensors.

Cartridge loader assembly The cartridge loader assembly includes the cartridge load mechanism and the cartridge load motor.

Scanner assembly The scanner assembly includes a rotating scanner with read and write heads, and the scanner motor.

Tape transport assembly The tape transport assembly contains the tape path load components, tape guiding elements, shock mounts, and card mounts.

Dynamic head cleaner (cleaning wheel) The dynamic head cleaner, or cleaning wheel, includes a small covered wheel attached to the end of a mechanical arm. The wheel makes contact with the scanner and heads each time a tape is loaded or unloaded. The dynamic head cleaner reduces the amount of media residue buildup on the heads, increasing the life of the heads and reducing the potential for soft errors that may occur during normal read and write operations.

The cleaning wheel is activated every time media is loaded or unloaded. 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.

Labels

The product ID label on the internal tape drive, shown in Figure 1-7, shows the machine level change history (MLCH), serial number, and SCSI configuration. The SCSI ID label on the bottom of the tape drive, shown in Figure 1-8, illustrates the tape drive SCSI ID settings. (See Appendix A for the tabletop model's label locations.)

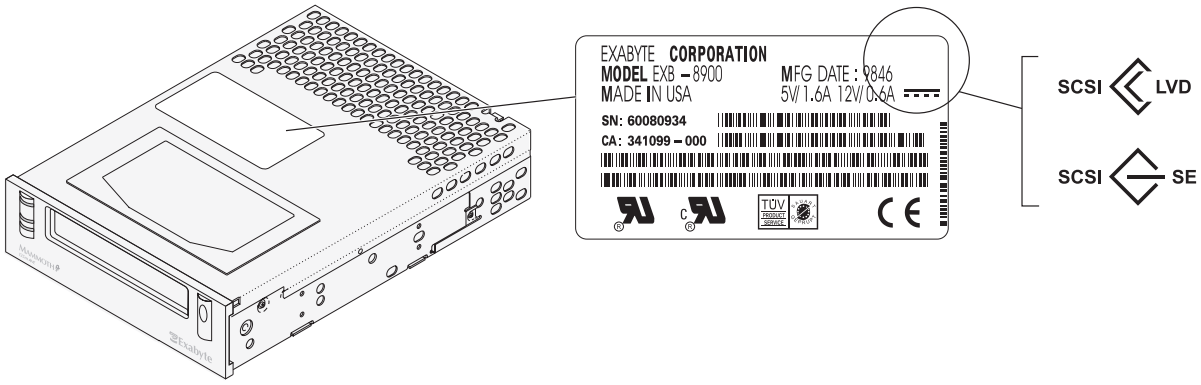


Figure 1-7 Product ID label location for the internal model

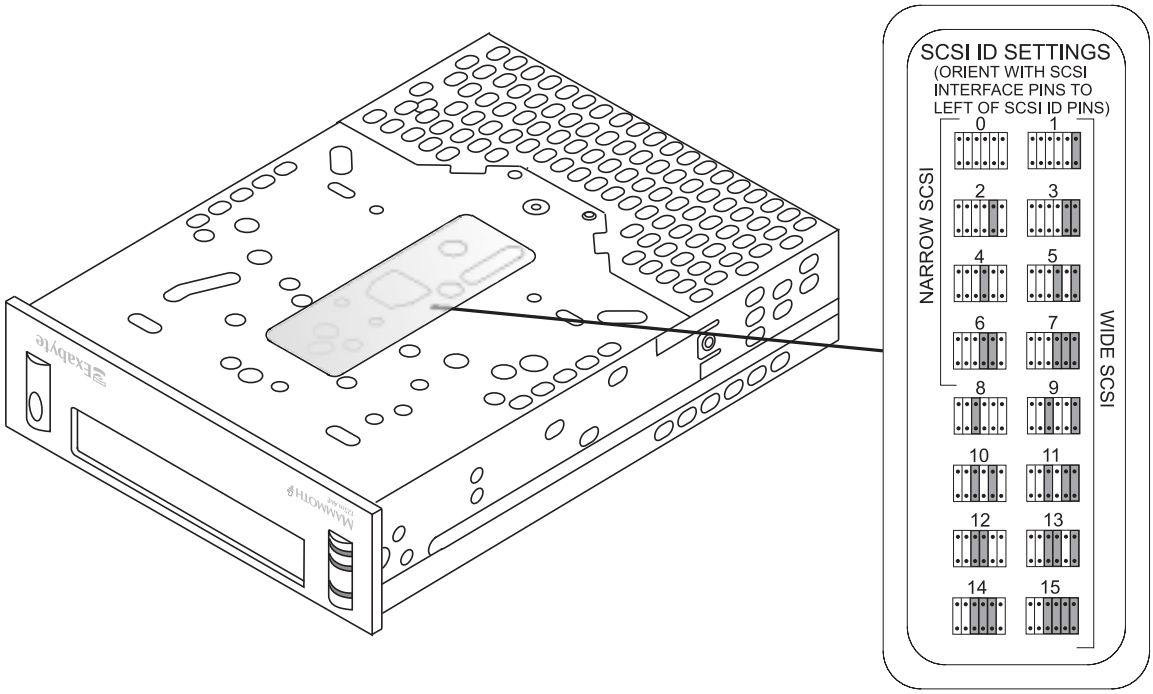


Figure 1-8 SCSI ID label location for the internal model

2 Installation and Operation

This chapter provides information about installing and operating the Exabyte Mammoth-LT tape drive.

Installation in an Enclosure

Installing the internal model of the tape drive in an enclosure involves these steps:

- Setting the SCSI ID
- Mounting the tape drive
- Connecting the SCSI cable
- Terminating the tape drive, if it is the last device on the SCSI bus
- Grounding the tape drive
- Connecting the tape drive to power

Note: See Appendix A for information about installing the tabletop model.

Setting the SCSI ID

The SCSI ID is set at the factory to a number from 0 through 7 for narrow SCSI, and 0 through 15 for wide SCSI. You can change the SCSI ID for the internal tape drive by using the back panel jumpers or by installing a remote switch.

Figure 2-1 and Figure 2-2 show the location of the SCSI ID connector for narrow and wide SCSI, respectively.

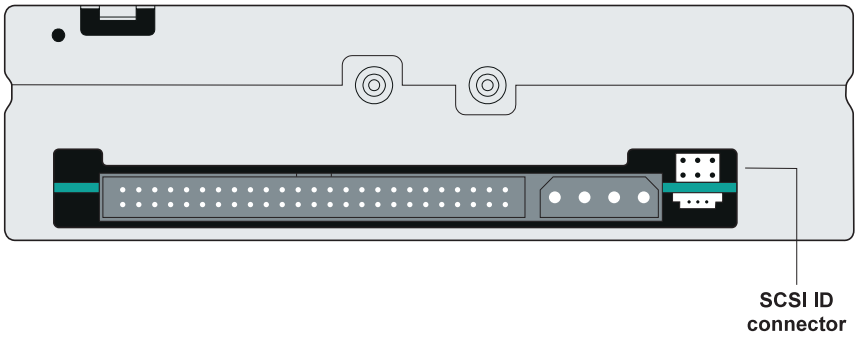


Figure 2-1 Narrow SCSI: SCSI ID connector location

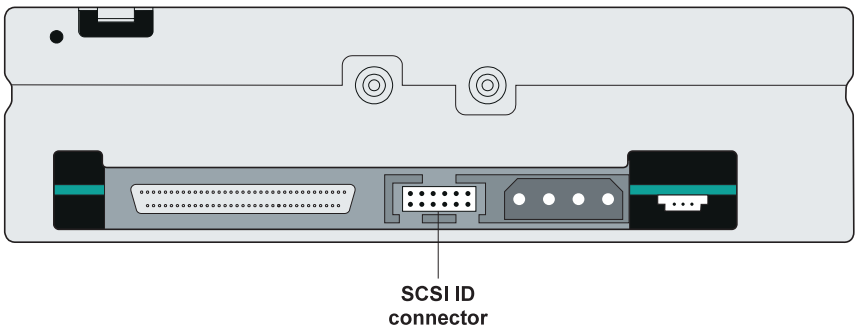


Figure 2-2 Wide SCSI: SCSI ID connector location

SCSI ID Jumpers

You can set the SCSI ID by repositioning the jumpers included with the tape drive. The SCSI ID label on the bottom of the tape drive, shown in Figure 1-8 on page 1-10, shows the SCSI ID settings for both narrow and wide SCSI interfaces.

If you need additional jumpers:

- **For a narrow SCSI interface**, use a 0.1-inch jumper (for example, AMP part number 531220-2).
- **For a wide SCSI interface**, use a 2 mm mini jumper (for example, AMP part number 382575-2).

Remote Switch

You can set the SCSI ID by removing the jumpers and connecting a remote switch (not included) to the SCSI ID connector.

- **For a narrow SCSI interface**, use a female Molex® 2061 or equivalent cable connector to control the address remotely. This part is not a pre-made switch, but allows you to connect a remote SCSI switch of your own design. The Molex connector is used for discrete wires.
- **For a wide SCSI interface**, use an AMP part number 1-111623-7. The AMP part is used with a ribbon cable; AMP does not currently offer a discrete wire version. The connector mates to all 12 of the pins on the wide connector; however, only the right-most eight pins are used for the SCSI ID (the four left-most pins are currently reserved for future use).

Mounting the Tape Drive

The single-ended internal tape drive meets industry-standard, 5.25-inch half-high form factor mounting requirements. The LVD internal tape drive is approximately 0.36 inches (9.2 mm) longer than industry-standard form factor. The tape drive can be mounted either horizontally or vertically and in a stationary or sliding position.

As shown in Figure 2-3, the main housing of the tape drive includes three sets of four mounting holes to 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).

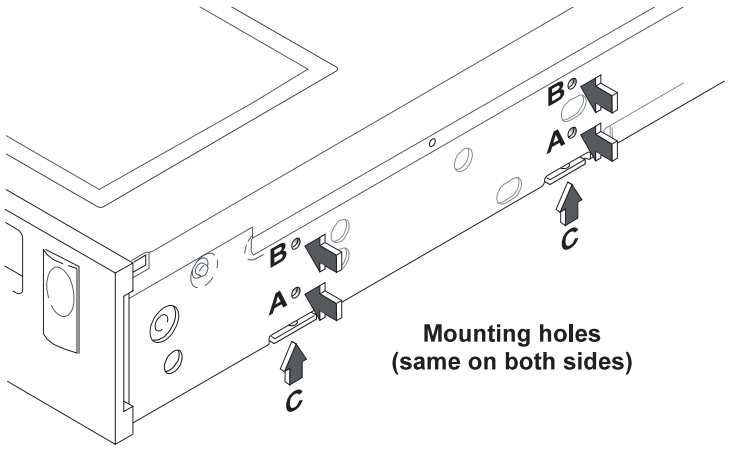


Figure 2-3 Mounting holes

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, with a maximum intrusion of 6 millimeters. **For proper mounting, use the correct screw length.**
- Ensure that the tape drive is securely mounted and that the chassis is not subject to distortion.
- Ensure that no objects such as screw heads, cables, or adjacent devices are pressing against the frame.
- Do not obstruct the tape drive's ventilation slots. This ensures that the tape drive can be adequately cooled. Clearance is also needed at the rear panel to allow adequate air flow through the unit.

Figure 2-4 shows the locations of the mounting holes.

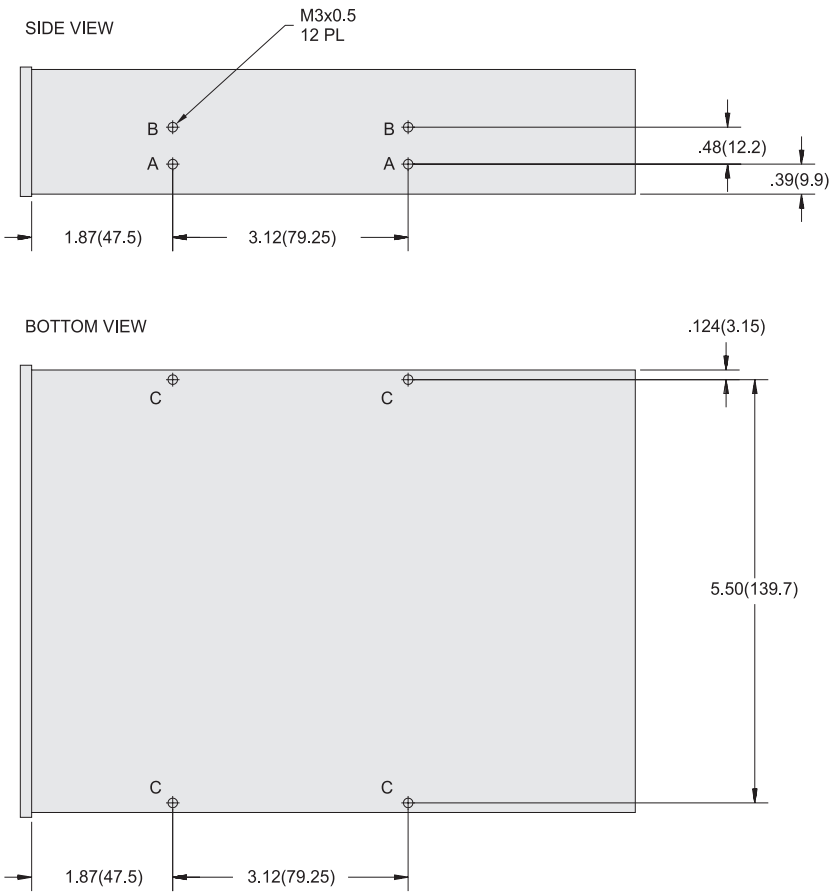


Figure 2-4 Mounting hole dimensions in inches (and millimeters)

Connecting the SCSI Cable

The SCSI cable connected to the internal tape drive must conform to the specifications outlined in this section.

Although you can connect single-ended and LVD tape drives to the same SCSI bus, mixing the two types of devices will result in all devices on the bus operating as single-ended devices. Refer to the product ID label (see Figure 1-7 on page 1-10) to determine the SCSI configuration of your tape drive.

> **CAUTION**
>
> All wide SCSI configurations use the same 68-pin connector. Do not connect a low-voltage differential (LVD) wide tape drive to a high-voltage differential (HVD) wide SCSI bus. Doing so may cause the SCSI bus to hang.

Cable Length

The maximum length of the SCSI cable depends on whether you are using a single-ended narrow or LVD wide configuration, as follows:

- **For a single-ended narrow configuration**, the maximum allowable bus length is 3 meters (9.8 feet). A bus length up to 6 meters is acceptable if the transfer rate is less than 5 MB/second. A stub length of no more than 0.1 meters (4 inches) is allowed off the mainline interconnection within any connected equipment.

- **For an LVD wide configuration**, the maximum allowable bus length is 12 meters (39 feet) if you have more than two devices on the bus. If the bus is a point-to-point configuration (two devices–the target and the initiator), the bus length can be up to 25 meters (82 feet). A stub length of no more than 0.1 meters (4 inches) is allowed off the mainline interconnection within any connected equipment.

The stub length within the tape drive is less than 80 mm.

SCSI Cable Connector Requirements

The SCSI cable must have one of the following connectors:

- **For a single-ended narrow SCSI configuration:** 50-pin female, AMP 1-746285-0
- **For an LVD wide SCSI configuration:** 68-pin male, AMP 786090-7

The following tables show the connector pin assignments for each configuration.

Table 2-1 Single-ended narrow SCSI connector pin assignments

Signal	Pin number		Signal
GROUND	1	2	–DB(0)
GROUND	3	4	–DB(1)
GROUND	5	6	–DB(2)
GROUND	7	8	–DB(3)
GROUND	9	10	–DB(4)
GROUND	11	12	–DB(5)
GROUND	13	14	–DB(6)
GROUND	15	16	–DB(7)
GROUND	17	18	–DB(P)
GROUND	19	20	GROUND
GROUND	21	22	GROUND
OPEN	23	24	OPEN
OPEN	25	26	TERMPWR
OPEN	27	28	OPEN
GROUND	29	30	GROUND
GROUND	31	32	–ATN
GROUND	33	34	GROUND
GROUND	35	36	–BSY
GROUND	37	38	–ACK
GROUND	39	40	–RST
GROUND	41	42	–MSG
GROUND	43	44	–SEL
GROUND	45	46	–C/D
GROUND	47	48	–REQ
GROUND	49	50	–I/O

Table 2-2 LVD wide SCSI 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)

Impedance

Ideally, to match the cable terminators, the cable should have the characteristic impedance shown in Table 2-3.

Table 2-3 Ideal characteristic impedances for SCSI cables

Single-ended narrow	LVD wide
132 ohms	110 ohms

➤ **Important** To minimize discontinuities and signal reflections, Exabyte recommends that cables used on the same bus have the same impedances.

Primary Conductor

A minimum primary conductor size of 28 AWG is recommended to minimize noise effects and ensure proper distribution of terminator power.

Terminating the Tape Drive

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.

Use one of the terminator types listed below or an equivalent. Terminators for single-ended and LVD buses are not identical. Do not mix the variants.

- **For a single-ended narrow SCSI configuration:** AMP 750381-1
- **For an LVD wide SCSI configuration:** AMP 796051-1 (SE/LVD multi-mode)

➤ **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.

Grounding the Tape Drive

To protect the tape drive from electrostatic discharge (ESD), you must attach the tape drive to the enclosure's metal chassis (using the mounting holes shown in Figure 2-3). If you need additional chassis grounding, use *either* of the following methods:

- Connect a ¼-inch female spade connector to the grounding tab.
- Connect an M3×0.5×6 mm self-tapping screw to the grounding hole.

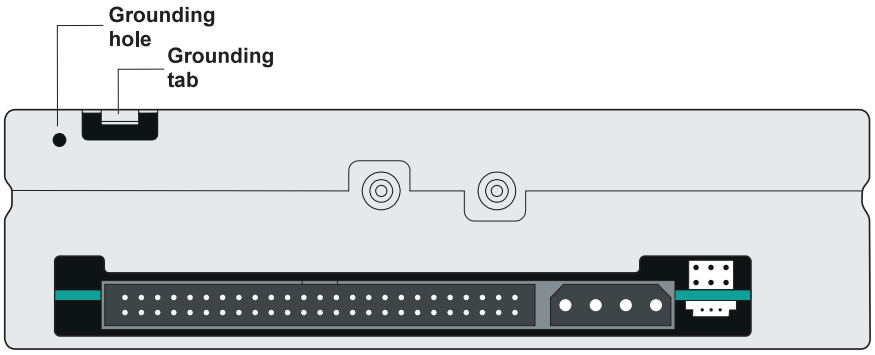


Figure 2-5 Grounding tab and grounding hole (single-ended narrow shown)

Note: The power supply returns are connected to the chassis, so you cannot isolate logic common ground from chassis ground.

Connecting Power

The internal tape drive's power connector is compatible with power connectors used for standard 5.25-inch, half-high devices. Use an AMP 1-480424-0 series or equivalent female power connector.

Figure 2-6 and Figure 2-7 show the location of the power connector on the single-ended narrow and LVD wide SCSI tape drives, respectively.

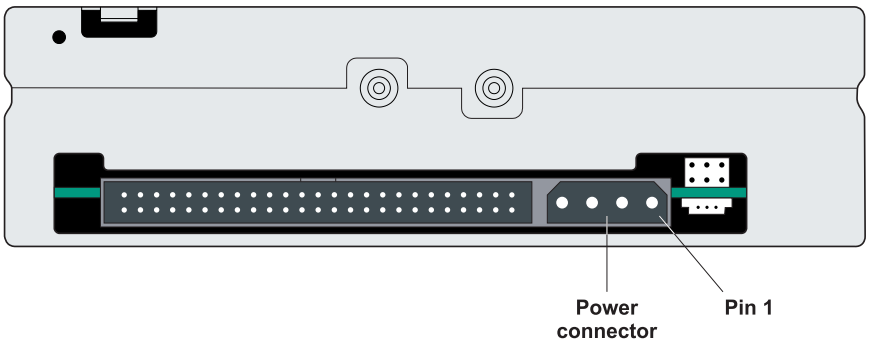


Figure 2-6 Power connector location (single-ended narrow)

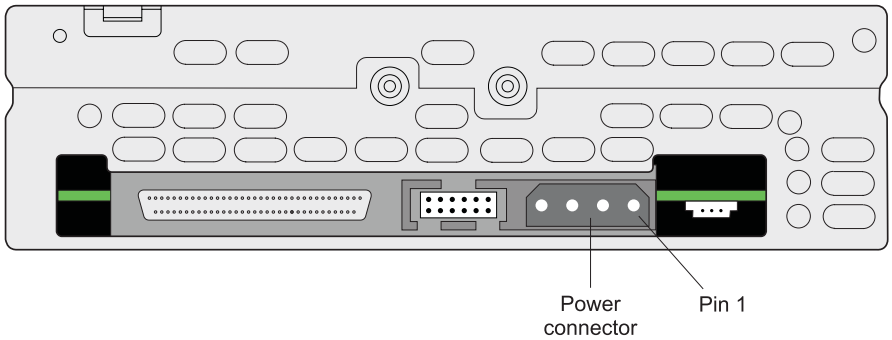


Figure 2-7 Power connector location (LVD wide)

Table 2-4 lists the pin assignments for the power connector.

Table 2-4 Pin assignments for power connector

Pin number	Assignment
1	+ 12 VDC
2	Ground, 12 VDC return
3	Ground, 5 VDC return
4	+ 5 VDC

Tape Drive Operation

Tape drive operation involves these procedures:

- Using data cartridges
- Monitoring the LEDs
- Cleaning the tape drive with a cleaning cartridge
- Resetting the tape drive (if an error occurs)

Figure 2-8 shows the controls and indicators for operating the tape drive.

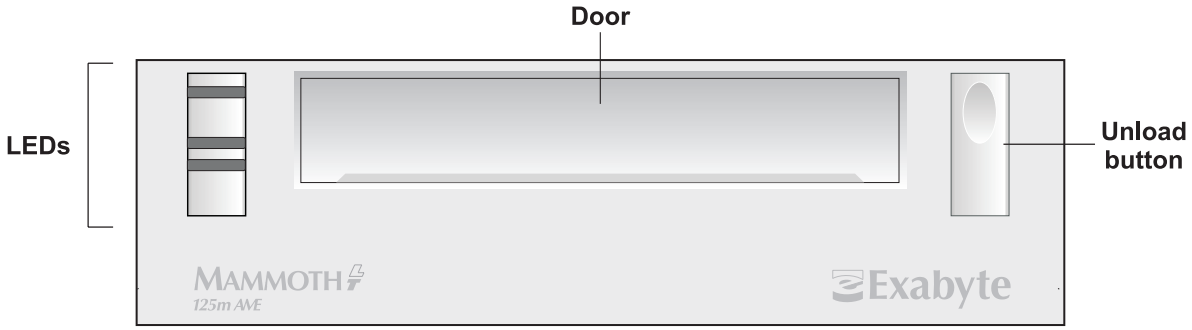


Figure 2-8 Front panel controls and indicators

Using Data Cartridges

The tape drive uses data-quality, 8mm advanced metal evaporated (AME) Exatape™ data cartridges, available from Exabyte in 22m and 125m lengths. These cartridges require no formatting or other media conditioning before use.

Table 2-5 provides data capacities for each length of cartridge.

Table 2-5 Data capacities of Exatape AME data cartridges

Length	Compressed (2:1 compression ratio)	Uncompressed
125m	28 gigabytes	14 gigabytes
22m	5 gigabytes	2.5 gigabytes

➤ **Important** The Mammoth-LT tape drive does not support the Exatape 170m AME tape length. If you try to insert this tape, the tape drive automatically ejects it.

The tape drive can also read data from metal particle (MP) tape when it is written in one of the following formats: 8500c, 8500, or 8200. The tape drive cannot read data written in 8200c format.

➤ **Important** Although the tape drive can read data from metal particle tape, it cannot write data to this type of tape. You must use Exatape data-grade advanced metal evaporated (AME) media for writing data.

Manually Loading and Unloading a Cartridge

To load a cartridge, insert it into the tape drive door. The tape drive loads the tape in approximately 20 seconds. When the middle LED is on, the tape drive is ready for read and write operations.

To unload a cartridge, press the unload button. The tape drive then completes any command in process, writes any buffered information to tape, rewinds to the beginning of the tape, and ejects the cartridge.

Monitoring the LEDs

The tape drive contains three LEDs for indicating its operational status. The LEDs have the following general meanings:

- **Top LED (amber)**. When this LED is flashing, an error has occurred. When this LED is on, the tape drive needs to be cleaned.
- **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.

Table 2-6 shows the LED combinations that occur during normal tape drive operation.

Note: You may occasionally observe LED combinations and sequences not described in the table. These other combinations represent special or unusual conditions that are beyond the scope of this table.

Table 2-6 LED states

	Tape Drive State							
	POST 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**
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	❊

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

Cleaning the Tape Drive

The Exabyte Mammoth-LT features an integrated dynamic head cleaner (cleaning wheel) for automatic self-cleaning of the recording heads and scanner. The cleaning wheel is activated every time media is loaded or unloaded. 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.

The self-cleaning action of the dynamic head cleaner typically extends the interval between manual cleanings to 72 tape motion hours. The interval depends on the number of tape motion hours and the type of tape being used (MP or AME). When cleaning is required, the top LED turns on. To help maintain data integrity and reliability, you should clean the tape drive as soon as possible after the LED turns on.

Note: The top LED turns on after 72 hours of AME cartridge use and after 10 hours of MP cartridge use.

➤ **Important** When you insert an AME cartridge after reading MP tape, the top LED turns on and the cartridge is ejected. Before you can use the AME tape, you must clean the tape drive with an Exabyte Mammoth Cleaning Cartridge (or a cleaning cartridge approved by Exabyte for use with Mammoth-LT).

Resetting the Tape Drive

You can use either of the following methods to reset the tape drive:

- Power the tape drive off and back on again.
- Press and hold the unload button for at least 10 seconds, then release the button. This clears any error and resets the tape drive.

3 SCSI Interface

This chapter provides an overview of the tape drive's SCSI interface, including supported messages and commands. For detailed information, refer to the *Exabyte Mammoth Tape Drive SCSI Reference.*

SCSI Features

The tape drive SCSI implementation includes the following features:

- Support for single-ended narrow or low-voltage differential (LVD) wide SCSI configurations (see page 3-2 for more information)
- Support for the Tape Alert tape drive status monitoring and messaging utility (see page 3-2 for more information)
- SCSI bus parity checking configurable through the MODE SELECT command
- Support for multiple SCSI hosts
- Support of the disconnect, reconnect and arbitration features

The SCSI implemented for the tape drive conforms to the following standards for a sequential access device:

- 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

Low-Voltage Differential SCSI

Low-voltage differential (LVD) SCSI offers the following performance advantages of the differential SCSI interface over single-ended SCSI:

- Noise immunity
- Insensitivity to ground shifts
- Reduced electromagnetic interference
- Extended cable lengths

However, unlike the high-voltage versions of the differential interface (HVD), LVD SCSI operates at a low voltage, allowing it to be fully compatible with existing single-ended SCSI buses. Unique circuitry in the tape drive determines the type of SCSI bus the tape drive is being used on, LVD or single-ended, and automatically configures drive operation to the appropriate bus capability.

➤ **Important** Using an LVD tape drive on a single-ended bus causes the tape drive to operate as a single-ended device. This eliminates the performance advantages provided by the differential interface.

Tape Alert

Tape Alert provides a standardized method for reporting errors and potential difficulties with the tape drive and media. The tape drive's internal Tape Alert firmware constantly monitors the tape drive and the media for errors and potential difficulties that could have an impact on backup quality. Any problems identified are flagged on the Tape Alert page returned by the LOG SENSE SCSI command.

When the tape drive is used with Tape Alert-compatible backup software, the software automatically reads the log page after the completion of each backup. If an error is flagged, the backup software displays a clear warning message, suggests a course of action to remedy the problem, and adds the Tape Alert message to its logs.

Table 3-1 lists the Tape Alert flags used by the tape drive. Each parameter is one byte long. Bit 0 contains the value for the flag, as follows:

0 – The flag is not currently set.
1 – The flag is currently set.

The remaining seven bits of the flag are not used.

Note: Issuing a LOG SENSE command that returns the Tape Alert page resets all of the flags to 0. The flags are also reset whenever the tape drive is reset and when the condition indicated by the flag is corrected.

Table 3-1 Tape Alert flags used by the tape drive

Flag Name	Type[a]	Description
Read	W	The tape drive is having problems reading data. No data has been lost, but there has been a reduction in the capacity of the tape.
Write	W	The tape drive is having problems writing data. No data has been lost, but there has been a reduction in the capacity of the tape.
Hard Error	W	A hard read/write error has occurred. The current operation has stopped because the tape drive cannot correct an error that occurred while the tape drive was reading or writing data.
Media	C	Media performance is severely degraded. The data is at risk. To safe guard the data on this tape, do the following: ▪ Copy any data you want to preserve to another tape. ▪ Do not use this tape again. ▪ Restart the current operation using a different tape. **Note:** The Tape History Log (THL) option must be enabled in the tape drive's EEPROM.
Read Failure	C	The tape drive can no longer read data from the tape. Either the tape is damaged or the tape drive is not operating correctly. ▪ Try reading data from a known good tape. If you can read this tape, replace the damaged tape. ▪ If the problem persists, contact Exabyte Technical Support.
Write Failure	C	The tape drive can no longer write data to the tape. Either the tape is damaged or the tape drive is not operating correctly. ▪ Try reading data from a known good tape. If you can read this tape, replace the damaged tape. ▪ If the problem persists, contact Exabyte Technical Support.
Media Life	W	The tape is past its specified life cycle. The data cartridge has reached the end of its useful life. ▪ Copy any data you want to preserve to another tape. ▪ Do not use this tape again. **Note:** The Tape History Log (THL) option must be enabled in the tape drive's EEPROM.
Not Data Grade	W	The tape drive cannot read the MRS stripes on the tape. The tape is not data grade. Any data you back up onto the tape is at risk. Replace the cartridge with one containing data-grade tape (for example, Exatape).

Table 3-1 Tape Alert flags used by the tape drive (*continued*)

Flag Name	Type[a]	Description
Write Protect	C	The initiator attempted to write to a write-protected data cartridge. Remove the write protection or use another cartridge.
No Removal	I	A data cartridge unload operation was attempted while the initiator was preventing media removal.
Cleaning Media	I	A cleaning cartridge is currently in the tape drive. If you want to back up or restore, insert a data cartridge.
Unsupported Format	I	The loaded tape contains data in an unsupported format.
Snapped Tape	C	The data cartridge in the tape drive contains a broken tape. ▪ Discard the data cartridge. ▪ Restart the current operation with a different tape.
Clean Now	C	The tape drive needs cleaning. ▪ If the tape drive is not currently in use, eject any data cartridge and insert a cleaning cartridge to clean the tape drive. ▪ If the tape drive is in use, wait until the current operation is complete, then insert a cleaning cartridge to clean the tape drive.
Clean Periodic	W	The tape drive needs to be cleaned at the next opportunity.
Expired Cleaning Media	C	The cleaning cartridge that was inserted into the tape drive is used up. Use a new cleaning cartridge to clean the tape drive.
Hardware A	C	The tape drive has a problem that is not read/write related. ▪ Reset the tape drive. ▪ Restart the operation. ▪ If the problem persists, contact Exabyte Technical Support.
Hardware B	C	The tape drive has a problem that is not read/write related. ▪ Turn the tape drive off and then on again. ▪ Restart the operation. ▪ If the problem persists, contact Exabyte Technical Support.
Interface	W	There is a problem in the SCSI interface between the initiator and the tape drive. ▪ Check all of the SCSI cables and connections. ▪ Restart the operation.
Eject Media	C	The current operation has failed. ▪ Eject the current data cartridge, then reload it. ▪ Restart the operation.
Download Fail	W	The last attempt to download new firmware has failed. Obtain the correct firmware and try again.

[a] I = Informational suggestion to user.
W = Warning. Remedial action is advised. Performance of data may be at risk.
C = Critical. Immediate remedial action is required.

SCSI Message System

The tape drive supports the SCSI messages listed in Table 3-2. Refer to the *Exabyte Mammoth Tape Drive SCSI Reference* for more information.

Table 3-2 SCSI messages

Hex value	Description	In (tape drive to initiator)	Out (initiator to tape drive)
00h	Command Complete	✔	
01h	Extended Message (Synchronous Data Transfer Request)	✔	✔
01h[a]	Extended Message (Wide Data Transfer Request)	✔	✔
02h	Save Data Pointers	✔	
03h	Restore Pointers	✔	
04h	Disconnect	✔	
05h	Initiator Detected Error		✔
06h	Abort		✔
07h	Message Reject	✔	✔
08h	No Operation		✔
09h	Message Parity Error		✔
0Ch	Bus Device Reset		✔
23h	Ignore Wide Residue	✔	
80h or C0h	Identify	✔	✔

[a] Wide data transfer is supported only by wide SCSI configurations.

SCSI-2 Command Set

The tape drive supports the SCSI-2 command set listed in Table 3-3.

Table 3-3 SCSI-2 commands

Command	OP code	Description
ERASE	19h	Causes the tape drive to erase all data from the current tape position to the physical end of partition.
INQUIRY	12h	Requests that general tape drive information be sent to the initiator.
LOAD/UNLOAD	1Bh	Causes the tape drive to load or unload the data cartridge.
LOCATE	2Bh	Positions the tape at a specified logical position. (Typically, this position is determined by data that was obtained through a previous READ POSITION command.)
LOG SELECT	4Ch	Manages a set of internal counters regarding read and write error recovery operations and amounts of data compressed. The initiator can set threshold and cumulative values for the counters or reset the counters.
LOG SENSE	4Dh	Returns the values of the counters managed by the LOG SELECT command.
MODE SELECT	15h or 55h	Allows you to specify medium, logical unit, and device parameters.
MODE SENSE	1Ah or 5Ah	Enables the tape drive to report medium, logical unit, or device parameters.
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	Allows or disallows the removal of the data cartridge from the tape drive.
READ	08h	Transfers one or more bytes or blocks of data from the tape to the initiator.
READ BLOCK LIMITS	05h	Requests that the tape drive return data identifying the maximum and minimum logical block lengths supported.
READ BUFFER	3Ch	Creates a diagnostic listing of the tape drive's current state or the contents of the tape drive's data buffer.
READ POSITION	34h	Reports the tape drive's current logical position but does not cause tape motion to occur. Used in conjunction with the LOCATE command.
RECEIVE DIAGNOSTIC RESULTS	1Ch	Reports the results of the tests requested by a previous SEND DIAGNOSTIC command.
RELEASE UNIT	17h and 57h	Releases the tape drive from exclusive use by the initiator that had previously reserved it with a RESERVE UNIT command.

Table 3-3 SCSI-2 commands (*continued*)

Command	OP code	Description
REQUEST SENSE	03h	Requests that the tape drive transfer sense data to the initiator.
RESERVE UNIT	16h and 56h	Reserves the tape drive for exclusive use by the initiator that issued the command.
REWIND	01h	Causes the tape drive to rewind the tape to the logical beginning of partition.
SEND DIAGNOSTICS	1Dh	Causes the tape drive to perform certain self-diagnostic tests.
SPACE	11h	Enables the tape drive to perform forward or backward searches using logical blocks, filemarks, or setmarks. Also allows spacing to end of data (EOD).
TEST UNIT READY	00h	Allows you to determine if the tape drive is ready to accept an appropriate medium access command.
VERIFY	13h	Enables the tape drive to verify one or more logical blocks of data on the tape.
WRITE	0Ah	Transfers one or more bytes or blocks of data from the initiator to the tape drive.
WRITE BUFFER	3Bh	Transfers new microcode from the initiator into the tape drive's control memory.
WRITE FILEMARKS	10h	Causes the tape drive to write any data remaining in its buffer, then to write one or more filemarks or setmarks to tape.

Notes

4 Technical Description

This chapter provides the following information about the tape drive:

- Write operations
- Read operations
- Data flow management
- Helical-scan recording
- Physical track structure
- Tape format
- Track and block counts
- Read /write compatibility

Write Operations

This section describes the following features of write operations:

- Data compression
- Data flow
- Error detection, correction, and recovery

Data Compression

By default, the tape drive writes compressed data, using the Improved Data Recording Capability (IDRC) algorithm. Its average compression ratio is 2:1, which can be higher or lower depending on the type of data.

Compression can be enabled and disabled through SCSI. If it is enabled, the tape drive constantly monitors the compression ratio to determine whether compressing the data will actually decrease the size of the data set. When a logical block expands (as it might, for example, when it has already been compressed by the initiator), the tape drive automatically switches to uncompressed format. It remains in this format until it encounters a compressible logical block. Then, it switches back to the compressed format.

Data Flow

Figure 4-1 provides a high-level overview of the flow of data during a write operation.

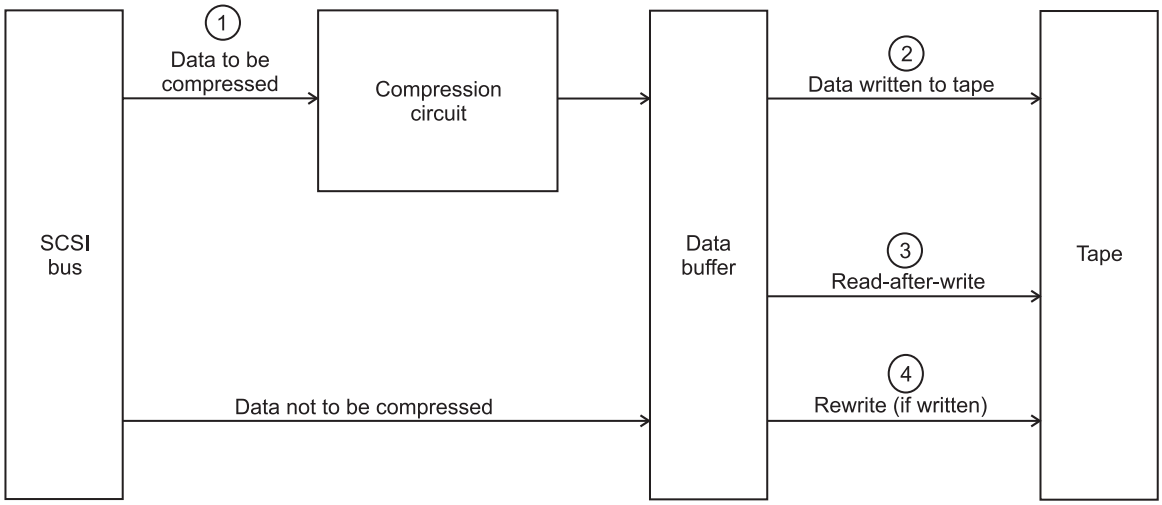


Figure 4-1 Write operations

The data flow process during a write operation is outlined below. (The steps below correspond to the circled numbers in the figure above.)

1. If you select compressed format for the tape at the logical beginning of a partition (LBOP), the data goes from the SCSI bus to the compression circuit where it is compressed. A 16-bit cyclic redundancy check (CRC) value is calculated on the original (uncompressed) data.

   After compression, the tape drive performs a data integrity check by decompressing the data, recalculating the CRC, and comparing it with the original CRC. After the check, the tape drive transfers the data to its 4-MB data buffer.

   If you select uncompressed format for the tape at LBOP, the data goes directly from the SCSI bus to the tape drive's 4 MB data buffer. (Data transfers between the SCSI bus and the buffer occur asynchronously or synchronously.)

2. When the motion threshold (see page 4-6) is exceeded in the data buffer, tape motion begins, error correction code (ECC) and physical-block CRC bytes are integrated with each physical block, and data is written to tape.

3. The tape drive performs a read-after-write check on the written data to ensure that the data on tape was written accurately.

4. If necessary, the tape drive rewrites the data.

Error Detection, Correction, and Recovery Procedures

As the tape drive writes data to tape, it integrates error correction code (ECC) and physical-block cyclic redundancy check (CRC) bytes with each physical block. After it writes data, the tape drive uses the ECC and CRC to perform a read-after-write check to ensure data reliability. By using read-after-write error checking and sophisticated error correction procedures, the tape drive offers a non-recoverable error rate of less than one bit in 10^{17} bits read.

Error Correction Code (ECC)

The Reed/Solomon ECC algorithms can correct a burst as long as 264 consecutive bytes in error and as many as 80 additional random errors in each physical data block. The ECC is capable of multiple burst and random error corrections. It has been designed to be extremely effective against the types of error patterns that may occur in tape drives that use helical-scan technology.

Cyclic Redundancy Check (CRC)

The tape drive also adds two bytes of CRC data to every physical block on tape. The CRC data is used in the read-after-write check.

Read-After-Write Checking

The tape drive performs a read-after-write check of the recorded user data to ensure full data reliability. If the tape drive determines that any data blocks should be rewritten, it rewrites the data without requiring host intervention or repositioning of the tape.

Read Operations

Figure 4-2 provides a high-level overview of the flow of data during a read operation.

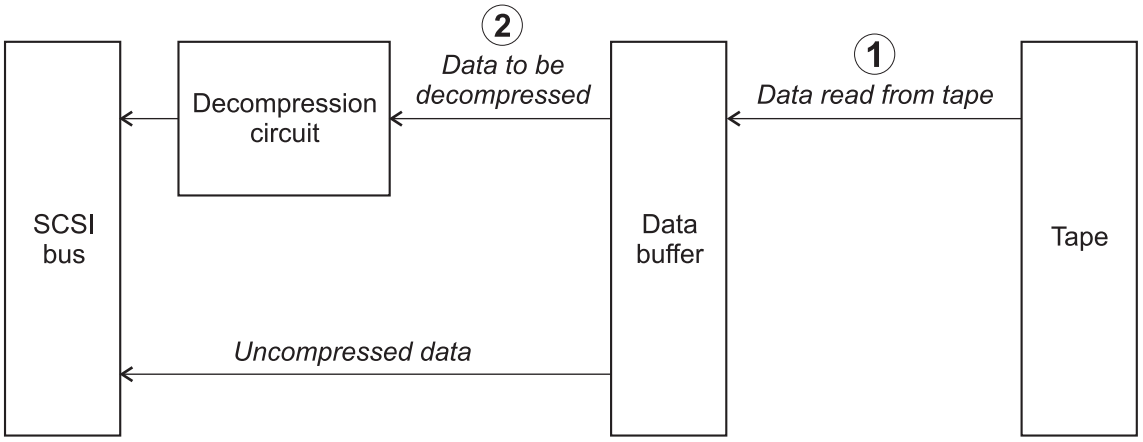


Figure 4-2 Read operations

The process for reading logical blocks of user data is outlined below.

1. The tape drive reads data from tape, uses ECC to correct errors as necessary for each physical block, and transfers data to the data buffer. The read operation continues until the buffer is full and tape motion stops.

2. If the data has been compressed, the data goes from the data buffer to the decompression circuit to be decompressed. Then, the decompressed data is sent to the SCSI bus.

   If the data has not been compressed, the data goes directly from the data buffer to the SCSI bus.

   In either case, the 2-byte logical block CRC, which was appended when the data was written, is again verified. This final integrity check ensures that all block reconstruction and decompression was successful.

Data Flow Management

The tape drive includes a 4-MB data buffer that enables it to operate as either a streaming or start/stop tape device, depending on the data transfer rate of the host system. In streaming mode, the tape drive transfers data continuously (to tape or to the host) without stopping tape motion. In start/stop mode, the tape drive stops and restarts tape motion to accommodate a slow host transfer rate.

The mode of operation (streaming or start/stop) depends on the rate that data can be transferred between the initiator and tape drive, as follows:

- **The tape drive operates in streaming mode** if the initiator can sustain a minimum transfer rate of 3 MB per second in uncompressed format or 6 MB per second in compressed format.

- **The tape drive operates in start/stop mode** if the initiator cannot sustain this minimum transfer rate; starting and stopping occur automatically.

Streaming Mode

When operating in streaming mode, the tape drive adapts to the host's data transfer rate by disconnecting from and reconnecting to the SCSI bus. The tape drive determines when to reconnect to the SCSI bus by comparing how full the buffer is to the *reconnect threshold*, as follows:

- During a write operation, if the tape drive's buffer fills with data from the host faster than the tape drive can write the data to tape, the tape drive disconnects from the SCSI bus while continuing to write data until the amount of space available in the buffer is equal to the reconnect threshold. The tape drive then reconnects to the SCSI bus to accept more data.

- During a read operation, if the host can accept data from the tape drive's buffer faster than the tape drive can fill the buffer with data from the tape, the tape drive disconnects from the SCSI bus until it has filled the buffer back up to a level equal to the reconnect threshold. Then the tape drive reconnects to the SCSI bus to transfer more data.

Start/Stop Mode

When operating in start/stop mode, the tape drive adapts to the host's data transfer rate by starting and stopping tape motion. The tape drive determines when to restart tape motion by comparing how full the buffer is to the *motion threshold*, as follows:

- During a write operation, the tape drive waits until the buffer is filled to a certain level (the motion threshold), starts the tape, records the buffered data, then stops the tape until the buffer can be filled to that level again by the host.

- During a read operation, the tape drive fills the buffer with data from the tape, stops the tape, waits for the host to accept enough data to empty the buffer to the motion threshold, then starts the tape and fills the buffer again.

Auto-Thresholding

By default, the tape drive automatically adjusts the reconnect and motion thresholds based on the host's data transfer rate to optimize throughput (*auto-thresholding*). You should operate the tape drive with auto-thresholding on at all times; however, if you want to test different thresholds, you can turn auto-thresholding off and set the thresholds manually, as described in the *Exabyte Mammoth Tape Drive SCSI Reference*.

Helical-Scan Recording

For high density recording, the tape drive implements advanced helical-scan recording technology. Helical-scan recorders write very narrow tracks on the tape, as shown in Figure 4-3.

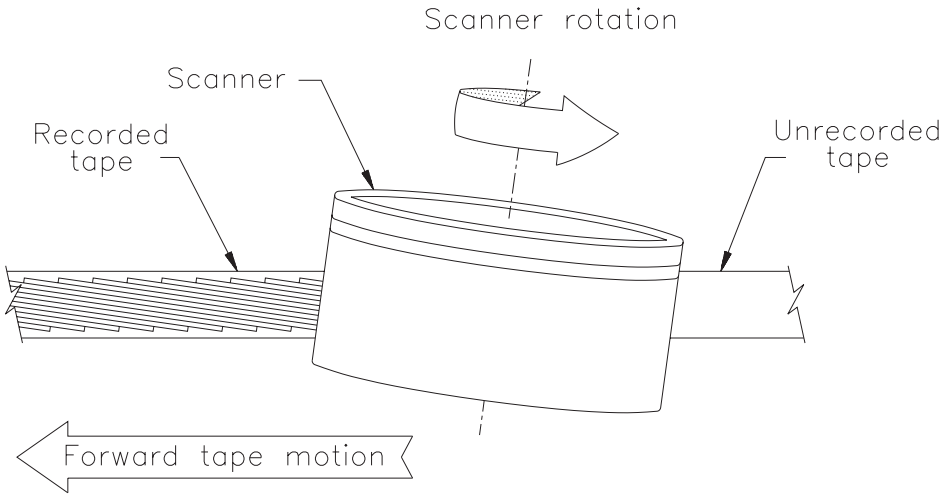


Figure 4-3 Helical-scan recording

The combination of the helical wrap of the tape around the scanner, the rotation of the scanner assembly, and the linear motion of the tape causes the heads to trace a track across the tape at an acute angle to the bottom edge of the tape. This recording method creates a track length that is several times longer than the width of the tape. Tracks can be accurately positioned with precise minimal tolerances, resulting in a very high number of tracks per inch.

Physical Track Structure

The Exabyte Mammoth-LT tape drive writes tracks of data using the Mammoth physical track structure. As shown in Figure 4-4, each physical track contains servo areas, clock sync areas, search fields, and 16 physical blocks. Each physical block contains the following information:

- 2 bytes of cyclic redundancy check (CRC) data
- 400 bytes of error correction code (ECC) data
- 1,012 bytes of uncompressed user data or 2,024 bytes of compressed user data (assuming a 2:1 compression efficiency)
- 26 bytes of header information

Note: The physical block header, ECC data, and physical block CRC data do not affect the data capacity of the tape.

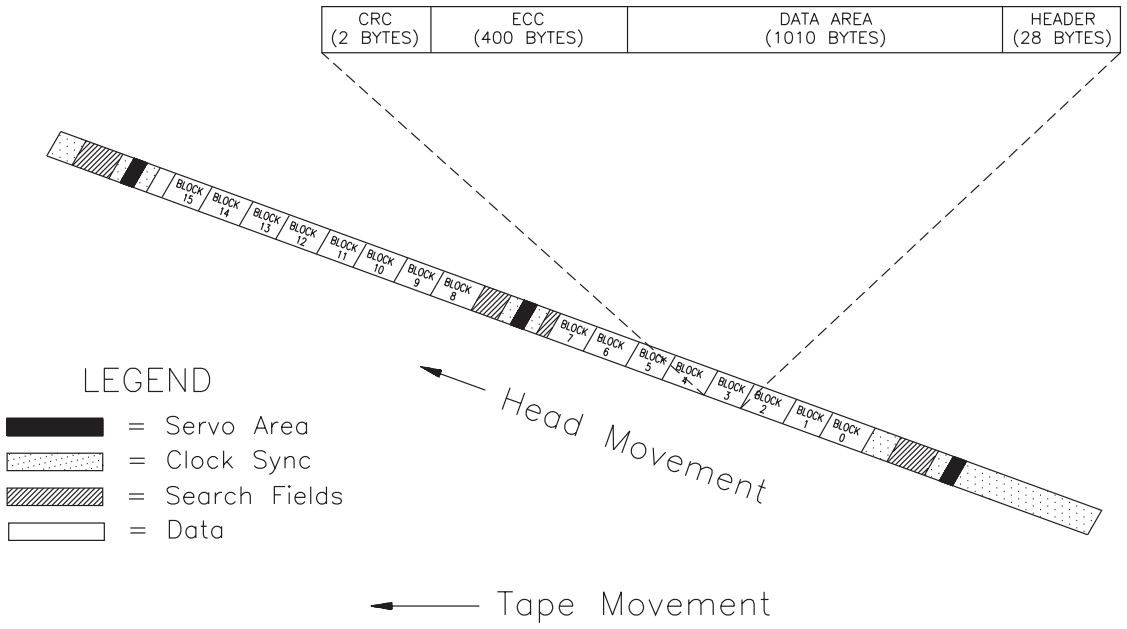


Figure 4-4 Physical block format

Tape Format

The following figure illustrates the format of the recorded tape.

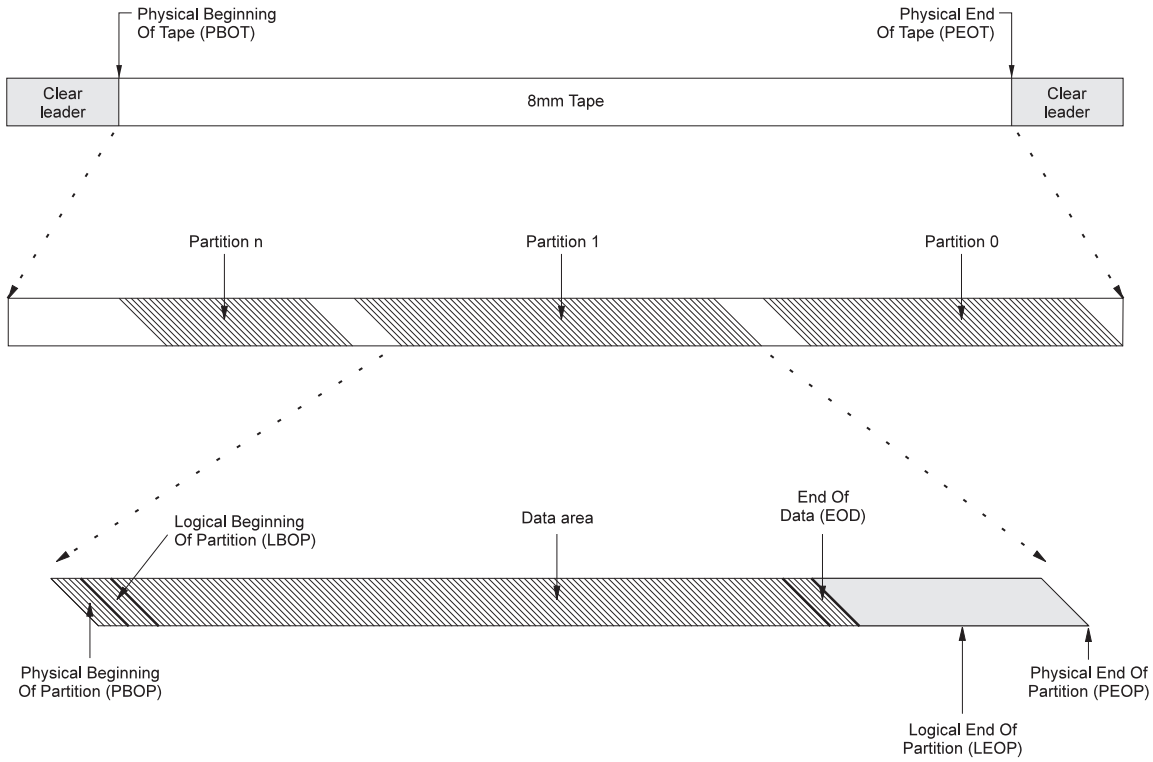


Figure 4-5 Tape format

Physical Beginning and End of Tape

As shown in the figure, each tape has a physical beginning and a physical end. The physical beginning of tape (PBOT) is located at the point on the tape where the clear leader material is attached to the media. This position is detected by an optical sensor.

The physical end of tape (PEOT) is located at the point on the tape where the clear trailer material is attached to the media. This position is detected by an optical sensor.

Partitions

As shown in Figure 4-5, a tape in Mammoth format is divided into *partitions*. A partition is a self-contained area on the tape that can be written and read independently. Partitions provide an effective way to maintain a directory on the tape.

Each partition can contain multiple data sets and files. The default is one partition per tape (in which case the entire tape is a single partition), but the tape drive can support as many as 64 partitions on a tape. You can use the MODE SELECT command to specify the number of partitions and the partition sizes.

For each partition, the tape drive places the following markers on the tape to help manage the data:

- Physical beginning of partition
- Logical beginning of partition
- Logical end of partition
- Physical end of partition

Physical Beginning of Partition (PBOP)

The physical beginning of partition (PBOP) mark consists of PBOP blocks. These blocks are recorded at the beginning of each partition when you format the tape for partitions using the MODE SELECT command.

If you do not partition the tape, the tape drive automatically records these blocks during the first WRITE command. PBOP blocks can only be overwritten by another MODE SELECT command.

Logical Beginning of Partition (LBOP)

The logical beginning of partition (LBOP) mark consists of LBOP blocks, which are blocks of redundant information recorded on the tape directly following PBOP. The tape drive uses LBOP blocks to perform automatic calibrations of the servo system. These blocks also contain data concerning the size and location of every partition on the tape.

Logical End of Partition (LEOP)

Logical end of partition (LEOP) is a *virtual* mark used to provide early warning to the host that physical end of partition (PEOP) is near. The tape drive calculates the LEOP based on the size of the partition.

➤ **Important** If you ignore LEOP and keep writing data to the tape, data can be written all the way to PEOP, leaving no room in the partition for an end of data (EOD) mark.

Physical End of Partition (PEOP)

Physical end of partition (PEOP) is also a virtual mark. When the tape is formatted and the tape drive determines the size of each partition, the tape drive calculates the location of PEOP and stores that information in the LBOP blocks. When the tape drive detects PEOP, the tape drive stops recording to prevent overwriting data in the next partition.

The last partition on the tape uses the physical end of tape (PEOT) instead of PEOP.

Data Area

Each partition contains a data area, which lies between LBOP and the end of data (EOD) mark. The tape drive determines the maximum size of the data area when the tape is partitioned, taking into account the length of the tape and the number of partitions you specify with MODE SELECT.

The data area consists of compressed or uncompressed user data, filemarks, and setmarks.

Compressed and Uncompressed Formats

Both uncompressed and compressed formats are allowed on the same tape. You can specify the format at the logical beginning of partition (LBOP) with the SCSI MODE SELECT command. If no MODE SELECT command is received, the tape drive uses the default format (compressed mode).

Note: If the tape is at a valid position for writing data other than LBOP, the tape drive writes data in the same logical format as the data already in that partition. When reading a data cartridge, the tape drive automatically determines the tape's format.

Logical Blocks

A *logical block* contains user data that is transferred from the host to the tape drive. Logical blocks can have either fixed or variable lengths, which can be intermixed on the tape. The tape drive supports uncompressed logical block sizes from 1 byte to 240 KB, which can be controlled with the MODE SELECT command. The number of logical blocks that can be written in a partition depends on the size of the partition and the logical block size.

Logical Block Compression When compression is turned on, the tape drive compresses logical blocks of user data before placing them in the physical blocks. Thus, each physical block contains a compressed representation of the original user data.

Logical Block Packing To optimize tape capacity when writing tapes, the tape drive packs logical blocks of user data into physical blocks. Each physical block on tape can contain multiple logical blocks. To prevent losing data capacity when small logical block sizes are used, the tape drive can begin writing a logical block in one physical block and end in a subsequent physical block. To keep track of logical blocks, the tape drive uses logical block headers.

Gap Bytes

A *gap byte* is a byte containing undefined data that the tape drive uses to fill empty space in a physical block. The tape drive may automatically write gap bytes in the following cases:

- At the end of a write operation.
- Before writing a filemark or setmark.
- When it is physically impossible to start the next logical block in the physical block because less than three bytes are available. (This is because the two-byte logical block header and at least one data byte must be present in the first physical block before the logical block can spill over to a second physical block.)

Gap bytes cannot be accessed by any SCSI command.

Gap Blocks and Gap Tracks A *gap block* is a physical block containing only gap bytes. A *gap track* is a physical track containing only gap blocks. When the tape drive stops at the end of a write operation, it writes gap tracks following the last track pair containing data blocks.

The gap tracks provide the track orientation required to append data. When a subsequent write operation begins, the controller repositions the tape and records the data on a track adjacent to a gap track.

Gap blocks cannot be accessed by any SCSI command.

Filemarks

Filemarks enable you to locate particular blocks of data on the tape quickly during a high-speed search. You use the WRITE FILEMARK command to write long or short filemarks. By using a SPACE or LOCATE command, you can position the tape to the data marked by long or short filemarks at up to 62.5 times the normal tape speed.

Long Filemarks A long filemark in Mammoth format is 94.7 KB long and consists of six tracks of information:

- Two gap tracks at the beginning
- Two tracks of filemark physical blocks
- Two gap tracks at the end

There is no logical limit to the number of filemarks you can write on a tape, but the physical limit is determined by the file sizes.

The information in the filemark physical blocks identifies the filemark's number and location on the tape. This information cannot be accessed or changed by the user. The gap tracks at the beginning and end allow file append and file splice operations. The tape drive may write additional gap tracks and gap blocks before the filemark to ensure that all data has been written to tape correctly or to complete tracks that are not completely filled with data blocks.

Short Filemarks A short filemark consists of a single physical block. This block contains information identifying the filemark's number and location on the tape. Short filemarks are not splice points.

Setmarks

You can issue a WRITE FILEMARK command to write one or more *setmarks* to tape. Setmarks, which are the same length as long filemarks, provide an additional way to indicate data boundaries on the tape. In a sense, they can be thought of as "hierarchically superior" filemarks. You can issue a LOCATE command to locate setmarks; however, you can also use a MODE SELECT command to suppress setmark detection during read, verify, space block, and space filemark operations.

There is no logical limit to the number of setmarks you can write on a tape, but the physical limit is determined by the file sizes.

End of Data (EOD)

The end of data mark consists of EOD blocks. These blocks are recorded directly after the last data or filemark block in a single partition. All EOD blocks contain the same information, which can be overwritten when new data is appended to existing data in the partition. The tape drive then records a new EOD mark at the end of the appended data.

Track and Block Counts

The tables below show the number of tracks and blocks on 22m and 125m tape.

Table 4-1 Number of tracks and blocks from LBOT to LEOT

Tape length	Tracks	Blocks	User bytes
22m	155,838	2,493,408	2,523,328,896
125m	925,986	14,815,782	14,993,571,635

Table 4-2 Number of tracks and blocks from LEOT to PEOT (average)

Tape length	Tracks	Blocks	User bytes
22m	5,120	81,920	82,903,040
125m	32,000	512,000	518,144,000

Read/Write Compatibility

Exabyte Mammoth-LT supports four data formats:

- Mammoth
- 8500c
- 8500
- 8200

8500c, 8500, and 8200 format The tape drive can read, but not write, 8500c, 8500, or 8200 format tapes.

8200c format The tape drive cannot read or write 8200c format tapes. When you attempt to read an 8200c format tape, the tape drive returns Check Condition Status with a sense key of Medium Error (3h) and an FSC of 1Ch.

Table 4-3 summarizes the tape drive's read and write compatibility with the data formats.

Table 4-3 Tape format compatibility of Exabyte Mammoth-LT

	Reads	Writes	Not Supported
Mammoth	✔	✔	
8500c	✔		
8500	✔		
8200c			✔
8200	✔		

5 Specifications and Standards

This chapter includes specifications for the Exabyte Mammoth-LT tape drive, including specifications for performance, reliability, power, environment, and shipping. This chapter also includes information about safety and agency standards.

Performance Specifications

This section describes the performance specifications for the tape drive.

Data Transfer Rates

The tape drive can achieve the data transfer rates listed below.

Table 5-1 Maximum data transfer rates

Data transfer rate	2 MB/sec. 4 MB/sec. (compressed; assuming a 2:1 ratio)
Burst transfer rate	7 MB/sec. asynchronous (with 1-foot cable)[a] 10 MB/sec. synchronous (narrow configuration or wide compressed configuration) 20 MB/sec. synchronous[b] (wide uncompressed configuration)

[a] The asynchronous transfer rate degrades as the cable length increases. For example, a 6-meter cable can achieve a maximum transfer rate of 3 to 4 MB/sec., depending on the cable impedance and termination quality.

[b] The LVD tape drive uses an interface that is compatible with Ultra and Ultra2 SCSI buses. The LVD interface allows the tape drive to be placed on the same bus as Ultra and Ultra2 SCSI devices without slowing the performance of these devices.

Read and Write Access Times

Read access time starts when the tape drive receives the last byte of the READ command (that is, when the initiator de-asserts ACK) and ends when the tape drive asserts REQ to indicate that it is ready to transfer the first data byte across the SCSI bus to the initiator.

Write access time starts when the tape drive receives the last byte of the WRITE command (that is, when the initiator de-asserts ACK) and ends when the tape drive asserts REQ to request that the initiator transfer the first data byte across the SCSI bus.

The following table lists typical read and write access times for the tape drive. Access time depends on whether the tape drive is operating in start/stop mode or streaming mode.

Table 5-2 Read/write access times

Mode	Typical	Maximum
Start/stop	300 µsec.	600 µsec
Streaming[a]	400 µsec.	900 µsec
Repeated CDB[b]	35 µsec.	55 µsec.

[a] In streaming mode, access times are slightly higher because there are additional performance demands on the microprocessor.

[b] A repeated CDB is a Command Descriptor Block that is identical to the previous CDB (transferring the same amount of data in the same mode).

Note: The measurement of access time does not include the initial READ or WRITE command received after the mode is changed (from write to read, or from read to write).

Reselection Phase Timeout

If the initiator fails to respond to a device reselection sequence, the tape drive times out after 250 msec. The tape drive continues to repeat the reselection process until it is reset, until the initiator finally responds, or until the reselection attempts exceed the specified number of retries.

Tape Speeds

File-Search Speed

The maximum search speed is 62.5 times the read/write speed (188 MB per second). The average search speed depends on the length of the search. The table below outlines the total search time required to locate to a file 10 GB away on the tape.

Table 5-3 Search speeds

Function	Description	Time (sec.)
Load	Insert cartridge to ready state	< 20
Search	Search 10 GB (85m), including acceleration and deceleration.	57
	Reposition to start of file	7
	Total search time	64

Rewind Tape Speed

The rewind speed is 62.5 times the read/write speed (62.5 inches per second). Rewind time starts when the initiator issues a REWIND command and ends when the tape drive returns a Command Complete message (for a non-immediate rewind). The maximum rewind time is 150 seconds, which assumes the following:

- The tape is positioned at LEOT when REWIND is issued.
- The tape has only one partition.
- The scanner has not stopped rotating.
- Tape tension has not been released.

Reposition Time

Reposition time starts when the initiator issues a command that stops the tape drive's motion control system and ends when the tape is repositioned, at nominal speed, so that the next byte of data can be transferred. Reposition time is independent of any interface delays.

Reposition time is approximately 0.5 seconds.

Drive Ready States

To save power and reduce wear on the tape and the internal mechanisms, the tape drive automatically moves through various states of inactivity based on the time since the last activity took place. As the tape drive proceeds from a ready state into inactivity, it progresses through the following states:

- Active
- Sleep 1
- Sleep 2

Sleep states enable the tape drive to return to an active state faster than if it was powered off and then back on, because the tape remains loaded and is not repositioned to LBOP. The table below defines sleep states, including SCSI response time for each state.

Table 5-4 Sleep states

	Active	Sleep 1	Sleep 2
Time since last activity	< 5 sec.	> 5 sec; < 30 sec.	> 30 sec.
Tape tensioned	✔		
Scanner spinning	✔	✔	
SCSI information command response time	normal	normal	normal
SCSI tape motion command response time	normal	+ 1.5 sec.	+ 5 sec.

The tape drive releases tape tension and goes into Sleep 1 state if the tape drive has not received a command to move the tape in the last 5 seconds. After releasing tape tension, the tape drive goes into Sleep 2 state and stops scanner rotation if it does not receive a tape motion command within 30 seconds of the last command.

Reliability Specifications

This section lists the reliability specifications for the tape drive, including hardware service life, mean time between failures (MTBF), data integrity, and data reliability. The tape drive attempts to provide warning on wear items and the need for preventive maintenance. This type of maintenance is not considered a failure.

Service Life

The tape drive has been designed to exceed a useful service life of five years, during which time all performance and reliability specifications are applicable.

Mean Time Between Failures (MTBF)

The predicted MTBF value for the tape drive is 250,000 hours. This value is based on a 10% duty cycle. The MTBF is defined as follows:

$$MTBF = \frac{\text{Total Power-on Hours}}{\text{Number of Relevant Equipment Failures}}$$

where:

- **Total Power-on Hours** is the total time the tape drive is drawing current from the input power supply system.
- **Relevant Equipment Failures** are those failures that cannot be corrected by the operating personnel and require the intervention of maintenance personnel.

Test Conditions

The MTBF value for the tape drive is determined under the following conditions:

- MTBF is specified for a maximum duty cycle of 10%, where duty cycle is defined as:

$$\text{Duty Cycle} = \frac{\text{Total Hours of Mechanical Operation}}{\text{Total Power-on Hours}} \times 100\%$$

- The tape drive is tested at an ambient temperature of 23° C ± 2° and a relative humidity of 45% relative humidity ± 10% (non-condensing).

- The tape drive is operated in accordance with operating specifications.

Conditions for the MTBF Value

Conditions under which the specifications for MTBF apply are as follows:

- The Exatape advanced metal evaporated (AME) data cartridges used must comply with any existing media standards.

- Environmental conditions for the tape drive and the data cartridges must be maintained as specified in this chapter.

- The tape drive must be cleaned with an Exabyte Mammoth Cleaning Cartridge (or a cleaning cartridge approved by Exabyte for Mammoth-LT) using the recommended cleaning procedure.

Restrictions for the MTBF Value

The following types of failures are excluded from the calculation of MTBF:

- Failures arising from incorrect operating procedures

- Cable failures, power supply failures, or other failures not caused by equipment

- Failures caused by incorrect grounding procedures or by interference from external sources

- Media failures, or any failures or degraded performance caused by use of faulty or damaged media

- New failures that arise from continued use of a failed, misaligned, or damaged tape drive

- Failures caused by incorrect maintenance procedures

- Failures for which early warnings have been provided

Data Integrity

Conditions under which data integrity is maintained are as follows:

- If there is a power loss while the tape drive is reading, no recorded data will be lost.
- If there is a power loss while the tape drive is writing, any data remaining in the buffer will be lost.
- The tape drive will not record incorrect data to tape without posting an error condition.
- The tape drive will not return incorrect data to the system without posting an error condition.

Data Reliability

Data reliability is specified as a bit error rate (BER) in units of errors per total number of bits transferred to the host.

Conditions for Data Reliability

The conditions under which the specifications for data reliability apply are as follows:

- The Exatape advanced metal evaporated (AME) data cartridges used must comply with any existing media standards.
- Data cartridges must be written and read on a tape drive that is in good operating condition and properly grounded.
- Environmental conditions for the tape drive and the data cartridges must be maintained as specified in this chapter.
- The tape drive must be cleaned with an Exabyte Mammoth Cleaning Cartridge (or a cleaning cartridge approved by Exabyte for Mammoth-LT) using the recommended cleaning procedure.

Restrictions for Data Reliability

The following types of errors are not included in the determination of data reliability:

- Errors caused by a failure of the tape drive
- Errors caused by faulty or damaged cartridges or media
- Errors caused by failure to comply with input power and grounding requirements, interference from external sources, or incorrect system operation or failure
- Errors corrected by the tape drive's ECC
- Errors occurring in blocks other than blocks containing user data

Write Reliability

Write reliability is determined by the rate of permanent write errors. During a write operation, the tape drive uses read-after-write checking to determine whether physical data blocks are correctly written to tape. When the read-after-write check criteria are not met for a data block, the tape drive rewrites the block. The tape drive keeps track of the number of times blocks are rewritten and stores this number internally. The number is available through the REQUEST SENSE command and the LOG SENSE command.

If the tape drive can rewrite the data block correctly, the error is a temporary write error, which does not affect write reliability. However, if the tape drive cannot write the data block correctly after completing the write recovery procedures, the error is a permanent write error. When a permanent write error occurs, the tape drive returns Check Condition status.

The rate for permanent write errors is as follows:

Bit error rate: less than 1.0×10^{-17}

Read Reliability

Read reliability is determined by the rate of permanent read errors. If, during a read operation, the tape drive cannot read a block that has been correctly written, it attempts to reread the block. The tape drive keeps track of the number of times it attempts to reread a block and stores this number internally. This number is available through the REQUEST SENSE command and the LOG SENSE command.

If the tape drive can reread the data block correctly, the error is a temporary read error, which does not affect read reliability. If, however, the tape drive cannot reread the data block correctly after completing the read recovery procedures, the error is a permanent read error. When a permanent read error occurs, the tape drive returns Check Condition status.

The rate for permanent read errors is as follows:

Bit error rate: less than 1.0×10^{-17}

Power Specifications

This section provides power specifications for the internal tape drive. (See Appendix A for power specifications for the tabletop tape drive.)

Voltages

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

Table 5-5 Power specifications

	+ 5 Volts	+ 12 Volts
Nominal tolerance: Ripple and noise[a] (60 Hz to 20 MHz)	± 5% 125 mVpp max	± 5% 125 mVpp max
Operating current (in amps): Nominal[b] Single-ended narrow SCSI LVD wide SCSI Peak[c] Single-ended narrow SCSI LVD wide SCSI	 1.5 1.8 2.1 2.1	 0.4 0.4 1.2 1.2

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

[b] Nominal current occurs during streaming write or read operation.

[c] 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

Notes: 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).

Power Consumption

Table 5-6 shows the internal tape drive's power consumption when operating and when idle.

Table 5-6 Power consumption

	SCSI configuration	
	Single-ended narrow	**LVD wide**
Power consumption when operating	11.5 watts	11.5 watts
Power consumption when idle	6.5 watts	6.5 watts

Environmental Specifications

Table 5-7 summarizes environmental specifications for the tape drive.

Table 5-7 Environmental specifications

	Operating (cartridge inserted)	**In storage[a] or not operating[b]**	**Being shipped[a]**
Tape path temperature range	+ 5° C to + 45° C (+ 41° F to + 113° F)	–40° C to + 60° C (–40° F to + 140° F)	
Temperature Variation[c]	1° C per minute; max 13° C per hour (2° F per minute; max 23° F per hour)	1° C per minute; max 20° C per hour (2° F per minute; max 36° F per hour)	
Relative Humidity[a]	20% to 80% Non-condensing	10% to 90% Non-condensing	
Wet Bulb	26° C (79° F) max		
Altitude	–304.8 m to + 3,048 m (–1,000 ft to + 10,000 ft)	–304.8 m to + 3,048 m (–1,000 ft to + 10,000 ft)	–304.8 m to + 12,192 m (–1,000 ft to + 40,000 ft)

[a] The tape drive is in its original packaging; no cartridge is inserted.

[b] The tape drive is unpacked; no cartridge is inserted.

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

Operating Environment

Figure 5-1 shows the temperature and humidity requirements for the tape drive, as measured at the tape path. The area within the dotted line represents the operating environment. Table 5-8 defines the points in the chart.

> ➤ **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. See Appendix A for more information.

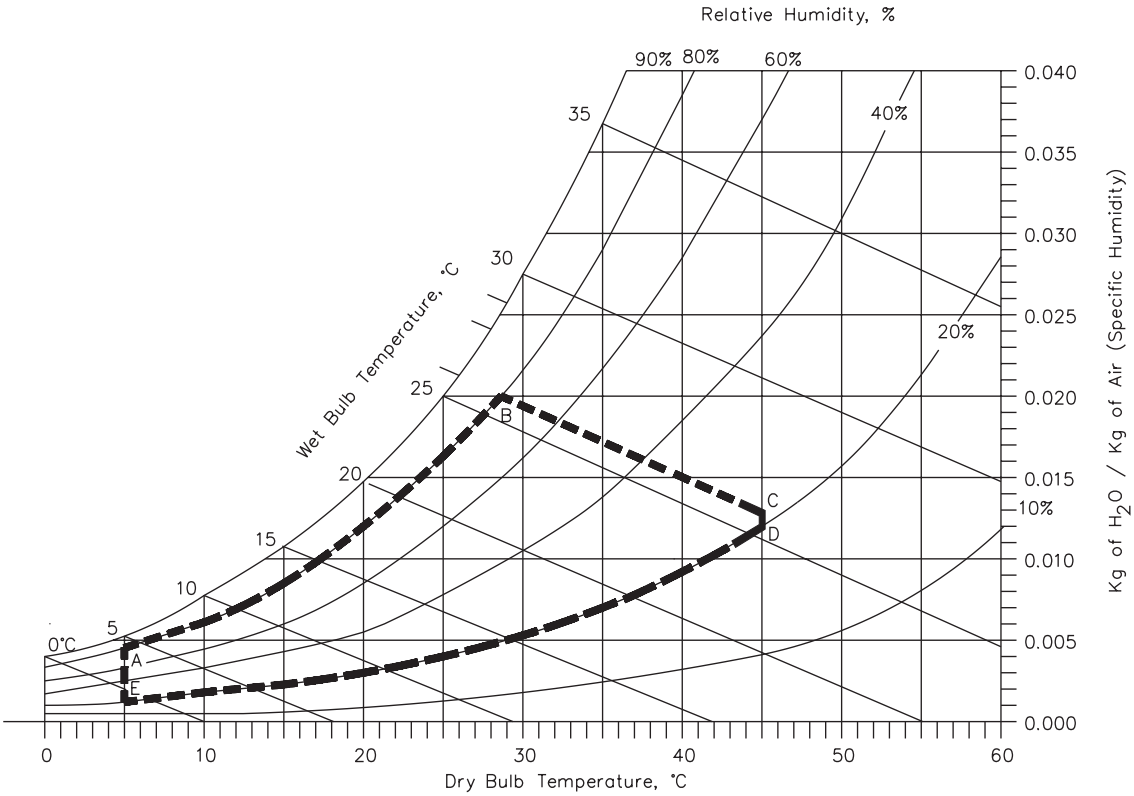


Figure 5-1 Tape path temperature and humidity ranges for operation

Table 5-8 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%

Air Flow Requirements

Note: See Appendix A for air flow requirements for the tabletop model.

When the tape drive is incorporated into an enclosure, adequate air flow must be provided for the tape drive to dissipate heat resulting from approximately 12 watts of power consumption. The air flow around the entire tape drive must be sufficient to prevent the tape path temperature from exceeding 45° C (113° F), as measured in the tape path using a thermocouple. The onboard thermistor may also be used; however, this device has an accuracy of ± 2° C.

Because increased air flow can mean increased dust particles in the tape drive, the Exabyte Mammoth-LT design minimizes air flow around the tape path. This helps to prevent particulate contamination of the heads and media.

Particulate Contamination Limits

The ambient operating environment should not exceed the particulate counts shown in Table 5-9.

Table 5-9 Particulate contamination limits

Particle Size (microns)	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

Figure 5-2 shows the particulate contamination profile of a typical office compared to the specifications for the tape drive. Contamination profiles of individual office areas vary.

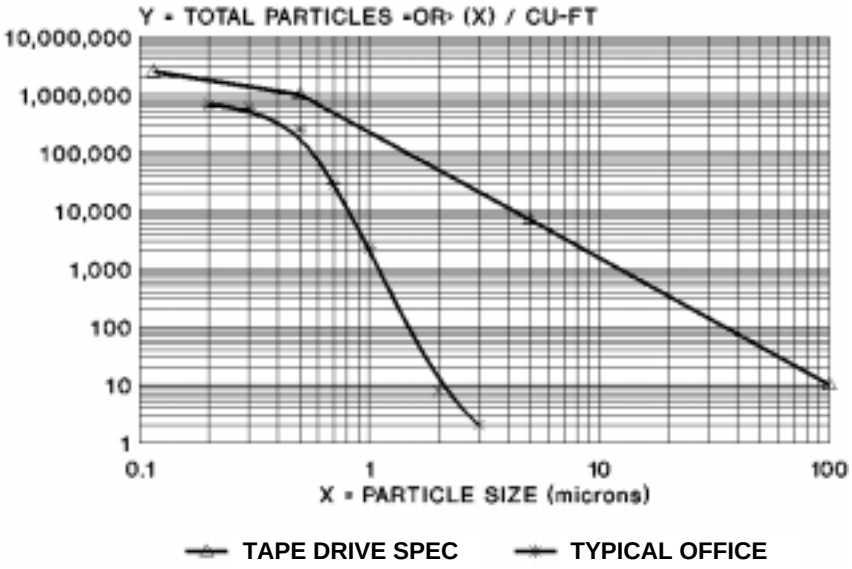


Figure 5-2 Particulate contamination specification vs. typical office

Shock Specifications

Table 5-10 lists the shock specifications for the tape drive. The operating shock levels indicate how much shock the tape drive can withstand while it is reading and writing data. The non-operating and storage shock levels indicate how much shock the tape drive can withstand when it is not operating. After withstanding this amount of shock, the tape drive will operate normally.

Table 5-10 Shock specifications

Operating (reading and writing)	In storage (in original packaging, no cartridge), or not operating (unpacked, no power applied)	Being shipped (in original packaging, no cartridge)	Handling
3 g for 5 ms[a]	45 g at a velocity change of 180 inch/sec[b]	ISTA Procedure 2A	Drop and Topple per IEC 68-2-31

[a] A minimum of 20 shock pulses were applied to each of the three orthogonal axes. The shock pulses were half-sine waves and were applied at a rate not exceeding one shock per second.

[b] A minimum of three trapezoidal shock pulses of 45 g were applied to each of the tape drive's six sides at a velocity change of 180 inches per second.

Vibration Specifications

Table 5-11 lists the vibration specifications for the tape drive during operation, non-operation, storage, and transportation. The operating specifications listed in this table indicate the amount of vibration that the tape drive can withstand while reading and writing data.

Table 5-11 Vibration specifications

Random vibration[a] applied during operation (reading and writing)	
1 Hz	PSD = 0.0000040 g^2/Hz
5 Hz	PSD = 0.0000270 g^2/Hz
10 to 150 Hz	PSD = 0.0004048 g^2/Hz
200 to 400 Hz	PSD = 0.0001079 g^2/Hz
Random vibration[b] applied during non-operation (unpacked) and storage (in original packaging)	
1 Hz	PSD = 0.0003 g^2/Hz
3 Hz	PSD = 0.00055 g^2/Hz
12 to 100 Hz	PSD = 0.01 g^2/Hz
400 Hz	PSD = 0.000003 g^2/Hz
Vibration applied during shipping (in original packaging)	
ISTA Procedure 2A	
Swept sine applied during non-operation[c] and operating[d]	
5 to 500 to 5 Hz	

[a] A 0.30 G RMS random vibration spectrum is applied to each of three orthogonal axes for a minimum of 20 minutes per axis.

[b] A 1.06 G RMS random vibration spectrum is applied to each of three orthogonal axes for a minimum of 20 minutes per axis.

[c] Three sweeps at one octave per minute are applied to each axis at 0.75 g (peak) input.

[d] Three sweeps at one octave per minute are applied to each axis at 0.3 g (peak) input.

Acoustic Noise

The overall, averaged A-weighted sound pressure levels (decibels) for the tape drive do not exceed the upper limits specified in Table 5-12.

Table 5-12 Acoustic noise

Operating mode	LWA[a]
The tape drive is powered on and idle.	45
The tape drive is fully operational and operating in streaming mode for a read or write operation.	45
The tape drive is performing a high-speed search or rewind operation (less than 2 minutes duration).	48

[a] LWA is the average A-weighted sound pressure level over the following frequency range: 5 Hz to 12.5 KHz.

Shipping Specifications

This section describes the shipping requirements for the internal model of the tape drive. For information about shipping the tabletop model, refer to Appendix A.

Shipping Cartons

The tape drive is sealed in a static protection bag and is shipped with either one drive per carton (single pack) or with three to five drives per carton (multi-pack). Table 5-13 shows shipping dimensions and weights for the tape drive.

Table 5-13 Shipping dimensions and weights

	Dimensions	Weight
Single-pack	13.5 inches long × 10.75 inches wide × 8.5 inches high (34.3 × 27.3 × 21.6 cm)	**1 tape drive**: 4.1 lbs (1.8 kg)
Multi-pack	23.25 inches long × 13.5 inches wide × 11.5 inches high (59.1 × 34.3 × 29.2 cm)	**3 tape drives**: 12 lbs (5.4 kg) **4 tape drives**: 15 lbs (6.5 kg) **5 tape drives**: 18 lbs (8.2 kg)

Both the single-pack and the multi-pack shipping cartons and internal packing materials are designed so that an enclosed tape drive does not receive a shock greater than 45 g when the carton is dropped on any surface, corner, or edge from the following heights:

- 48 inches (121.9 cm) at a velocity change of 192 inches per second (488 cm/sec) for the single-pack carton
- 36 inches (91.4 cm) at a velocity change of 167 inches per second (424 cm/sec) for the multi-pack carton

Both sizes of shipping carton pass the tests described in the International Safe Transit Association (ISTA) Procedure 2A for packaged products weighing less than 100 pounds.

Note: Do not use a multi-pack shipping carton when shipping a single tape drive. If you use a multi-pack shipping carton, you must place three, four, or five tape drives in the carton.

Packing Materials

The packing materials are unbleached, reusable, recyclable, and environmentally safe. The materials contain no chlorofluorocarbons (CFCs) or heavy metals.

To avoid damaging the tape drive, use the original shipping carton and packing materials (or replacement packaging obtained from the vendor) when repacking and shipping the tape drive. The shipping carton and packing materials are not intended to be used for shipping items other than an Exabyte half-high tape drive.

Safety and Regulatory Agency Compliance

This section lists the safety and regulatory agency compliance for both the internal and tabletop tape drive. See Appendix A for safety and regulatory agency information applicable only to the tabletop model.

Note: For the tabletop tape drive, the requirement for a shielded cabinet is met by the tabletop enclosure.

Safety Agency Standards

When purchased from Exabyte Corporation, both the internal and tabletop tape drive comply with the following domestic and international product safety standards.

- UL Standard 1950, 1st Edition, Safety of Information Technology Equipment
- CSA Standard C22.2 No. 950-95, Safety of Information Technology Equipment
- IEC 950/EN60950, A4 1997, Safety of Information Technology Equipment including Electrical Business Equipment

Note: The internal tape drive is certified as a component only. Certification of the final integrated product is the responsibility of the system integrator.

A Specifications for the Tabletop Tape Drive

This appendix describes specifications for the tabletop model of the tape drive that are not covered in the rest of this book. Unless noted in this appendix, the specifications in the previous chapters apply to both the internal and tabletop models.

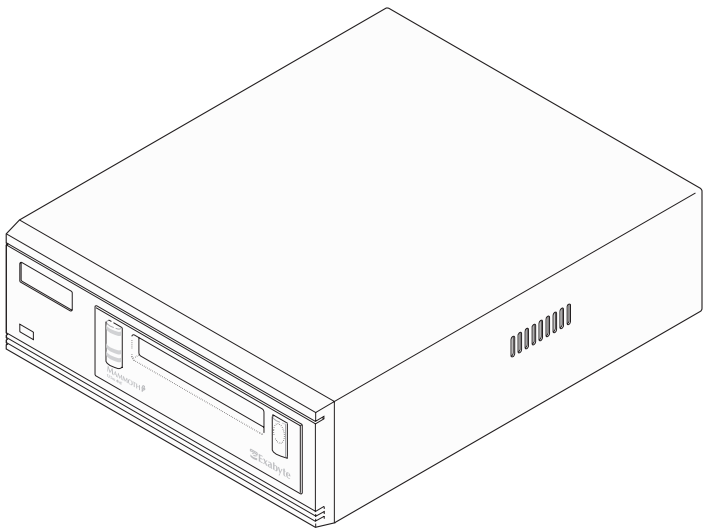


Figure A-1 Tabletop model of the tape drive

The tabletop model of the tape drive is a fully integrated standalone data storage system that includes the following features:

- An internal, self-switching power supply
- A variable-speed thermistor-controlled fan
- A remote SCSI ID switch
- Two SCSI connectors (both narrow and wide connectors available)
- A Monitor port for performing diagnostics and code updates
- Maximum EMI/RFI shielding that meets all applicable regulatory and safety agency requirements

The tabletop tape drive can be used in either a vertical or horizontal position.

Physical Features

This section describes the physical features of the tabletop model.

Size and Weight

The dimensions of the tabletop model are shown in Figure A-2. The tabletop model weighs 8.6 pounds (3.9 kilograms).

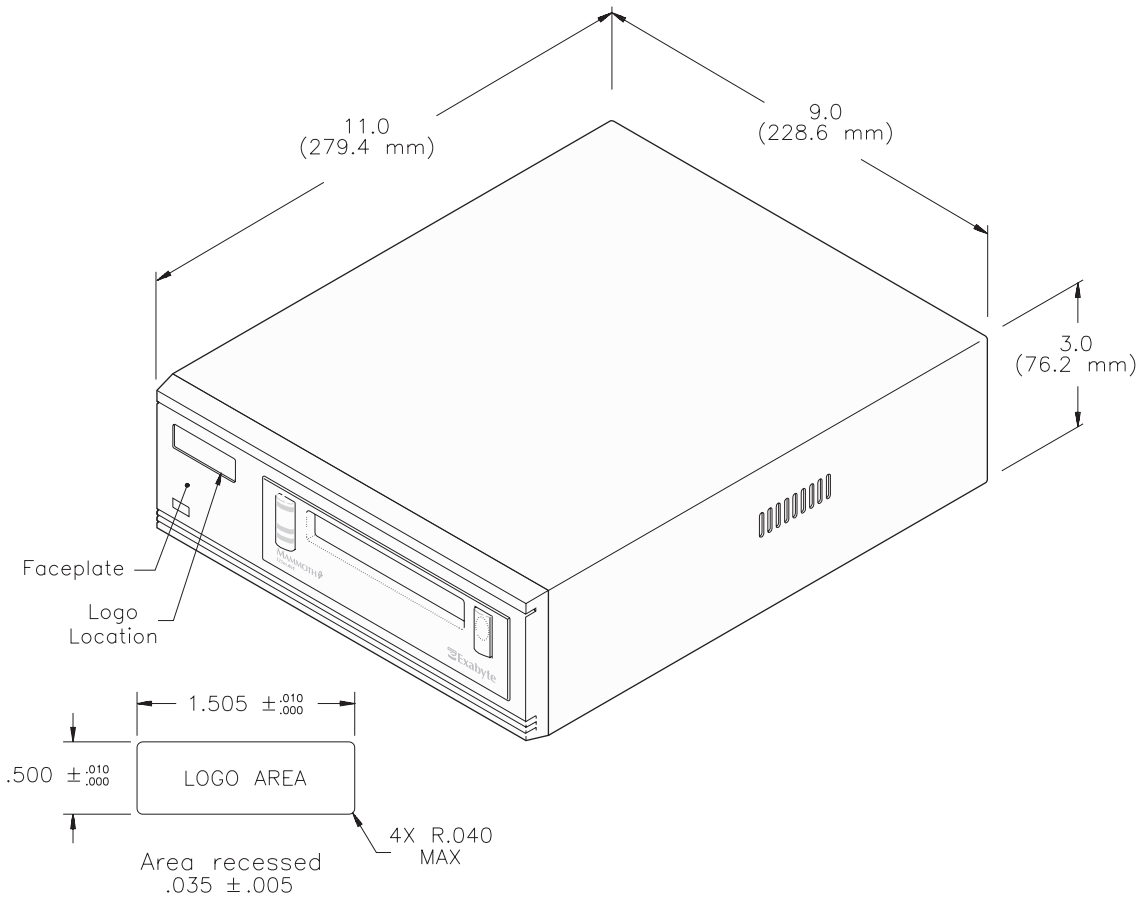


Figure A-2 Dimensions of the tabletop tape drive in inches (and millimeters)

Color

The standard enclosure, including the faceplate and door of the internal tape drive, is pearl white. For custom color information, contact your Exabyte account manager.

Front Panel Components

Figure A-3 shows the main components of the tabletop tape drive's front panel.

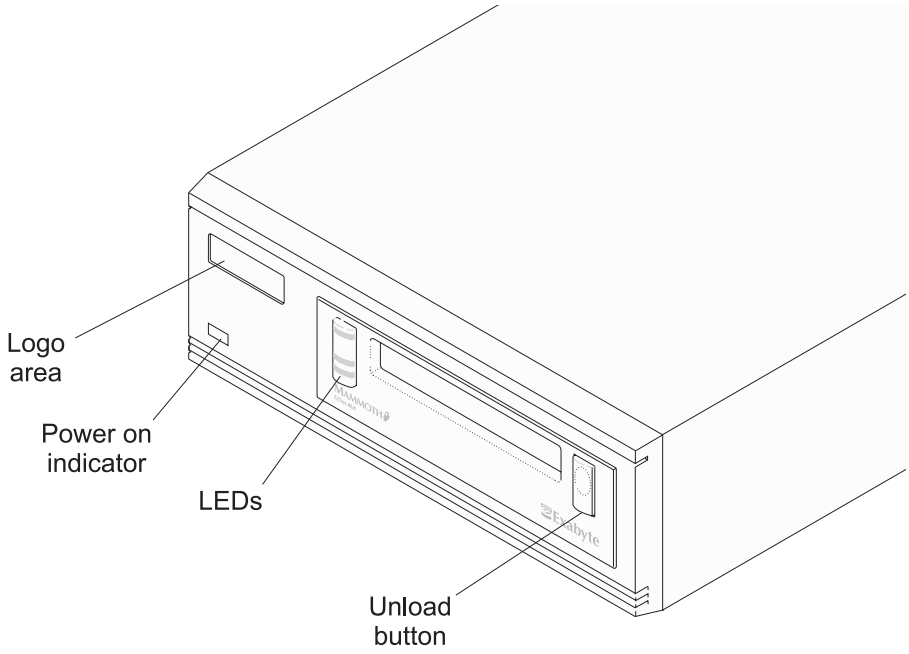


Figure A-3 Front panel components on the tabletop tape drive

Logo Area

The tabletop tape drive provides a recessed area in the upper left corner of the faceplate for a company logo. For custom label information, contact your Exabyte account manager.

Power-On Indicator

When you turn on the tabletop tape drive's power, the green power-on LED on the lower left corner of the faceplate lights up. When power is off or disconnected, the LED turns off.

Unload Button and LEDs

The functions of the unload button and the LEDs for the tabletop tape drive are the same as for the internal model. (See Chapter 2.)

Back Panel Components

Figure A-4 shows the main components of the tabletop tape drive's back panel.

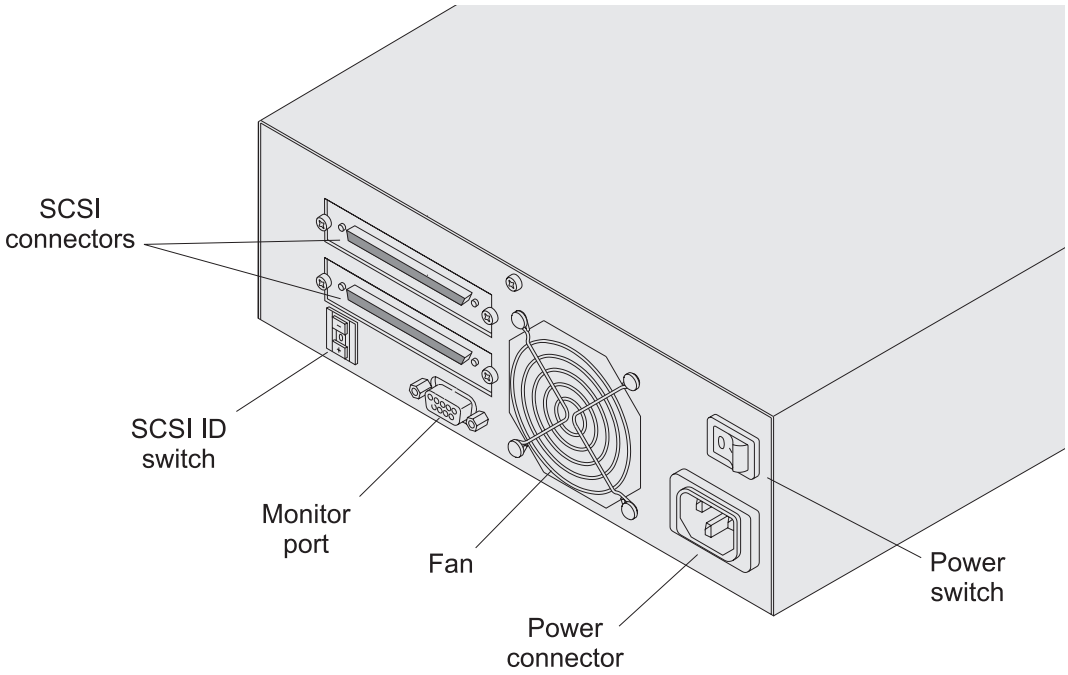


Figure A-4 Back panel components for the tabletop model

SCSI ID Switch

The SCSI ID switch is an incremental switch that enables you to set the address of the tape drive on the SCSI bus. The SCSI ID switch is recessed to prevent accidental selection.

SCSI Connectors

Two SCSI connectors enable you to connect the tape drive to a SCSI bus (50-pin connectors for narrow configurations or 68-pin connectors for wide configurations). See page A-8 for more information.

Monitor Port

You can use the Monitor port to change operating parameters, load microcode updates and perform diagnostic procedures on the tape drive. To use the Monitor port, you need the following items:

- An IBM AT, XT, or compatible system with a serial port
- A 9-pin RS-232 serial cable with a male D connector
- Mammoth Monitor program, available from Exabyte

Thermistor-Controlled Fan

A thermistor enables the fan to increase or decrease airflow as environmental temperatures change. The unique design of the enclosure provides air circulation throughout the tape drive.

The fan also features locked rotor protection. If a foreign object becomes lodged in the fan, the fan motor automatically shuts off. To restart the fan, turn off the power, remove the foreign object, and turn on the power.

Power Connector

The power cord connector provides access to the internal AC power supply for the enclosed tape drive. See page A-9 for power cord specifications.

Power Switch

The power switch allows you to turn power on and off for the enclosed tape drive.

Labels

The tabletop tape drive includes FCC, ESD, and serial number labels. These labels provide component, serial number, part number revision information, SCSI configuration, and electrical information. Figure A-5 shows the location of these labels. The FCC label also shows SCSI configuration (see Figure A-6). A label showing the Taiwan Bureau of Commodity Inspection and Quarantine (BCIQ) certification is on the bottom of the enclosure.

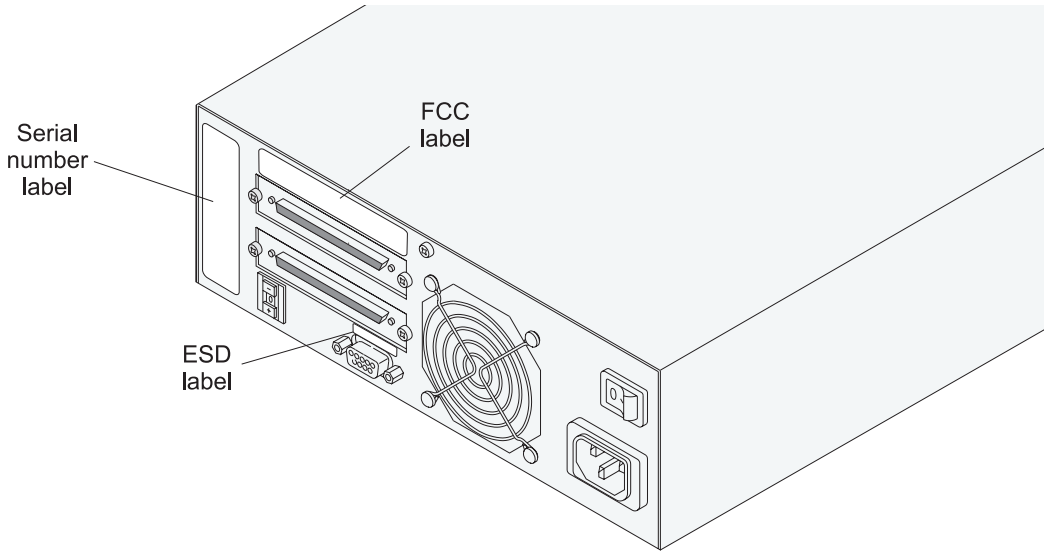


Figure A-5 Label locations for the tabletop model

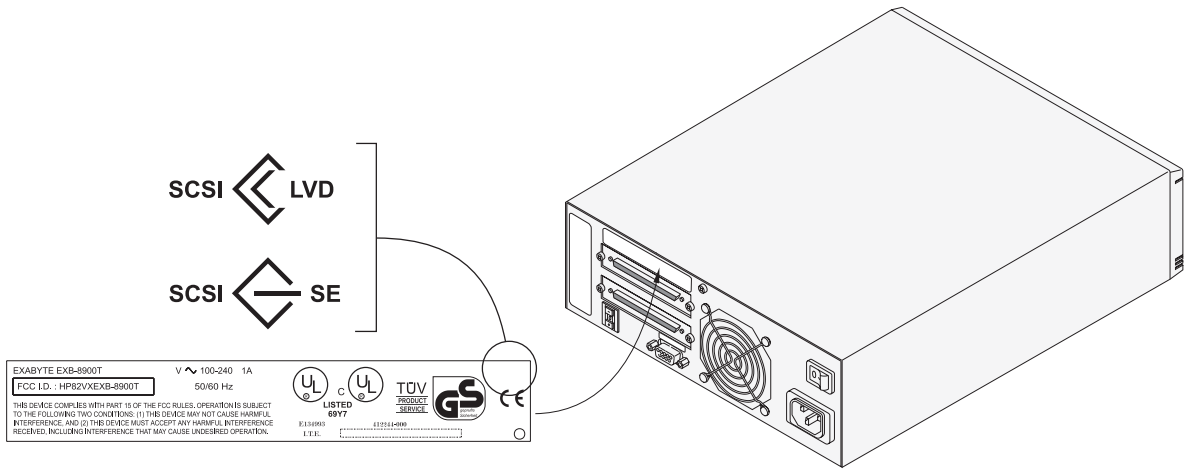


Figure A-6 SCSI configuration on FCC label

Installation Requirements

Installing the tabletop tape drive involves the following steps:

- Setting the SCSI ID
- Placing the orientation pads
- Connecting SCSI cables
- Terminating the tape drive, if necessary
- Connecting the power cable

This section describes the requirements for these steps. For detailed instructions for completing the installation tasks, refer to *Exabyte Mammoth-LT Tape Drive Installation and Operation*.

Setting the SCSI ID

You can use a pen or other fine-tipped instrument to change the SCSI ID switch on the back of the tabletop tape drive.

Placing the Orientation Pads

The tabletop model includes adhesive pads that you must apply to either the base or the right side, depending on how you plan to position the tape drive. These pads protect the tape drive's bottom surface and allow air to flow through the vents when the tape drive is positioned on its side. To install the pads, you must affix the pads to each corner, approximately 1/2-inch (1.3 cm) from the sides, as shown in Figure A-7. *For a horizontal orientation*, place the pads on the bottom. *For a vertical orientation*, place the pads on the right side (the side with the external vents).

CAUTION

If you want to position the tape drive on its side, you must place the pads on the right side. Otherwise, the air flow vents will be blocked and the enclosed tape drive will overheat.

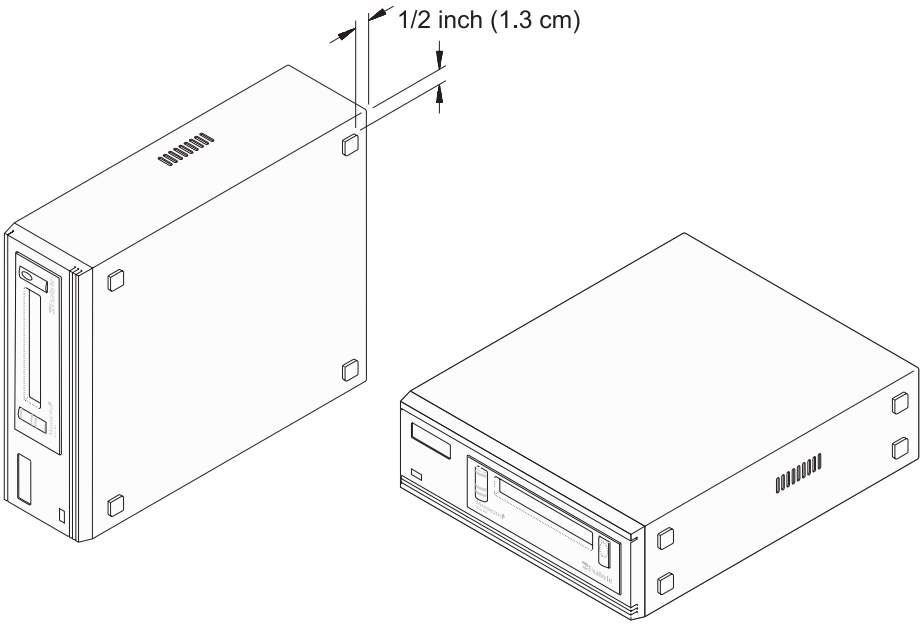


Figure A-7 Orientation pads for the tabletop model

Connecting SCSI Cables

CAUTION

All wide SCSI configurations use the same 68-pin connector. Do not connect a low-voltage differential (LVD) wide tape drive to a high-voltage differential (HVD) wide SCSI bus. Doing so may cause the SCSI bus to hang. Refer to the product ID label (see Figure A-6) to determine the SCSI configuration of your tape drive.

The tabletop tape drive does not include a SCSI cable. Select a cable that meets the specifications listed in Table A-1.

Table A-1 External SCSI cable specifications

	Single-ended narrow SCSI configuration	LVD wide SCSI configuration
Connector type	50-pin, high-density, shielded, male ribbon connector AMP PN 750681-1	68-pin, high-density, shielded, male ribbon connector AMP PN 750752-1
Maximum cable length[a]	3 meters (9.8 feet)[b]	12 meters (39 feet)[c]
Recommended impedance	132 ohms	110 ohms
Minimum conductor size	28 AWG	28 AWG

[a] Each tabletop tape drive attached to the SCSI bus uses 0.4 meters (1.31 feet) of the total allowable bus length internally. To determine the total length, add this amount to the length of cable used on the bus for each tabletop tape drive.

[b] A maximum cable length of 6 meters is acceptable if the transfer rate is less than 5 MB/sec.

[c] The maximum length is 12 meters (39 feet) if you have more than two devices on the bus. If the bus is a point-to-point configuration (two devices–the target and the initiator), the bus length can be up to 25 meters (82 feet).

Terminating the Tape Drive

If the tabletop tape drive is the last device on the SCSI bus, use one of the terminator types listed below or an equivalent. Terminators for single-ended and LVD buses are not identical. Do not mix the variants.

- **For a single-ended narrow SCSI configuration:** AMP 750381-1
- **For an LVD wide SCSI configuration:** AMP 796051-1 (SE/LVD multi-mode)

Connecting the Power Cord

The tabletop tape drive includes a 120 VAC three-conductor power cord for use in the United States and Canada. The three-conductor, 18AWG, SVT or SJT type AC power cord has a molded NEMA 5-15P male connector on one end and a molded IEC type CEE-22 female connector on the other end. The power cord is UL Listed and CSA Certified.

The tabletop tape drive can operate from 100 to 240 VAC, with a frequency of 50 or 60 Hz, without manual intervention. As described below, you must supply power cords for other input voltages or when using the tabletop tape drive outside of the United States and Canada.

International 220 VAC Power Cord

An international 220 VAC power cord for the tabletop tape drive must meet the following requirements:

- The power cord must have an attachment plug of the proper type, rating, and safety approval for the intended country.
- The power cord must have an IEC type CEE-22 female connector on one end.
- The cordage must be adequately rated and harmonized to CENELEC publication HD-21.

220 VAC Power Cord for the United States and Canada

A 220 VAC power for the tabletop tape drive must meet the following requirements:

- The power cord must have a NEMA 6-15P male connector on one end.
- The power cord must have an IEC type CEE-22 female connector on the other end.
- The cordage used must be an SVT or SJT type, three conductor, 18 AWG minimum.
- The power cord must comply with local electrical code.

Reliability Specifications

Mean Time Between Failures (MTBF)

The predicted MTBF value for the tape drive in an Exabyte tabletop enclosure (including the power supply, fan, and cables) is 115,000 hours. This value is based on a 10% duty cycle.

Mean Time to Repair

If the enclosed tape drive is treated as a field replaceable unit, the mean time to repair the tabletop tape drive (remove and replace the enclosed tape drive) is less than 15 minutes.

Power Specifications

This section describes the power specifications for the tabletop tape drive.

Power Supply

The tabletop tape drive uses an internal switching power supply. You do not need to change any input settings. The power supply automatically adjusts for changes in voltages and frequency within the specified range. An AC line filter minimizes interference.

Table A-2 lists the general specifications for the power supply.

Table A-2 Power supply specifications

Type	30 watts switching
Efficiency	60% minimum
Input voltage[a]	100 to 240 VAC @ 1 Amp maximum
Frequency[a]	50 or 60 Hz ± 5%
Switching frequency	> 30 KHz

[a] Autoswitching input selection—no user selection required.

AC Power Characteristics

The tabletop tape drive continues to operate when the AC power experiences intermittent operations, voltage surges, and voltage spikes. Table A-3 provides power consumption specifications.

Table A-3 AC power consumption

Average current	0.265 amps
Maximum current	0.340 amps

Environmental Specifications

The environmental specifications for the internal tape drive (described in Chapter 5), apply to the tabletop tape drive as well. However, because the tabletop tape drive includes an enclosure, ambient temperature and humidity must be maintained at the levels described in this section to achieve the tape path requirements discussed on page 5-12.

To meet tape path temperature and humidity requirements, maintain the tabletop tape drive's ambient operating environment within the area defined by the dotted lines in Figure A-8. Table A-4 defines the points in the chart.

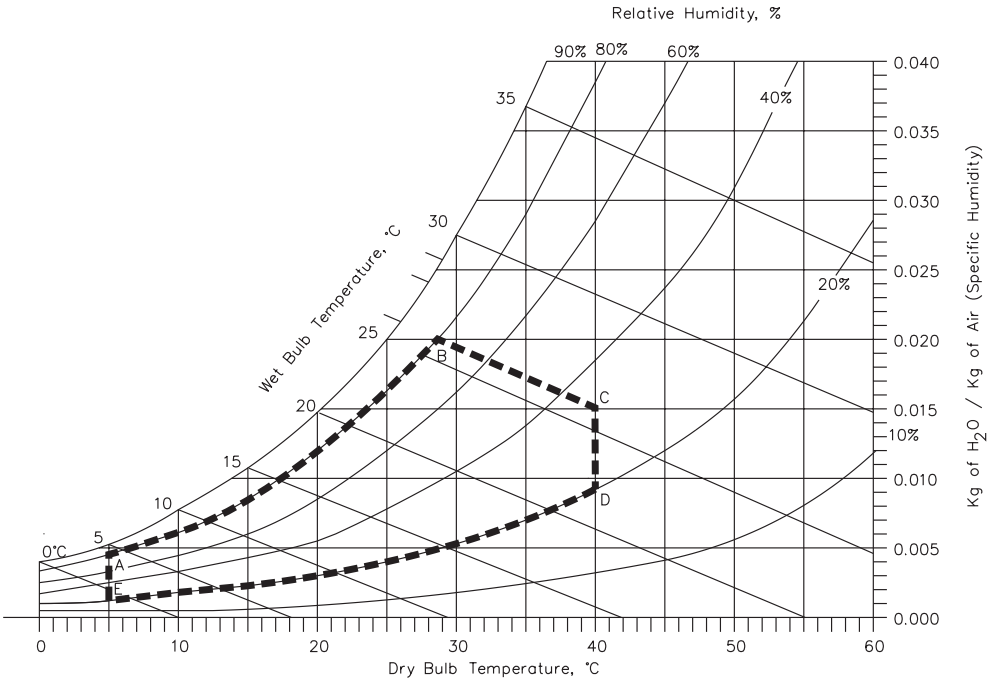


Figure A-8 Ambient operating environment for the tabletop tape drive

Table A-4 Temperature and humidity points for Figure A-8

Point	Temperature	Humidity
A	5° C	80%
B	29° C	80%
C	40° C	34%
D	40° C	20%
E	5° C	20%

Acoustic Noise

The overall, averaged A-weighted sound pressure levels (decibels) for the tabletop tape drive do not exceed the upper limits specified in Table A-5.

Table A-5 Acoustic noise limits for the tabletop tape drive

Operating mode	LWA[a]
The tape drive is powered on and idle.	48
The tape drive is fully operational and operating in streaming mode for a read or write operation.	48
The tape drive is performing a high-speed search or rewind operation (less than 2 minutes duration).	49

[a] LWA is the average A-weighted sound pressure level over the following frequency range: 5 Hz to 12.5 KHz.

Air Flow in the Tabletop Enclosure

A thermistor-controlled fan controls air flow through the tabletop enclosure. Air flows from the front of the tabletop enclosure to the rear through a specially designed series of vents built into the enclosure. The thermistor increases or decreases air flow based on environmental temperature changes.

Figure A-9 shows the flow of air through the tabletop enclosure.

> **CAUTION**
>
> Do not cover the air flow vents on the right side of the tabletop tape drive. Covering these vents can cause the tape drive to overheat and damage equipment and the data cartridge.

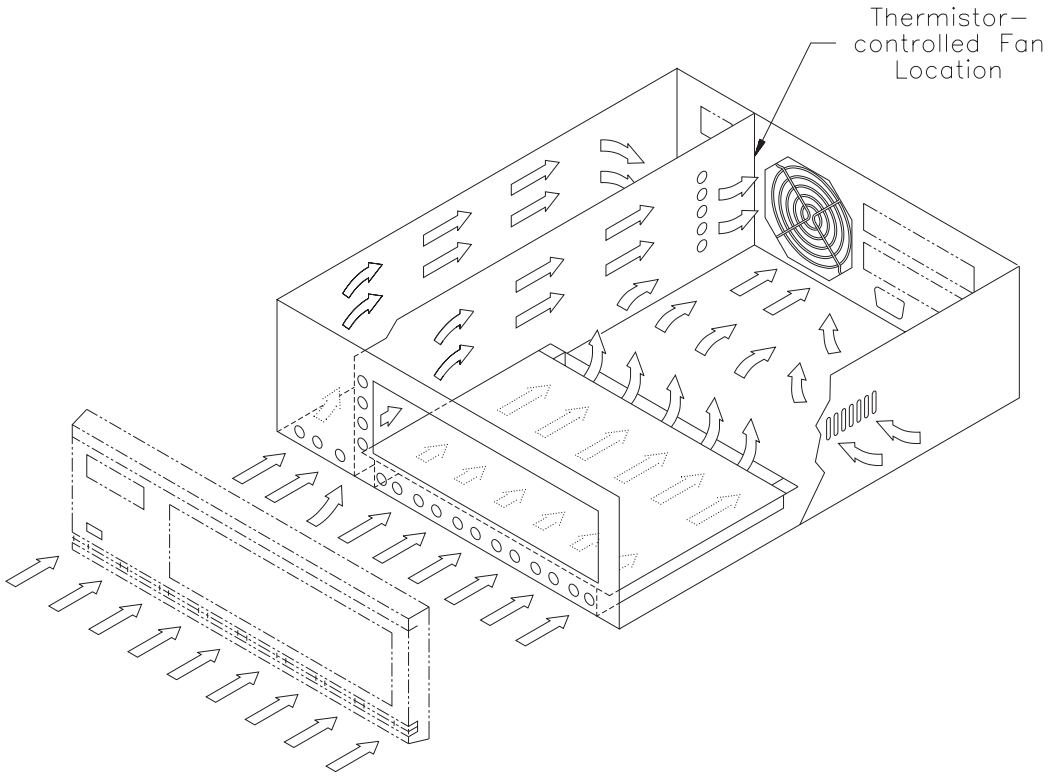


Figure A-9 Air flow through the tabletop enclosure

Shipping Specifications

When shipped, the tabletop tape drive is sealed in a static protection bag and is shipped with one unit per carton.

The shipping cartons and internal packing materials are designed so that the enclosed tabletop tape drive does not receive a shock greater than 45 g when the carton is dropped on any surface, corner, or edge from the following height:

- 36 inches (91.4 cm) at a velocity change of 167 inches per second (424 cm/sec)

The shipping carton passes the tests described in the International Safe Transit Association (ISTA) Procedure 2A for packaged products weighing less than 100 pounds.

Table A-6 provides the shipping carton's outside dimensions and weight.

Table A-6 Dimensions and weight of the shipping carton

Length	17 ¾ inches (45 cm)
Width	16 ¼ inches (41 cm)
Height	10 ¾ inches (27 cm)
Weight (with tape drive)	10 pounds (4.5 kg)

The tabletop tape drive's packing materials are unbleached, reusable, recyclable, and environmentally safe. The materials contain no chlorofluorocarbons (CFCs) or heavy metals.

When repacking and shipping the tabletop tape drive, use the original shipping carton and packing materials (or replacement packaging obtained from the vendor) to avoid damaging the tape drive. The shipping carton and packing materials are not intended to be used for shipping items other than a tabletop tape drive.

Safety and Regulatory Agency Compliance

This section lists the safety and regulatory agency compliance for the tabletop tape drive. This information is in addition to the information in Chapter 5.

Note: For the tabletop tape drive, the requirement for a shielded cabinet is met by the tabletop enclosure.

Radiated Emissions

When properly installed in a shielded cabinet with shielded cables and adequate grounding of the SCSI bus and input power, the tape drive meets the requirements for radiated and conducted emissions as defined by the following standards:

USA:	FCC, CFR 47, Ch. I, Part 15, Subpart B, Class B
Canada:	ICES-003, Class B
Australia:	AS/NZ 3548, Class B
Taiwan:	CNS-13438, Class A
Europe:	EN55022/CISPR 22, Class B

Electrostatic Discharge (ESD) Limits

When properly installed in a shielded cabinet with shielded cables and adequate grounding of the SCSI bus and input power, the tape drive meets the following requirement of EN 61000-4-2: 1995, Immunity to Electrostatic Discharge (ESD):

- Contact discharges, 4 kV
- Air-gap discharges, 8 kV

The tape drive can withstand up to:

- 15 kilovolts air-gap discharge applied to non-metallic surfaces accessible during normal use without degradation or non-recoverable loss of function due to damaged equipment of firmware.

- 8 kilovolts direct discharge applied to metallic surfaces accessible during normal use without degradation or non-recoverable loss of function due to damaged equipment or firmware.

Radiated RF Field Immunity

When properly installed in a shielded cabinet with shielded cables and adequate grounding of the SCSI bus and input power, the tape drive meets the following requirement of EN 61000-4-3, 1996, Radiated RF Field Immunity.

The tape drive will continue to operate without error when subjected to a radiated RF field of 3 volts/meter with 80%, 1 kHz amplitude modulation (AM).

Electrical Fast Transient/Burst (EFT) Immunity

When properly installed in a shielded cabinet with shielded cables and adequate grounding of the SCSI bus and input power, the tape drive meets the following requirement of EN 61000-4-4: 1995, Electrical Fast Transient/Burst Immunity.

The tape drive will continue to operate without error when subjected to EFT of 2 kV on the AC power ports and 1 kV on the I/O ports (SCSI and serial ports).

Surge Immunity

When properly installed in a shielded cabinet with shielded cables and adequate grounding of the SCSI bus and input power, the tape drive meets the following requirement of EN 61000-4-5: 1995, Surge Immunity.

The tape drive will continue to operate without error when subjected to a surge of 2 kV for A.C. mains and 1 kV for D.C. ports.

Conducted Radio Frequency Field Immunity

When properly installed in a shielded cabinet with shielded cables and adequate grounding of the SCSI bus and input power, the tape drive meets the following requirement of EN 61000-4-6: 1996, Conducted Radio Frequency Immunity.

The tape drive will continue to operate without error when subjected to a field of 3 $V_{(rms)}$.

Voltage Dips, Interruptions, and Variations Immunity

When properly installed in a shielded cabinet with shielded cables and adequate grounding of the SCSI bus and input power, the tape drive meets the following requirement of EN 61000-4-11: 1994, Voltage Dips, Interruptions, and Variations Immunity.

The tape drive will continue to operate without error after being exposed to a 70% voltage dip for 10 milliseconds (ms). The tape drive will be self-recoverable or can be restored by the operator after being exposed to a 40% voltage dip for 100 ms and after a power interruption of 5 seconds.

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