



MAGNUM TAPE DRIVE (LTO-3)

PRODUCT MANUAL



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PART NUMBER 1014548 Revision A

REVISION HISTORY	Revision	Date	Description
	A	May 2005	Initial release.

NOTE: The most current information about this product is available at Exabyte's web site (www.exabyte.com).

**PRODUCT
WARRANTY
CAUTION**

The Exabyte Magnum Tape Drive (LTO-3) is warranted to be free from defects in materials, parts, and workmanship, and conforms to the current product specification. For the specific details of your warranty, refer to your sales contract or contact the company from which you purchased the tape drive.

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.
- ▶ Use of any type of data cartridge other than an Exabyte LTO tape or an Exabyte-approved LTO data cartridge.
- ▶ Use of any type of cleaning material other than an Exabyte LTO tape Cleaning Cartridge.
- ▶ Repair or modification by any one other than Exabyte's personnel or agent in a manner differing from the maintenance instructions provided by Exabyte.
- ▶ Removal of the Exabyte identification label(s).
- ▶ Physical abuse due to improper packaging of returned drives.

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



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).

FCC NOTICE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**LASER SAFETY
NOTICE**

This tape drive contains components that comply with performance standards that are set by the U.S. Food and Drug Administration (Part 21CFR, 1040.10/11). This means that these products belong to a class of laser products that do not emit hazardous laser radiation. This classification was accomplished by providing the necessary protective housing and scanning safeguards to ensure that laser radiation is inaccessible during operation or is within Class I limits. External safety agencies have reviewed these products and have obtained approvals to the latest standards as they apply to this product type.

**END OF LIFE (EOL)
PLAN**

This tape drive is a purchased unit. Therefore, it is the sole responsibility of the purchaser to dispose of it in accordance with local laws and regulations at the time of disposal. This unit contains recyclable materials. The materials should be recycled where facilities are available and according to local regulations.

**CONTACTING
EXABYTE**

To obtain general information	
Exabyte Corporate Headquarters	Exabyte Corporation 2108 55th Street Boulder, CO USA 80301 (303) 442-4333
World Wide Web	www.exabyte.com
To obtain technical support	
Exabyte Technical Support	www.exabyte.com/products/hardwarewarranty.cfm
To order supplies and accessories	
Exabyte Sales Support	1-800-774-7172
	1-800-392-8273 (Exabyte Media)
To obtain service	
Exabyte Service	www.exabyte.com/support/contact/index.cfm



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HOW TO USE THIS MANUAL

This manual describes how to install, operate, and maintain the Magnum Tape Drive (LTO-3). It also provides functional, performance, and environmental specifications.

WHERE TO LOOK FOR INFORMATION

Installation

If you are installing the tape drive for the first time, refer to the following chapters:

- ▶ [Chapter 1](#) provides an overview of the tape drive's features and components.
- ▶ [Chapter 2](#) provides instructions for installing the tape drive, connecting it to the host computer, and powering it on.

Operation, troubleshooting, maintenance, and service

Refer to these chapters for information about operating, maintaining, and troubleshooting your tape drive:

- ▶ [Chapter 3](#) provides instructions for using the tape drive, including reading the single-character display and the status LED, loading and unloading cartridges, and cleaning the tape drive.
- ▶ [Chapter 4](#) describes the types of tape cartridges to use and defines the conditions for storing and shipping them. It also describes how to handle the cartridges, how to set a cartridge's write-protect switch, and guidelines for using bar code labels.
- ▶ [Chapter 5](#) provides troubleshooting recommendations.
- ▶ [Chapter 6](#) provides information about service and maintenance for the tape drive, including returning it for service, upgrading firmware, and obtaining a diagnostic listing.
- ▶ [Appendix A](#) describes the error and informational codes that appear on the single-character display.
- ▶ [Appendix B](#) provides instructions for using the tape drive's diagnostic and maintenance functions to identify and correct problems.
- ▶ [Appendix C](#) provides a complete list of the TapeAlert flags supported by the tape drive. The TapeAlert flags may aid during problem determination.
- ▶ [Chapter D](#) provides information about the new Write Once, Read Many (WORM) capability of the LTO-3 tape drive.

Specifications, standards, and terms

These chapters are for engineering, purchasing, or marketing personnel who want to evaluate the tape drive to determine the feasibility of integrating it into their product lines.

- ▶ [Chapter 7](#) provides specifications for the tape drive, including performance, reliability, power, and environmental specifications. This chapter also provides safety and regulatory agency standards compliance information.
- ▶ The [Glossary](#) provides definitions of terms used in this manual and in other documentation associated with the tape drive.

RELATED PUBLICATIONS

For more information about the tape drive and the standards used by the tape drive, refer to the following publications. To order an Exabyte publication, see [“Contacting Exabyte” on page iv](#). To download a PDF version of an Exabyte publication, visit the Exabyte web site (www.exabyte.com).

IBM Ultrium LTO-3 Publications

Note: See the IBM web site at www.ibm.com/servers/storage/support/lto/ltoem/ to locate additional information about IBM LTO Ultrium tape drives.

Standards Publications

These publications are available on the web at www.t10.org.

- ▶ *SCSI Parallel Interface-3 (SPI-3)*, International Committee on Information Technology Standards (INCITS)
- ▶ *SCSI-3 Stream Commands (SSC)*, American National Standards Institute (ANSI)
- ▶ *SCSI Stream Commands-2 (SSC-2)*, ANSI
- ▶ *SCSI Primary Commands-2 (SPC-2)*, ANSI
- ▶ *SCSI Primary Commands-3 (SPC-3)*, ANSI

CONVENTIONS USED IN THIS MANUAL

This manual uses the following conventions:

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

! Important Read information marked by the “Important” icon for information that will help you complete a procedure, avoid extra steps, or avoid future problems.

**Caution**

Read the information marked by the “CAUTION” icon for information you must know to avoid damaging the tape drive or losing data.

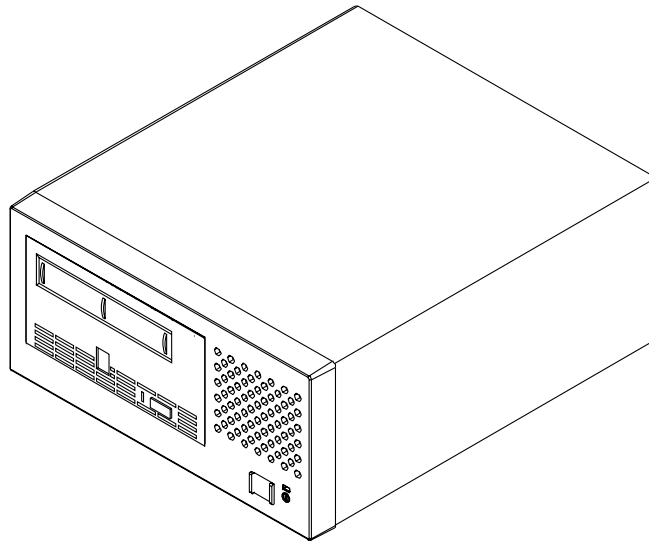
**Warning**

Read text marked by the “WARNING” icon for information you must know to avoid personal injury.

Notes

MAGNUM TAPE DRIVE (LTO-3) FEATURES

The Exabyte Magnum Tape Drive (LTO-3) offers high-capacity, performance, and technology designed for the midrange open systems environment. This new model incorporates the new Linear Tape-Open (LTO) Generation 3 tape drive, which more than doubles maximum tape drive performance over the Generation 2 LTO Ultrium Tape Drive (Ultrium 2). The tape drive is the third-generation tape drive in the Ultrium series of products. It is available with a SCSI Ultra160 LVD Interface for connection to a wide spectrum of open system servers.



The tape drive offers a formatted cartridge capacity of up to 400 GB (800 GB assuming 2:1 compression ratio) and a sustained data transfer rate of 80 MB per second (160 MB per second assuming 2:1 compression ratio).

Features of the Magnum Tape Drive (LTO-3) include:

- ▶ Burst data transfer rate of 160 MB per second.
- ▶ Larger internal buffer (the size has been doubled over the Ultrium 2 to 128 MB).

- ▶ On-the-fly error correction of soft errors in the memory arrays in data and control paths.
- ▶ New dual stage 16 channel head activator for precision head alignment to help support higher track density with improved data integrity and backwards compatibility with previous LTO generation.
- ▶ Graceful dynamic braking designed to maintain tension until the tape comes to a complete stop, to help prevent stretching or breaking the tape, and loose tape wraps
- ▶ New independent tape loader and threader motors designed to help with cartridge insertion in the tape drive.
- ▶ Highly integrated electronics designed to reduced the total number of components in the drive, lower chip temperatures, and reduce power requirements, helping to provide for a more reliable drive.

COMPONENTS

This section describes the major components of the tape drive.

FRONT PANEL COMPONENTS

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

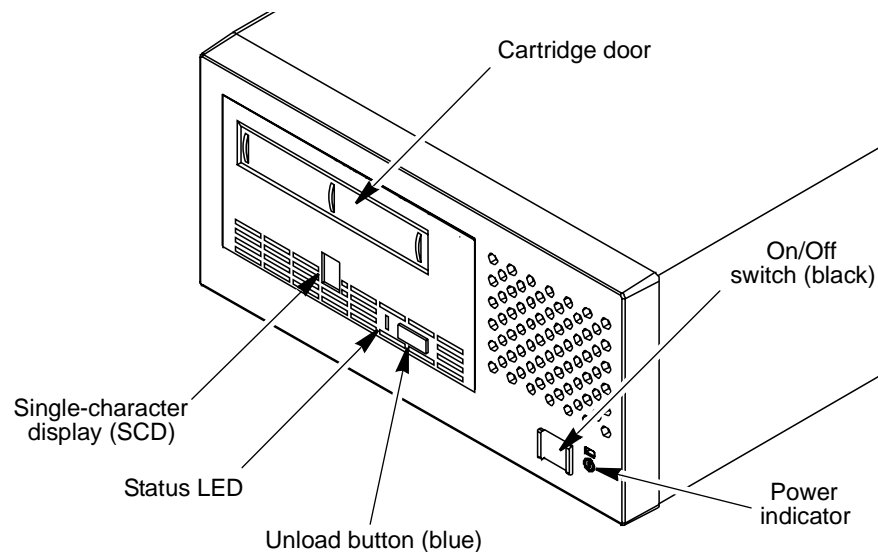


Figure 1-1 Front-panel components

Cartridge Door Used for inserting the cartridge into the tape drive.

Single-character Display Provides a single-character code for error conditions and informational messages. It also provides codes for Diagnostic or maintenance functions. These codes are described in [Table A-1 on page 56](#). A red dot appears in the corner of the display when a drive dump is available (see [“Performing Diagnostics and Maintenance Functions” on page 61](#) for more information).

Status LED (Light Emitting Diode) Indicates the current operating status information, which is described in [Table 3-1 on page 15](#).

Unload Button Used to unload the tape and eject the cartridge.

On/Off Switch Used to turn power on and off.

Power Indicator Shows the power-on status of the tape drive.

BACK PANEL COMPONENTS

[Figure 1-2](#) shows the back-panel components of the of the tape drive.

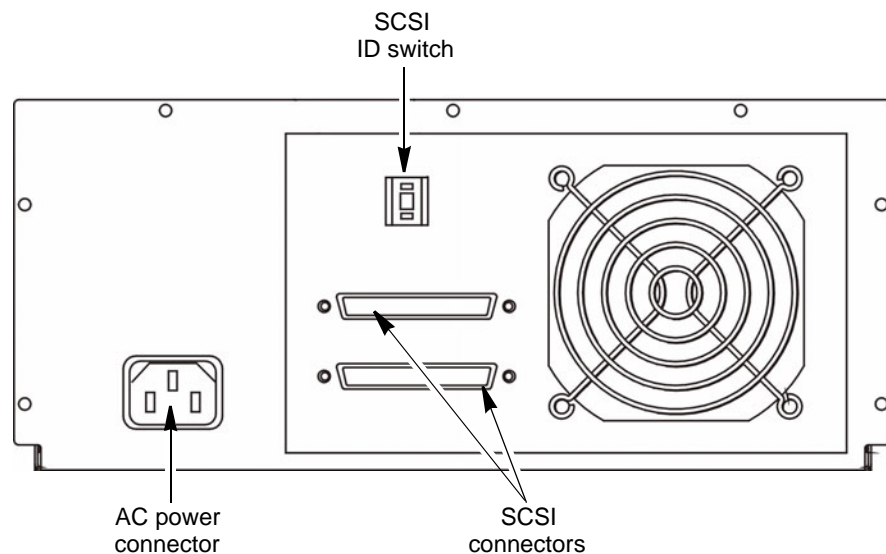


Figure 1-2 Back-panel components

On/Off Switch Used to turn power on and off.

AC Power Connector Used to provide power through a grounded AC power connector. A power cord is included with the tape drive.

SCSI Connectors Used to connect the tape drive to the SCSI bus with two SCSI cables or one SCSI cable and a terminator. These connectors are 68-pin, wide, Ultra160 LVD connectors.

SCSI ID Switch Used to set the tape drive SCSI ID.

Notes

INSTALLING THE TAPE DRIVE

This chapter provides step-by-step instructions for installing the tape Drive. The information in this chapter expands on the instructions in the *Quick Start* guide that accompanied your tape drive.

BEFORE YOU BEGIN

Before you begin installing the tape drive, do the following:

- ✓ **Make sure that the SCSI host bus adapter card installed in the host computer, any necessary device drivers, and your backup software are compatible with the tape drive.** — Make certain that an LVD SCSI host bus adapter (HBA) and any necessary drivers installed in the host computer are compatible with the tape drive. Using an Ultra160 LVD SCSI host bus adapter will provide optimum performance.

! Important Data transfer protocols for tape and disk drives are very dissimilar. For that reason, it is strongly recommended that you avoid running tape and disk drives on the same host adapter. A configuration with tape and disk on a single host adapter gives a slow and unreliable performance.

! Important To avoid performance problems, do not connect the tape drive to a single-ended SCSI bus. Exabyte does not support operating the tape drive on a SCSI bus that has single-ended devices attached.

! Important Do not connect the tape drive to a RAID controller.

To obtain information about which software applications work with the tape drive, visit Exabyte's web site (www.exabyte.com). You can install the software application on the host computer before or after you install the tape drive. However, if you install the software first, you may need to reconfigure it for use with the tape drive.

- ✓ **Ensure that the work area is free from conditions that could cause electrostatic discharge (ESD).** — Discharge static electricity from your body by touching a known grounded surface, such as a computer's metal chassis.
- ✓ **Inspect the Power Cord and Outlet** — Inspect the power cord plug to ensure that it matches the power receptacle. Ensure that the electrical outlets that you use are properly grounded and that the circuit breaker is turned on.

**Warning**

An electrical outlet that is not correctly wired could place hazardous voltage on metal parts of the system or the devices that attach to the system. It is the responsibility of the customer to ensure that the outlet is correctly wired and grounded to prevent an electrical shock.

- ✓ **Power Down the Host Computer System** — Turn off all devices attached to the computer to which you plan to connect the tape drive, then turn off the computer. Disconnect all power cables.

UNPACK THE TAPE DRIVE

All Exabyte tape drives are tested, inspected, and carefully packaged at the factory. However, because shipping damage can occur, you should follow the steps below to unpack the tape drive:

1. Visually inspect the shipping container and notify your freight carrier immediately if you see any damage.
2. Place the shipping container on a flat, clean, stable surface. If parts are missing or the equipment is damaged, notify your supplier or Exabyte.
3. Save the original shipping container and packaging materials in case you need to reship the tape drive.

INSTALL THE TAPE DRIVE

When installing the tape drive, refer to [Figure 2-1](#) for the location of the back-panel components.

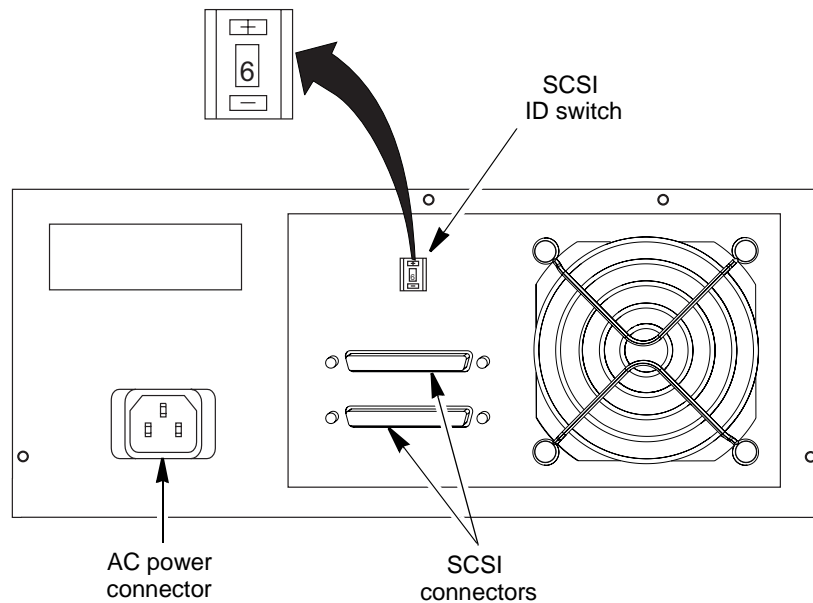


Figure 2-1 Back-panel components

STEP 1. SET THE SCSI ID

1. Determine whether you need to change the SCSI ID used by the tape drive.

The tape drive is shipped with a SCSI ID of 0. If another device on the SCSI bus is already configured with this SCSI ID, you will need to change the tape drive's SCSI ID.

Notes:

- ▶ The range of SCSI IDs is 0 through 15. The priority of SCSI IDs is: 7, 6, 5, 4, 3, 2, 1, 0, 15, 14, 13, 12, 11, 10, 9, 8.
- ▶ Do not select an ID that is already in use by any device on the SCSI bus.
- ▶ Do not select the SCSI ID of the SCSI host adapter card. The priority of this ID is usually higher than any device on the SCSI bus. Generally, the SCSI ID for the host adapter is set to 7.

2. Change the SCSI ID, if necessary.

To change the default ID, use a small pointed object (such as a ballpoint pen) to press the + and – tabs above and below the SCSI ID indicator, until the desired SCSI ID appears.

Note: If you change the SCSI ID after you complete the installation, turn the tape drive off, then back on again to activate the new SCSI ID.

STEP 2. POSITION THE TAPE DRIVE

Position the tape drive anywhere that is convenient to the host. The only restrictions are the length of the power cord and the length of the SCSI cable. Recommended locations are:

- ▶ Away from high-traffic areas, especially if the floor is carpeted.
- ▶ Out of computer rooms to avoid toner and paper dust. Do not store paper supplies next to any unit.
- ▶ Away from moving air, such as doorways, open windows, fans, and air conditioners.
- ▶ Off the floor.
- ▶ In a horizontal position.
- ▶ Where data cartridges can be easily inserted.

The tape drive should not be stacked. Do not place anything on top of the tape drive. To minimize any contamination from airborne particles, ensure that the cover is always closed.

STEP 3. CONNECT POWER

1. Because the tape drive may not complete the Power-On Self Test (POST) without SCSI termination, connect a terminator (or SCSI bus with termination) to one of the two SCSI connectors on the back of the tape drive.
2. Plug the power cord into the tape drive, then plug the other end into a grounded electrical outlet.
3. Power-on the tape drive by pressing the power switch. The tape drive runs the POST, which checks all hardware except the tape drive head. During the POST, the single-character display (SCD) flashes several segmented characters. Each segmented character represents a test performed during the POST. When the POST finishes, the single-character display momentarily lights all 8 segments and then goes blank. The status LED briefly becomes solid amber, then becomes solid green.

STEP 4. RUN THE WRITE PERFORMANCE TEST (FUNCTION CODE F).

The Write Performance Test (Function Code F) performs procedures to ensure that the tape drive can read from and write to tape. The diagnostic loops ten times and takes approximately 5 minutes to complete.

Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately.



Caution

For this test, use only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the tape drive overwrites the data on the cartridge.

Use the following steps to run the Write Performance Test:

1. Make sure that no cartridge is in the tape drive.

! Important If a cartridge is in the tape drive, it will eject the first time that you press the unload button and the tape drive will not be placed in maintenance mode.

2. Within 2 seconds, press the unload button three times. The status LED becomes solid amber and **0** appears in the single-character display (SCD), indicating that the tape drive is in maintenance mode.

Note: Maintenance functions cannot be performed concurrently with read or write operations. While in maintenance mode, the drive does not receive SCSI commands from the host.

3. Press the unload button once per second until **F** appears in the SCD. (If you cycle past the desired code, press the unload button once per second until the code redisplay.)
4. Press and hold the unload button for 3 seconds. After you select the function **C**, the SCD flashes to indicate that the tape drive is waiting for a cartridge.
5. Within 60 seconds, insert a scratch data cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

6. After you insert the cartridge **F** flashes on the SCD and the test begins:

- ▶ If no error is detected, the test loops and begins again. After the tenth loop, the test stops and the tape drive automatically exits maintenance mode.

To stop the loop, press the Unload Button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.

- ▶ If the write performance is degraded less than 94%, the status LED flashes amber and the tape drive posts an error code to the SCD. To determine the error, locate the code in [Table A-1 on page 56](#). The tape drive unloads the data cartridge and exits maintenance mode. To clear the error, cycle power (turn it off, then on again).

STEP 5. CONNECT THE TAPE DRIVE TO THE SCSI BUS

The SCSI bus cable connects the tape drive to the host. You can connect the SCSI bus cable (and the terminator) to either SCSI connector on the back of the tape drive. Make sure the cable is a wide Ultra2 SCSI LVD cable with a 68-pin, high-density male connector.



Caution

Do not use a noncompliant SCSI cable; it will degrade the tape drive's performance and can cause random, nonreproducible errors.

Guidelines for Connecting to SCSI

Keep these guidelines in mind as you plan your SCSI connections:

- ▶ **For maximum performance, limit the number of tape drives that you attach to one SCSI bus.** The maximum number is based on the type of bus that you have and the amount of data compression achieved. Ultra SCSI buses have a bandwidth of 40 MB per second; Ultra2 SCSI buses have a bandwidth of 80 MB per second; Ultra160 SCSI buses have a bandwidth of 160 MB per second.

The Magnum Tape Drive (LTO-3) is capable of data transfer rates of up to 80 MB per second with no compression and 160 MB per second at 2:1 compression. **To achieve maximum performance, you should attach only one tape drive to an Ultra SCSI bus, Ultra2 SCSI bus, or Ultra160 SCSI bus.**

- ▶ **Do not connect single-ended SCSI devices.** Although single-ended SCSI is compatible with LVD SCSI, Exabyte does not support connecting single-ended devices to the SCSI bus attached to the tape drive.
- ▶ **Do not connect the tape drive to a RAID controller.** The tape drive will not operate if it is connected to a RAID controller.
- ▶ **Do not exceed SCSI bus length restrictions.** Make sure the SCSI bus attached to the tape drive does not the following lengths:
 - ▶ For an LVD bus with a single device, do not use a total cabling length that exceeds 25 m (82 feet).
 - ▶ For an LVD bus with more than two devices, do not use a total cabling length that exceeds 12 meters (39 feet).
- ▶ **Make sure the SCSI bus is properly terminated.** You must install a terminator on the device at the physical end of the SCSI bus. If the tape drive terminates the SCSI bus, you must install the required terminator on one of the tape drive's SCSI connectors.

To connect the tape drive to the SCSI bus:

1. Turn off the tape drive.
2. If the host's SCSI bus is in operation, stop all activity on the bus that you are connecting to (for instructions about how to stop SCSI bus activity, refer to your host's documentation).
3. Configure your SCSI connections.
 - ▶ If the tape drive is the last or only device on the SCSI bus, connect a SCSI cable between the tape drive and the host, as shown in [Figure 2-2](#). Install a terminator on the unused SCSI connector

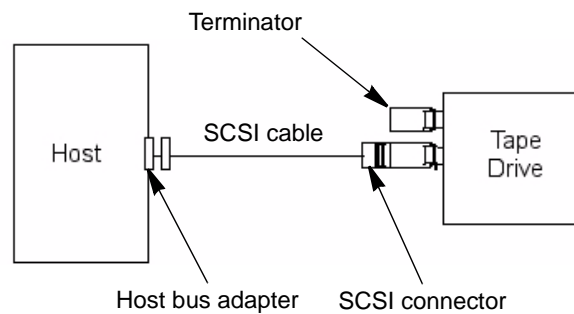


Figure 2-2 Tape drive is last or only device on the SCSI bus

- ▶ If the tape drive is one of multiple devices on the SCSI bus, connect SCSI cables between the tape drive and other devices on the bus, as shown in [Figure 2-3](#). If there are additional devices on the SCSI bus, ensure that only the device at the physical end of the bus is terminated.

! Important To avoid potential damage to your SCSI devices, do not mix LVD and HVD/DIFF SCSI host bus adapters, tape drives, or terminators on the same bus.

! Important Do not connect the tape drive to a RAID controller.

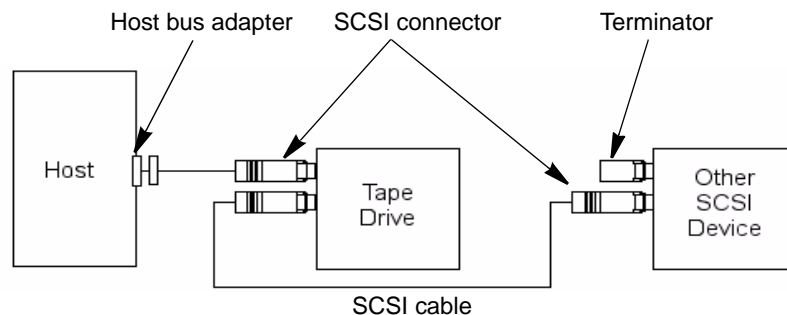


Figure 2-3 Another peripheral is the last device on SCSI bus

4. Power on the host computer system.

STEP 6. INSTALL DEVICE DRIVERS

Device drivers are software that enables the tape drive to interact with a variety of hosts. The latest levels of device drivers and driver documentation for the tape drive are available on the Support section of Exabyte's web site, www.exabyte.com. For applications that use other device drivers, refer to the application's documentation to determine which drivers to use.

- ▶ If you intend to use your drive with an existing or new commercial software application, refer to that application's installation instructions to install the device driver and configure the tape drive.

Note: If you intend to use your tape drive with a commercial software application, it is recommended that you use the tape drivers provided with the software instead of the device driver provided on the web site. Only install a device driver from the web if the instructions from your commercial software application tell you to do so.

- ▶ If you do not intend to use your drive with a commercial software application, download and install the device driver from Exabyte's web site, www.exabyte.com. Refer to the installation instructions on the download page.

STEP 7. CONFIGURE THE TAPE DRIVE TO THE HOST

To configure the tape drive for use, refer to the documentation for your host and application software.

3

OPERATING THE TAPE DRIVE

This chapter describes how to operate the tape drive.

USING THE FRONT PANEL CONTROLS AND INDICATORS

Figure 3-1 shows the controls and indicators on the front panel of the tape drive. The following sections describe using these controls and indicators.

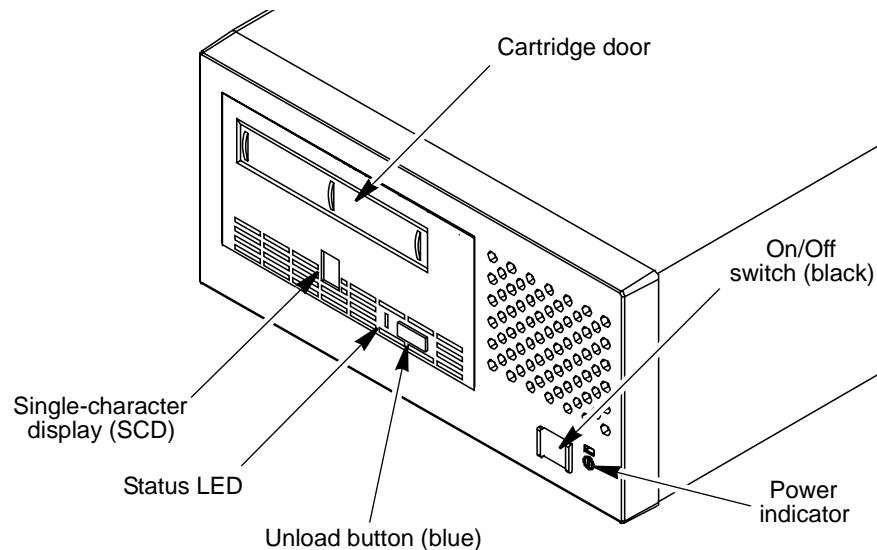


Figure 3-1 Front-panel components

USING THE POWER SWITCH

The power switch is a push button switch that lets you turn the tape drive on or off.

- ▶ To power the tape drive on, push the power switch once. The power indicator will light when power is on.

- ▶ To power it off, push the switch again. When you place the power switch in the off position, the primary electrical power within the enclosure is still active. If you do not want electrical power to be present in the enclosure, unplug the tape drive's power cord from the receptacle at the rear of the tape drive (see [Figure 1-2 on page 3](#)).

USING THE UNLOAD BUTTON

! Important If you press the Unload Button during host operation, the tape drive ends the command that is being processed, and unloads and ejects the tape cartridge. Note that (depending on its location on the reel) the tape may take as long as 10 minutes to completely rewind and eject.

The unload button enables you to perform the following functions:

- ▶ Rewind the tape into the cartridge and eject the cartridge from the tape drive. For more information, see [“Unloading a Cartridge” on page 18](#).
- ▶ Enter or exit maintenance mode, or perform diagnostic or maintenance functions. For more information, see [“Performing Diagnostics and Maintenance Functions” on page 61](#).
- ▶ Perform a panic reset of the tape drive. To perform a panic reset, press and hold the unload button on the tape drive for 10 seconds. The tape drive forces a dump and overwrites the existing dump. The tape drive then reboots to allow communication.

! Important If the tape drive detected a permanent error and displayed an error code, it automatically forces a drive dump (also known as a save of the firmware trace). If you perform a panic reset of the tape drive, the existing dump will be overwritten and lost.

MONITORING THE STATUS LED AND SINGLE-CHARACTER DISPLAY

The status LED provides information about the state of the tape drive. The light can be green or amber, and (when lit) solid or flashing.

The single-character display (SCD) is blank during normal operation. When needed, the single-character display provides the following information:

- ▶ Error conditions and informational messages. [Table A-1 on page 56](#) lists the codes for error conditions and informational messages. If multiple errors occur, the code with the highest priority (represented by the lowest number) displays first. When the error is corrected, the code with the next highest priority displays, and so on until no errors remain.
- ▶ Diagnostic or maintenance functions. [“Performing Diagnostics and Maintenance Functions” on page 61](#) describes the single-character codes used for diagnostic or maintenance functions.

- ▶ If a drive dump is present while the tape drive is in maintenance mode, a single red dot illuminates on the display. To copy the dump to tape, see “Function Code 5 — Copy Drive Dump” on page 68.

The red dot turns off when you obtain the dump (by using an firmware update tape, a SCSI command, or a library command). If no dump is present while the tape drive is in maintenance mode, the single red dot does not illuminate.

Table 3-1 lists the conditions of the Status Light and Single-character Display (SCD) and provides an explanation of what each condition means. For any condition other than those listed, the Status Light is not illuminated.

Table 3-1 Meaning of Status LED and Single-character Display (SCD)






If Status LED is...	and SCD displays...	Description
Off 	Off	The tape drive has no power, or is powered off.
Green/Solid 	Off	The tape drive is powered on and in an idle state.
Green/Flashing 	Off	One of the following applies: <ul style="list-style-type: none"> ▪ The tape drive is reading from the tape, writing to the tape, rewinding the tape, locating data on the tape, or unloading the tape. ▪ The drive is performing a recovery operation because it contained a cartridge during the power-on cycle.
Amber/Solid 	Error Code Red characters or segments Flashing 0 Flashing function	One of the following applies: <ul style="list-style-type: none"> ▪ The drive is displaying error code(s) from the error code log. ▪ The tape drive is powering on, resetting, or in maintenance mode. ▪ The tape drive is exiting maintenance mode. ▪ The drive is executing the selected function while in maintenance mode.

Table 3-1 Meaning of Status LED and Single-character Display (SCD) (continued)

If Status LED is...	and SCD displays...	Description
Amber/Flashing 	Error Code	One of the following applies: <ul style="list-style-type: none"> The LED flashes once per second. An error occurred and the tape drive or media may require service. Or the tape drive may need cleaning. Note the code displayed on the single character display, then go to Table A-1 on page 56 to determine the meaning of the error code.
	Function code C	<ul style="list-style-type: none"> The LED flashes once per second. The tape drive needs leaning
	Function code 2 or Off	<ul style="list-style-type: none"> The LED flashes twice per second. The tape drive is updating firmware.^a The SCD displays 2 if using a field microcode replacement (FMR) cartridge. The SCD is off if the update is over the SCSI interface. See “Upgrading Firmware” on page 47 for additional information.
	Off	<ul style="list-style-type: none"> The LED flashes twice per second. Either: <ul style="list-style-type: none"> The tape drive detected an error and is performing a firmware recovery. Tape drive resets automatically. There is a drive dump in flash memory
	Flashing C	<ul style="list-style-type: none"> The LED flashes twice per second. The tape drive needs a cartridge loaded.

^a Power should not be removed from the tape drive until the microcode update is complete. The tape drive indicates that the update is complete by resetting and performing POST.

LOADING A CARTRIDGE

To insert a data cartridge:

1. Ensure that the tape drive is powered-on.
2. Ensure that the write-protect switch is properly set (see [“Setting the Write-Protect Switch” on page 23](#)).

3. Grasp the cartridge so that the write-protect switch faces you, as shown in Figure 3-2.

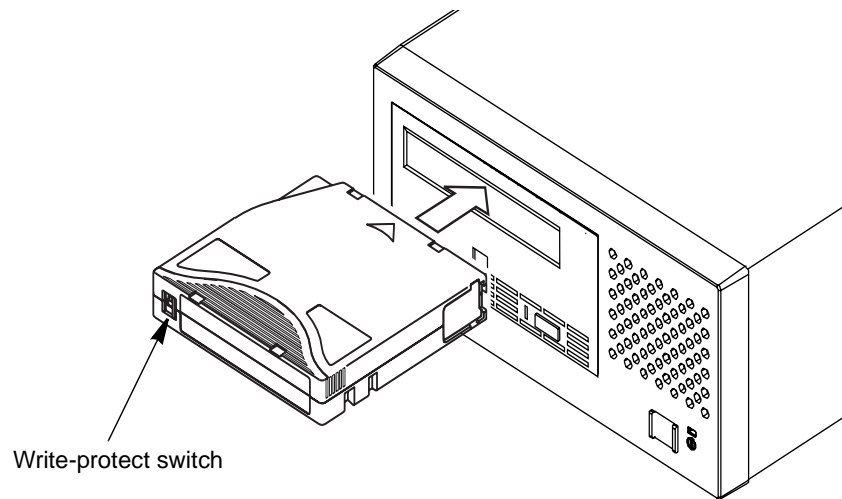


Figure 3-2 Inserting a cartridge into the tape drive

4. Slide the cartridge through the door and into the tape load compartment. The Status Light will flash green, then become solid green. The SCD remains blank.

Notes:

- ▶ If the cartridge is already in an ejected position and you want to reinsert it, remove the cartridge then insert it again.
- ▶ If the cartridge is already loaded and you cycle the power (turn it off, then on), the tape will reload.
- ▶ If you set the write-protect switch so that data cannot be written to it (in the locked position), the SCD will flash amber.

UNLOADING A CARTRIDGE



Caution

Be sure to remove any loaded cartridge before powering off the tape drive. Leaving a cartridge in the tape drive when you power off may result in damage to the cartridge or the tape drive.

To unload a cartridge:

1. Ensure that the tape drive is powered-on.
2. Press the unload button. The tape drive does the following:
 - ▶ Completes any command in process
 - ▶ Writes any buffered information to tape
 - ▶ Rewinds to the beginning of the tape
 - ▶ Writes any pertinent information to the cartridge memory
 - ▶ Partially ejects the cartridge
3. Grasp the partially ejected cartridge and remove it from the tape drive.

MID-TAPE RECOVERY

If a power cycle or reset occurs while a cartridge is loaded, the drive will slowly rewind the tape and eject the cartridge. The slow rewind may take up to 10 minutes.

CLEANING THE DRIVE HEADS

This section describes when and how to clean the tape drive heads to maintain optimal performance. Circulating air may introduce debris into the tape path. If debris builds up on the heads, error rates increase and backups take longer because the tape drive must rewrite the data. When necessary, clean the tape drive using an LTO Ultrium cleaning cartridge to maximize drive reliability and the life of your tapes.

DETERMINING WHEN TO CLEAN THE TAPE DRIVE

When the tape drive requires cleaning, **C** displays on the single-character display and the status LED flashes amber. The tape drive should be cleaned as soon as possible after notification.

Note: Some software applications may notify you that the tape drive requires cleaning. Refer to your software documentation for more information.

USING A CLEANING CARTRIDGE

Insert a LTO Ultrium Cleaning Cartridge into the tape drive. The tape drive automatically performs the cleaning cycle. When finished, the tape drive ejects the cleaning cartridge.



Caution

Do not use any cleaning method other than the LTO Ultrium Cleaning Cartridge (or a cleaning cartridge approved by Exabyte for use with LTO-3 drives). Using other cleaning methods may void the tape drive's warranty.

Do not rewind and reuse the material in a cleaning cartridge. Reuse may redistribute contaminants previously removed from the tape path. If all cleaning material has been used, discard the cartridge and use a new cleaning cartridge.

RESETTING THE TAPE DRIVE



Caution

Before resetting the tape drive, make sure that it is not performing any operations and is not communicating over the SCSI bus.

To reset the tape drive, perform one of the following steps:

- ▶ Power the tape drive off and then on again.
- ▶ Send a bus device reset (0Ch) message to the tape drive. A device reset clears all input/output (I/O) processes on that SCSI bus.
- ▶ Send a SCSI bus reset. (Make sure no other devices are using the SCSI bus.)

CLEANING THE TAPE DRIVE

Clean the exterior surface of the tape drive with a damp towel. If a liquid all-purpose cleaner is used, apply it to the towel. Do not spray the enclosure.

USING THE TAPE BACKUP SOFTWARE

Refer To the user's operating guide supplied with your tape backup application.

Notes

4

ULTRIUM MEDIA

Use only data cartridges and cleaning cartridges designed specifically for LTO Ultrium tape drives.

DATA CARTRIDGES

Figure 4-1 shows an LTO Ultrium data cartridge and its components.

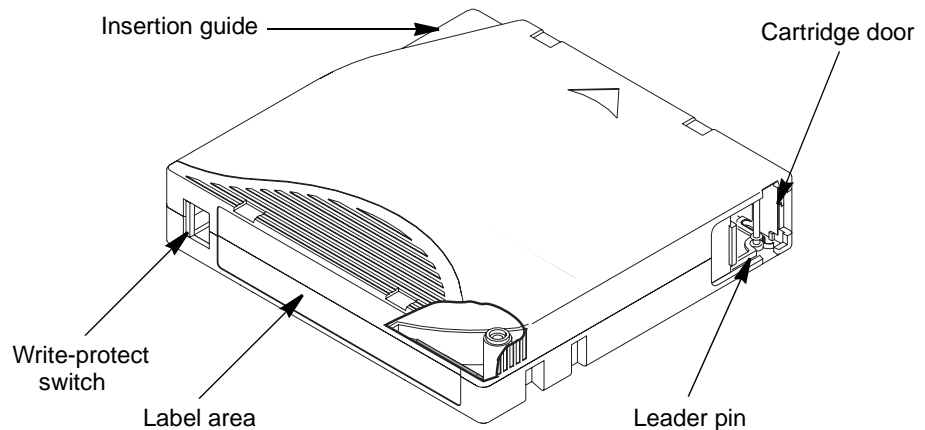


Figure 4-1 LTO Ultrium data cartridge components

Cartridge door The cartridge door protects the tape from contamination when the cartridge is out of the tape drive.

Leader pin Behind the door, the tape is attached to a leader pin. When you insert the cartridge into the tape drive, a threading mechanism pulls the pin (and tape) out of the cartridge, across the tape drive head, and onto a non-removable take-up reel. The head can then read or write data from or to the tape.

Label area The label area provides a location for you to place a label. Affix only a bar code label. When affixing a label, place it only in the recessed label area. A label that extends outside of the recessed area can cause loading problems in the tape drive. See [“Guidelines for Using Bar Code Labels” on page 24](#) for additional information.

Write-protect switch The write-protect switch prevents data from being written to the data cartridge.

Insertion guide The insertion guide is a large, notched area that prevents you from inserting the cartridge incorrectly.

Media (not shown) The LTO Ultrium data cartridges contain 1/2-inch, dual-coat, metal-particle tape. When processing tape in the cartridges, Ultrium Tape Drives use a linear, serpentine recording format.

- ▶ The Ultrium 3 drive reads and writes data on 704 tracks, 16 tracks at a time.
- ▶ The Ultrium 2 drive reads and writes data on 512 tracks, 8 tracks at a time.
- ▶ The Ultrium 1 drive reads and writes data on 384 tracks, 8 tracks at a time.

The first set of tracks (16 for Ultrium 3; 8 for Ultrium 2 and 1) is written from near the beginning of the tape to near the end of the tape. The head then repositions to the next set of tracks for the return pass. This process continues until all tracks are written and the cartridge is full, or until all data is written.

All generations of the LTO Ultrium Data Cartridge have a nominal cartridge life of 5000 load and unload cycles.

CARTRIDGE COMPATIBILITY

The tape drive reads tapes that have been written by other licensed LTO Ultrium 3 tape drives. It also writes to tapes that can be read by other licensed LTO Ultrium 3 drives or LTO Ultrium 2 drives. [Table 4-1](#) shows the cartridge and write/read format compatibility for LTO Ultrium tape drives.

Table 4-1 Cartridge and format compatibility for LTO Ultrium tape drives

Tape Drive	LTO Ultrium Data Cartridge Type		
	400 GB (LTO-3) (slate blue)	200 GB (LTO-2) (purple)	100 GB (LTO-1) (black)
Ultrium 3 (LTO-3)	Read/Write	Read/Write	Read Only
Ultrium 2 (LTO-2)		Read/Write	Read/Write
Ultrium 1 (LTO-1)			Read/Write

For maximum capacity, use Ultrium 3 data cartridges with the Magnum Tape Drive (LTO-3). You can purchase LTO Ultrium data cartridges, as well as LTO cleaning cartridges, from Exabyte.

DATA CAPACITIES

Table 4-2 lists the data capacities for the LTO Ultrium data cartridges.

Table 4-2 Data capacities in gigabytes (GB)

Cartridge	Capacity, ^a Native	Capacity, ^a Compressed ^b
LTO Ultrium 400 GB (Generation 3)	400 GB ^c	800 GB
LTO Ultrium 200 GB (Generation 2)	200 GB	400 GB
LTO Ultrium 100 GB (Generation 1)	100 GB	200 GB

^a Maximum capacity; assumes the host computer keeps the tape drive streaming.

^b Assumes a 2:1 compression ratio. Actual compressed capacity varies depending on the type of data being recorded.

^c One gigabyte equals 1,000,000,000 bytes.

CLEANING CARTRIDGES

A universal LTO Ultrium Cleaning Cartridge is used to clean the drive heads. The drive itself determines when a head needs to be cleaned. It alerts you by displaying **C** on the single-character display and the status light flashing amber. To clean the heads, insert the cleaning cartridge into the tape load compartment (see “Cleaning the Drive Heads” on page 18). The tape drive performs the cleaning automatically. When the cleaning is finished, the drive ejects the cartridge.

Note: If a cleaning cartridge is inserted when the drive does not need to be cleaned or when the cartridge has expired, the drive will automatically eject the cartridge. (The cleaning cartridges are valid for 50 uses.)

SETTING THE WRITE-PROTECT SWITCH

The position of the write-protect switch on the data cartridge, shown in Figure 4-1, determines whether you can write to the tape.

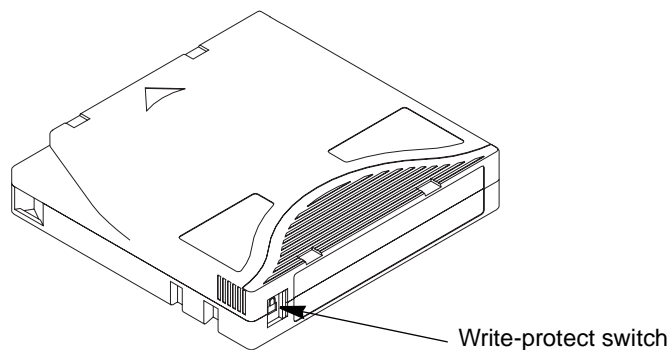



Figure 4-2 Setting the write-protect switch

Before you insert a cartridge into the tape drive, slide the write-protect switch on the cartridge to the desired position, as follows:

- ▶ If the switch is set to the unlocked  (solid red) position, data cannot be written to the tape.
- ▶ If the switch is set to the unlocked (black void) position, data can be written to the tape.

If possible, use your host's application software to write-protect your cartridges (instead of manually setting the write-protect switch). This allows the host's software to identify a cartridge that no longer contains current data and is eligible to become a scratch (blank) data cartridge. Do not write-protect scratch (blank) cartridges; the tape drive will not be able to write new data to them.

If you must manually set the write-protect switch, slide it left or right to the desired position, as shown in [Figure 4-2](#).

GUIDELINES FOR USING BAR CODE LABELS

Apply the following guidelines whenever using bar code labels:

- ▶ Use only Exabyte-approved bar code labels on cartridges.
- ▶ Do not reuse a label or reapply a used label over an existing label.
- ▶ Before applying a new label, remove the old label by slowly pulling it at a right angle to the cartridge case.
- ▶ Use peel-clean labels that do not leave a residue after being removed. If there is glue residue on the cartridge, remove it by gently rubbing it with your finger. Do not use a sharp object, water, or a chemical to clean the label area.
- ▶ Examine the label before applying it to the cartridge. Do not use the label if it has voids or smears in the printed characters or bar code (scanning the label will take much longer if the bar code is not readable).
- ▶ Remove the label from the label sheet carefully. Do not stretch the label or cause the edges to curl.
- ▶ Position the label within the recessed label area (see [Figure 4-1 on page 21](#)).
- ▶ With light finger pressure, smooth the label so that no wrinkles or bubbles exist on its surface.
- ▶ Verify that the label is smooth and parallel, and has no roll-up or roll-over. The label must be flat to within 0.5 mm (0.02 in.) over the length of the label and have no folds, missing pieces, or smudges.
- ▶ Do not place other machine-readable labels on other surfaces of the cartridge. They may interfere with the ability of the drive to load the cartridge.

HANDLING DATA CARTRIDGES

**Caution**

Do not insert a damaged tape cartridge into your tape drive. A damaged cartridge can interfere with the reliability of the drive and may void the warranties of the drive and the cartridge. Before inserting a tape cartridge, inspect the cartridge case, cartridge door, and write-protect switch for breaks.

If you need to recover data from a damaged cartridge, contact Exabyte Technical Support (see [page iv](#)).

Incorrect handling or an incorrect environment can damage the LTO Ultrium data cartridge or its magnetic tape. To avoid damage to your tape cartridges and to ensure the continued high reliability of your tape drive, follow the guidelines in the following sections.

PROVIDE TRAINING

- ▶ Post procedures that describe proper media handling in places where people gather.
- ▶ Ensure that anyone who handles tape has been properly trained in handling and shipping procedures. This includes operators, users, programmers, archival services, and shipping personnel.
- ▶ Ensure that any service or contract personnel who perform archiving are properly trained in media-handling procedures.
- ▶ Include media-handling procedures as part of any services contract.
- ▶ Define and make personnel aware of data recovery procedures.

PROVIDE PROPER ACCLIMATION AND ENVIRONMENTAL CONDITIONS

- ▶ Before you use a data cartridge, acclimate it to the operating environment for 24 hours or the time necessary to prevent condensation in the drive (the time will vary, depending on the environmental extremes to which the drive was exposed).
- ▶ Ensure that all surfaces of a cartridge are dry before inserting it.
- ▶ Do not expose the cartridge to moisture or direct sunlight.
- ▶ Do not expose recorded or blank cartridges to stray magnetic fields of greater than 100 oersteds (for example, terminals, motors, video equipment, X-ray equipment, or fields that exist near high-current cables or power supplies). Such exposure can cause the loss of recorded data or make the blank cartridge unusable.
- ▶ Maintain the conditions that are described in [“Environmental and Shipping Specifications for Data Cartridges” on page 35](#).

PERFORM A THOROUGH INSPECTION

After purchasing a cartridge and before using it, perform the following steps:

- ▶ Inspect the cartridge's packaging to determine potential rough handling.
- ▶ When inspecting a cartridge, open only the cartridge door. Do not open any other part of the cartridge case. The upper and lower parts of the case are held together with screws; separating them destroys the usefulness of the cartridge.
- ▶ Inspect the cartridge for damage before using or storing it.
- ▶ Inspect the rear of the cartridge (the part that you load first into the tape load compartment) and ensure that there are no gaps in the seam of the cartridge case (see [Figure 4-3](#)). If there are gaps in the seam, the leader pin may be dislodged. Contact Exabyte Technical Support for assistance (see ["Contacting Exabyte" on page iv](#)).

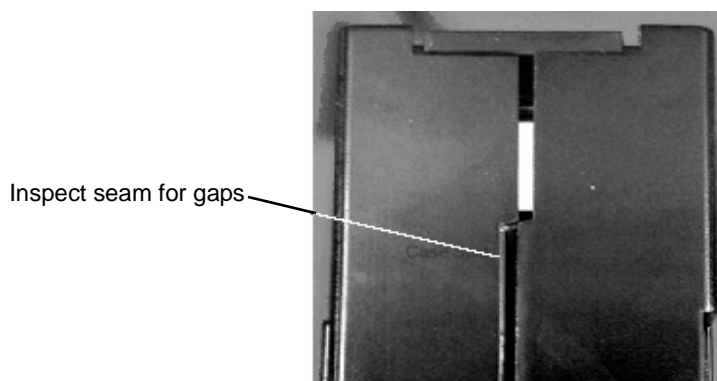


Figure 4-3 *Inspect the cartridge seams for gaps*

- ▶ If you suspect that the cartridge has been mishandled but it appears usable, copy any data onto a good cartridge immediately for possible data recovery. Discard the mishandled cartridge.
- ▶ If you must recover data from a damaged cartridge, contact Exabyte Technical Support for assistance (see ["Contacting Exabyte" on page iv](#)).
- ▶ Review handling and shipping procedures.

HANDLE THE CARTRIDGE CAREFULLY

- ▶ Do not drop the cartridge. If the cartridge drops, slide the cartridge door back and ensure that the leader pin is properly seated in the pin-retaining spring clips. If the leader pin has become dislodged, contact Exabyte Technical Support for assistance (see ["Contacting Exabyte" on page iv](#)).
- ▶ Do not handle tape that is outside the cartridge. Handling the tape can damage the tape's surface or edges, which may interfere with read or write reliability. Pulling on tape that is outside the cartridge can damage the tape and the brake mechanism in the cartridge.

- ▶ Do not stack more than six cartridges.
- ▶ Do not degauss a cartridge that you intend to reuse. Degaussing makes the tape unusable.

CARTRIDGE STORAGE GUIDELINES

As a general rule, use a new (or relatively unused) cartridge to store any critical data you may need to recover many years from now. Do not use a cartridge that has reached its retirement point. For routine backups that get overwritten each day or week, it is acceptable to reuse cartridges until they are ready for retirement.

The best storage container for the cartridges (until they are opened) is the original shipping container. The plastic wrapping prevents dirt from accumulating on the cartridges and partially protects them from humidity changes.

Proper storage of cartridges helps prevent media-related problems. To ensure successful archival storage, follow these guidelines:

- ▶ Remove the cartridge from the tape drive and store it as soon as possible after you have finished writing or reading data. Avoid handling the cartridge excessively. Never open the cartridge door or touch the tape.
- ▶ Label each cartridge. The information in [“Guidelines for Using Bar Code Labels” on page 24](#) also applies to other types of label you might use on the cartridge.
- ▶ Set the cartridge write-protect switch to prevent accidental over-writing by moving the switch to the edge of the cartridge. (See [“Setting the Write-Protect Switch” on page 23.](#))
- ▶ Keep each cartridge in its protective case or a container designed for cartridge storage.
- ▶ Store cartridges away from copiers and printers to avoid contamination by toner and paper dust.
- ▶ Store cartridges away from objects or devices that emit strong magnetic fields.

ENSURE PROPER PACKAGING FOR SHIPMENT

When you ship a cartridge, place it in its jewel case or in a sealed, moisture-proof bag to protect it from moisture, contaminants, and physical damage. Ship the cartridge in a shipping container that has enough packing material to cushion the cartridge and prevent it from moving within the container.

- ▶ When you ship a cartridge, ship it in its original or better packaging.
- ▶ Always ship or store a cartridge in a jewel case.

- ▶ Use only a recommended shipping container that securely holds the cartridge in its jewel case during transportation. Ultrium Turtlecases (by Perm-A-Store) have been tested and found to be satisfactory. They are available at www.turtlecase.com.
- ▶ Never ship a cartridge in a commercial shipping envelope. Always place it in a box or package.
- ▶ If you ship the cartridge in a cardboard box or a box of a sturdy material, ensure the following:
 - ▶ Place the cartridge in polyethylene plastic wrap or bags to protect it from dust, moisture, and other contaminants.
 - ▶ Pack the cartridge snugly; do not allow it to move around.
 - ▶ Double-box the cartridge (place it inside a box, then place that box inside the shipping box) and add padding between the two boxes.

REPOSITIONING OR REATTACHING A LEADER PIN

The following sections describe how to reposition or reattach the leader pin in a damaged data cartridge.



Caution

Use a repaired tape cartridge only to recover data and move it to another cartridge. Continued use of a repaired cartridge may void the warranties of the drive and the cartridge. If the leader pin in your cartridge becomes dislodged from its pin-retaining spring clips or detaches from the tape, you must use the IBM Leader Pin Reattachment Kit to reposition or reattach it. Check the IBM web site for information about ordering this kit (see [page xiv](#)). (Do not reattach the pin if you must remove more than 7 meters (23 feet) of leader tape.)

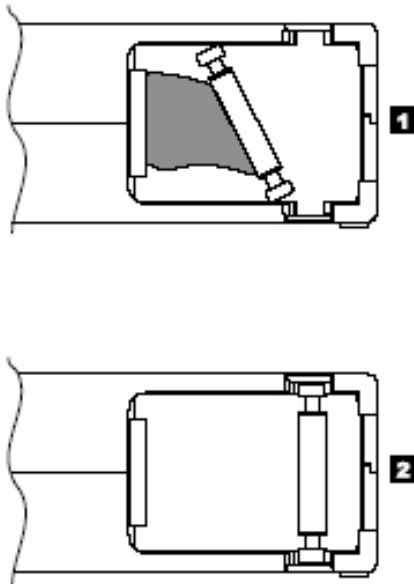
To place the leader pin in its proper position, you will need the following tools:

- ▶ Plastic or blunt-end tweezers
- ▶ Cartridge manual rewind tool (from Leader Pin Reattachment Kit)

Note: Contact IBM (see [page xiv](#)) for information about ordering the IBM Leader Pin Reattachment Kit (part number 08L9129).

REPOSITIONING A LEADER PIN

A leader pin that is improperly seated inside a cartridge can interfere with the operation of the drive. [Figure 4-4](#) shows a leader pin in the incorrect **1** and correct **2** positions.



Note: The cartridge door is open and the leader pin is visible inside the cartridge.

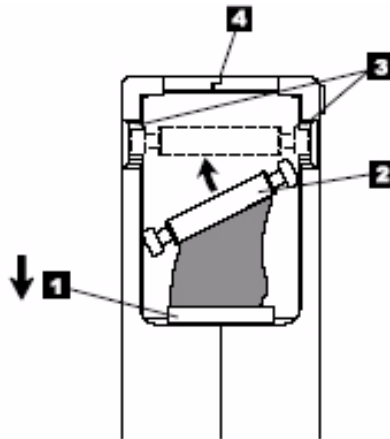
Figure 4-4 Leader pin in the incorrect and correct positions

To reposition the leader pin, perform the following steps.

1. Slide open the cartridge door (**1** in [Figure 4-5](#)) and locate the leader pin (**2**) (you may need to shake the cartridge gently to roll the pin toward the door).
2. With plastic or blunt-end tweezers, grasp the leader pin and position it in the pin-retaining spring clips (**3**).
3. Press the leader pin gently into the clips until it snaps into place and is firmly seated. Ensure that there are no gaps in the seam of the cartridge (**4**).

! Important If gaps exist, do not continue with this procedure and do not use the cartridge. Instead, contact Exabyte Technical Support (see [page iv](#)).

4. Close the cartridge door.



Note: The cartridge door is open to show the leader pin.

Figure 4-5 Placing a dislodged leader pin into the correct position

5. To rewind the tape, insert the cartridge manual rewind tool (1 in Figure 4-6) into the cartridge's hub (2) and turn it clockwise until the tape becomes taut.
6. Remove the rewind tool by pulling it away from the cartridge.

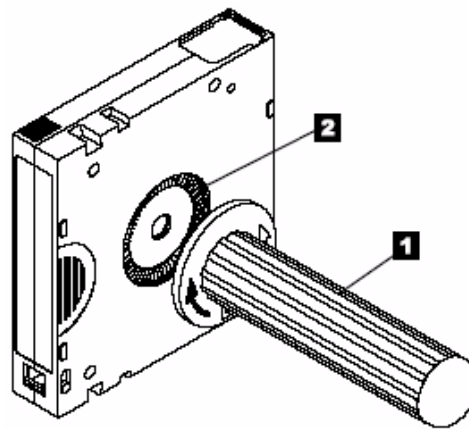


Figure 4-6 Rewinding the tape into the cartridge

REATTACHING A LEADER PIN

The first meter of tape in a cartridge is leader tape. Once the leader tape has been removed there is a possibility of tape breakage. After reattaching the leader pin, transfer data from the defective tape cartridge. Do not reuse the defective tape cartridge.

The Leader Pin Reattachment Kit contains three parts:

- ▶ **Leader pin attach tool** (see ❶ in Figure 4-7). A plastic brace that holds the cartridge door open.
- ▶ **Cartridge manual rewind tool** (see ❷ in Figure 4-7). A device that fits into the cartridge's hub and lets you wind the tape into and out of the cartridge.
- ▶ **Pin supplies** (see ❸ in Figure 4-7). Leader pins and C-clips.

Note: Contact IBM (see page xiv) for information about ordering the IBM Leader Pin Reattachment Kit (part number 08L9129).

-
- ! Important**
- Use only the IBM Leader Pin Reattachment Kit to reattach the leader pin to the tape. Other methods of reattaching the pin will damage the tape, the drive, or both.
 - Use this procedure on your tape cartridge only when the leader pin detaches from the magnetic tape and you must copy the cartridge's data onto another cartridge. Destroy the damaged cartridge after you copy the data. This procedure may affect the performance of the leader pin during threading and unloading operations.
 - Touch only the end of the tape. Touching the tape in an area other than the end can damage the tape's surface or edges, which may interfere with read or write reliability.
-

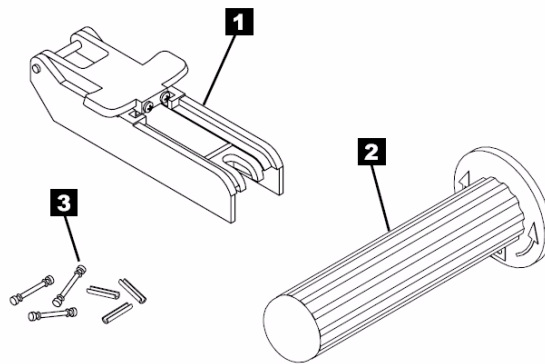
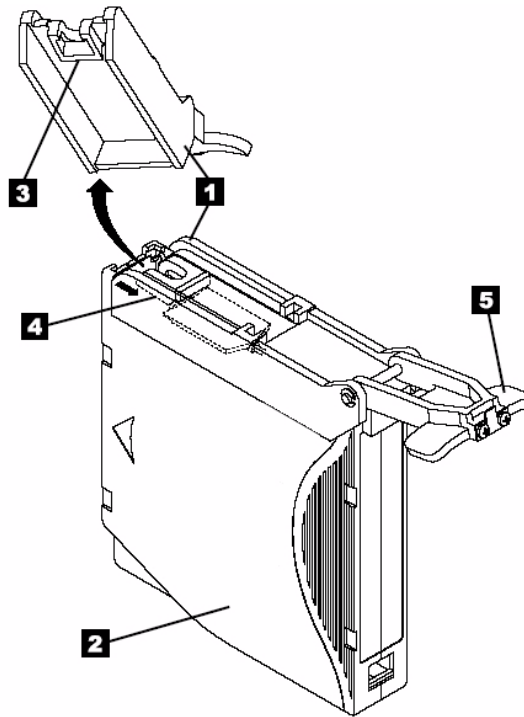


Figure 4-7 Leader pin reattachment kit

The following procedure describes reattaching a leader pin by using the IBM Leader Pin Reattachment Kit:

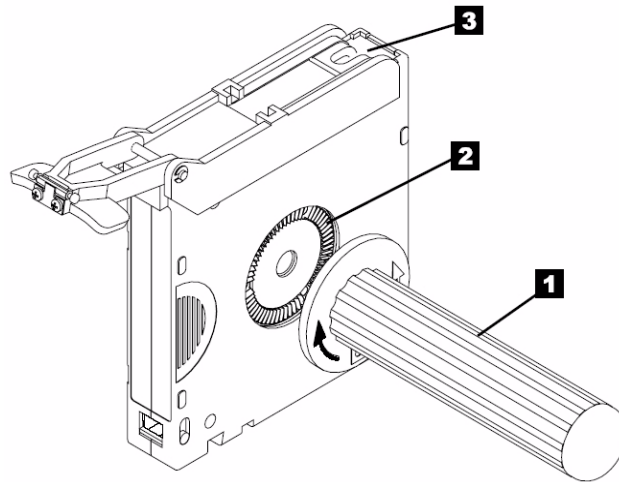
1. Attach the leader pin attach tool (❶ in Figure 4-8) to the cartridge (❷) so that the tool's hook (❸) latches into the cartridge's door (❹). Pull the tool back to hold the door open, then slide the tool onto the cartridge. Open the tool's pivot arm (❺).



Note: To hold the cartridge door open, hook the tool into the door and pull the tool back.

Figure 4-8 Attaching the leader pin tool to the cartridge

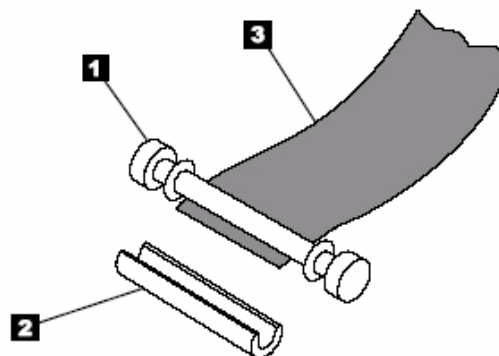
2. To find the end of the tape inside the cartridge, attach the cartridge manual rewind tool (❶ in Figure 4-9) to the cartridge's hub (❷) by fitting the tool's teeth between the teeth of the hub. Turn the tool clockwise until you see the end of the tape inside the cartridge. Then, slowly turn the rewind tool counterclockwise to bring the tape edge toward the cartridge door (❸).



Note: Turn the cartridge manual rewind tool clockwise to see the end of the tape, then turn it counterclockwise to bring the tape to the cartridge door.

Figure 4-9 Winding the tape out of the cartridge

3. Continue to turn the rewind tool counterclockwise until approximately 12.7 cm (5 in.) of tape hangs from the cartridge door. If necessary, grasp the tape and pull gently to unwind it from the cartridge.
4. Remove the rewind tool by pulling it away from the cartridge. Set the tool and the cartridge aside.
5. On the leader pin (❶ in Figure 4-10), locate the open side of the C-clip (❷). The C-clip is a small black part that secures the tape (❸) to the pin.
6. Remove the C-clip from the leader pin by using your fingers to push the clip away from the pin. Set the pin aside and discard the clip.



Note: Use your fingers to push the C-clip off the leader pin.

Figure 4-10 Removing the C-clip from the leader pin

7. Position the tape in the alignment groove of the leader pin attach tool (see ❶ in Figure 4-11).
8. Place a new C-clip into the retention groove ❷ (Figure 4-11) on the leader pin attachment tool and make sure that the clip's open side faces up.
9. Place the leader pin (from step 6 on page 33) into the cavity ❸ (Figure 4-11) of the leader pin attach tool.

! Important To prevent the leader pin from rolling into the cartridge, in the following step use care when folding the tape over the pin.

10. Fold the tape over the leader pin and hold it with your fingers (see Figure 4-11).

Note: Use care to ensure that the tape is centered over the leader pin. Failure to properly center the tape on the pin will cause the repaired cartridge to fail. When the tape is properly centered, a 0.25-mm (0.01-in.) gap exists on both sides of the pin.

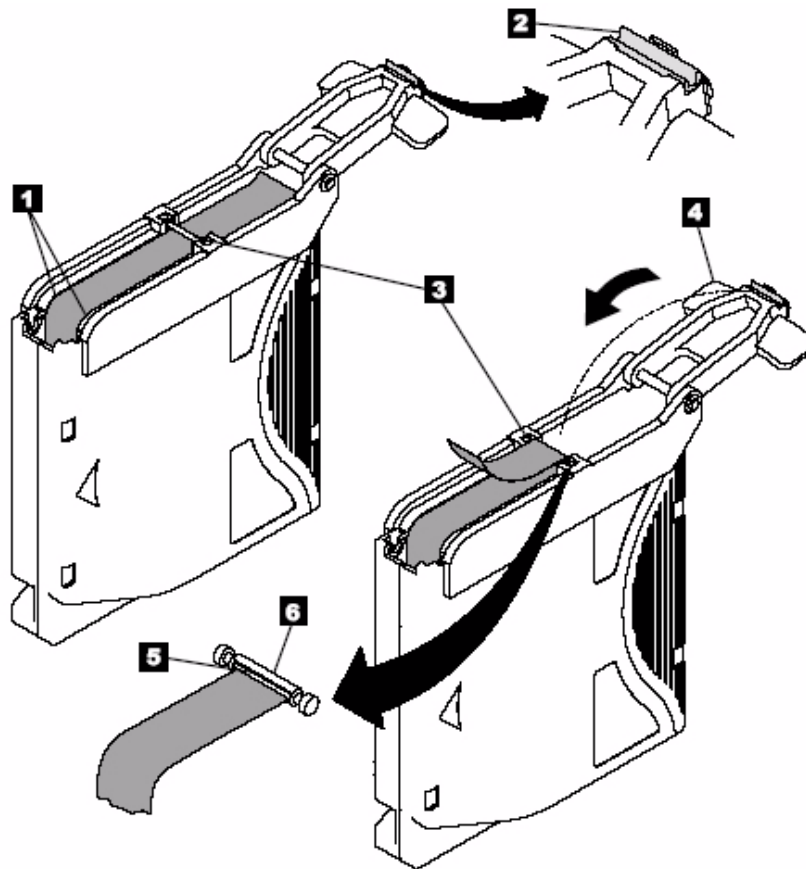


Figure 4-11 Attaching the leader pin to the tape

11. Close the pivot arm ❹ of the leader pin attach tool by swinging it over the leader pin so that the C-clip snaps onto the pin and the tape.

12. Swing the pivot arm open and trim the excess tape ⑤ so that it is flush with the reattached leader pin ⑥.
13. Use your fingers to remove the leader pin from the cavity ③ in the leader pin attach tool.
14. Use the cartridge manual rewind tool to wind the tape back into the cartridge (wind the tape clockwise). Ensure that the leader pin is latched by the pin-retaining spring clips on each end of the leader pin.
15. Remove the rewind tool.
16. Remove the leader pin attach tool by lifting its end up and away from the cartridge.

! Important Use a repaired tape cartridge only to recover data and move it to another cartridge. Continued use of a repaired cartridge may void the warranties of the drive and the cartridge.

ENVIRONMENTAL AND SHIPPING SPECIFICATIONS FOR DATA CARTRIDGES

Before you use a tape cartridge, acclimate it to the operating environment for 24 hours or the time necessary to prevent condensation in the drive (the time will vary, depending on the environmental extremes to which the cartridge was exposed).

The best storage container for the cartridges (until they are opened) is the original shipping container. The plastic wrapping prevents dirt from accumulating on the cartridges and partially protects them from humidity changes.

When you ship a cartridge, place it in its jewel case or in a sealed, moisture-proof bag to protect it from moisture, contaminants, and physical damage. Ship the cartridge in a shipping container that has enough packing material to cushion the cartridge and prevent it from moving within the container.

Table 4-3 gives the environment for operating, storing, and shipping LTO Ultrium data cartridges.

Table 4-3 Environment for operating, storing, and shipping the LTO Ultrium data cartridge

Environmental Factor	Operating	Operational Storage ^a	Archival Storage ^b	Shipping
Temperature	10 to 45°C (50 to 113°F)	16 to 32°C (61 to 90°F)	16 to 25°C (61 to 77°F)	-23 to 49°C (-9 to 120°F)
Relative humidity (noncondensing)	10 to 80%	20 to 80%	20 to 50%	5 to 80%
Wet bulb temperature	26°C (79°F)	26°C (79°F)	26°C (79°F)	26°C (79°F)

^a Operational storage equals less than 1 year.

^b Archival storage equals 1 to 10 years.

DISPOSING OF TAPE CARTRIDGES

Under the current rules of the U.S. Environmental Protection Agency (EPA), regulation 40CFR261, the LTO Ultrium data cartridge is classified as non-hazardous waste. As such, it may be disposed of in the same way as normal office trash. These regulations are amended from time to time, and you should review them at the time of disposal.

If your local, state, country (non-U.S.A.), or regional regulations are more restrictive than EPA 40CFR261, you must review them before you dispose of a cartridge. Contact IBM (see [page xiv](#)) for information about the materials that are in the cartridge.

If a tape cartridge must be disposed of in a secure manner, you can erase the data on the cartridge by using a high-energy AC degausser (use a minimum of 1200 oersted peak field over the entire space that the cartridge occupies). Degaussing makes the cartridge unusable.

If you burn the cartridge and tape, ensure that the incineration complies with all applicable regulations.

5

TROUBLESHOOTING

If you encounter problems when running the tape drive, refer to the troubleshooting flowchart in [Figure 5-1](#). For explanations of codes on the Single-character Display (SCD), see [Appendix A, “Errors Codes,”](#) on page 55.

Note: The Support section of the Exabyte web site, www.exabyte.com, also provides helpful troubleshooting tips.

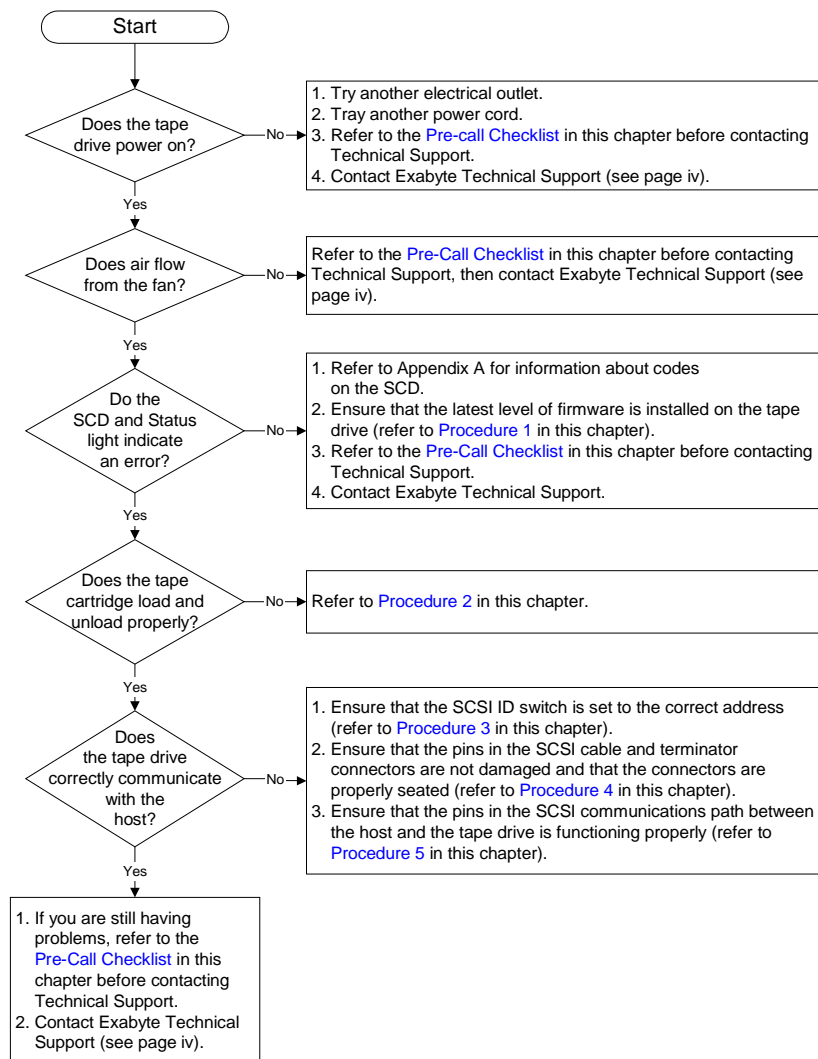


Figure 5-1 Flow chart for analyzing tape drive problems

PROCEDURE 1: DETERMINING FIRMWARE LEVEL AND CAPTURING A DRIVE DUMP

Use LTOTool (available as a free download from Exabyte's web site at www.exabyte.com/downloads) to view the tape drive's current drive firmware level and capture a drive dump. The readme file that accompanies the program (or the online help for the Windows version) provides instructions for using the utility. You can also use the tape drive diagnostics to create the dump (see "Function Code 4 — Force a Drive Dump" on page 67).

Compare the firmware level currently loaded in the tape drive with the latest available firmware level on Exabyte's web site at www.exabyte.com/downloads. You can use LTOTool to update drive firmware to the latest level (see "Updating Firmware Over the SCSI Bus" on page 47).

PROCEDURE 2: INSPECTING A CARTRIDGE FOR DAMAGE

If the cartridge fails to load or unload properly, perform the following steps:

1. Check that the leader pin is attached and properly seated (see [Figure 4-4 on page 29](#)) by opening the cartridge door and observing the pin's placement.
2. Inspect the cartridge case, the cartridge door, and the write-protect switch for damage.
3. Inspect the rear of the cartridge (the part that you load first into the tape load compartment) and ensure that there are no gaps in the seam of the cartridge case (see [Figure 4-3 on page 26](#) and [Figure 4-5 on page 30](#)). If there are gaps, the leader pin may be dislodged. Go to "Repositioning or Reattaching a Leader Pin" on page 28.
4. Try loading or unloading another tape cartridge.
 - ▶ If you cannot load or unload another cartridge, contact your service representative for additional problem determination.
 - ▶ If you successfully load or unload another cartridge, discard the cartridge that originally failed.

Notes:

- ▶ If a damaged or mishandled cartridge is the problem, see "Handling Data Cartridges" on page 25 for proper instructions about handling media. It is possible that your other cartridges may also be damaged.
- ▶ If your cartridge does not eject properly, contact your service representative.

PROCEDURE 3: VERIFYING SCSI ADDRESS SWITCH POSITION

If your host is not communicating with the drive, the drive's SCSI address switch may be set incorrectly:

1. Check the SCSI address switch to ensure that it is set to the desired SCSI ID (see [Step 1. "Set the SCSI ID" on page 7](#)).
2. Make sure that the ID is not one that is used by another device or the SCSI host adapter (note that because ID 7 is the highest priority ID on the SCSI bus, it is usually reserved for the primary SCSI host adapter).
3. If you change a SCSI ID, power cycle the drive to effect the change.

PROCEDURE 4: CHECKING SCSI CONNECTIONS

If your host is not communicating with the drive, the SCSI cable or terminator connector pins may be damaged or not seated correctly, or the SCSI bus length may be incorrect.

1. Check whether the SCSI ID is unique. If not, select a unique SCSI ID and reconfigure the system. The new ID is effective at the next power-on.
2. Check whether the parameters for the SCSI adapter installation are correct.
3. Ensure that a SCSI terminator is attached to each end of the bus (one terminator is usually installed at the host).
4. Ensure that no more than two bus terminations (typically, one on the host adapter and one at the last device on the bus) are present.
5. Limit the number of devices on the bus.
6. Check that the SCSI connectors are properly seated (this includes the terminator and cable connectors). Push the connectors into their receptacle connectors, and (if applicable) tighten the retention screws until firmly seated. Then, retry the operation.
7. If communication still fails, check all connector pins for damage. Disconnect the terminator and cables and inspect them for bent, recessed, or missing pins. If necessary, replace the damaged component and ensure that all connectors are properly seated, then retry the operation.
8. If communication still fails, check the length of the SCSI bus cable. I
 - ▶ If your drive is the **only** device on the SCSI bus, ensure that the total bus length does not exceed 25 m (82 ft.). I
 - ▶ If there are other devices on the bus, ensure that the total length does not exceed 12 m (39 ft.).
9. If the problem persists, contact Exabyte Technical Support for assistance (see [page iv](#)).

PROCEDURE 5: VERIFYING SCSI INTERFACE COMMUNICATIONS

The best way to thoroughly verify host-to-device communications is to exercise activity over the SCSI bus from the host to the drive and back. Use LTOTool (available as a free download from Exabyte's web site at www.exabyte.com/downloads) to determine whether communication over the SCSI bus is satisfactory. The readme file that accompanies the program (or the online help for the Windows version) provides instructions for using the utility.

RESOLVING SCSI BUS ERRORS

The procedure for fixing SCSI bus errors varies, depending on whether the error is consistent or intermittent, and whether your configuration contains single or multiple tape drives. The sections that follow describe how to fix each type of error.

FIXING A CONSISTENT ERROR WITH A SINGLE DRIVE ON A SCSI BUS

When a consistent error occurs on a single drive on the bus, you must determine whether the problem is with one of the SCSI bus components, the host hardware or software, or with the tape drive.

1. Ensure that the power is on to the tape drive.
2. Ensure that the tape drive's SCSI address is the same as the SCSI address assigned by the host.
3. If the problem persists, contact Exabyte Technical Support for assistance (see [page iv](#)).

FIXING A CONSISTENT ERROR WITH MULTIPLE DRIVES ON A SCSI BUS

When a consistent error occurs in a configuration that has multiple drives on the SCSI bus, you must determine if the problem exists with more than one drive. If the problem is with all of the devices on the SCSI bus, the bus is stuck in a SCSI phase and cannot change to another phase or the SCSI cable from the host to the first device is defective.

1. Ensure that the SCSI cable from the host to the first device is connected.
2. Disconnect all but the first drive on the SCSI bus. Move the terminator to the first SCSI device.

Note: Ensure that the SCSI terminator is always on the last drive on the SCSI bus.

3. Run a utility (such as LTO Tool) to determine whether the error will occur.
 - ▶ If the error occurs, contact Exabyte Technical Support for assistance (see [page iv](#)).
 - ▶ If the error does not occur, connect one drive at a time back to the bus and repeat step 3 for each drive until you can identify which drive is defective.
4. Determine if the problem is with only one drive or with two or more drives.
 - ▶ If the problem is with only one drive, contact Exabyte Technical Support for assistance (see [page iv](#)).
 - ▶ If the problem is with two or more drives, locate the first drive that has the error and replace the SCSI cable that connects the tape drive and the interposer (if installed).

FIXING AN INTERMITTENT ERROR WITH A SINGLE DRIVE ON A SCSI BUS

When an intermittent error occurs on a single drive on the bus, you must determine whether the problem is with the terminator, the SCSI cables, the tape drive, or the host hardware.

1. Replace the SCSI terminator on the tape drive.
2. Run the operation that caused the error. If the problem persists, the problem may be with the cable.
3. Isolate which cable is causing the problem by replacing one cable at a time and running the operation that caused the error after each replacement. If the problem persists after all cables have been replaced, the problem may be with the tape drive.
4. Replace the tape drive. If the problem persists, the problem is with your host. Consult your host's documentation.

FIXING AN INTERMITTENT ERROR WITH MULTIPLES DRIVES ON A SCSI BUS

Refer to the host's error logs to determine which drive is the source of the problem:

- ▶ If only one drive is reporting a SCSI failure, replace that drive.
- ▶ If multiple drives are reporting SCSI failures, the problem may be with the terminator or the SCSI cables:
 - ▶ Replace the terminator and run the operation that caused the error. If the problem persists, the problem may be with the cables.
 - ▶ Isolate which cable is causing the problem by replacing one cable at a time and run the operation that caused the error after each replacement.

RESOLVING MEDIA-RELATED PROBLEMS

To resolve problems that are related to media, the tape drive's firmware includes the following diagnostics:

- ▶ Test Cartridge & Media verifies whether a suspect cartridge and its magnetic tape are acceptable for use. See [“Function Code E — Test Cartridge & Media” on page 71](#) for more information.
- ▶ Statistical Analysis and Reporting System (SARS) assists in isolating failures between media and hardware. To determine the cause of failure, SARS uses the cartridge performance history that is saved in the cartridge memory (CM) and the tape drive performance history that is kept in the tape drive's flash erasable programmable read-only memory (EPROM). Any failures that SARS detects are reported as TapeAlert flags on the host (see [“Tape Alert Flags” on page 77](#)).

**Caution**

If you insert the IBM LTO Ultrium Data Cartridge into another manufacturer's drive, the SARS data in the cartridge memory may become lost or invalid.

If you encounter a media-related problem, use the following procedure:

**Caution**

For this test, use only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the tape drive overwrites the data on the cartridge.

1. If possible, run the data cartridge in a different drive. If the operation fails in the other drive and code **6** or **7** displays, replace the media. If the operation succeeds, run the Test Cartridge & Media diagnostic (see [“Function Code E — Test Cartridge & Media” on page 71](#)).
2. If the Test Cartridge & Media diagnostic fails, replace the media. If it runs successfully, clean the tape drive and run the tape drive diagnostics (see [“Cleaning the Drive Heads” on page 18](#) and run the tape drive's diagnostic self-test (see [“Function Code 1 — Run Drive Diagnostics” on page 64](#)).
3. If the tape drive diagnostic self-test fails, replace the tape drive. If the tape self-test runs successfully, repeat the operation that produced the initial media error.

BEFORE CONTACTING TECHNICAL SUPPORT

Before contacting Exabyte Technical Support, complete the following steps to gather all of the required information. Having this information available before you call Technical Support will allow your representative to help you as efficiently as possible. When you have all of the required information see [“Contacting Exabyte” on page iv](#) to contact Technical Support.

TAPE DRIVE INFORMATION

- ▶ **Tape drive serial number and firmware level.** What is the tape drive’s serial number? What version of firmware is currently loaded in the tape drive?
- ▶ **Run one of the following diagnostic methods.** Test the tape drive to identify problems. Make a note of any error messages from the tests.
 - a. Run [“Function Code 1 — Run Drive Diagnostics” on page 64](#) to determine whether the drive can properly load and unload cartridges, and read and write data.

Optionally, you may run also one of the following diagnostics:

- [“Function Code E — Test Cartridge & Media” on page 71](#) to determine whether a suspect cartridge and its magnetic tape are acceptable.
 - [“Function Code F — Write Performance Test” on page 72](#) to ensure that the drive can read from and write to tape.
 - [“Function Code H — Test Head” on page 73](#) to ensure that the tape drive’s head and tape-carriage mechanics work correctly.
 - [“Function Code J — Run Fast Read/Write Test” on page 74](#) to ensure that the drive can read from and write to tape.
 - [“Function Code L — Load/Unload Test” on page 75](#) to test the drive’s ability to load and unload a tape cartridge.
- b. Use the diagnostic tests in LTOTool to test the tape drive and the SCSI interface. The readme file that accompanies the program (or the online help for the Windows version) provides instructions for using the utility.

SCSI BUS INFORMATION

- ▶ **SCSI host bus adapter make and model.** What is the make and model of SCSI host bus adapter connected to the tape drive? Make certain that the LVD SCSI host bus adapter and any necessary drivers installed in the host computer are compatible with the tape. Exabyte does not support using the tape drive on a RAID controller.
- ▶ **SCSI bus configuration.** What is the configuration of the SCSI bus used by the tape drive?
 - ▶ Verify that all cables (both ends) are connected properly.
 - ▶ Ensure that you are using the correct SCSI terminator (LVD).
 - ▶ Before attaching the SCSI cables, ensure that the connector does not contain bent or recessed pins.
 - ▶ Ensure that all retention screws for the SCSI cable and terminator are securely tightened.
 - ▶ Is the SCSI bus terminated at the physical end of the bus?
 - ▶ What is the total SCSI cable length for all devices (both internal and external devices) on the SCSI bus? If your drive is the **only** device on the SCSI bus, ensure that the total bus length does not exceed 25 m (82 ft.). If there are other devices on the bus, ensure that the total length does not exceed 12 m (39 ft.).
 - ▶ Check all SCSI cables connectors for bent pins and confirm that all connectors are firmly seated.

OPERATING SYSTEM INFORMATION

- ▶ **Operating system.** What operating system is being used? Are all current patches installed?
- ▶ **Device drivers.** Are the appropriate drivers installed for the tape drive and SCSI host bus adapter? Are they at the most recent level? Refer to the installation instructions for your SCSI host bus adapter card.
 - ▶ Download tape drive device drivers from Exabyte's web site at www.exabyte.com/downloads.
 - ▶ For the device drivers of independent software vendors (ISVs), visit the appropriate third-party web site.

BACKUP APPLICATION INFORMATION

- ▶ **Backup application name and version.** What backup application is being used?
- ▶ **Compatibility.** Does your application support the Magnum Tape Drive (LTO-3)? Refer to the supported hardware devices list from the application provider.
- ▶ **Device driver.** Is the appropriate driver installed for the tape drive? Refer to the installation instructions for your backup application.
- ▶ **Backup application log files.** Have the log files from your backup application ready to send to Technical Support.

DIAGNOSTIC INFORMATION

- ▶ **Write/Read test results.** Use LTOTool and run a Write/Read test of the tape drive and then capture the diagnostic log from the tape drive and save it to a file. Have the diagnostic log file ready to send to Technical Support. The readme file that accompanies the program (or the online help for the Windows version) provides instructions for using the utility.

If the LTOTool Write/Read test reports an error, clean the drive and run the test again on a new tape.

- ▶ **Diagnostic log taken after an error.** Capture diagnostic logs from both the tape drive immediately after your backup software reports an error. Use [“Function Code 4 — Force a Drive Dump” on page 67](#) or LTOTool to capture the diagnostic log from the tape drive.

Notes

SERVICING THE TAPE DRIVE

This chapter provides information about service for the tape drive, including:

- ▶ Upgrading firmware
- ▶ Returning the tape drive for service

UPGRADING FIRMWARE



Caution

Do not power-off the tape drive while a firmware update is in progress.

Periodically check for updated levels of drive firmware by visiting the download page on the Exabyte web site at www.exabyte.com/downloads. You can update your drive's firmware using either of the following methods:

- ▶ Download the new firmware image and transfer it to the tape drive over the SCSI bus.
- ▶ Download the new firmware image and transfer it to a field microcode replacement (FMR) data cartridge. You can then use this cartridge to load the new firmware into the tape drive.

UPDATING FIRMWARE OVER THE SCSI BUS

When you update the tape drive's firmware by using the SCSI bus, the procedure varies, depending on whether your host uses an IBM[®] tape device driver or a non-IBM tape device driver (such as a driver from Sun[®], Hewlett-Packard[®], or Microsoft[®]).

- ▶ To update firmware and create diagnostic listings for the tape drive from a host that uses an IBM[®] tape device driver, download LTOTool from www.exabyte.com/downloads. LTOTool allows you to upgrade firmware and perform diagnostics over the tape drive's SCSI interface. Refer to the readme file provided with the program for installation instructions. Refer to the program's online help for instructions on performing firmware upgrades and diagnostics.
- ▶ To update firmware from a host that uses a non-IBM tape device driver, refer to the documentation for that device driver.

UPDATING THE FIRMWARE WITH AN FMR DATA CARTRIDGE

Note: You must download the updated firmware from Exabyte's web site and then use that firmware to create an FMR data cartridge (see "Function Code 3 — Create FMR Tape" on page 66).

To update the tape drive's firmware from an FMR data cartridge:

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see page 63).
2. Press the unload button once per second until **2** appears in the SCD. If you cycle past **2**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Within 60 seconds, insert the FMR data cartridge.

! Important

If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, **2** flashes and the tape drive loads the updated firmware from the FMR data cartridge into its erasable programmable read-only memory (EPROM) area:
 - ▶ If the update completes successfully, the tape drive displays **0**, rewinds and unloads the FMR tape, resets itself, and is ready to use the new firmware.
 - ▶ If the update fails, the tape drive posts an error code to the single-character display (to resolve the error, see Table A-1 on page 56). The tape drive then unloads the FMR tape and exits maintenance mode.

RETURNING THE TAPE DRIVE FOR SERVICE

If you need to return the tape drive to the factory for service, follow these steps:

1. Before returning a drive for service, contact Exabyte Service (see [page iv](#)) or your Exabyte-authorized service provider for return authorization and shipping instructions. If your service provider instructs you to return the tape drive directly to Exabyte, contact Exabyte Service to obtain a Return Materials Authorization (RMA) number and the shipping address.
2. Remove and keep all cartridges, cables, and terminators.

**Caution**

If a cartridge is stuck in the tape drive, do not attempt to manually extract it. You could damage the cartridge or tape drive. If necessary, contact Exabyte Technical Support for assistance.

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

**Caution**

Exabyte is not responsible for shipping damage caused by an improperly packaged drive.

To avoid damaging the tape drive and voiding your warranty, use the original shipping materials (or replacement materials from your vendor).

Notes

7

SPECIFICATIONS

This chapter provides specifications for the Magnum Tape Drive (LTO-3).

TAPE DRIVE PERFORMANCE

Table 7-1 lists the tape drive performance characteristics.

Table 7-1 Tape drive performance specifications

Performance Characteristic	Specification
Data transfer rate (native)	80 MB/second ^{a, b}
Maximum sustained data rate ^c	135 MB/second ^d
Burst transfer rate (maximum)	160 MB/second ^d
Nominal load-to-ready time	15 seconds
Nominal unload time	15 seconds
Average search time to first byte of data	46 seconds
Maximum rewind time	88 seconds

^a Rate is determined by the tape drive's speed matching algorithms. The built-in data-compression capability of the tape drive can provide higher data rates than the native data transfer rate. However, the actual throughput is a function of many components, such as the host system processor, disk data rate, block size, data compression ratio, SCSI bus capabilities, and system or application software.

^b Using Ultrium 3 media.

^c Assuming a maximum compression ratio of 2:1.

^d When attached to an Ultra160 LVD SCSI bus. All sustained data rates are dependent on the capabilities of the interconnect (for example, an UltraSCSI bus is limited to less than 40 MB/sec).

SIZE AND WEIGHT

Table 7-2 shows the dimensions and weight for tape drive. The external tape drive is a standalone unit that can fit on a desktop.

Table 7-2 Size and weight

Specification	Measurement
Depth (with bezel)	12.06 cm (4.75 in.)
Length (with bezel)	29.21 cm (11.5 in.)
Width (with bezel)	25.02 cm (9.85 in.)
Weight (without a cartridge)	6.45 kg (14.2 lbs)

POWER SPECIFICATIONS

The power specifications for the tape drive include both the requirements for the tape drive and the enclosure components.

Power Supply

The 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. Table 7-3 lists the power specifications for the tape drive.

Table 7-3 Power specifications

Input voltage^a	100 to 240 VAC
Frequency	50 to 60 Hz
AC input current	1.0 amp at 100 VAC 0.5 amp at 240 VAC

^a Autoswitching input selection; no user selection required.

ENVIRONMENTAL CONDITIONS FOR THE TAPE DRIVE

Table 7-4 summarizes the environmental requirements for the tape path in either the internal or external models of the tape drive. The following sections provide additional detail about these requirements.

Table 7-4 Temperature and humidity specifications for the tape drive

Specification	Operating ^{a,b}	Storage ^c / Nonoperating	Transporting ^c
Temperature range	+10°C to +38°C (+50°F to +100°F)	-40°C to +60°C (-40°F to +140°F)	
Relative humidity	20% to 80% non-condensing	10% to 90% non-condensing	
Wet bulb temperature	26°C (79°F) max.	Non-condensing	
Maximum altitude	+2,500 m (+8,208 ft)		+12,192 m (+40,000 ft)

^a The tape drive temperature and humidity must be stabilized in the specified environment for at least 24 hours.

^b Temperature measurements are made in the tape path.

^c The tape drive is in its original shipping container. When the tape drive is moved from a cooler storage environment to a warmer operating environment, it must acclimate in its packaging for 24 hours to prevent damage from condensation.

SAFETY AND REGULATORY COMPLIANCE

The Magnum Tape Drive (LTO-3) complies with the regulatory agency standards listed on the product label located on the enclosure when installed in accordance with this manual.

Notes

A

ERRORS CODES

Error codes are presented on the Single-character Display (SCD), and the Status Light will be flashing amber once per second. [Table A-1](#) describes the errors and messages that appear on the tape drive's single-character display and in the tape drive's error log.

Notes:

- ▶ The codes on the single-character display have different meanings, depending on whether they display during normal operations or while the tape drive is in maintenance mode. Codes that occur during normal operations are defined in [Table A-1](#). Codes that occur while in maintenance mode are defined in [“Performing Diagnostics and Maintenance Functions” on page 61](#).
- ▶ The single-character display clears when you power-off the tape drive, remove the data cartridge, or place the tape drive in maintenance mode.

! Important If the tape drive detects a permanent error and displays an error code other than **0**, it automatically performs a drive dump. If you force a drive dump, the existing dump will be overwritten and data will be lost. After you force a drive dump, do not turn off the power to the tape drive or you may lose the dump data.

Table A-1 Tape drive codes for error conditions and informational messages

Code	Cause and Action
0	<p>No error occurred and no action is required. This code displays:</p> <ul style="list-style-type: none"> ▪ When power is cycled (turned off, then on) to the tape drive. ▪ When diagnostics have finished running and no error occurred. <p>Note: The single-character display is blank during normal operation of the tape drive.</p>
1	<p>Cooling problem. The tape drive detected that the recommended operating temperature was exceeded. Perform the following action:</p> <ol style="list-style-type: none"> 1. Ensure that the cooling fan is rotating and is quiet. If not, replace the tape drive. 2. Remove any blockage that prevents air from flowing freely through the tape drive. 3. Ensure that the operating temperature is within the specified range (see “Environmental Conditions for the Tape Drive” on page 53). 4. If the operating temperature is within the specified range and the problem persists, replace the tape drive <p>The error code clears when you power-off the tape drive or place it in maintenance mode.</p>
2	<p>Power problem. The tape drive detected that the externally supplied power is either approaching the specified voltage limits (the tape drive is still operating) or is outside the specified voltage limits (the tape drive is not operating). Perform the following action:</p> <ol style="list-style-type: none"> 1. Ensure that the power connector is properly seated. 2. Ensure that the proper voltages are being applied within the tolerances allowed (see “Power Specifications” on page 52). 3. If the proper voltages are being applied but the problem persists, replace the tape drive. <p>The error code clears when you power-off the tape drive or place it in maintenance mode.</p>
3	<p>Firmware problem. The tape drive determined that a firmware error occurred. Perform the following action:</p> <p>Note: Do not force a new dump; the tape drive has already created one.</p> <ol style="list-style-type: none"> 1. Collect a drive dump do one of the following: <ul style="list-style-type: none"> ▪ Use LTO Tool (see “Procedure 1: Determining Firmware Level and Capturing A Drive Dump” on page 38). ▪ Use the host’s SCSI interface by using a device driver utility or system tool. To obtain a dump, determine whether your host is installed with a utility that can read files from the host’s memory. If it is, use that utility to obtain the dump. ▪ Use the tape drive diagnostics (see “Function Code 5 — Copy Drive Dump” on page 68). 2. Power the tape drive off and on, then retry the operation that produced the error. 3. If the problem persists, download and install new firmware (see “Upgrading Firmware” on page 47) and retry the operation. 4. If the problem still persists, contact Exabyte Technical Support (see page iv). <p>The error code clears when you power-off the tape drive or place it in maintenance mode</p>

Table A-1 Tape drive codes for error conditions and informational messages

Code	Cause and Action
4	<p>Firmware or drive problem. The tape drive determined that a firmware or drive hardware failure occurred. Perform the following action:</p> <p>Note: Do not force a new dump; the tape drive has already created one.</p> <ol style="list-style-type: none"> 1. Collect a drive dump do one of the following: <ul style="list-style-type: none"> ▪ Use LTO Tool (see “Procedure 1: Determining Firmware Level and Capturing A Drive Dump” on page 38). ▪ Use the host’s SCSI interface by using a device driver utility or system tool. To obtain a dump, determine whether your host is installed with a utility that can read files from the host’s memory. If it is, use that utility to obtain the dump. ▪ Use the tape drive diagnostics (see “Function Code 5 — Copy Drive Dump” on page 68). 2. Power the tape drive off and on, then retry the operation that produced the error. The error code clears when you power-off the tape drive or place it in maintenance mode. 3. If the problem persists, run “Function Code 1 — Run Drive Diagnostics” on page 64. <ul style="list-style-type: none"> ▪ If the test FAILED, contact Exabyte Technical Support (see page iv) and send the drive dump collected in step 1 to them. ▪ If the test PASSED, make sure that you have the most current version of firmware and retry the operation.
5	<p>Drive hardware problem. The tape drive determined that a tape path or read/write error occurred. To prevent damage to the tape drive or tape, the tape drive will not allow you to insert a cartridge if the current cartridge was successfully ejected. The error code may clear when you cycle power to the tape drive or place it in maintenance mode. If the problem persists, replace the tape drive.</p> <p>Note: Copy the drive dump to flash memory before returning the drive. For instructions, refer to “Function Code 5 — Copy Drive Dump” on page 68.</p>
6	<p>Drive or media error. The tape drive determined that an error occurred, but it cannot isolate the error to faulty hardware or to the data cartridge. Perform the following action:</p> <p>For Problems with Writing Data:</p> <p>If the problem occurred while the tape drive was writing data to the tape, and if you know the volume serial number (located on the cartridge label) of the data cartridge loaded in the tape drive when the problem occurred, retry the operation with a different cartridge:</p> <ul style="list-style-type: none"> ▪ If the operation succeeds, the original cartridge was defective. Copy data from the defective cartridge and discard it. ▪ If the operation fails and another drive is available, insert the cartridge into the other drive and retry the operation. <ul style="list-style-type: none"> ▪ If the operation fails, discard the defective cartridge. ▪ If the operation succeeds, insert a scratch cartridge into the first drive and run the tape drive diagnostics (see “Function Code 1 — Run Drive Diagnostics” on page 64). <ul style="list-style-type: none"> – If the diagnostics fail, replace the tape drive. – If the diagnostics succeed, the error was temporary.

Table A-1 Tape drive codes for error conditions and informational messages

Code	Cause and Action
<p>6 (cont.)</p>	<p>For Problems with Writing Data: (continued)</p> <ul style="list-style-type: none"> ▪ If the operation fails and another drive is not available, insert a scratch cartridge into the tape drive and run the tape drive diagnostics (see “Function Code 1 — Run Drive Diagnostics” on page 64). ▪ If the diagnostics fail, replace the tape drive. ▪ If the diagnostics succeed, discard the cartridge. <p>If the problem occurs with multiple data cartridges or if you do not know the data cartridge’s volume serial number, run the tape drive diagnostics (see “Function Code 1 — Run Drive Diagnostics” on page 64):</p> <ul style="list-style-type: none"> ▪ If the diagnostics fail, replace the tape drive. ▪ If the diagnostics succeed, run the Test Head diagnostic (see “Function Code H — Test Head” on page 73). ▪ If the Test Head diagnostic fails, replace the tape drive. ▪ If the Test Head diagnostic succeeds, replace the cartridges that caused the problem. <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p> <p>For Problems with Reading Data:</p> <p>If the problem occurred while the tape drive was reading data from the tape, and if you know the volume serial number of the data cartridge, perform one of the following procedures:</p> <ul style="list-style-type: none"> ▪ If another drive is available, insert the cartridge into the other drive and retry the operation: <ul style="list-style-type: none"> ▪ If the operation fails, discard the defective cartridge. ▪ If the operation succeeds, insert a scratch cartridge into the first drive and run the tape drive diagnostics (see “Function Code 1 — Run Drive Diagnostics” on page 64): <ul style="list-style-type: none"> – If the diagnostics fail, replace the tape drive. – If the diagnostics succeed, the error was temporary. ▪ If another drive is not available, insert a scratch cartridge into the tape drive and run the tape drive diagnostics (see “Function Code 1 — Run Drive Diagnostics” on page 64): <ul style="list-style-type: none"> ▪ If the diagnostics fail, replace the tape drive. ▪ If the diagnostics succeed, discard the cartridge. <p>If the problem occurs with multiple data cartridges or if you do not know the data cartridge’s volume serial number, run the tape drive diagnostics (see “Function Code 1 — Run Drive Diagnostics” on page 64):</p> <ul style="list-style-type: none"> ▪ If the diagnostics fail, replace the tape drive. ▪ If the diagnostics succeed, run the Test Head diagnostic (see “Function Code H — Test Head” on page 73). ▪ If the Test Head diagnostic fails, replace the tape drive. ▪ If the Test Head diagnostic succeeds, replace the cartridges that caused the problem. <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p>

Table A-1 Tape drive codes for error conditions and informational messages


Code	Cause and Action
7	<p>A high probability of media error. The tape drive determined that an error occurred because of a faulty data cartridge. Try another data cartridge. If the problem occurs with multiple tape cartridges, use the following procedure:</p> <p> Caution</p> <p>When you run the Test Cartridge & Media diagnostic, data on the suspect tape is overwritten. Use only a scratch data cartridge to run the test.</p> <p>If possible, run the tape cartridge in a different tape drive. If the operation in the other unit fails and 6 or 7 displays, replace the media. If the operation succeeds, run “Function Code E — Test Cartridge & Media” on page 71.</p> <ul style="list-style-type: none"> ▪ If the diagnostic fails, replace the media. ▪ If the diagnostic succeeds, clean the drive head (see “Cleaning the Drive Heads” on page 18) and run “Function Code 1 — Run Drive Diagnostics” on page 64. <ul style="list-style-type: none"> ▪ If the drive diagnostic fails, replace the drive. ▪ If the drive diagnostic succeeds, perform the operation that produced the initial media error. <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p>
8	<p>Drive or SCSI bus failure. The tape drive determined that a failure occurred in the tape drive’s hardware or in the SCSI bus. See “Resolving SCSI Bus Errors” on page 40. The error code clears 10 seconds after the tape drive detected the error or when you place the tape drive in maintenance mode.</p>
9	<p>Tape drive or RS-422 error. The tape drive determined that a failure occurred in the tape drive’s hardware or in the RS-422 connection. Replace the tape drive. The error code clears 10 seconds after the drive detected the error or when you place the tape drive in maintenance mode.</p>

Table A-1 Tape drive codes for error conditions and informational messages

Code	Cause and Action
A	<p>Tape drive hardware problem. The tape drive determined that a problem occurred which degraded the operation of the tape drive, but it did not restrict continued use. If the problem persists, determine whether the problem is with the drive or the media.</p> <p>Note: The drive is usable, though the Single-character Display continues to indicate an error and the Status Light flashes amber. The error code may clear when you cycle power to the tape drive or place it in maintenance mode.</p> <p>To determine if the problem is with the drive hardware or the tape media, perform the following procedures:</p> <ol style="list-style-type: none"> 1. If possible, run the tape cartridge in a different drive. If the operation in the other drive fails and 6 or 7 displays, replace the media. If the operation succeeds, run “Function Code E — Test Cartridge & Media” on page 71). 2. If the Test Cartridge & Media diagnostic fails, replace the media. If it runs successfully, clean the failing drive and run the drive diagnostics (see “Cleaning the Drive Heads” on page 18 and “Function Code 1 — Run Drive Diagnostics” on page 64). If the drive diagnostics run successfully, perform the operation that produced the initial drive error. 3. If the problem persists replace the drive. <p>If it is not possible to run the tape cartridge in a different drive, perform the following procedures:</p> <ol style="list-style-type: none"> 1. Clean the failing drive and run the drive diagnostics (see “Cleaning the Drive Heads” on page 18 and “Function Code 1 — Run Drive Diagnostics” on page 64). If the drive diagnostics run successfully, run “Function Code E — Test Cartridge & Media” on page 71). 2. If the Test Cartridge & Media diagnostic fails, replace the media. If it runs successfully, perform the operation that produced the initial drive error. 3. If the problem persists replace the drive.
B	<p>No error or message is assigned. See error code 8 in this table.</p>
C	<p>The tape drive needs to be cleaned. Clean the tape drive. See “Cleaning the Drive Heads” on page 18.</p> <p>The error code clears when you clean the tape drive or place it in maintenance mode.</p>
D	<p>No error or message assigned. See error code 0 in this table.</p>
=	<p>The unload button is depressed. Verify that the button pushes freely.</p>

B

PERFORMING DIAGNOSTICS AND MAINTENANCE FUNCTIONS

The tape drive can run diagnostics, test write and read functions, test a suspect data cartridge, update its own firmware, and perform other diagnostic and maintenance function.

! Important Maintenance functions cannot be performed concurrently with read or write operations. While in maintenance mode, the tape drive does not accept SCSI commands from the host.

Table B-1 describes each diagnostic and maintenance function that the drive can perform, gives the function code which appears on the single-character Display (SCD), and directs you to the instructions for performing the function. It is recommended that you use a scratch (blank) data cartridge for diagnostic testing.

Table B-1 Diagnostic and maintenance functions

Function Code	Diagnostic or Maintenance Function	Look here for instructions...
0	Exit Maintenance Mode: Causes the drive to become available for reading and writing data.	Page 63
1	Run Drive Diagnostics: Runs tests to determine whether the drive can properly load and unload cartridges, and read and write data.	Page 64
2	Update Tape Drive Firmware from FMR Tape: Loads updated firmware from a field microcode replacement (FMR) tape.	Page 65
3	Create FMR Tape: Copies its field microcode replacement (FMR) data to a scratch (blank) data cartridge.	Page 66
4	Force a Drive Dump: Performs a dump of data (also known as saving a microcode trace).	Page 67
5	Copy Drive Dump: Copies data from a drive dump (captured by using Function Code 4) to the beginning of a scratch (blank) data cartridge, copies a drive dump to flash memory, or erases a dump from flash memory.	Page 68

Table B-1 Diagnostic and maintenance functions

Function Code	Diagnostic or Maintenance Function	Look here for instructions...
6	Run SCSI Wrap Test: Performs a check of the SCSI circuitry from and to the SCSI connector. Requires a special connector. Contact Exabyte Technical Support for information about using this diagnostic.	Page iv
7	Not used.	N/A
8	Unmake FMR Tape: Erases the FMR data on a scratch (blank) data cartridge and rewrite the cartridge memory on the tape. This turns the cartridge into a valid scratch data cartridge.	Page 69
9	Display Error Code Log: Displays the last 10 error codes, one at a time (the codes are ordered; the most recent is presented first and the oldest (tenth) is presented last).	Page 70
A	Clear Error Code Log: Erases the contents of the error code log.	Page 70
C	Insert Cartridge into Tape Drive: This function cannot be selected by itself, but is a part of other maintenance functions (such as Run Tape Drive Diagnostics and Create FMR Tape) that require a tape cartridge to be loaded.	Page 70
E	Test Cartridge & Media: Performs tests to ensure that a suspect cartridge and its magnetic tape are acceptable.	Page 71
F	Write Performance Test: Performs tests to ensure that the drive can read from and write to tape.	Page 72
H	Test Head: Performs tests to ensure that the tape drive's head and tape-carriage mechanics are working correctly.	Page 73
J	Fast Read/Write Test: Performs tests to ensure that the drive can read from and write to tape.	Page 74
L	Load/Unload Test: Tests the drive's ability to load and unload a tape cartridge.	Page 75
P or U	Enable Post Error Reporting (P): When selected, deferred-check conditions are reported to the host. Disable Post Error Reporting (U): When selected, deferred-check conditions are NOT reported to the host.	Page 76

SETTING THE TAPE DRIVE TO MAINTENANCE MODE

The tape drive must be in maintenance mode to perform its diagnostic functions. To place the tape drive in maintenance mode:

1. Make sure that no cartridge is in the tape drive.

! Important If a cartridge is in the tape drive, it will eject the first time that you press the unload button and the tape drive will not be placed in maintenance mode.

2. Press the unload button three times within two seconds. The SCD displays **0** and the status LED becomes solid amber, indicating that the tape drive is in maintenance mode.

Maintenance functions cannot be performed concurrently with read or write operations. While in maintenance mode, the drive does not receive SCSI commands from the host.

3. Select the desired diagnostic or maintenance function. The following sections describe the functions and provide instructions for using them.

FUNCTION CODE 0 — EXITING MAINTENANCE MODE

Function Code **0** makes the drive available for reading and writing data.

Press and hold the Unload Button for three or more seconds to take the drive out of maintenance mode. The Status Light turns off.

- ▶ If no error is detected, **0** temporarily appears in the SCD, then goes blank. The drive then exits maintenance mode.
- ▶ If an error is detected, the SCD shows an error code but still exits maintenance mode. To determine the error, locate the code in [Table A-1 on page 56](#). To clear the error, turn the power off, then on again.

The drive also exits maintenance mode automatically after it completes a maintenance function or after ten minutes if no action has occurred.

FUNCTION CODE 1 — RUN DRIVE DIAGNOSTICS

- ▶ Approximate Run Time = 20 minutes per loop
- ▶ Total Number of Loops = 10

Function Code 1 runs tests that determine whether the drive can properly load and unload cartridges, and read and write data.

The diagnostic loops ten times. Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately.



Caution

For this test, use only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the tape drive overwrites the data on the cartridge.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **1** appears in the SCD. If you cycle past **1**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds. The SCD flashes **1** until the Power-on-Self-Test (POST) completes. After approximately 30 seconds, the SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge.
4. Insert a scratch data cartridge (blank) data cartridge that is not write-protected (or the tape drive will exit maintenance mode). The SCD changes to a flashing **1** and the read/write portion of the test begins.

! Important

If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

- ▶ If the diagnostic completes successfully, it begins again and runs for a maximum of 10 times. After the tenth loop, the diagnostic stops and automatically exits maintenance mode.

To stop the loop, press the Unload Button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds and unloads the cartridge, and then exits maintenance mode. The solid amber Status Light turns off.

- ▶ If the diagnostics fail, the status LED flashes amber and an error code displays on the SCD. The tape drive unloads the data cartridge and exits maintenance mode. To clear the error, turn the power off, then on again. To resolve the error, locate the code in [Table A-1 on page 56](#).

FUNCTION CODE 2 — UPDATE DRIVE FIRMWARE FROM FMR TAPE

Function Code 2 causes the tape drive to load updated firmware from a field microcode replacement (FMR) tape.



Caution

Do not power-off the tape drive while a firmware update is in progress.

Note: You can also update the drive firmware over the SCSI bus using Exabyte's LTO Tool. See ["Updating Firmware Over the SCSI Bus" on page 60](#) for more information.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **2** appears in the SCD. If you cycle past **2**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Insert the FMR data cartridge.
4. After you insert the cartridge, the SCD changes to a flashing **2** and the tape drive loads the updated firmware from the FMR data cartridge into its erasable programmable read-only memory (EPROM) area:
 - ▶ If the update completes successfully, the tape drive displays **0**, rewinds and unloads the FMR tape, resets itself, and is ready to use the new firmware.
 - ▶ If the update fails, the tape drive posts an error code to the SCD (to resolve the error, see [Table A-1 on page 56](#)). The tape drive then unloads the FMR tape and exits maintenance mode. Contact Exabyte Technical Support for assistance (see [page iv](#)).

FUNCTION CODE 3 — CREATE FMR TAPE

Function Code 3 causes the tape drive to copy its field microcode replacement (FMR) data to a scratch data cartridge. You can then use this tape to update the firmware in another Magnum Tape Drive (LTO-3).



Caution

Make sure that you insert a scratch (blank) data cartridge or a cartridge that may be overwritten. The tape drive overwrites any existing data on the cartridge.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **3** appears in the SCD. If you cycle past **3**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Insert the scratch cartridge.

! Important

If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, the SCD changes to a flashing **3** and the tape drive copies the FMR data to the scratch data cartridge:
 - ▶ If the tape drive creates the FMR tape successfully, it displays **0**, rewinds and unloads the new FMR tape, and exits maintenance mode.
 - ▶ If the tape drive fails to create the FMR tape, it posts an error code to the SCD (to resolve the error, see [Table A-1 on page 56](#)). The tape drive then unloads the FMR tape and exits maintenance mode.

FUNCTION CODE 4 — FORCE A DRIVE DUMP

Function Code 4 causes the tape drive to perform a collection (or *dump*) of its internal data. (A drive dump is also known as a diagnostic listing.) The dump can only be analyzed by Exabyte Technical Support (see [“Contacting Exabyte” on page iv](#)).

Note: When an error code displays, a red dot also displays to remind you that a dump already exists. If you perform Function Code 4, it will overwrite the dump and cause the error information to be lost.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **4** appears in the SCD. If you cycle past **4**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. After you select the function, **4** displays, followed by **0**. The SCD then goes blank, and the tape drive exits maintenance mode.

An illuminated red dot on the SCD indicates that a drive dump has been created. To retrieve the dump from the tape drive, see [“Function Code 5 — Copy Drive Dump” on page 68](#).

You can also perform this operation when the tape drive is in normal operating mode. Simply press and hold the unload button for 10 seconds.

FUNCTION CODE 5 — COPY DRIVE DUMP

Function Code 5 causes the tape drive to copy data from a drive dump (captured with Function Code 4) to the beginning of a scratch data cartridge. An illuminated red dot on the single-character display indicates that a drive dump has been created.



Caution

Make sure that you insert a scratch (blank) data cartridge or a cartridge that may be overwritten. The tape drive overwrites any existing data on the cartridge.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second to cycle through the following functions on the SCD:
 - ▶ 5 followed by 0: no function
 - ▶ 5 followed by 1: copy dump to tape
 - ▶ 5 followed by 8: copy dump to flash
 - ▶ 5 followed by 3: erase flash

If you cycle past the desired function, continue to press the unload button until it displays again.

3. To select the function, press and hold the unload button for three or more seconds, then release it. After you select the function, the SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Insert the scratch data cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, the SCD flashes the selected function and the tape drive writes the dump data to the tape (at the beginning of the tape).
 - ▶ If the copy operation completes successfully, the SCD displays **0** displays, the tape drive rewinds and unloads the tape, and exits maintenance mode.
 - ▶ If copy operation fails, the tape drive posts an error code to the SCD (to resolve the error, see [Table A-1 on page 56](#)). The tape drive then unloads the FMR tape and exits maintenance mode.
5. From the host, issue the SCSI READ command to read the dump from the tape to a file or electronic image. For information about where to send the electronic image, contact Exabyte Technical Support (see [page iv](#)).

FUNCTION CODE 8 — UNMAKE FMR TAPE

Function Code 8 causes the tape drive to erase the field microcode replacement (FMR) data on a scratch data cartridge and rewrite the cartridge memory on the tape. This turns the cartridge into a valid scratch data cartridge.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **8** appears in the SCD. If you cycle past **8**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Insert the FMR cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, the SCD changes to a flashing **8**, the tape drive erases the firmware on the tape, then rewrites the header in the cartridge memory to change the cartridge to a valid scratch data cartridge:
 - ▶ If the operation is successful, the tape drive displays **0**, rewinds and ejects the newly converted scratch data cartridge, and exits maintenance mode.
 - ▶ If the operation is not successful, the tape drive posts an error code to the SCD (to resolve the error, see [Table A-1 on page 56](#)). To clear the error, turn the power off, then on again.

FUNCTION CODE 9 — DISPLAY ERROR CODE LOG

Function Code 9 causes the tape drive to display the last 10 error codes, one at a time (the codes are ordered; the most recent is presented first and the oldest (tenth) is presented last).

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **9** appears in the SCD. If you cycle past **9**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it to view the most recent error code.
4. Press the unload button again to view successive error codes. Let two or three seconds pass between each button press.
5. Press the unload button again to view successive error codes.
6. After viewing all of the error codes, exit the maintenance mode by pressing the unload button again.

FUNCTION CODE A — CLEAR ERROR CODE LOG

Causes the tape drive to erase the contents of the error code log.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **A** appears in the SCD. If you cycle past **A**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **A**, followed by **0**. The tape drive erases all errors from the error code log, then exits maintenance mode.

FUNCTION CODE C — INSERT CARTRIDGE INTO DRIVE

This function cannot be selected by itself. It relates to other maintenance functions (such as Run Drive Diagnostics or Create FMR Tape) that require an FMR data cartridge or scratch data cartridge that is not write protected.

FUNCTION CODE E — TEST CARTRIDGE & MEDIA

- ▶ Approximate Run Time = 15 minutes per loop
- ▶ Total Number of Loops = 10

Function Code E causes the tape drive to perform a Write/Read test (on the edge bands) to ensure that a suspect cartridge and its magnetic tape are acceptable.



Caution

The tape drive overwrites any existing data on the suspect tape.

The diagnostic loops ten times. Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **E** appears in the SCD. If you cycle past **E**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Within 60 seconds, insert a scratch data cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, **E** flashes and the test begins:
 - ▶ If no error is detected, the test begins again and runs for a maximum of 10 times. After the tenth loop, the test stops and the tape drive automatically exits maintenance mode.

To stop the loop, press the Unload Button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds the tape, unloads the cartridge, and exits maintenance mode.

- ▶ If an error is detected, the tape drive posts an error **6** or **7** to the SCD (another code could appear), unloads the data cartridge, and exits maintenance mode. To clear the error, turn the power off, then on again. To resolve the error, locate the code in [Table A-1 on page 56](#).

FUNCTION CODE F — WRITE PERFORMANCE TEST

- ▶ Approximate Run Time = 5 minutes
- ▶ Total Number of Loops = 10

Function Code F causes the tape drive to perform tests to ensure that the tape drive can read from and write to tape.

The diagnostic loops ten times. Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately.

This diagnostic performs fewer tests than the Run Drive Diagnostics test (Function Code 1). The tape drive takes approximately three minutes to run the test. The Fast Read/Write Test is not as comprehensive a test and is not recommended for isolating errors between the tape drive and the media.



Caution

The tape drive overwrites any existing data on the suspect tape.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **F** appears in the SCD. If you cycle past **F**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Within 60 seconds, insert a scratch data cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, **F** flashes and the test begins.
 - ▶ If no error is detected, the test begins again and runs for a maximum of 10 times. After the tenth loop, the test stops and the tape drive automatically exits maintenance mode.

To stop the loop, press the unload button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.

- ▶ If the number of written data sets is at least 6% less than the total number of data sets expected, the Status Light flashes amber and the tape drive posts an error code to the SCD. To determine the error, locate the code in [Table A-1 on page 56](#). The tape drive unloads the data cartridge, and exits maintenance mode. To clear the error, turn the power off, then on again.

FUNCTION CODE H — TEST HEAD

- ▶ Approximate Run Time = 10 minutes
- ▶ Total Number of Loops = 10

Function Code H performs tests to ensure that the tape drive's head and tape-carriage mechanics work correctly.

The diagnostic loops ten times. Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately.



Caution

Make sure that you insert a scratch (blank) data cartridge or a cartridge that may be overwritten. The tape drive overwrites any existing data on the cartridge.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **H** appears in the SCD. If you cycle past **H**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Within 60 seconds, insert a scratch data cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, **H** flashes and the test begins:
 - ▶ If no error is detected, the test begins again and runs for a maximum of 10 times. After the tenth loop, the test stops and the tape drive automatically exits maintenance mode.

To stop the loop, press the unload button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.

- ▶ If an error is detected, the tape drive displays **5** on the SCD. To determine the error, locate the code in [Table A-1 on page 56](#). The tape drive unloads the data cartridge, and exits maintenance mode. To clear the error, turn the power off, then on again.

FUNCTION CODE J — RUN FAST READ/WRITE TEST

- ▶ Approximate Run Time = 5 minutes
- ▶ Total Number of Loops = 10

Function Code J performs tests to ensure that the drive can read from and write to tape.

The diagnostic loops ten times. Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately.



Caution

Make sure that you insert a scratch (blank) data cartridge or a cartridge that may be overwritten. The tape drive overwrites any existing data on the cartridge.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **J** appears in the SCD. If you cycle past **J**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Within 60 seconds, insert a scratch (blank) data cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

4. After you insert the cartridge, the SCD changes to a flashing **J**. The tape drive runs the tests.
 - ▶ If no error is detected, the test begins again and runs for a maximum of 10 times. After the tenth loop, the test stops and the tape drive automatically exits maintenance mode.

To stop the loop, press the unload button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.
 - ▶ If an error is detected, the Status Light flashes amber, the tape drive posts an error code to the SCD. To determine the error, locate the code in [Table A-1 on page 56](#). The tape drive unloads the data cartridge, and exits maintenance mode. To clear the error, turn the power off, then on again.

FUNCTION CODE L — LOAD/UNLOAD TEST

- ▶ Approximate Run Time = 15 seconds per loom
- ▶ Total Number of Loops = 10

Function Code L tests the drive's ability to load and unload a tape cartridge.

The diagnostic loops ten times. Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately.

Note: Even though no data is written to tape, it is recommended that you use a blank (scratch) cartridge for this test.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Press the unload button once per second until **L** appears in the SCD. If you cycle past **L**, continue to press the unload button until it displays again.
3. To select the function, press and hold the unload button for three or more seconds, then release it. The SCD changes to a flashing **C** to indicate that the tape drive is waiting for you to insert a cartridge. Within 60 seconds, insert a scratch (blank) data cartridge.

! Important If you fail to insert the cartridge quickly enough, the tape drive will exit maintenance mode. You must then set the tape drive to maintenance mode again and restart the test.

If you insert an invalid or write-protected data cartridge, **7** appears in the single-character display. The tape drive unloads the cartridge and exits maintenance mode.

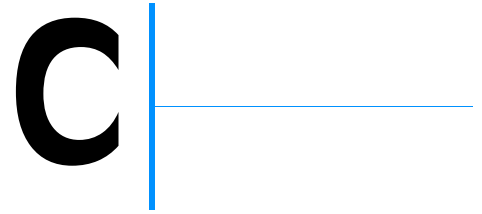
4. After you insert the cartridge, the SCD changes to a flashing **L**. The tape drive runs the tests.
 - ▶ If no error is detected, the test begins again and runs for a maximum of 10 times. After the tenth loop, the test stops and the tape drive automatically exits maintenance mode.

To stop the loop, press the unload button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.
 - ▶ If an error is detected, the test stops and the tape drive displays **6** on the SCD. To determine the error, locate the code in [Table A-1 on page 56](#). The tape drive unloads the data cartridge, and exits maintenance mode. To clear the error, turn the power off, then on again.

FUNCTION CODE P OR U — ENABLE OR DISABLE POST ERROR REPORTING

Used by support personnel during error detection, this function is an alternate method of setting or preventing the post error (PER) bit in the SCSI Read-Write Error Recovery Page. By default POST error reporting is disabled.

1. Make sure that the tape drive does not contain a cartridge, then set it to maintenance mode (see [page 63](#)).
2. Perform one of the following operations:
 - ▶ If error reporting is currently disabled, enable post error reporting by pressing the unload button once per second until **U** appears in the SCD. Press and hold the unload button for three or more seconds until **P** appears in the SCD, then release.
 - ▶ If error reporting is currently enabled, disable post error reporting by pressing the unload button once per second until **P** appears in the SCD. Press and hold the unload button for three or more seconds until **U** appears in the SCD, then release.
3. After you select the function, the single-character display will show one of the following:
 - ▶ **P** to indicate that post error reporting is enabled.
 - ▶ **U** to indicate that post error reporting is disabled.



TAPE ALERT FLAGS

TapeAlert is a patented technology and standard of the American National Standards Institute (ANSI) that defines conditions and problems that are experienced by drives. The technology enables a host to read TapeAlert flags set by the drive on its LOG SENSE TapeAlert Page (page code 2Eh) over the SCSI interface. [Table C-1](#) lists the TapeAlert flags that are supported by the tape drive.

Table C-1 TapeAlert flags supported by the tape drive

Flag Number	Flag Parameter (in hex)	Flag Type	Description	Action Required
3	03h	Hard error	Set for any unrecoverable read, write, or positioning error. (This flag is set in conjunction with flags 4, 5, or 6.)	Refer To the Action Required column for Flag 4, 5, or 6 in this table.
4	04h	Media	Set for any unrecoverable read, write, or positioning error that is due to a faulty data cartridge.	Replace the data cartridge.
5	05h	Read failure	Set for any unrecoverable read error where isolation is uncertain and failure could be due to a faulty data cartridge or to faulty drive hardware.	<ul style="list-style-type: none"> ▪ If Flag 4 is also set, the cartridge is defective. Replace the data cartridge. ▪ If Flag 4 is not set, see error code 6 in Table A-1 on page 56.
6	06h	Write failure	Set for any unrecoverable write or positioning error where isolation is uncertain and failure could be due to a faulty data cartridge or to faulty drive hardware.	<ul style="list-style-type: none"> ▪ If Flag 9 is also set, make sure that the write-protect switch is set so that data can be written to the tape (see “Setting the Write-Protect Switch” on page 23). ▪ If Flag 4 is also set, the cartridge is defective. Replace the data cartridge. ▪ If Flag 4 is not set, see error code 6 in Table A-1 on page 56.

Table C-1 TapeAlert flags supported by the tape drive (continued)

Flag Number	Flag Parameter (in hex)	Flag Type	Description	Action Required
8	08h	Not data grade	Set when severe servo errors occur while loading a data cartridge.	Replace the data cartridge. If this error occurs with multiple tapes, see error code 6 in Table A-1 on page 56 .
9	09h	Write protect	Set when the tape drive detects that the data cartridge is write-protected.	Make sure that the cartridge's write-protect switch is set so that the tape drive can write data to the tape (see "Setting the Write-Protect Switch" on page 23).
10	0Ah	No removal	Set when the tape drive receives an UNLOAD command after the host prevented the data cartridge from being removed.	Refer to the documentation for your host's operating system.
11	0Bh	Cleaning media	Set when you load a cleaning cartridge into the tape drive.	No action required.
12	0Ch	Unsupported format	Set when you load an unsupported cartridge type into the tape drive or when the cartridge format has been corrupted.	Use a supported data cartridge.
15	0Fh	Cartridge memory chip failure	Set when a cartridge memory (CM) failure is detected on the loaded data cartridge.	Replace the cartridge. If this error occurs on multiple tapes, see error code 6 in Table A-1 on page 56 .
16	10h	Forced eject	Set when you manually unload the data cartridge while the tape drive was reading or writing	No action required.
18	12h	Tape directory corrupted in the cartridge memory	Set when the tape drive detects that the tape directory in the cartridge memory has been corrupted.	Re-read all data from the tape to rebuild the tape directory.
20	4h	Clean now	Set when the tape drive detects that it needs cleaning.	Clean the tape drive. See "Cleaning the Drive Heads" on page 18 .
21	15h	Clean periodic	Set when the tape drive detects that it needs routine cleaning.	Clean the tape drive as soon as possible. The tape drive can continue to operate, but you should clean the tape drive soon. See "Cleaning the Drive Heads" on page 18 .

Table C-1 TapeAlert flags supported by the tape drive (continued)

Flag Number	Flag Parameter (in hex)	Flag Type	Description	Action Required
22	16h	Expired clean	Set when the tape drive detects a cleaning cartridge that has expired.	Replace the cleaning cartridge.
23	17h	Invalid cleaning tape	Set when the tape drive expects a cleaning cartridge and the loaded cartridge is not a cleaning cartridge.	Use a valid cleaning cartridge.
30	1Eh	Hardware A	Set when a hardware failure occurs which requires that you reset the tape drive to recover.	<ol style="list-style-type: none"> 1. Reset the tape drive (see “Resetting the Tape Drive” on page 19). 2. If resetting the tape drive does not recover the error, use the error code from the single-character display or the SCSI drive sense data to determine what caused the error (see Table A-1 on page 56).
31	1Fh	Hardware B	Set when the tape drive fails its internal self tests.	Use the error code on the single-character display, library user interface, or SCSI drive sense data (see Table A-1 on page 56).
32	20h	Interface	Set when the tape drive detects a problem with the SCSI interface.	Refer to error code 8 or 9 in Table A-1 on page 56 .
33	21h	Eject media	Set when a failure occurs that requires you to unload the cartridge from the tape drive.	Unload and reload the data cartridge.
34	22h	Download fail	Set when an firmware image is unsuccessfully downloaded to the tape drive via the SCSI interface.	Ensure that it is the correct image. Download the firmware image again (see “Upgrading Firmware” on page 47).
36	24h	Drive temperature	Set when the tape drive’s temperature sensor indicates that the tape drive’s temperature is exceeding the recommended temperature of the enclosure.	Refer to error code 1 in Table A-1 on page 56 .
37	25h	Drive voltage	Set when the tape drive detects that the externally supplied voltages are either approaching the specified voltage limits or are outside the voltage limits.	Refer to error code 2 in Table A-1 on page 56 .

Table C-1 TapeAlert flags supported by the tape drive (continued)

Flag Number	Flag Parameter (in hex)	Flag Type	Description	Action Required
39	27h	Diagnostics required	Set when the tape drive detects a failure that requires diagnostics to isolate the problem.	Refer to error code 6 in Table A-1 on page 56 .
51	33h	Tape directory invalid at unload	Set when the tape directory on the data cartridge that was previously unloaded is corrupted. The file-search performance is degraded.	Rebuild the tape directory by reading all the data.
52	34h	Tape system area write failure	Set when the data cartridge that was previously unloaded could not write its system area successfully.	Copy the data to another data cartridge, then discard the old cartridge.
53	35h	Tape system area read failure	Set when the tape system area could not be successfully read at load time.	Copy the data to another data cartridge, then discard the old cartridge.

D | _____

WRITE ONCE, READ MANY (WORM) CAPABILITY

OVERVIEW

Certain records retention and data security applications require a Write Once, Read Many (WORM) method for storing data on tape. To meet this data storage requirement, a new WORM feature is now available on the Magnum Tape Drive (LTO-3).

No physical hardware changes are required to make the tape drive compatible with the WORM feature; however, appropriate WORM-capable drive firmware must be installed. See [“Requirements” on page 82](#) for minimum drive firmware requirements.

WORM MEDIA

Because standard read/write media are incompatible with the WORM feature, a specially formatted WORM tape cartridge (see [Figure D-1](#)) is required. Each WORM cartridge has a unique, worldwide cartridge identifier (WWCID), which comprises the unique CM chip serial number and the unique tape media serial number.

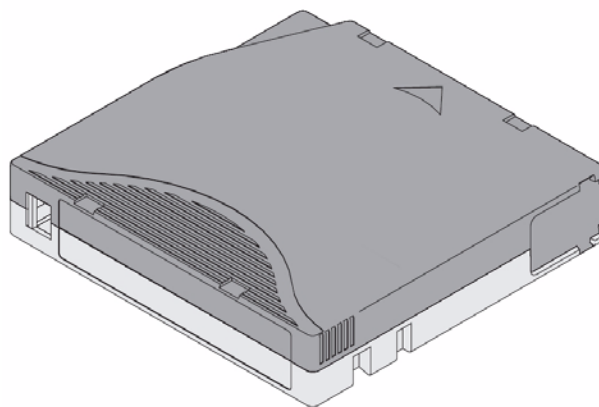


Figure D-1 Ultrium 3 WORM Tape Cartridge

Table D-1 lists WORM media specifications.

Table D-1 WORM tape cartridge specifications

Tape Cartridge	Case Color	Native Data Capacity
Ultrium 3 WORM	Slate blue top; platinum (silvery gray) bottom	400 GB (800 GB at 2:1 compression)

DATA SECURITY ON WORM MEDIA

Certain built-in security measures help ensure that the data written on a WORM cartridge does not become compromised, for example:

- ▶ The format of an IBM Ultrium 3 400 GB WORM Tape Cartridge is unlike that of standard read/write media. This unique format prevents a drive that lacks WORM-capable firmware from writing on a WORM tape cartridge.
- ▶ When the drive senses a WORM cartridge, the firmware prohibits the changing or altering of user data already written on the tape. The firmware keeps track of the last appendable point on the tape.

WORM MEDIA ERRORS

The following conditions cause WORM media errors to occur:

- ▶ Information in the servo manufacturer's word (SMW) on the tape must match information from the cartridge memory (CM) module in the cartridge. If it does not match, a media Error Code 7 will post on the drive's single-character display (SCD).
- ▶ Inserting a WORM tape cartridge into a drive that is not compatible with WORM causes the cartridge to be treated as an unsupported medium. The drive will report a media Error Code 7. Upgrading the drive firmware to the correct code level will resolve the problem.

REQUIREMENTS

Using the WORM feature requires WORM-capable drive firmware release 54xx or higher and special WORM tape cartridges (see [“WORM Media” on page 81](#)). You can use LTOTool to determine the firmware level currently in the tape drive. Refer to the readme file provided with the program for installation instructions. Refer to the program's online help for instructions on determining the tape drive firmware level.

If your tape drive has an earlier version of firmware, you can download the updated firmware by visiting the download page on the Exabyte web site at www.exabyte.com/downloads.

Note: Refer to [“Upgrading Firmware” on page 47](#) for instructions on upgrading the tape drive firmware.

TAPEALERT FLAGS

Table D-2 shows the new TapeAlert flags associated with the WORM cartridge. Refer to Appendix C for additional information about TapeAlert.

Table D-2 TapeAlert flags associated with the WORM media

Parameter Code		Description	Set	Clear	Type
In Hex	In Decimal				
3Bh	59	(WORM Medium – Integrity Check Failed) Set when the drive determines that the data on tape is suspect from a WORM point of view.		L	Critical
3Ch	60	(WORM Medium – Overwrite Attempted) Set when the drive rejects a Write operation because the rules for allowing WORM writes have not been met.	E		Critical

ERROR CODES

Tape drive errors associated with the new WORM capability result in either a Medium Error (Sense Key 3h) or a Data Protect error (Sense Key 7h). The tape drive returns this error information in response to a SCSI REQUEST SENSE command. Refer to the tape drive SCSI reference for additional information about the error codes returned by the REQUEST SENSE command.

Table D-3 shows the new ASC/ASCQ error codes for Sense Key 3h (Medium Error).

Table D-3 ASC/ASCQ error codes for a Medium Error (SK 3) with WORM media

ASC	ASCQ	Description
04h	10h	Logical Unit Not Ready, Auxiliary Memory Not Accessible.
11h	12h	Auxiliary Memory Read Error
30h	0Dh	Medium Error/WORM Medium – Integrity Check: Set when the drive rejects a Read operation because the current cartridge is a Suspicious WORM cartridge, and the WTRE bit is set to 0.

Table D-4 shows the new ASC/ASCQ error codes for Sense Key 7h (Data Protect).

Table D-4 ASC/ASCQ error codes for a Data Protect error (SK 7) with WORM media

ASC	ASCQ	Description
30h	0Dh	Data Protect/WORM Medium – Integrity Check: Set when the drive rejects a Write operation because the current cartridge is a Suspicious WORM cartridge.
30h	0Ch	Data Protect/WORM Medium – Overwrite Attempted: Set when the drive rejects a Write operation because the rules for allowing WORM writes have not been met.

Notes



GLOSSARY

2:1 Compression The relationship between the quantity of data that can be stored with compression as compared to the quantity of data that can be stored without compression. In 2:1 compression, twice as much data can be stored with compression as can be stored without compression.

American National Standards Institute (ANSI) Organization that sets standards for SCSI and the safety of electrical devices.

ampere (A) A unit of measure for electric current that is equivalent to a flow of one coulomb per second, or equivalent to the current produced by one volt applied across a resistance of one ohm.

adapter See *adapter card*.

adapter card A circuit board that adds function to a computer.

backups The short-term retention of records used for restoring essential business and host files when vital data has been lost because of program or host errors or malfunctions.

bar code A code representing characters by sets of parallel bars of varying thickness and separation which are read optically by transverse scanning.

bar code label A specially coded label that can be affixed to a tape cartridge and which enables a device to identify the cartridge and its volume serial number

bezel The removable frame that fits over the front of the tape drive.

bus In a network, the electrical pathway between a computer and other devices.

byte A string that consists of a certain number of bits (usually 8) which are treated as a unit and represent a character. A byte is a fundamental unit of data.

C See *Celsius (C)*.

capacity The amount of data that can be contained on storage media and expressed in bytes.

cartridge See *tape cartridge*.

cartridge door On a tape cartridge, the hinged barrier that can be opened to access, or closed to protect, the magnetic tape within the cartridge.

cartridge memory See *LTO cartridge memory (LTO-CM)*.

Celsius (C) Having a thermostatic scale on which the interval between the freezing point and the boiling point of water is divided into 100 degrees, with 0 degrees representing the freezing point and 100 degrees representing the boiling point.

cleaning cartridge A tape cartridge that is used to clean the heads of a tape drive. Contrast with data cartridge.

clockwise In the direction that the hands of a clock rotate, as viewed from the front.

compression The reduction in size of data to save space by eliminating gaps, empty fields, redundancies, and unnecessary data to shorten the length of records or blocks. Either the backup application or the tape drive can perform compression.

configure To describe to a host the devices, optional features, and programs installed on the system.

counterclockwise In a direction opposite to that in which the hands of a clock rotate, as viewed from the front.

current The quantity of charge per unit of time. Current is measured in amperes.

cycle power To apply and remove electrical power to a device within a short time span.

data Any representations such as characters or analog quantities to which meaning is, or might be, assigned.

data cartridge A tape cartridge that is dedicated to storing data. Contrast with *cleaning cartridge*.

data compression See *compression*.

data transfer rate The average number of bits, characters, or blocks per unit of time that pass between corresponding equipment in a data transmission system. The rate is expressed in bits, characters, or blocks per second, minute, or hour.

DC See *direct current (DC)*.

degauss To make a magnetic tape nonmagnetic by exposing the tape to electrical coils which carry currents that neutralize the magnetism of the tape.

device Any hardware component or peripheral, such as a tape drive or tape library, that can receive and send data.

device driver A file that contains the firmware that is needed to use an attached device.

diagnostic A software program that is designed to recognize, locate, and explain faults in equipment or errors in programs.

direct current (DC) An electric current flowing in one direction only and substantially constant in value.

drive A data-storage device that controls the movement of the magnetic tape in a tape cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape.

drive dump The recording, at a particular instant, of the contents of all or part of one storage device into another storage device, usually as a safeguard against faults or errors, or in connection with debugging.

drive head The component that records an electrical signal onto magnetic tape, or reads a signal from tape into an electrical signal.

Driver See [device driver](#).

drive sense data See [SCSI drive sense data](#).

dump See [drive dump](#).

eject To remove or force out from within.

error log Maintained by the tape drive, a list that contains the ten most recent error codes. The codes identify errors that pertain to the drive.

Exabyte (1) A network storage backup company that designs, manufactures, and markets industry-leading data storage products including tape drives and automated tape libraries.

(2) measurement of data:

One Exabyte =

1,000 Petabytes, or
 1,000,000 Terabytes, or
 1,000,000,000 Gigabytes, or
 1,000,000,000,000 Megabytes, or
 1,000,000,000,000,000 Kilobytes, or
 1,000,000,000,000,000,000 bytes

file A named set of records that are stored or processed as a unit.

FTP site Any electronic repository of information that uses the File Transfer Protocol (FTP) for transferring files to and from hosts. Use of an FTP site requires a user ID and possibly a password.

firmware The proprietary code that is usually delivered as part of an operating system. Firmware is more efficient than software that is loaded from an alterable medium, and is more adaptable to change than pure hardware circuitry. An example of firmware is the Basic Input/Output System (BIOS) in read-only memory (ROM) on a PC motherboard.

GB See *Gigabyte*.

Gigabyte One billion (1 000 000 000) bytes.

ground An object that makes an electrical connection with the earth.

hardware The physical equipment or devices that form a computer. head. See *drive head*.

head A device that uses induction to write a data pattern onto magnetic media and then uses either inductance or magnetoresistance to read the data back.

Head Resistance Measurements test Part of the Test Head diagnostic, a procedure that determines whether the tape drive's head works correctly. The test measures the head's ability to withstand cracks and other defects.

host The controlling or highest-level system in a data communication configuration. Synonymous with *server*.

ID Identifier.

inch (in.) A unit of length equal to 1/36 yard or 25.4 mm.

input/output (I/O) Data that is provided to a computer or data that results from computer processing.

insertion guide On the surface of the tape cartridge, a large, notched area that prevents you from inserting the cartridge incorrectly.

install (1) To set up for use or service. (2) The act of adding a product, feature, or function to a host or device either by a singular change or by the addition of multiple components or devices.

interposer An adapter-like device that allows a connector of one size and style to connect to a mating connector of a different size and style. Data provided to the computer or data resulting from computer processing.

I/O See *input/output (I/O)*.

jumper (1) A tiny connector that fits over a pair of protruding pins in a connector. A jumper can be moved to change electrical connectors. When in place, the jumper connects the pins electrically. (2) To place a jumper on a connector pin.

label A slip of paper with an adhesive backing that can be written on and affixed to a tape cartridge as a means of identification or description.

label area On the LTO Ultrium Tape Cartridge, a recessed area next to the write-protect switch where a bar code label must be affixed.

leader block Located within the tape drive, the part that engages the steel pin which is attached to the tape in an LTO Ultrium Tape Cartridge. Once engaged, the leader-pin block pulls the tape from the cartridge into the drive.

leader pin On the tape cartridge, a small metal column that is attached to the end of the magnetic tape. During tape processing the leader pin is grasped by a threading mechanism, which pulls the pin and the tape out of the cartridge, across the drive head, and onto a takeup reel. The head can then read or write data from or to the tape.

LED Light Emitting Diode. A semiconductor diode that emits light when subjected to an applied voltage and that is used in an electronic display.

Linear Tape-Open (LTO) A type of tape storage technology developed by the IBM Corporation, Hewlett-Packard, and Certance. LTO technology is an “open format” technology, which means that its users will have multiple sources of product and media. The “open” nature of LTO technology enables compatibility between different vendors’ offerings by ensuring that vendors comply with verification standards. The LTO technology is implemented in two formats: the Accelis format focuses on fast access; the Ultrium format focuses on high capacity. The Ultrium format is the preferred format when capacity (rather than fast access) is the key storage consideration.

Load The process of inserting a cartridge into the tape drive. Following the insertion of a tape cartridge into the tape load compartment, the act of positioning the tape (performed by the tape drive) for reading or writing by the drive’s head.

log sense data See *SCSI log sense data*.

loop (1) A series of instructions that is repeated until a terminating condition is reached. (2) To connect so as to complete a loop.

Low Voltage Differential (LVD) A low-noise, low-power, and low-amplitude electrical signaling system that enables data communication between a supported host and the tape drive. LVD signaling uses two wires to drive one signal over copper wire. The use of wire pairs reduces electrical noise and crosstalk.

LTO See *Linear Tape-Open (LTO)*.

LTO cartridge memory (LTO-CM). Within each IBM LTO Ultrium Data Cartridge, an embedded electronics and interface module that can store and retrieve a cartridge’s historical usage and other information.

LVD See *Low Voltage Differential (LVD)*.

magnetic tape A tape with a magnetizable surface layer on which data can be stored by magnetic recording. maintenance mode. The state of operation in which the tape drive must be before it can run diagnostics, verify write and read operations, verify a suspect tape cartridge, update its own firmware, and perform other diagnostic and maintenance functions.

MB See *Megabyte (MB)*.

media The plural of medium.

medium A physical material in or on which data may be represented, such as magnetic tape.

Megabyte (MB) One million (1 000 000) bytes.

msec Millisecond; one-thousandth of a second.

network A configuration of data processing devices and software that is connected for information interchange.

Noise Any kind of magnetic or electric interference detected by the electronics.

oersted The unit of magnetic field strength in the unrationalized centimeter-gram-second (cgs) electromagnetic system. The oersted is the magnetic field strength in the interior of an elongated, uniformly wound solenoid that is excited with a linear current density in its winding of one ampere per 4π centimeters of axial length.

offline The operating condition that the tape drive is in when the host's applications cannot interact with it.

online The operating condition that the tape drive is in when the host's applications can interact with it.

Open Systems Computer systems whose standards are not proprietary.

operating environment The temperature, relative humidity rate, and wet bulb temperature of the room in which the tape drive routinely conducts processing.

parity The state of being even-numbered or odd-numbered. A parity bit is a binary number that is added to a group of binary numbers to make the sum of that group always odd (odd parity) or even (even parity).

parity error A transmission error that occurs when the received data does not have the parity that is expected by the receiving system. This usually occurs when the sending and receiving systems have different parity settings.

port (1) A system or network access point for data entry or exit. (2) A connector on a device to which cables for other devices such as display stations and printers are attached. (3) The representation of a physical connection to hardware. A port is sometimes referred to as an adapter; however, there can be more than one port on an adapter.

power connector Located at the rear of the tape drive, the connector to which the internal power cable of an enclosure connects.

power cord A cable that connects a device to a source of electrical power.

power-off To remove electrical power from a device.

power-on, powered-on (1) To apply electrical power to a device. (2) The state of a device when power has been applied to it.

read To acquire or interpret data from a storage device, from a data medium, or from another source.

reboot To reinitialize the execution of a program by repeating the initial program load (IPL) operation.

record The smallest distinct set of data bytes that is supplied from a host for processing and recording by a tape drive, and the smallest distinct set of data to be read from tape, reprocessed, and made available to a host by a tape drive.

relative humidity The ratio of the amount of water vapor actually present in the air to the greatest amount possible at the same temperature.

reset To return a device or circuit to a clear state.

scratch cartridge A data cartridge that contains no useful data, but can be written to with new data.

SCSI See *Small Computer Systems Interface (SCSI)*.

SCSI bus (1) A collection of wires through which data is transmitted from one part of a computer to another. (2) A generic term that refers to the complete set of signals that define the activity of the Small Computer Systems Interface (SCSI).

SCSI ID A unique address (from 1 to 15) assigned to each device attached to a SCSI bus. See also *bus*.

SCSI connector Located at the rear of the tape drive, the connector that facilitates commands to and from the host, and to which the internal SCSI cable of an enclosure connects.

SCSI device Anything that can connect into the SCSI bus and actively participate in bus activity.

SCSI drive sense data In response to inquiry from the host about an error condition, a packet of SCSI sense bytes that contains information about the error and that is sent back to the host by the drive.

SCSI ID connector Located at the rear of the tape drive, the connector that enables the drive's SCSI address to be set. Addresses are determined by the placement of jumpers on the pins.

SCSI interface See *Small Computer Systems Interface (SCSI)*.

SCSI log sense data In response to inquiry from the host about the tape drive's error logs and counters, a packet of SCSI sense bytes which contains that information and which is sent back to the host by the drive. Log sense data is used to diagnose problems, especially if the problems are intermittent.

second One sixtieth of a minute.

sense data Data that describes an I/O error. Sense data is presented to a host in response to a Sense I/O command.

server A functional unit that provides services to one or more clients over a network. Examples include a file host, a print host, or a mail server. Synonymous with *host*.

single-character display Located at the front of the tape drive, an LED that presents an alphabetical or numeric code which represents a diagnostic or maintenance function, error condition, or informational message.

sleep mode A power-management function that causes the tape drive's electronics to automatically enter a low-power mode by which to conserve energy.

Small Computer Systems Interface (SCSI) A standard used by computer manufacturers for attaching peripheral devices (such as tape drives, hard disks, CD-ROM players, printers, and scanners) to computers (hosts). Pronounced "scuzzy." Variations of the SCSI interface provide for faster data transmission rates than standard serial and parallel ports (up to 160 megabytes per second). The variations include:

- ▶ **Fast/Wide SCSI:** Uses a 16-bit bus, and supports data rates of up to 20 MB/second.
- ▶ **SCSI-1:** Uses an 8-bit bus, and supports data rates of 4 MBps.
- ▶ **SCSI-2:** Same as SCSI-1, but uses a 50-pin connector instead of a 25-pin connector, and supports multiple devices.
- ▶ **Ultra SCSI:** Uses an 8- or 16-bit bus, and supports data rates of 20 or 40 MB/second.
- ▶ **Ultra2 SCSI:** Uses an 8- or 16-bit bus and supports data rates of 40 or 80 MB/second.
- ▶ **Ultra3 SCSI:** Uses a 16-bit bus and supports data rates of 80 or 160 MB/second.
- ▶ **Ultra160 SCSI:** Uses a 16-bit bus and supports data rates of 160 MB/second.

software Programs, procedures, rules, and any associated documentation pertaining to the operation of a computer system.

speed matching A technique used by the tape drive to dynamically adjust its native (uncompressed) data rate to the slower data rate of a host. Speed matching improves system performance and reduces backhitch.

status LED Located at the front of the tape drive, an LED that can be green or amber, and (when lit) solid or flashing. The condition of the light represents the state of the drive.

Streaming An operational mode that occurs when the data transfer rate to or from the host closely matches the tape drive's data transfer rate, allowing the tape drive to read or write data in a continuous stream.

TapeAlert patented technology and ANSI standard that defines conditions and problems that are experienced by tape drives.

TapeAlert flags Status and error messages that are generated by the TapeAlert utility and display on the host's console.

tape cartridge A removable storage case that houses belt-driven magnetic tape that is wound on a supply reel and a takeup reel.

tape drive A data-storage device that controls the movement of the magnetic tape in a tape cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 100 GB per cartridge; with 2:1 compression, its capacity is up to 200 GB.

tape path Within a tape drive, the channel in which the media moves.

terminate To prevent unwanted electrical signal reflections by applying a device (known as a terminator) that absorbs the energy from the transmission line.

terminator (1) A part that is used to end a SCSI bus. (2) A single-port, 75-ohm device that is used to absorb energy from a transmission line. Terminators prevent energy from reflecting back into a cable plant by absorbing the radio frequency signals. A terminator is usually shielded, which prevents unwanted signals from entering or valid signals from leaving the cable system.

Test Head diagnostic A test that determines whether the heads of the tape drive are operating properly and whether the drive can correctly read from and write to tape.

transfer rate See *data transfer rate*.

Ultra160 LVD SCSI interface See *Small Computer Systems Interface (SCSI)*.

unload The act (performed by the drive) of unthreading tape from the drive's internal tape path and returning it (with the leader block) to the tape cartridge.

utility See *utility program*.

utility program A computer program that supports computer processes. For example, a diagnostic program, a trace program, or a sort program.

V DC Volts DC (direct current).

volt The SI (international) unit of potential difference and electromotive force. Formally defined as the difference of electric potential between two points of a conductor that carries a constant current of one ampere when the power dissipated between these points is equal to one watt.

wet bulb temperature The temperature at which pure water must be evaporated adiabatically at constant pressure into a given sample of air in order to saturate the air under steady-state conditions. Wet bulb temperature is read from a wet bulb thermometer.

write To make a permanent or transient recording of data in a storage device or on a data medium.

write protected Applicable to a tape cartridge, the condition that exists when some logical or physical mechanism prevents a device from writing on the tape in that cartridge.

write-protect switch Located on the tape cartridge, a switch that prevents accidental erasure of data. Pictures of a locked and unlocked padlock appear on the switch. When you slide the switch to the locked padlock, data cannot be written to the tape. When you slide the switch to the unlocked padlock, data can be written to the tape.

Write/Read test Part of the Test Head diagnostic, a procedure that determines whether the tape drive can correctly read from and write to tape.



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