Dell PowerVault LTO Tape Drive

User's Guide

Note

Before you use this information and the product it supports, read the general information under *Notices* in the *Dell PowerVault LTO Tape Drive User's Guide*.

NOTE indicates important information that helps you make better use of your system.

NOTICE indicates either potential damage to hardware or loss of data and describes how to avoid the problem.

CAUTION indicates a potential for property damage, personal injury, or death.

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Chapter 1. Introduction

Overview

The LTO PowerVault tape drive is a high-performance, high-capacity data-storage device that is designed to back up and restore data and archive and retrieve files in an Open Systems environment. The drive can be integrated into a system (internal model) or can be provided as a separately packaged desktop unit (external model). There are eight generations of the Dell PowerVault tape drives in the LTO series of products.

Figure 1 on page 1 shows the internal model of the tape drive. Figure 2 on page 2 shows the separately purchased external model of the tape drive. Figure 3 on page 2 shows the rack mount model.
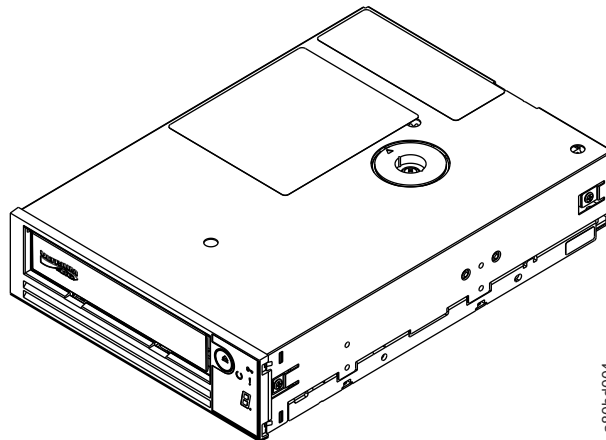
Figure 1. Tape drive internal model
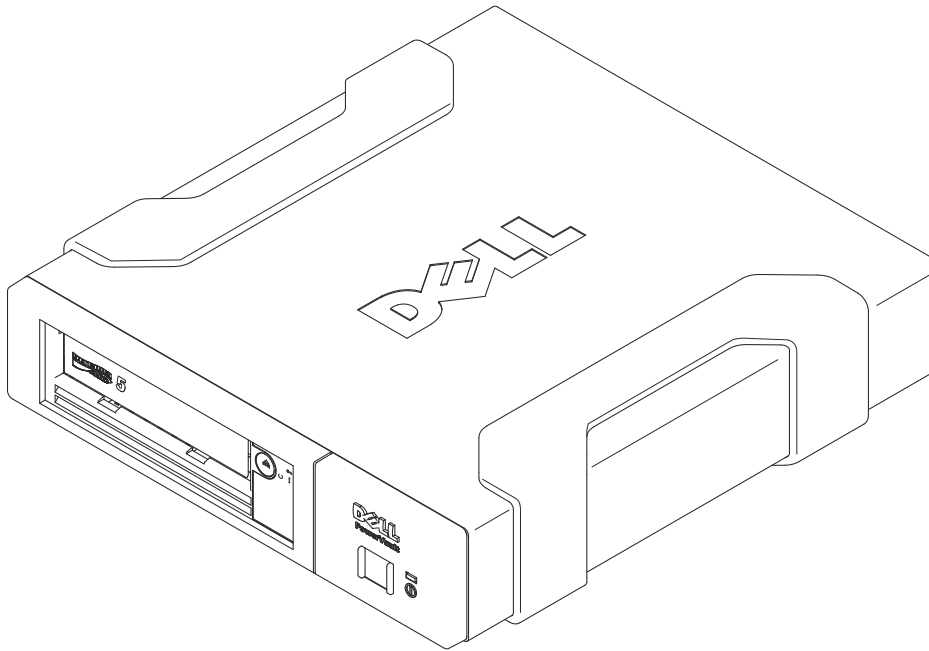
Figure 2. Tape drive external model
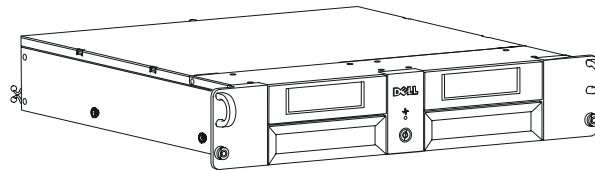
Figure 3. Tape drive rack mount model

Serial Attached SCSI (SAS) interface

A drive with a SAS (Serial Attached SCSI) interface can be linked directly to controllers. The SAS interface offers the following advantages over the traditional SCSI interface.

- SAS enables multiple devices (up to 128) of different sizes and types to be connected simultaneously with thinner and longer cables.
- Offers full-duplex signal transmission.
- SAS drives can be hot-plugged.

Specifications and features

Specifications

Table 1. Drive information and performance specification					
Generation	**LTO 9**	**LTO 8**	**LTO 7**	**LTO 6**	**LTO 5**
Inquiry	ULT3580-HH9 ULTRIUM-HH9	ULT3580-HH8 ULTRIUM-HH8	ULT3580-HH7 ULTRIUM-HH7	ULT3580-HH6 ULTRIUM-HH6	ULT3580-HH5 ULTRIUM-HH5
Interface (speed)	FC (8 Gb) SAS (12 Gb)	FC (8 Gb) SAS (6 Gb)	FC (8 Gb) SAS (6 Gb)	FC (8 Gb) SAS (6 Gb)	FC (8 Gb) SAS (6 Gb)

Table 1. Drive information and performance specification (continued)					
Generation	**LTO 9**	**LTO 8**	**LTO 7**	**LTO 6**	**LTO 5**
Native data rate	300 Mb/s (L9) 300 Mb/s (L8)	300 Mb/s (L8) 300 Mb/s (M8) 300 Mb/s (L7)	300 Mb/s (L7) 160 Mb/s (L6) 140 Mb/s (L5)	160 Mb/s (L6) 140 Mb/s (L5) 120 Mb/s (L4)	140 Mb/s (L5) 120 Mb/s (L4) 80 Mb/s (L3)
Sustained data rate (L6, L7, L8 and L9 compressed at 2.5:1 compression; L5 and earlier compressed at 2:1compression)	FC 700 Mb/s (L9) 700 Mb/s (L8) SAS 720 Mb/s (L9) 720 Mb/s (L8)	FC 700 Mb/s (L8) 700 Mb/s (M8) 700 Mb/s (L7) SAS 600 Mb/s (L8) 540 Mb/s (M8) 500 Mb/s (L7)	FC 700 Mb/s (L7) 400 Mb/s (L6) 280 Mb/s (L5) SAS 500 Mb/s (L7) 400 Mb/s (L6) 280 Mb/s (L5)	FC and SAS 400 Mb/s (L6) 280 Mb/s (L5) 240 Mb/s (L4)	FC and SAS 280 Mb/s (L5) 240 Mb/s (L4) 160 Mb/s (L3)
Burst data rate	800 Mb/s FC 1200 Mb/s SAS	800 Mb/s FC 600 Mb/s SAS	800 Mb/s FC 600 Mb/s SAS	800 Mb/s FC 600 Mb/s SAS	800 Mb/s FC 600 Mb/s SAS
Nominal load-to-ready time	16 seconds	15 seconds	15 seconds	12 seconds	12 seconds
-Initialized tape	16 seconds	NA	NA	NA	NA
-Uninitialized tape[2]	40-132 minutes	NA	NA	NA	NA
Nominal unload time	56 seconds	24 seconds	20 seconds	17 seconds	17 seconds
Average space record time from load point	65 seconds	59 seconds	56 seconds	62 seconds	60 seconds
Average rewind time (REWIND command)	62 seconds	59 seconds	60 seconds	NA	NA
Average rewind time (part of UNLOAD command, dependent on mount activity)[3]					
Less than 5 Gb of contiguous data transferred	62 seconds	59 seconds	60 seconds	NA	NA
5 Gb to 50 Gb of contiguous data transferred	124 seconds	59 seconds	60 seconds	NA	NA
All other types of mount activity	186 seconds	59 seconds	60 seconds	NA	NA

Table 1. Drive information and performance specification (continued)					
Generation	LTO 9	LTO 8	LTO 7	LTO 6	LTO 5

[1] By using the built-in data-compression capability of the tape drive, greater data rates than the native data transfer rate are achieved. However, the actual throughput is a function of many components, such as the host system processor, disk data rate, block size, data compression ratio, SAS bus capabilities, and system or application software.

[2] Cartridge initialization time can vary. See "Media optimization" on page 4 for more information.

[3] See "Archive mode unthread" on page 5 for more information.

Remember:

- All sustained data rates depend on the capabilities of the interconnect.
- Drive performance varies with media generation and drive interface (SAS/FC).

With the LTO M8 tape cartridge, the native capacity is 9 TB and the compressed capacity (at 2.5:1) is 22.5 TB.

Features

The tape drive has the following features.

- Built-in read-after-write verification for a high level of data integrity
- Burst data transfer rate of 1200 MB per second
- 1024 MB of read/write cache memory
- Intelligent LTO DC dual-mode compression algorithm
- Fail-safe leader capture mechanism with pinpick error recovery.
- Reads cartridge memory in LTO cartridges
- TapeAlert support for improved diagnostic and troubleshooting
- Speed matching (the drive can slow down to match the system data rate).
- Sleep mode for energy conservation
- Backward read and write compatibility dependent on generation.
- Compatible with all cartridges dependent on generation that bears the official Ultrium LTO logo. For more information, see "Data cartridges" on page 21.
- Able to interchange tapes with other LTO tape drives that bear the official Ultrium LTO logo.
- Support for WORM (Write Once Read Many) using WORM media
- Data encryption capability by using LTO Ultrium 4, 5, 6, 7, M8, 8 and 9 media
- Ethernet interface for transferring drive firmware and dumps only (not an iSCSI interface).
- Diagnostics of the drive over the Ethernet service port (not an iSCSI interface)

Drive features

Media optimization

Media optimization is a new feature for the LTO9 tape drive with L9/LZ media.

The increased number of tracks used to write data on tape requires greater precision. Media optimization creates a referenced calibration for each cartridge that enables the tape drive's intelligent alignment to optimize data placement. LTO-9 media optimization enhances LTO tape long-term media durability.

It is important to consider when media optimization will be performed:

- Media optimization will be performed on first load of L9/LZ media during initialization.
- Recommendation is to perform first load in the location of deployment, which should be in a stable environment that meets the recommended environmental specification.
- Media optimization is a one-time operation that can be completed on any drive in the environment, enabling the media to be used across all tape drives without further optimization.

Other considerations for media optimization:

- Media optimization averages 40 minutes per first load of a cartridge to a tape drive. Although most media optimizations will complete within 60 minutes some media optimizations may take up to 2 hours.
- Interruption of the process is not recommended.
- A different mount will not necessarily improve the time to complete the one-time optimization.

An update to software may be required. Contact your software application provider for more details. Customized software, not provided as a standard market product, may require modification to ensure the software can handle the extended first mount time.

Recommended access order (RAO) open function

RAO enables tape control applications to accelerate the retrieval of a certain number of files from a single tape thereby reducing the seek time between those files.

A feature of the LTO-9 full-height drives is the ability to accept a list of User Data Segments and reorder those User Data Segments into a recommended access order that minimizes the locate portion of the time to read those User Data Segments. This sorted list is called a Recommended Access Order (RAO) list. A User Data Segment (UDS) is defined as a grouping of contiguous logical objects (i.e., logical blocks and filemarks) and is described by partition number, beginning logical object identifier, and ending logical object identifier.

The RAO implementation in LTO produces the best results for performance enhancement when there is little variability in block size or data compression ratio. When the variability in compression ratio or block sizes increase, the accuracy of the locate estimates may be reduced and any potential performance enhancements may be diminished.

Archive mode unthread

The time that is required for an unload depends on how the cartridge has been used during the mount. This is based on the current position and how far from the beginning of tape (BOT) the media has been moved since mount. For details on unload performance, see "Specifications and features" on page 2.

Speed matching

To improve system performance, the drive uses a technique that is called *speed matching* to dynamically adjust its native (uncompressed) data rate to the slower data rate of a server.

With speed matching, the drive operates at different speeds when it is reading or writing the Ultrium 7 or later cartridge format. Native data rates are shown in the table.

Table 2. Performance parameters for full height drives			
	Ultrium Generation Media		
	Generation 9 media	**Generation 8 media**	**Generation 7 media**
Speed matching data rates (MB/sec)	408	365.0	306.0
	385	341.0	287.52
	366	318.0	268.56
	347	306.4	250.66
	325	273.0	231.86
	305	249.5	213.06
	284	226.0	194.26
	263	203.0	175.46
	244	180.0	157.67
	223	157.5	138.52
	203	135.0	120.11
	177	112.0	101.46

Table 3. Performance parameters for half height drives			
	Ultrium Generation Media		
	Generation 9 media	**Generation 8 media**	**Generation 7 media**
Speed matching data rates (MB/sec)	284	306.4	306.0
	263	273.0	287.52
	244	249.5	268.56
	223	226.0	250.66
	203	203.0	231.86
	177	180.0	213.06
	-	157.5	194.26
	-	135.0	175.46
	-	112.0	157.67
	-	-	138.52
	-	-	120.11
	-	-	101.46

If the server's net (compressed) data rate is between two of the preceding native data rates, the drive calculates the appropriate data rate at which to operate. Speed matching dramatically reduces backhitch, the condition that occurs when a tape stops, reverses, and restarts motion. A backhitch is usually the result of a mismatch between the data rates of the server and the drive.

Channel calibration

System performance is optimized by *channel calibration*.

System performance is further optimized by a feature that is called *channel calibration,* in which the drive automatically customizes each read/write data channel to compensate for variations in such things as the recording channel 's transfer function, the media, and characteristics of the drive head.

Data cartridge capacity scaling

Capacity scaling enables faster random access to data.

The **SET CAPACITY SCSI** command enables a customer to capacity scale a data cartridge to enable faster random access. As an example, a customer can capacity scale a data cartridge to 20% of its normal length that improves the average access time by almost a factor of 5. However, it also reduces the native capacity of the tape to 80 GB160 GB300 GB500 GB1.2 TB.

Encryption

The LTO tape drive supports host Application Managed Encryption (AME), with T10 encryption methods.

Data encryption is supported by LTO Ultrium 4 and later data cartridges only.

The encryption-enabled drive contains the necessary hardware and firmware to encrypt and decrypt host tape application data. Encryption policy and encryption keys are provided by the host application. A drive digital certificate is installed at manufacturing time. Each drive receives a unique serial number and certificate. The T10 Application can validate each drive instance by checking the drive's digital certificate.

Tape backup software

You need backup software that supports the Dell PowerVault tape drive. As a general rule, native backup applications (such as **NTBackup** and **tar**) do not provide the required data streaming rate to get the full performance of your tape drive. It is recommend that you use a backup application that provides better memory management as well as other useful features, such as **TapeAlert**. For the latest supported software versions, go to the Dell support website at http://www.Dell.com/support or visit the support site of your backup software vendor.

Front panel
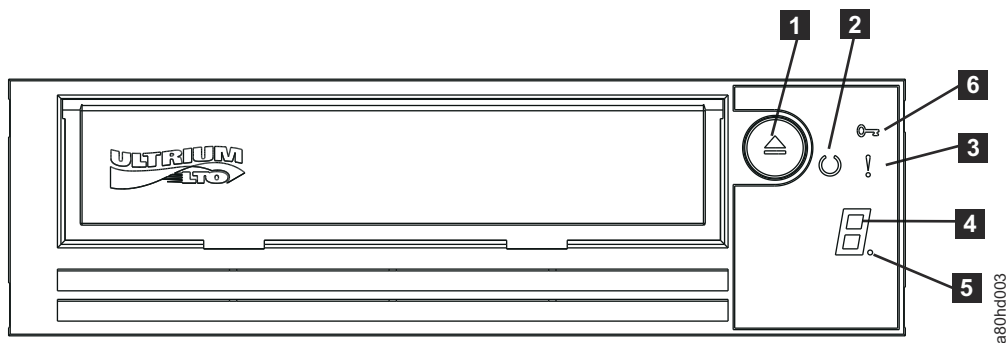
Figure 4. Front panel

1	**Eject**	4	Single-character display (SCD)
2	Ready/Activity LED	5	Single dot
3	Fault LED	6	Encryption Status LED

1. **Eject** enables you to complete several functions. These functions are described in detail in Chapter 3, "Using the tape drive," on page 20 .

2. **Ready/Activity LED** The front panel of your Dell PowerVault LTO tape drive has a green Ready/Activity LED providing information about the state of the tape drive. The LED can be solid on or flashing when lit. See Table 4 on page 8 for more descriptions.

3. **Fault LED** The front panel of your Dell PowerVault LTO tape drive has an amber fault LED indicating the drive has encountered an error, is not in a normal operational status, or needs cleaning. See Table 4 on page 8 for more detailed description.

4. **Single-character display (SCD)** This LED presents a single-character code for diagnostic/maintenance functions, error conditions, and informational messages.

5. **Single dot** This single-character display is blank during normal operation. When a single dot illuminates and flashes on the display, the drive created a dump of vital technical data to drive memory.

6. **Encryption status LED** This white LED indicates all data (except for the label information) on the cartridge is encrypted. (LTO Ultrium 5 and above cartridges only.)

Table 4. SCD, Ready/Activity LED, and Fault LED descriptions

Condition of green Ready/ Activity LED	Condition of amber Fault LED	Condition of white encryptio n LED	Condition of the SCD Panel	Condition of the SCD Dot	Meaning of LEDs and SCD Panel and SCD Dot
Off	Off	Off	Off	Off	The tape drive has no power or is powered off.
On Solid	Off	Off	Off or ⎣	Off	The tape drive is powered on or (if a solid ⎣ displays in the single character display) needs cleaning. **Note:** If a cartridge is loaded, the white Encryption status light is on when all the data on the cartridge is encrypted (excluding the label). LTO Ultrium 5 and above cartridges only.

Condition of green Ready/ Activity LED	Condition of amber Fault LED	Condition of white encryption LED	Condition of the SCD Panel	Condition of the SCD Dot	Meaning of LEDs and SCD Panel and SCD Dot
Flashing once per second	Off	On or Off	Off	Off	The tape drive is reading from the tape, writing to the tape, rewinding the tape, locating data on the tape, loading the tape, or unloading the tape. The Encryption LED is On if all the data on the cartridge is encrypted during these drive operations. The Ready/Activity LED also flashes green if the tape drive contains a cartridge during the power on cycle. In this case, the drive completes POST and slowly rewinds the tape. This process might take approximately 13 minutes. The Ready/ Activity LED stops flashing when the drive completes the recovery and is ready for a read or write operation. To eject the cartridge, press **Unload**. **Note:** The white Encryption status light is on when all the data on the cartridge is encrypted (excluding the label). LTO Ultrium 5 and above cartridges only.
Flashing once per second	Off	On or Off	C	Off	The drive is performing media optimization.
Off	On/Solid	Off	On Solid	On/Off	The tape drive is in Maintenance mode or is displaying an error code on the SCD in Maintenance mode option 9.
Off	On Solid	Off	Flashing once per second	On/Off	Executing the selected option while in Maintenance mode.
Off	Flashing once per second	Off	On Solid	Off	An error occurred and the tape drive or media might require service or drive may require cleaning. Note the code on the single character display, and then go to the error code table in the troubleshooting section to determine the meaning of the error codes. If a C appears on the SCD, a cleaning cartridge must be loaded.

Table 4. SCD, Ready/Activity LED, and Fault LED descriptions (continued)

| Table 4. SCD, Ready/Activity LED, and Fault LED descriptions (continued)					
Condition of green Ready/ Activity LED	Condition of amber Fault LED	Condition of white encryption LED	Condition of the SCD Panel	Condition of the SCD Dot	Meaning of LEDs and SCD Panel and SCD Dot
Off	Flashing twice per second	Off	Off	Off	The drive is updating firmware.
Off	Flashing once every 2 seconds	Off	Off	Off	The drive detected an error and is running a firmware recovery. It resets automatically.

Rear panel
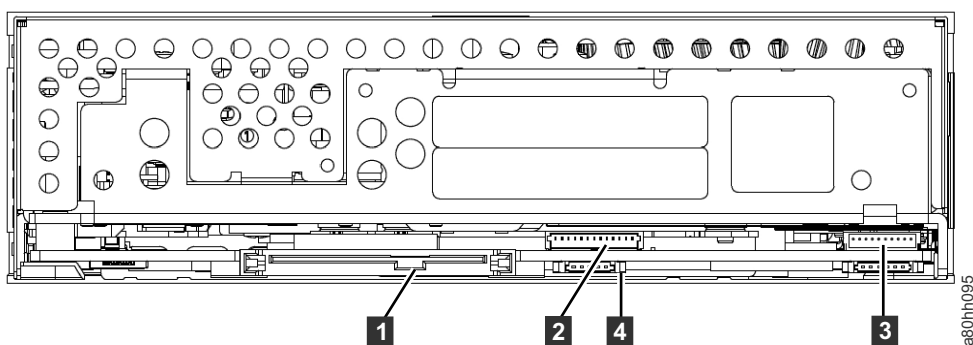
Figure 5. Rear panel of internal SAS tape drive

1	SAS connector	3	Library interface
2	Ethernet - not iSCSI - for transferring firmware and dumps only	4	LED controls for library drive sled
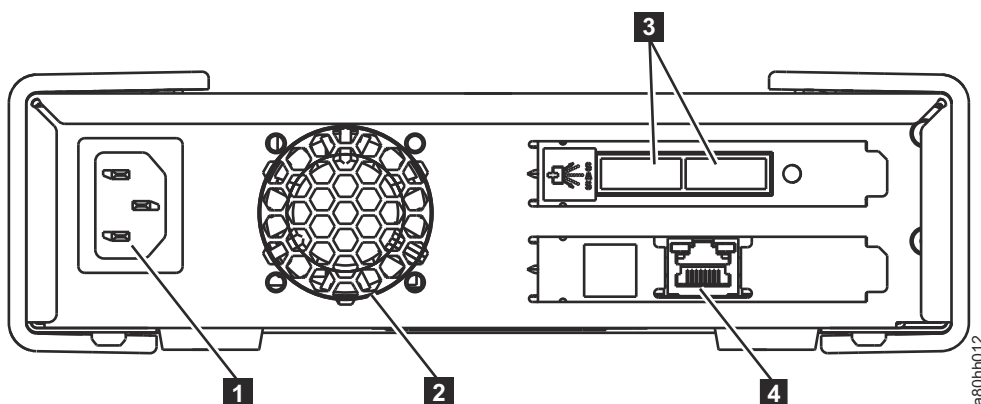
Figure 6. Rear panel of external SAS tape drive

1	Power connector	3	Mini-SAS connectors (HD connectors for LTO9)
2	Fan enclosure	4	Ethernet - not iSCSI - for transferring firmware and dumps only
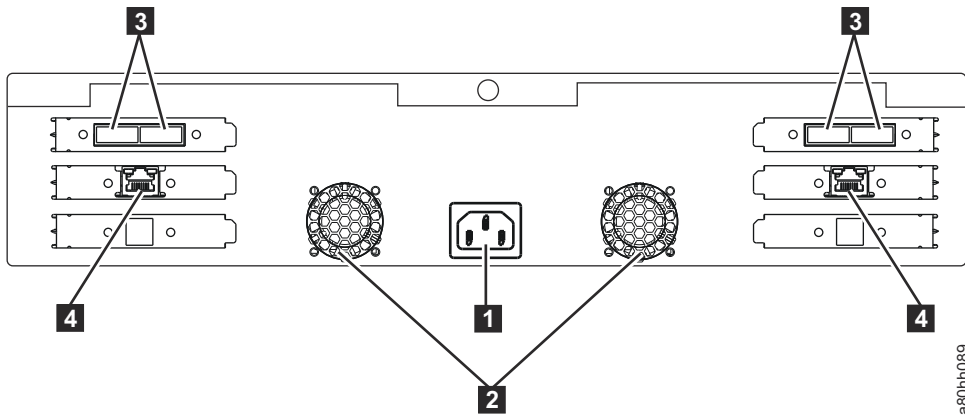
Figure 7. Rear panel of the rack mount tape drive

1	Power connector	3	Mini-SAS connectors (HD connectors for LTO9)
2	Fan enclosure	4	Ethernet - not iSCSI - for transferring firmware and dumps only

Chapter 2. Setting up the tape drive

Preinstalled internal drives

Dell completes the installation and setup of internal tape drives that are shipped as part of a system. If tape backup software is included in your system, refer to the installation instructions included with the software.

For the current supported software versions, go to the Dell support website http://www.Dell.com/support or go to the support site of your backup software vendor.

Installing internal drives

If your internal tape drive is not preinstalled, the installation instructions are described in the following sections.

Installing the drive - Prerequisites

The Dell PowerVault tape drive is a SAS device. For additional information, see "Specifications and features" on page 2. It is recommended that you use a dedicated SAS host bus adapter for this tape drive.

Mounting bay

One industry-standard, 5 1/4 inch, half-height bay is needed to install the Dell PowerVault tape drive. The supported mounting configurations are horizontally with the base of the drive parallel to the ground, or vertically with either the left or right side of the drive parallel to the ground.

Install and configure the drive according to the instructions provided in the Dell documentation for your system.

Mounting hardware

Most systems use trays or rails to mount the tape drive. If the mounting hardware is preinstalled, slide the drive into the mounting bay. Some systems do not use slides or rails and drives must be fixed in place with screws.

Installing the internal drive - Step-by-step instructions

1. Unpacking the tape drive

   Unpack the tape drive and store the packaging. You might need the packaging if you return the unit for service.

   Some time is required if the temperature of the drive when unpacked is different than the temperature of its operating environment, measured at the front of the bezel near the air intake area. See **1** in

. The recommended time is 4 hours after the drive is unpacked or 1 hour after any condensation that you can see evaporates, whichever is greater. To allow the drive to adjust to its new environment, apply the following measures:

- If the drive is colder than its operating environment and the air contains sufficient humidity, condensation might occur in the drive and damage it. When the drive warms to the operating temperature range (greater than 10-degrees C or 50-degrees F) and no danger of condensation is present (the air is dry), warm the drive more quickly by powering it on for 30 minutes. Use a scratch tape to test the drive before a tape that contains data is inserted.

- If the drive is hotter than its operating environment, the tape can stick to the drive head. When the drive cools to the operating temperature range (less than 40-degrees C or 104-degrees F), cool the drive more quickly by applying airflow for 30 minutes. Power on the drive and use a scratch tape to test it before a tape that contains data is inserted.

If you are uncertain about whether the temperature of the drive is within the recommended operating range or the humidity is sufficient to cause condensation, allow the drive to adjust to its new environment for the full 4 hours.
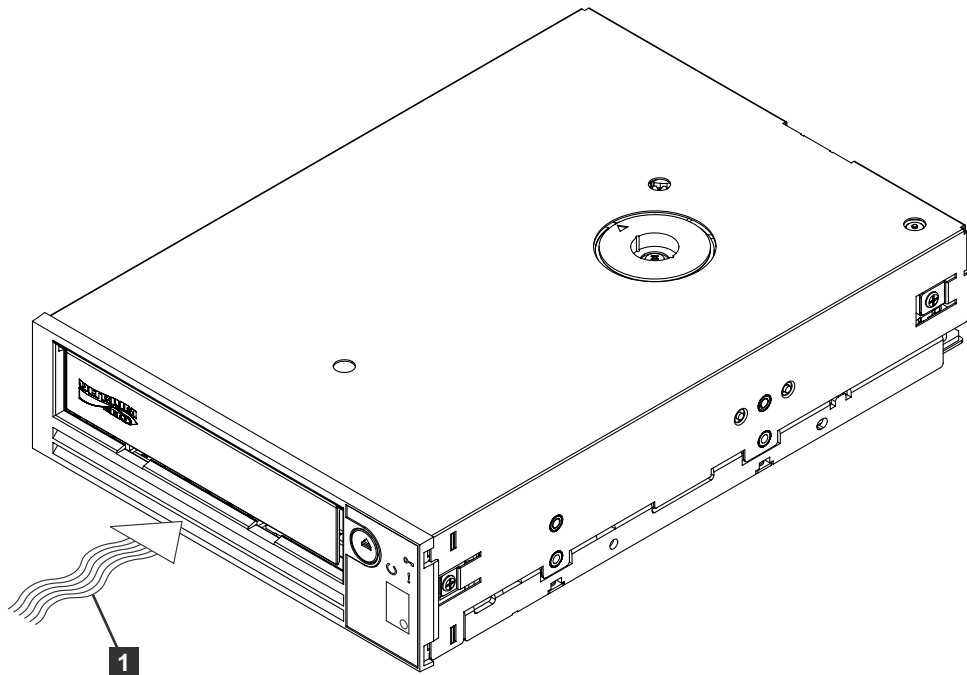
Figure 8. Air intake area

1   Air intake area

2. Removing power from the system

   a. Power-off the system.

   b. Disconnect the power cord from both the electrical outlet and the system.

3. Preparing the mounting bay in your system

   ⚠️ **CAUTION:** To avoid personal injury or damage to the system or tape drive, ensure that the system power cord is disconnected before you install the drive.

   Refer to your system's documentation for instructions on how to prepare the mounting bay to receive the tape drive.

4. Attaching mounting hardware

   If your system requires special rails or other hardware to install the tape drive, mount them on the tape drive in this step.

   If your system does not require special mounting hardware, proceed to step 5.

5. Installing the tape drive

   Slide the tape drive into the open bay, aligning the tray or rails with the slots in the bay, as shown in .
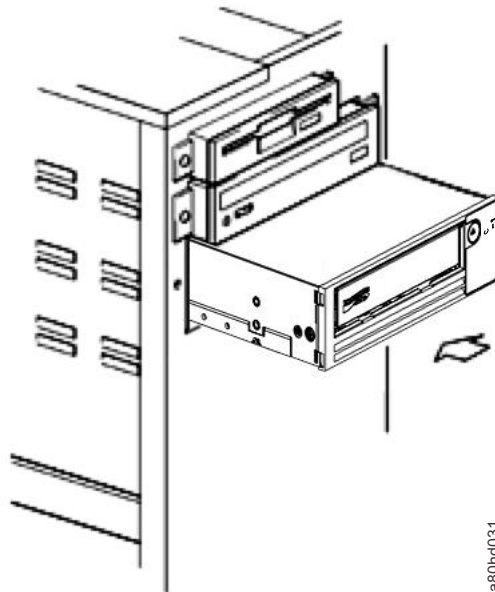
Figure 9. Install the drive

If your system does not use mounting hardware, check that the holes in the chassis are aligned with the holes in the side of the tape drive (see).
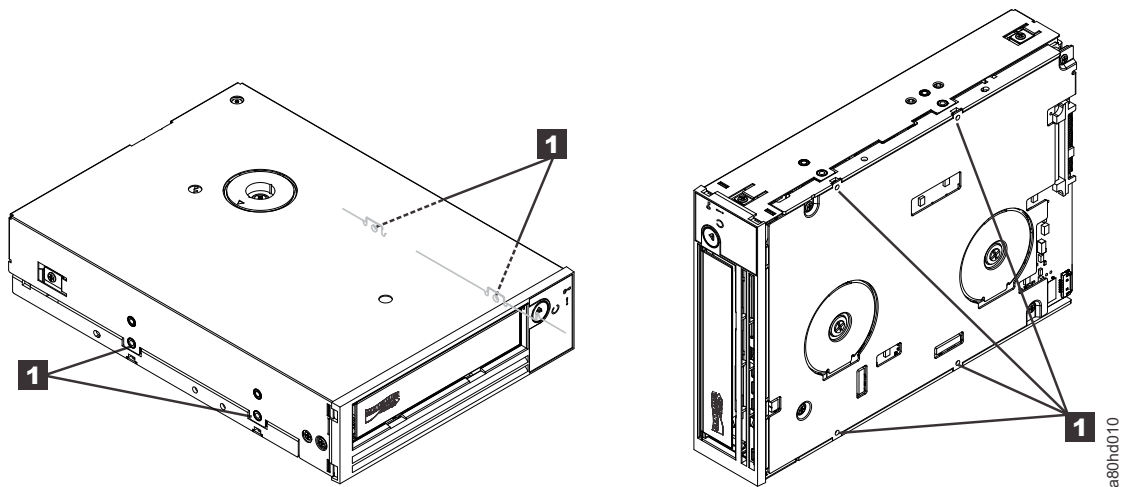
Figure 10. Mounting Holes on tape drive

1	M-3 mounting screw holes

Do not secure the drive with screws because you might need to move the drive to get the cables in place.

6. Attaching SAS cable

   Attach the system SAS cable to the drive SAS connector, as shown in .
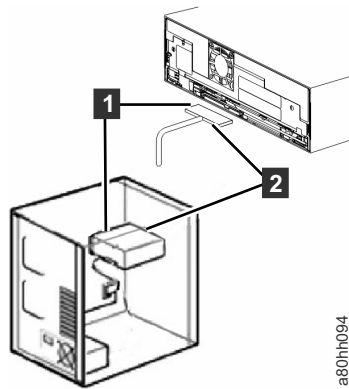
Figure 11. Attaching SAS cable

1	SAS cable
2	Power cable

7. Securing the tape drive

   The tape drive can now be secured to the system as shown in <u>Figure 12 on page 15</u>. There are several ways to secure the drive. If the drive is on rails or in a sled, then push it in place. Some systems require the drive to be inserted into a media bay and attached directly to the system with screws.
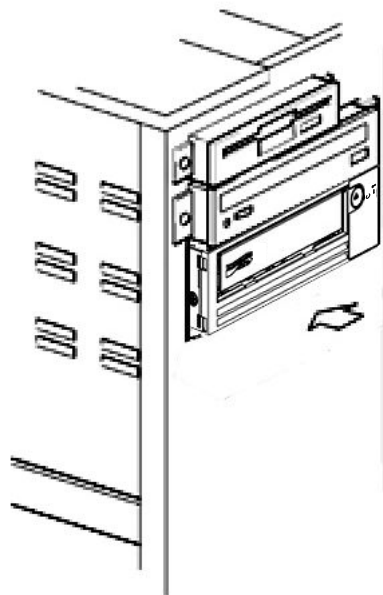
Figure 12. Secure the drive

8. Connecting host system power and testing power to the tape drive

   Connect the power cord to the system and to the electrical outlet. To ensure that the drive is receiving power, watch for the following indicators while the power to the system is turned on:

   a. The single-character display presents a series of random characters.

   b. The single-character display becomes blank (not lit).

   c. The Fault LED briefly turns on, then the ready/activity LED turns on solid.

Installing external and rack mount drives

Installing the drive - Prerequisites

The SAS tape drive has a burst transfer rate of 1200 MB per second. It is recommended that a dedicated host bus adapter is used for the tape drive.

Your system must have a properly installed and configured SAS host adapter or a SAS controller on the motherboard (if available) with driver software that supports the tape drive. Do not connect to a RAID controller channel; RAID controller channels are for disk drives only.

Installing the external drive - Step-by-step instructions

1. Positioning the tape drive

   Position the tape drive convenient to the system. The only restrictions are the length of the power cord and the length of the SAS cable. The following locations are recommended:

   - Away from high-traffic areas, especially if the floor is carpeted.
   - Out of copy 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.
   - Where the tape cartridge can easily be inserted.

   The following mounting positions are supported:

   - In a horizontal or vertical position for external drives.
   - In a horizontal position for rack-mounted drives.

   Notice: The external tape drive must not be stacked. Do not place anything on top of the unit.

2. Connecting power

   An external Dell PowerVault tape drive operates by using any voltage in the range 100 - 240 volts (50 - 60 Hz). No adjustment is needed. To connect your drive to the power supply:

   a. Plug the power cable securely into the socket on the rear panel of the drive.

   b. Plug the other end of the power cable into a grounded power outlet.

   c. Power on the tape drive by pressing **Power**. The tape drive runs the POST, which checks all hardware except the drive head.

3. Connecting the SAS cable

   Attach one end of the SAS cable to the SAS host adapter card installed in the system. Attach the other end of the SAS cable to the SAS connector on the rear panel of the tape drive. The cable can be up to 5 m (16.4 ft) long for LTO 7 and 8 generation drives. For LTO 9 generation drives, the cables can have a maximum length of 4 m. This configuration is shown in Figure 13 on page 16.
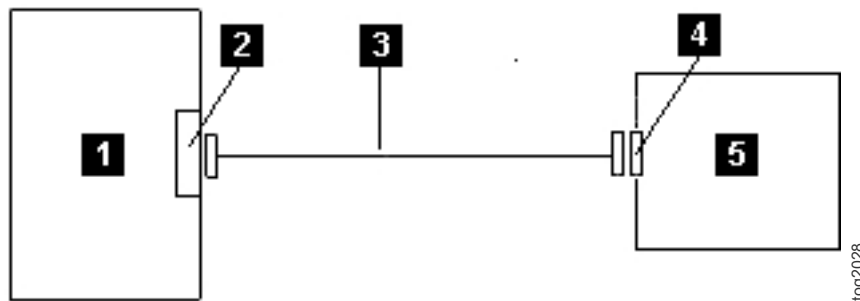
Figure 13. Connecting the SAS cable

1	System	**4**	Drive SAS connector

2	SAS host adapter card	**5**	Tape drive
3	SAS cable		

To connect a second system to the tape drive, attach one end of the second SAS cable to the SAS host adapter installed in the second system. Attach the other end of the second SAS cable to the other SAS port on the rear panel of the tape drive. This configuration is shown in .
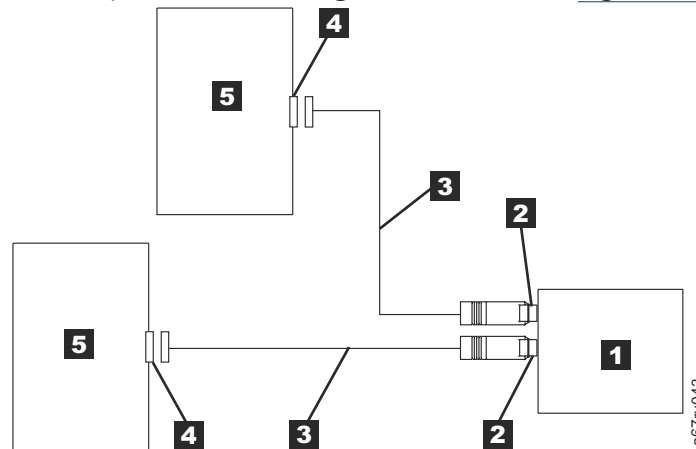
Figure 14. Connecting two SAS Hosts to one tape drive

1	Tape drive	**4**	SAS host adapter card
2	Drive shaft connector	**5**	System
3	SAS cable		

Note: Unlike SCSI, the SAS architecture does not support daisy-changing.

4. Configuring the tape drive to the host

   Power on the tape drive. Refer to your system and application software manuals to configure the tape drive for use.

Verifying drive operation

After you install the drive hardware, verify that it is functioning properly before you store your valuable data. Turn on the system. For external drives, turn on the drive before you turn on the system.

The tape drive runs its Power-On Self Test (POST), which checks all hardware except for the drive head. The single-character display (SCD) presents a series of random characters, and then becomes blank (not lit). The fault LED flashes once, then the Ready/Activity LED turns on solid.

Verify that the tape drive installation was successful. Following the instructions given with your Tape Backup Software application, write test data to a tape, read the test data from the tape, and compare the data read from the tape with the original data on disk.

Loading device drivers

Microsoft Windows Server

This section describes how to install the Microsoft Windows Server device drivers for the tape drive.

Notice: Some backup software applications do not require device drivers to be loaded and, in some cases, installing device drivers could interfere with proper functioning of the application. See the documentation for the respective application before loading these drivers. The current drivers are available at http:// www.Dell.com/support.

Ethernet Service Port procedures

Updating the drive firmware by using the Ethernet interface

Note: The drive uses a limited version of FTP protocol to communicate on the Ethernet interface. It is recommended to use a simple, command line FTP session, such as the DOS command prompt, when communicating with the drive. This product is not intended to be connected directly or indirectly by any means whatsoever to interfaces of public telecommunications networks. When the IP address is changed to the customer LAN or DHCP obtained a new address, the default address of the tape drive is still available. This action does not create a LAN conflict as the customer LAN address takes operational preference. The default address does not conflict with other drives that have the default address. When the drive comes online, the drive checks if the default address is on the LAN and does not become active while another drive is active. This operation is acceptable and at times a multi-drive LAN might see different drives with accessible default address.

Important: The Ethernet port is for Service only. Do not connect the customer network to Service ports.

1. Obtain the current drive firmware from the web. Go to http://www.Dell.com/support.
2. Connect an Ethernet patch cable to the drive's Ethernet interface and to a computer. To meet electromagnetic immunity requirements, a shielded Ethernet cable is required.
3. Create an FTP session between the drive and the computer. The drive's default IP address: `169.254.0.3`.
4. At the user prompt, type `guest` and press **Enter**.
5. At the password prompt, press **Enter**. No response is needed.
6. Type `bin` to set the communication mode to binary.
7. Type `put firmware name` to transfer the firmware to the drive. Replace `firmware name` with the actual firmware file name. The drive resets automatically when the transfer is complete and the FTP session is lost. Type `quit` to end the FTP session.
8. After the drive resets, the new firmware is loaded on the drive.
9. Remove the Ethernet patch cable from the drive's Ethernet interface.

Capturing a drive memory dump by using the Ethernet interface

Another way to capture a drive dump is by using the Ethernet port. To capture a dump on the drive by using the Ethernet interface, follow these steps.

Note: The drive uses a limited version of FTP protocol to communicate on the Ethernet interface. It is recommended to use a simple, command line FTP session, such as the DOS command prompt, when communicating with the drive. This product is not intended to be connected directly or indirectly by any means whatsoever to interfaces of public telecommunications networks.

Important: The Ethernet port is for Service only. Do not connect the customer network to Service ports.

1. Connect an Ethernet patch cable to the drive's Ethernet interface and to a computer. To meet electromagnetic immunity requirements, a shielded Ethernet cable is required.
2. Create an FTP session between the drive and the computer. The drive's default IP address: `169.254.0.3`.
3. At the user prompt, type `guest` and press **Enter**.
4. At the password prompt, press **Enter**. No response is needed.
5. Type `bin` to set the communication mode to binary.
6. Type `mget *.dmp` to transfer a drive dump to the computer. If a dump exists, the drive shows you the memory dump name and ask if you want to transfer it to the computer. Type y to transfer the existing dump or n to skip this dump file. Then, the drive asks if you want a forced dump. Type y to force a dump and to transfer the forced dump to the computer, or type n to skip forcing a dump.
7. Type `quit` to end the FTP session.

8. Remove the Ethernet patch cable from the drive's Ethernet interface.

Chapter 3. Using the tape drive

Operating the tape drive

Turn on the external drive by pushing **Power** on the front panel (Figure 15 on page 20). Turn on the rack mount drive by pushing **Power** on the front panel (Figure 16 on page 20).The tape drive runs its Power-On Self-Test (POST). At the end of the hardware self-test, the ready/activity LED must be solid green.
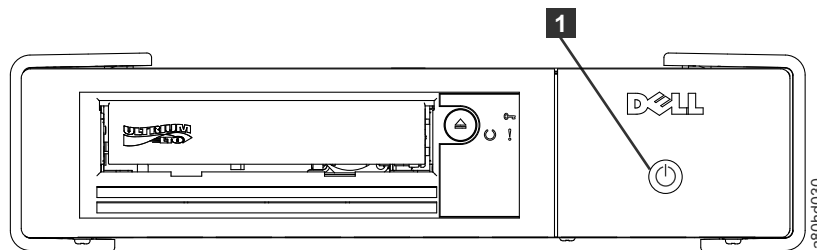
Figure 15. Turning on the external drive

| 1 | | **Power** |
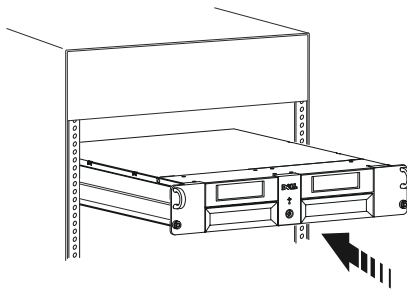
Figure 16. Turning on the rack mount drive

Resetting the drive

You can reset the drive without powering off the drive and system. This action might be necessary if the drive stops responding. Press and hold **Eject** on the front panel of the tape drive for 10 seconds (Figure 17 on page 21). The drive forces a memory dump of vital technical data to drive memory and overwrites the existing dump. The drive then restarts to allow communication.
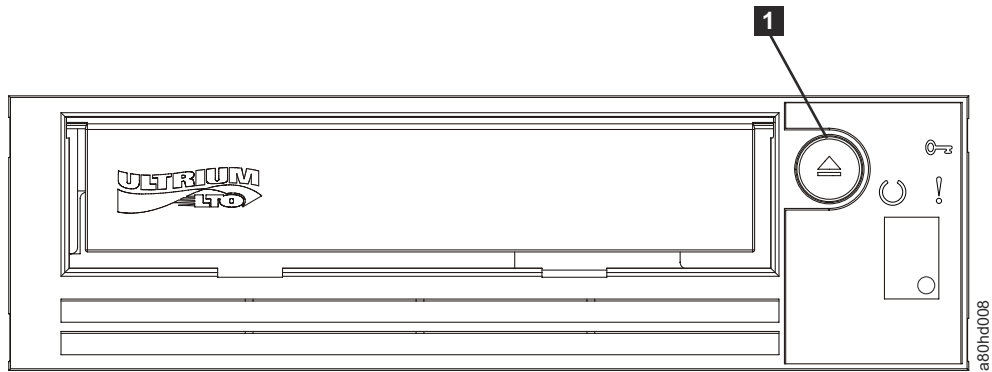
Figure 17. Resetting the drive

| 1 | | Eject |

Data cartridges

The Dell PowerVault tape drive is compatible with the cartridges of its predecessors. The following table describes the functions that are supported on the different compatible media types.

Table 5. Supported Functions of Compatible Media Types											
LTO cartridge Gen	Tape length nominal (m)	Data capacity native[1] (TB)	Data capacity compressed [2] (TB)	Power® Vault Gen LTO9	Power Vault Gen LTO8	Power Vault Gen LTO7	Power Vault Gen LTO6	Power Vault Gen LTO5	Power Vault Gen LTO4	Power Vault Gen LTO3
9	1035	18	45	Yes	No	No	No	No	No	No
9 WORM	1035	18	45	Yes	No	No	No	No	No	No
8	960	12	30	Yes	Yes	Yes	No	No	No	No
8 WORM	960	12	30	Yes	Yes	Yes	No	No	No	No
LTO M8*	960	9	22.5	No	Yes	No	No	No	No	No
7	960	6	15	No	Yes	Yes	No	No	No	No
7 WORM	960	6	15	No	Yes	Yes	No	No	No	No
6	846	2.5	6.25	No	No	Yes	Yes	No	No	No
6 WORM	846	2.5	6.25	No	No	Yes	Yes	No	No	No
5	846	1.5	3	No	No	RO	Yes	Yes	No	No
5 WORM	846	1.5	3	No	No	RO	Yes	Yes	No	No
4	820	800 GB	1.6	No	No	No	RO	Yes	Yes	No
4 WORM	820	800 GB	1.6	No	No	No	RO	Yes	Yes	No
3	680	400® GB	800 GB	No	No	No	No	RO	Yes	Yes

LTO cartridge Gen	Tape length nominal (m)	Data capacity native[1] (TB)	Data capacity compressed[2] (TB)	Power® Vault Gen LTO9	Power Vault Gen LTO8	Power Vault Gen LTO7	Power Vault Gen LTO6	Power Vault Gen LTO5	Power Vault Gen LTO4	Power Vault Gen LTO3
3 WORM	680	400	800 GB	No	No	No	No	RO	Yes	Yes
2	609	200 GB	400 GB	No	No	No	No	No	RO	Yes
1	609	100 GB	200 GB	No	No	No	No	No	No	RO
1	319	50 GB	100 GB	No	No	No	No	No	No	RO
1	203	30 GB	60 GB	No	No	No	No	No	No	RO
1	97	10 GB	20 GB	No	No	No	No	No	No	RO

Table 5. Supported Functions of Compatible Media Types (continued)

* In any tape product with M8 cartridges, the minimum LTO8 tape drive firmware version is HB82.

[1]1 GB = 1 000 000 000 bytes.

[2]Compression Ratio

- 2.5:1 = LTO9, LTO8, LTO7, LTO6
- 2:1 = LTO5, LTO4, and LTO3

[3]RO = Read Only

LTO Type M Cartridge (M8)

The LTO Program introduced a new capability with LTO8 tape drives: the ability to write 9 TB (native) on a brand new LTO Ultrium 7 cartridge instead of 6 TB (native) as specified by the LTO7 format. Such a cartridge is called an LTO7 initialized LTO Type M cartridge. These LTO Type M cartridges are identifiable by using an automation bar code label that ends with the last 2 characters "M8".

Table 6. LTO7 and LTO8 Cartridge Types

Cartridge/Density type	Bar code label	Cartridge Packaging/ Silkscreen labeling	Native capacity	Tape Drive compatibility
L9	xxxxxxL9	LTO Ultrium 9	18 TB	LTO9
L8	xxxxxxL8	LTO Ultrium 8	12 TB	LTO9, LTO8
M8	xxxxxxM8	LTO Ultrium 7	9 TB	LTO8
L7	xxxxxxL7	LTO Ultrium 7	6 TB	LTO7, LTO8

From now on, these cartridges are referred to as L9, L8, M8, and L7.

Only new, unused LTO Ultrium 7 cartridges can be initialized as M8 cartridges. When a cartridge is initialized as M8, it cannot be changed back to L7. Initialized M8 cartridges can be written and read only in an LTO8 tape drive. LTO7 tape drives cannot read initialized M8 cartridges.

M8 cartridges can be purchased as either pre-initialized (also referred to as "labeled and initialized") M8 data cartridges or uninitialized M8 data cartridges (M8 WORM cartridges are not supported). For either option, the bar code label is included. However, the uninitialized M8 data cartridge must first be initialized in tape libraries that support the automatic initialization of uninitialized M8 cartridges while under the control of ISV applications that recognize the "M8" bar code label.

A tape cartridge is initialized when it is first loaded into a compatible tape drive and data is written by the ISV application at the beginning of tape (sometimes referred to as "labeling a tape" or "writing from BOT"). The tape drive then establishes the density of the media.

If an uninitialized M8 cartridge is not initialized in a tape library that supports uninitialized M8 cartridges, then the cartridge might inadvertently and silently be initialized at the L7 density (that is, at a 6 TB native capacity) even if the bar code label states "M8". This action might occur with the usage of stand-alone LTO7 tape drives, stand-alone LTO8 tape drives, earlier LTO8 tape drive firmware, or earlier ISV software that does not recognize that M8 cartridges must be mounted only in LTO8 tape drives. M8 cartridges that are inadvertently initialized at the L7 density can continue to be read and written in LTO7 and LTO8 tape drives. However, they remain limited to the 6 TB native capacity.

In any tape product with M8 cartridges, the minimum LTO8 tape drive firmware version is HB82.

Loading, unloading, and write-protecting cartridges

Use only LTO Ultrium format cartridges with your drive, as specified in the LTO Ultrium standard. Ensure that only one label is stuck to the label area of the cartridge. Do not use nonstandard labels, and do not stick anything to the cartridge other than in the label area.

shows the LTO Ultrium data cartridge and its components.
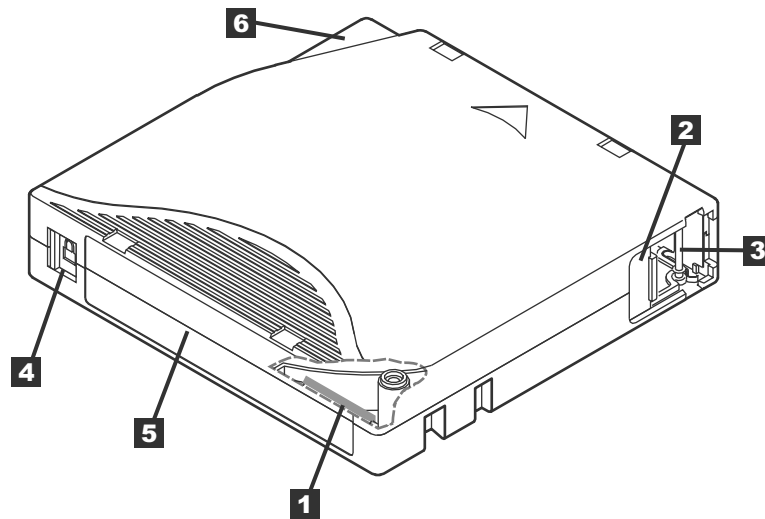
Figure 18. LTO Ultrium data cartridge

1	LTO cartridge memory	4	Write-protect switch
2	Cartridge door	5	Label area
3	Leader pin	6	Insertion guide

Loading a tape cartridge

1. Ensure that the tape drive is powered on. The ready/activity LED is solid green.
2. Ensure that the write-protect switch (see 3 in Figure 18 on page 23) is properly set. See "Setting the write-protect switch on tape cartridges" on page 24.
3. Grasp the cartridge so that the write-protect switch faces you.

4. Slide the cartridge into the tape load compartment. See . The tape drive automatically loads the cartridge.

- If the cartridge is already in the ejected position and you want to reinsert it, remove the cartridge and then insert it again.
- If the cartridge is already loaded and you cycle the power (turn it off, then on), the cartridge does not automatically eject. When the drive powers back on, the cartridge is brought back to the loaded position.
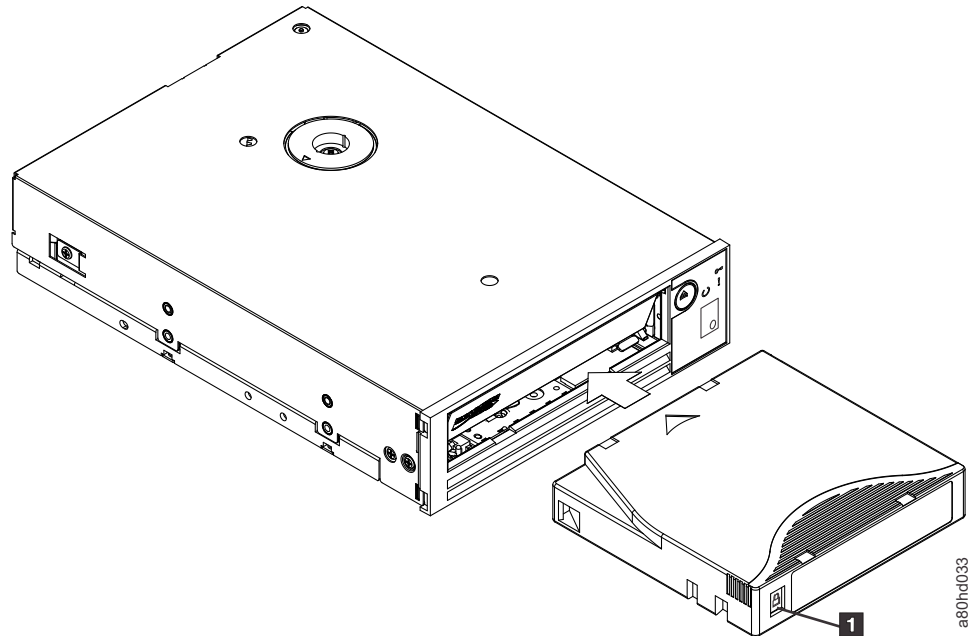
Figure 19. Loading

| 1 | | Write-protect switch |

Unloading a tape cartridge

1. Ensure that the tape drive is powered on. The ready/activity LED is solid green.
2. Press **Eject**. See **1** in . The drive rewinds the tape and ejects the cartridge. The ready/activity LED flashes green while the tape rewinds, then goes out before the cartridge ejects.
3. After the cartridge ejects, grasp the cartridge and remove it.

The tape drive writes any pertinent information to the cartridge memory whenever you unload a tape cartridge.

Notice: Do not remove a tape cartridge while the drive activity indicator is on.

Setting the write-protect switch on tape cartridges

Notice: Write-protection does not prevent a cartridge from being erased by bulk-erasure or degaussing. Do not bulk-erase Ultrium format cartridges. Bulk-erasing destroys prerecorded servo information and renders the cartridge unusable. Always use the long or quick erase command in your backup software to erase cartridges.

The position of the write-protect switch () on the tape cartridge determines whether you can write to the tape:

- If the switch is set to locked (locked padlock), data cannot be written to the tape.
- If the switch is set to unlocked (unlocked padlock or black void), data can be written to the tape.
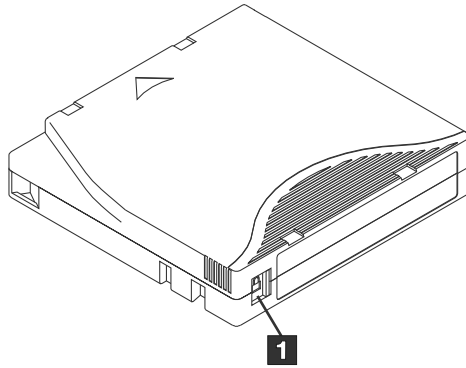
Figure 20. Setting the write-protect switch

| 1 | | Write-protect switch |

To set the switch, slide it left or right to the wanted position.

Notice: Always set the write protection tab before the cartridge is loaded into the drive. Sliding the tab after loading causes unpredictable results and might result in drive errors or backup failure.

Caring for tape cartridges

Notice: Do not insert a damaged tape cartridge into your tape drive. A damaged cartridge can interfere with the reliability of the drive and might 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.

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

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.

Ensure proper packaging

- When you ship a cartridge, ship it in its original or similar 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.
- 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.

Provide proper acclimation and environmental conditions

- Before you use a cartridge, let it acclimate to the normal operating environment for 1 hour. If you see condensation on the cartridge, wait an additional hour.
- 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 following environmental conditions outlined in .

Table 7. Environment specification								
Product operation (equipment is powered on)								
Dry-bulb temperature			**Humidity range, non-condensing**			**Maximum dew point temperature[4]**	**Maximum wet-bulb temperature[5]**	**Maximum elevation**
Allowable[2]	**Recommended[3]**	**Maximum rate of change**	**Allowable**	**Recommended**	**Maximum rate of change**	22°C (72°F) for LTO 9	26°C (79°F)	3050 m (10,000 feet)
15 to 35°C (59 to 95°F)	15 to 25°C (59 to 77°F)	5°C/hour (9°F/hour)	20% to 80% RH	20% to 50% RH	5% RH/hour with no condensation			

Note:

1. Product equipment is removed from the original shipping container and installed but not in use - for example, during repair, maintenance, or upgrade.
2. Derate maximum dry-bulb temperature 1°C/300 m above 900 m (1.8°F/1,000 feet above 3,000 feet).
3. Derate maximum recommended dry-bulb temperature 1°C/300 m above 1,800 m (1.8°F/1,000 feet above 6,000 feet).
4. Applies to LTO 9 drives
5. Applies to LTO drive generations 1 through 8.

Perform a thorough inspection

- 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. If there are gaps in the seam, the leader pin may be dislodged.
- Check that the leader pin is properly seated.

- If you suspect that the cartridge has been mishandled but it appears useable, copy any data onto a good cartridge immediately for possible data recovery. Discard the mishandled cartridge.
- 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.
- 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.

Cleaning the tape mechanism

Dell PowerVault tape drives are developed to have a minimal cleaning requirement. The tape drive displays a $\boxed{C}$ on the Single-character display (SCD) and the fault LED flashes amber when the drive needs cleaning. Insert a cleaning cartridge into the tape drive when the $\boxed{C}$ Is displayed.

Notice: Use only LTO cleaning cartridges that are labeled "universal." The tape drive is compatible only with the LTO Ultrium universal cleaning cartridges. Use of any other type of cleaning cartridge or method can damage the read/write head in your drive. If you load any other type of cleaning cartridge, the tape drive displays a $\boxed{7}$ in the SCD and retains the cartridge until it is ejected manually by pressing **Eject**.

An LTO Ultrium universal cleaning cartridge is supplied with each tape drive. Do *not* use swabs or other means of cleaning the heads. The cleaning cartridge uses a special tape to clean the tape heads.

Though the number might vary according to the manufacturer, the universal cleaning cartridge is generally valid for 50 separate cleaning operations. If you try to use the cleaning cartridge beyond 50 separate cleaning operations, an error code of $\boxed{7}$ displays. Eject the cleaning cartridge and replace it with a new one.

To use the LTO Ultrium universal cleaning cartridge:

1. Insert a cleaning cartridge into the tape drive. The tape drive completes the cleaning automatically. When the cleaning is finished, the drive ejects the cartridge.
2. Remove the cleaning cartridge from the drive.

Chapter 4. Troubleshooting

Obtaining drivers and firmware upgrades

Notice: When firmware is updated, do not power off the tape drive until the update is complete, or the firmware might be lost.

For information on the current versions of firmware, see the Dell support website at http://www.Dell.com/support.

Selecting a Diagnostic or Maintenance function

The tape drive can run diagnostics, test write and read functions, test a suspect tape cartridge, and complete other diagnostic and maintenance functions. The drive must be in maintenance mode to complete these functions. To place the drive in maintenance mode and select a diagnostic or maintenance function, see Table 8 on page 29.

Note: The host interface on this tape drive is Serial Attached SCSI (SAS). This interface presents SCSI protocol to the tape drive. In this User's Guide, references to SCSI relate to SCSI protocol, not the serial interface that it is transmitted over.

Note: You cannot complete maintenance functions concurrently with read or write operations. While in maintenance mode, the tape drive does not accept SCSI commands from the system. Close all tape drive applications before maintenance mode is entered.

Table 8. Diagnostic and Maintenance Function Codes and Descriptions

Function Code 1 - Run Tape Drive Diagnostics

Causes the tape drive to run self-tests.

⚠️ **Attention:** Insert only a scratch data cartridge for this test. Data on the cartridge is overwritten.

Note: If you inserted an invalid tape cartridge (see "Data cartridges" on page 21), error code ⎍ or ⎞ displays in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (see "Loading, unloading, and write-protecting cartridges" on page 23), error code ⎡P⎤ displays in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

1. Ensure that no cartridge is in the drive.
2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until ⎢ appears in the single-character display. If you cycle past ⎢, continue to press **Eject** until it reappears.
4. To select the function, press and hold **Eject** for 3 seconds. After you select the function, ⎢ flashes, then ⎣C⎦ flashes. When ⎣C⎦ flashes, the drive is waiting for a cartridge.
5. Within 60 seconds, insert a scratch data cartridge that is not write-protected.

   Note: If you wait longer than 60 seconds to load a cartridge, the drive automatically exits maintenance mode. If you insert a write-protected cartridge, the tape drive displays a ⎡P⎤ and retains the cartridge until it is manually ejected. When the cartridge is ejected and removed, the tape drive exits maintenance mode.

   After you insert the cartridge, ⎢ flashes and the test begins.

   - The diagnostic test takes approximately 5 minutes to run. The tape drive unloads and loads the cartridge during the test. Do not try to remove the cartridge when it unloads the first time. Wait for the test to complete.

   - If the diagnostic completes successfully, the cartridge ejects, the single-character display flashes a ⎡0⎤, then goes blank, and the drive exits maintenance mode. If the diagnostic fails, the fault LED flashes and an error code displays. When the cartridge is manually ejected and removed, the tape drive automatically exits maintenance mode.

   - To halt the diagnostic and terminate the test, press **Eject** twice anytime during the test. The drive acknowledges the request by slowing the flash rate of the ⎡F⎤ on the single-character display from twice per second to once per second. The tape drive rewinds and unloads the cartridge and then exits maintenance mode.

Function Code 2 - RESERVED (Service Function)

Function Code 3 - RESERVED (Service Function)

Table 8. Diagnostic and Maintenance Function Codes and Descriptions (continued)

Function Code 4 - Force a Dump of Vital Data to Tape Drive Memory

Causes the tape drive to complete a collection (or dump) of vital technical data and save it to drive memory. (A drive dump is also known as a save of the firmware trace.)

Notice: When an error code is displayed in maintenance mode, the tape drive also displays a dot to remind you that a dump exists. If you complete Function Code 4, it overwrites the dump and causes the error information to be lost.

1. Ensure that there is no cartridge in the drive.
2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until ⌑4 appears in the single-character display. If you cycle past ⌑4, continue to press **Eject** until it reappears.
4. To select the function, press and hold **Eject** for 3 seconds. After you select the function, ⌑4 displays, followed by ⌑0. The single-character display then goes blank, and the tape drive exits maintenance mode.

You can also complete this operation when the tape drive is in normal operating mode. Press and hold **Eject** for 10 seconds.

Function Code 5 - RESERVED (Service Function)

Function Code 6 - RESERVED (Service Function)

Function Code 7 - RESERVED (Service Function)

Function Code 8 - RESERVED (Service Function)

Function Code 9 - Display Error Code Log

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 (10th) is presented last.)

To view the drive error log:

1. Ensure that there no cartridge is in the drive.
2. Within a 2-second interval, press **Eject** 3 times. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until ⌑9 appears in the single-character display.
4. Press and hold **Eject** for 3 seconds to view the most recent error code.
5. Refer to "Descriptions and corrective actions" on page 38 to determine the meaning of the code and the action to take.
6. Press **Eject** to view the next error code. (The codes are ordered - the most recent is presented first and the oldest (10th) is presented last.)
7. Continue to press **Eject** until ⌑0 appears, indicating that no more error codes exist. If no errors were encountered or the log was cleared, a ⌑0 appears immediately and the drive exits maintenance mode. A maximum of 10 error codes are stored.

To redisplay the error codes, repeat steps 1 - 7.

Table 8. Diagnostic and Maintenance Function Codes and Descriptions (continued)

Function Code A - Clear Error Code Log

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

1. Ensure that there is no cartridge in the drive.

2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.

3. Press **Eject** once per second until $\boxed{A}$ appears in the single-character display. If you cycle past $\boxed{A}$, continue to press **Eject** until it reappears.

4. To select the function, press and hold **Eject** for 3 seconds. After you select the function, the tape drive erases all errors from the error code log, displays $\boxed{0}$, then exits maintenance mode.

Function Code C - Insert Cartridge Into Tape Drive

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

Table 8. Diagnostic and Maintenance Function Codes and Descriptions (continued)

Function Code E - Test Cartridge & Media

Causes the tape drive to complete a Write/Read test (on the edge bands) to ensure that a suspect cartridge and its magnetic tape are acceptable. The tape drive takes approximately 15 minutes to run one loop of the test. The test loops 10 times before it completes.

- If no error is detected, the test begins again and runs for a maximum of 10 times. After the 10th loop, the test stops and the drive automatically exits maintenance mode.

- If an error is detected, the tape drive displays ⬚6 or ⬚7 in the single-character display. Once the cartridge is manually ejected and removed, the tape drive exits maintenance mode.

- To halt the diagnostic at the end of the current 15-minute test loop, press **Eject** once. The drive acknowledges the request by slowing the length of time that the currently displayed character flashes on the single-character display (from twice per second to once per second). The diagnostic continues to the end of its loop and then stops. The tape drive then rewinds, unloads the cartridge, and exits maintenance mode.

- To halt the diagnostic immediately and stop the test that is running, press **Eject** twice. The tape drive rewinds, unloads the cartridge, and exits maintenance mode.

⚠️ **Attention:** Data on the suspect tape is overwritten.

Note: If you inserted an invalid tape cartridge (see "Data cartridges" on page 21), error code ⬚J or ⬚7 displays in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (see "Loading, unloading, and write-protecting cartridges" on page 23), error code ⬚P displays in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

1. Ensure that there is no cartridge in the drive.
2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until ⬚E appears in the single-character display. If you cycle past ⬚E, continue to press **Eject** until it reappears.
4. To select the function, press and hold **Eject** for 3 seconds. After you select the function, ⬚C flashes. When ⬚C flashes, the drive is waiting for a cartridge. Within 60 seconds, insert the suspect data cartridge (or the tape drive exits maintenance mode). 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 10th loop, the test stops and the drive automatically exits maintenance mode. To halt the test, press **Eject**. The tape drive then rewinds and unloads the cartridge, displays ⬚0, and exits maintenance mode.

   - If an error is detected, the tape drive displays ⬚6 or ⬚7. Once the cartridge is manually ejected and removed, the tape drive exits maintenance mode.

Table 8. Diagnostic and Maintenance Function Codes and Descriptions (continued)

Function Code F - Write Performance Test

Causes the tape drive to complete tests to ensure that the drive can read from and write to tape. This diagnostic completes fewer tests than the Run Tape Drive Diagnostics test (Function Code 1). The tape drive takes approximately 3 minutes to run the test. The Fast Read/Write Test is not a comprehensive a test and is not recommended for isolating errors between the drive and the media.

⚠️ **Attention:** Data on the suspect tape is overwritten.

Note: If you inserted an invalid tape cartridge (see "Data cartridges" on page 21), error code $\boxed{J}$ or $\boxed{7}$ displays in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (see Table 5 on page 21), error code $\boxed{P}$ displays in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

1. Ensure that there is no cartridge in the drive.
2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until $\boxed{F}$ appears in the single-character display. If you cycle past $\boxed{F}$, continue to press **Eject** until it reappears.
4. To select the function, press and hold **Eject** for 3 seconds. After you select the function, $\boxed{C}$ flashes. When $\boxed{C}$ flashes, the drive is waiting for a cartridge. Within 60 seconds, insert the suspect data cartridge (or the tape drive exits maintenance mode). After you insert the cartridge, $\boxed{F}$ flashes and the test begins.

   - If no error is detected, the test begins again and runs for a maximum of 10 times. Each loop takes approximately 3 minutes to run. After the 10th loop, the test stops and the drive automatically exits maintenance mode.
   - If an error is detected, the tape drive displays an error code. Once the cartridge is manually ejected and removed, the tape drive exits maintenance mode.
   - To halt the diagnostic at the end of the current 3-minute test loop, press **Eject** once. The drive acknowledges the request by slowing the length of time that the currently displayed character flashes on the single-character display (from twice per second to once per second.) The diagnostic continues to the end of its loop and then stops. The tape drive then rewinds, unloads the cartridge, and exits maintenance mode.
   - To halt the diagnostic immediately and stop the test that is running, press **Eject** twice. The tape drive rewinds, unloads the cartridge, and exits maintenance mode.

Table 8. Diagnostic and Maintenance Function Codes and Descriptions (continued)

Function Code H - Test Head

Causes the tape drive to complete the Head Resistance Measurements test and a Write/Read test (on the center of the tape). The drive runs these tests to ensure that the tape drive's head and tape-carriage mechanics are working correctly. The tape drive takes approximately 10 minutes to run the test.

Note: If you inserted an invalid tape cartridge (see "Data cartridges" on page 21), error code ⊔ or ⁊ displays in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (see Table 5 on page 21), error code ⎅ displays in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

1. Ensure that there is no cartridge in the drive.
2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until ⊞ appears in the single-character display. If you cycle past ⊞, continue to press **Eject** until it reappears.
4. To select the function, press and hold **Eject** for 3 seconds. After you select the function, ⊏ flashes. When ⊏ flashes, the drive is waiting for a cartridge. Within 60 seconds, insert a scratch data cartridge (or the tape drive exits maintenance mode). After you insert the cartridge, ⊞ flashes and the test begins.

   - If no error is detected, the test begins again and runs for a maximum of 10 times. Each loop takes approximately 10 minutes to run. After the 10th loop, the test stops and the drive automatically exits maintenance mode.
   - If an error is detected, the tape drive displays ⎓, unloads the tape cartridge, and exits maintenance mode.
   - To halt the diagnostic at the end of the current 10-minute test loop, press **Eject** once. The drive acknowledges the request by slowing the length of time that the currently displayed character flashes on the single-character display (from twice per second to once per second). The diagnostic continues to the end of its loop and then stops. The tape drive then rewinds, unloads the cartridge, and exits maintenance mode.
   - To halt the diagnostic immediately and stop the test that is running, press **Eject** twice. The tape drive then rewinds, unloads the cartridge, and exits maintenance mode.

Table 8. Diagnostic and Maintenance Function Codes and Descriptions (continued)

Function Code J - Fast Read/Write Test

Approximate Run Time = 5 minutes

Total Number of Loops = 10

Function Code ⎿⎦ completes tests to ensure that the drive can read from and write to tape.

The diagnostic loops 10 times. Press **Eject** to stop the diagnostic and exit maintenance mode. Pressing **Eject** once aborts the test at the end of the current test loop. Pressing **Eject** twice aborts the test immediately.

⚠️ **Attention:** For this test, insert only a scratch (blank) data cartridge or a cartridge that might be overwritten. During the test, the drive overwrites the data on the cartridge.

Note: If you inserted an invalid tape cartridge (see "Data cartridges" on page 21), error code ⎿⎦ or 7 displays in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (see Table 5 on page 21), error code P displays in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

1. Ensure that there is no cartridge in the drive.
2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until ⎿⎦ appears in the single-character display. If you cycle past ⎿⎦, continue to press **Eject** until it reappears.
4. Press and hold **Eject** for 3 or more seconds, then release it to select the function. The single-character display changes to a flashing C.
5. Within 60 seconds, insert a scratch data cartridge that is not write-protected.

   Note: If you wait longer than 60 seconds to load a cartridge, the drive automatically exits maintenance mode. If you insert a write-protected cartridge, the tape drive displays a P and retain the cartridge until it is manually ejected. Once the cartridge is ejected and removed, the tape drive exits maintenance mode.

After you insert the cartridge, the single-character display changes to a flashing ⎿⎦, and the tape drive runs the tests.

Note: If you inserted an invalid cartridge, error code 7 appears in the single-character display. The tape drive retains the cartridge until it is manually ejected. Once ejected, the tape drive exits maintenance mode.

- If no error is detected, the test loops and begins again. To stop the loop, press **Eject** for 1 second and release. When the loop ends, the drive rewinds, unloads the tape, and exits maintenance mode.
- If an error is detected, the fault LED flashes amber, then the tape drive posts an error code to the single-character display. To determine the error, locate the code in "Descriptions and corrective actions" on page 38. Once the cartridge is manually ejected and removed, the tape drive exits maintenance mode.

Table 8. Diagnostic and Maintenance Function Codes and Descriptions (continued)

Function Code L - Load/Unload Test

Approximate Run Time = 15 seconds per loop

Total Number of Loops = 10

Function Code $\boxed{L}$ tests the drive's ability to load and unload a tape cartridge.

The diagnostic loops 10 times. To stop the diagnostic and exit maintenance mode, press **Eject** once to abort the test.

⚠️ **Attention:** The diagnostic loops 10 times. To stop the diagnostic and exit maintenance mode, press **Eject** once to abort the test.

Note: If you inserted an invalid tape cartridge (see "Data cartridges" on page 21), error code $\boxed{U}$ or $\boxed{7}$ displays in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (see Table 5 on page 21), error code $\boxed{P}$ displays in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

1. Ensure that there is no cartridge in the drive.
2. Press **Eject** 3 times within an interval of 2 seconds. The fault LED becomes solid amber, which means that the drive is in maintenance mode.
3. Press **Eject** once per second until $\boxed{L}$ appears in the single-character display. If you cycle past $\boxed{L}$, continue to press **Eject** until it reappears.
4. Press and hold **Eject** for 3 or more seconds, then release it to select the function. The single-character display changes to a flashing $\boxed{C}$.
5. Within 60 seconds, insert a scratch data cartridge that is not write-protected.

   Note: If you wait longer than 60 seconds to load a cartridge, the drive automatically exits maintenance mode. If you insert a write-protected cartridge, the tape drive displays a $\boxed{P}$ and retain the cartridge until it is manually ejected. Once the cartridge is ejected and removed, the tape drive exits maintenance mode.

After you insert the cartridge, the single-character display changes to a flashing $\boxed{L}$. The tape drive runs the tests.

- If no error is detected, the test loops and begins again. To stop the loop, press **Eject** for 1 second and release. When the loop ends, $\boxed{0}$ temporarily appears in the single-character display. The drive rewinds the tape and unloads the cartridge. The drive then exits maintenance mode.

- If an error is detected the test stops, $\boxed{7}$ appears in the single-character display. To determine the error, locate $\boxed{7}$ in "Descriptions and corrective actions" on page 38. The drive unloads the tape cartridge and exits maintenance mode. To clear the error, turn the tape drive powers off, then on again.

Function Code P or U - RESERVED (Service Function)

General guidelines

If you encounter problems when running the Dell PowerVault tape drive, refer to Table 9 on page 37 for common problems. If the problem is not identified, refer to "Methods of receiving errors and messages " on page 37. The color and condition of the LEDs might also indicate a problem.

Table 9. General troubleshooting

If the problem is this...	Do this...
A code displays on the single-character display and the fault LED flashes amber.	The tape drive detected an error or is directing you to an informational message. See "Methods of receiving errors and messages " on page 37.
The ready/activity LED or single-character display never turns on.	The tape drive has no power. Check the power at the power source. Connect power to the tape drive. If the problem persists, contact Dell technical support.
The tape drive does not load a tape cartridge.	One of the following actions occurred: • A tape cartridge is already loaded. To remove the cartridge, press **Eject**. If the cartridge does not eject, turn off the power to the tape drive, then turn it back on. After the ready/activity LED becomes solid green, press **Eject** to eject the cartridge. • The cartridge tray might not be in the correct position. Press **Eject** to return the tray to the correct position. • The tape cartridge was loaded incorrectly. To properly load a cartridge, see the Loading section in "Loading, unloading, and write-protecting cartridges" on page 23. • The tape cartridge might be defective. Load another tape cartridge. If the problem exists for multiple cartridges, the tape drive is defective. Contact Dell technical support. • The tape drive has no power. Connect power to the tape drive.
The tape drive does not unload the tape cartridge.	The tape cartridge is stuck or is broken. Press **Eject**. If the cartridge does not eject, turn off the power to the tape drive, and then turn it back on. (Note that the mid-tape recovery could take up to 10 minutes to complete.) If the cartridge still does not eject, manually remove it (see "Recovering a tape cartridge" on page 50).
The system received TapeAlert flags.	See Table 12 on page 46.
The system reported system problems (such as selection or command time-outs, or parity errors).	See "Fixing SAS connectivity problems" on page 45.
Codes display on the single-character display, but the ready/activity LED does not turn on.	The tape drive is defective. Contact Dell technical support.
The tape drive does not respond to system commands.	Press and hold **Eject** on the drive for 10 seconds to force a drive dump. The drive saves the dump and then reboots to allow communication to the drive to occur. Do not cycle power, as this action erases the contents of the dump.

Methods of receiving errors and messages

Use Table 10 on page 38 as a guide for identifying error codes and message codes reported by the tape drive, its computer (if applicable), or the system.

Note: The codes on the single-character display have different meanings, depending on whether they display during normal operations or while the drive is in Maintenance mode. Codes that occur during normal operations are defined in "Descriptions and corrective actions" on page 38. Codes that occur while in maintenance mode are defined in "Selecting a Diagnostic or Maintenance function" on page 28

Table 10. Methods of receiving errors and messages

If the error or message was presented by...	Do this...
The system's display (if the tape drive is enclosed in a library or autoloader)	Refer to the documentation for the system.
The tape drive's single-character display and the fault LED flashes amber	See "Descriptions and corrective actions" on page 38. To determine the meaning of the LED, see the "Front panel" on page 7 section in the Introduction.
The tape drive's single-character display and the fault LED is solid amber	See "Selecting a Diagnostic or Maintenance function" on page 28. To determine the meaning of the fault LED activity, see the "Front panel" on page 7 section in the Introduction.
SCSI log sense data (such as TapeAlert flags) or SCSI drive sense data	See Table 12 on page 46 or "Descriptions and corrective actions" on page 38.
The tape drive's error log	See "Descriptions and corrective actions" on page 38.

Descriptions and corrective actions

Table 11 on page 38 gives descriptions of the errors and messages that pertain to the tape drive, and tells what to do when you receive them.

Notice: If the tape drive detects a permanent error and displays an error code other than $\boxed{0}$, it automatically completes a dump of vital data to drive memory. If you force a dump, the existing dump is overwritten and data is lost. After you force a dump, do not turn off the power to the tape drive or you might lose the dump data.

Table 11. Descriptions and corrective actions

The single-character display clears if you power-off the drive.	

Code	Cause and Action
$\boxed{0}$	No error occurred and no action is required. This code displays: • When power is cycled (turned off, then on) to the tape drive. • When diagnostics have finished running and no error occurred. **Note:** The single-character display is blank during normal operation of the tape drive.

Table 11. Descriptions and corrective actions (continued)	
1	Cooling problem. The tape drive detected that the recommended operating temperature was exceeded. Complete the following action: 1. If a fan is present in the system, ensure that it is rotating and is quiet. If not, replace the fan. (For instructions about replacing the fan, see your system's documentation.) 2. Remove any blockage that prevents air from flowing freely through the tape drive. 3. Ensure that the operating temperature and airflow is within the specified range (seeChapter 2, "Setting up the tape drive," on page 12). 4. If the proper voltages are being applied but the problem persists, contact Dell technical support. The error code clears when you power-off the tape drive or place it in Maintenance mode.
2	Power problem. The tape drive detected that the externally supplied power is either approaching the specified voltage limits (the drive is still operating) or is outside the specified voltage limits (the drive is not operating). Complete the following action. 1. Ensure that the power connector is properly seated. 2. Ensure that the proper DC voltages are being applied within the tolerances allowed (see Chapter 2, "Setting up the tape drive," on page 12). 3. If the proper voltages are being applied but the problem persists, contact Dell technical support. The error code clears when you power-off the tape drive or place it in Maintenance mode.
3	Firmware problem. The tape drive determined that a firmware error occurred. Complete the following action: 1. 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. 2. If the problem persists, download the latest firmware and retry the operation.
4	Firmware or tape drive problem. The tape drive determined that a firmware or tape drive hardware failure occurred. Complete the following action. 1. 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. 2. If the problem persists, download the current firmware and retry the operation; if new firmware is not available, contact Dell technical support.
5	Tape drive hardware problem. The drive determined that a tape path or read/write error occurred. To prevent damage to the drive or tape, the drive does not allow you to insert a cartridge if the current cartridge was successfully ejected. The error code might clear when you cycle power to the tape drive or place it in Maintenance mode. If the problem persists, contact Dell technical support.

Table 11. Descriptions and corrective actions (continued)	

⬚6	Tape drive or media error. The drive determined that an error occurred, but it cannot isolate the error to faulty hardware or to the tape cartridge. Complete the appropriate action, as described.
	
	• Check the cartridge type and the operation you are trying (Read or Write) to make sure it is supported on the tape drive you are using. See "Data cartridges" on page 21.
	• Try the operation again with another cartridge. 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.
	  – 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 in "Selecting a Diagnostic or Maintenance function" on page 28).
	    - If the diagnostics fail, contact Dell technical support.
	    - If the diagnostics succeed, the error was temporary.
	• If the operation fails and another drive is not available, insert a scratch cartridge into the drive and run the tape drive diagnostics (see Function Code ⬚1 in "Selecting a Diagnostic or Maintenance function" on page 28).
	  – If the diagnostics fail, contact Dell technical support.
	  – If the diagnostics succeed, discard the cartridge.

6, *continued*	**For Problems with Writing Data** If the problem occurred while the drive was writing data to the tape, and if you know the volume serial number (located on the cartridge label) of the tape cartridge loaded in the drive when the problem occurred, retry the operation with a different cartridge:

	If the problem occurs with multiple tape cartridges or if you do not know the tape cartridge's volume serial number, run the tape drive diagnostics (see Function Code I in "Selecting a Diagnostic or Maintenance function" on page 28):
	
	• If the diagnostics fail, contact Dell technical support.
	• If the diagnostics succeed, run the Test Head diagnostic (see Function Code H in "Selecting a Diagnostic or Maintenance function" on page 28).
	  – If the Test Head diagnostic fails, contact Dell technical support.
	  – If the Test Head diagnostic succeeds, replace the cartridges that caused the problem.
	
	The error code clears when you remove the tape cartridge or place the drive in Maintenance mode.

	If the problem occurred while the drive was reading data from the tape, and if you know the volume serial number of the tape cartridge, perform one of the following procedures:
	
	• If another drive is available, insert the cartridge into the other drive and retry the operation:
	  – 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 I in "Selecting a Diagnostic or Maintenance function" on page 28):
	    - If the diagnostics fail, contact Dell technical support.
	    - If the diagnostics succeed, the error was temporary.
	• If another drive is not available, insert a scratch cartridge into the drive and run the tape drive diagnostics (see Function Code I in "Selecting a Diagnostic or Maintenance function" on page 28)
	  – If the diagnostics fail, contact Dell technical support.
	  – If the diagnostics succeed, discard the cartridge
	
	For Problems with Reading Data
	
	If the problem occurs with multiple tape cartridges or if you do not know the tape cartridge's volume serial number, run the tape drive diagnostics (see Function Code I in "Selecting a Diagnostic or Maintenance function" on page 28):
	
	• If the diagnostics fail, contact Dell technical support.
	
	• If the diagnostics succeed, run the Test Head diagnostic (see Function Code H in "Selecting a Diagnostic or Maintenance function" on page 28).
	  – If the Test Head diagnostic fails, contact Dell technical support.
	  – If the Test Head diagnostic succeeds, replace the cartridges that caused the problem.
	
	The error code clears when you remove the tape cartridge or place the drive in Maintenance mode.

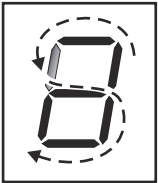|	
7	A high probability of media error. The tape drive determined that an error occurred because of a faulty tape cartridge. Try another tape cartridge. If the problem occurs with multiple tape cartridges, see "Resolving media-related problems" on page 45. This error also appears if you are loading an expired cleaner cartridge. The error code clears when you remove the tape cartridge or place the drive in Maintenance mode.
8	Tape drive or interface failure. The tape drive determined that a failure occurred in the tape drive's hardware or in the bus. See "Fixing SAS connectivity problems" on page 45. The error code clears 10 seconds after the drive detected the error or when you place the drive in Maintenance mode.
9	Library to drive interface (RS-422) error. This interface is not used in the PowerVault tape drive.
A	Tape drive hardware problem. The tape drive determined that a problem occurred that degraded the operation of the tape drive, but it did not restrict continued use. If the problem persists, contact Dell technical support. The drive is usable, though the single-character display continues to indicate an error and the fault LED flashes amber. The error code might clear when you cycle power to the tape drive or place it in Maintenance mode.
b	No error or message is assigned.
C	The tape drive needs to be cleaned. Clean the tape drive. See "Cleaning the tape mechanism" on page 27. The error code clears when you clean the tape drive or place it in Maintenance mode.
d	No error or message is assigned.
E	Not applicable for a SAS drive.
F	Not applicable for a SAS drive.
J	Incompatible media. The tape drive detected that an unsupported cartridge was loaded. Verify that the generation of the loaded cartridge is supported on the tape drive. See "Data cartridges" on page 21.
P	Write operation to a write-protected cartridge was attempted (includes any attempt to overwrite a WORM protected tape). Ensure that the tape cartridge is the correct media type. See "Data cartridges" on page 21 to determine which cartridges can be written by your tape drive. If the tape cartridge is the correct media type, check the write-protect switch on the cartridge. The drive does not write to a write-protected cartridge. The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.
P (encircled/boxed)	Encryption Error. The drive detected a configuration or setup error before an encryption operation.
=	**Eject** is depressed. Verify that the button pushes freely.

Table 11. Descriptions and corrective actions (continued)

Table 11. Descriptions and corrective actions (continued)	
	Mid-Tape Recovery. The SCD flashes one segment at a time to complete one figure-eight motion, then flashes the number 9, then flashes one segment at a time to complete one figure-eight motion, then flashes the number 8. This action continues until the number 1 flashes and the drive completes. You can eject the cartridge once the count down ends by pressing **Eject**.

Drive Status

1. Connect an Ethernet cable to the drive or bridge box.

   Important: The Ethernet port is for Service only. Do not connect the customer network to Service ports.

2. Using a web browser, connect to http://169.254.0.3. The drive status page is displayed.

☐ Drive Information	
☐ Host Interface	
☐ Ethernet Settings	☐ VPD Encryption Settings
☐ Drive Statistics	☐ Tape Statistics
☐ Error Code Log	

Figure 21. Drive Status page

3. Check the appropriate boxes to get information on that topic.

☑ Drive Information			
Serial Number	YR1013000128	Single Character Display	
Model	ULT3580-HH6	Status Indicators	
Code Level	LTO6_C68N	Current Time (origin)	259 seconds (Power On)
Status	idle		

☑ Host Interface		Port 0	Port 1
Status		unknown	unknown
WWID		50050763124B6B89	50050763128B6B89
SAS Address			
Speed		unknown	unknown
Transport Layer Retries this Power-On		0	0

☑ Ethernet Settings		☑ VPD Encryption Settings	
	Port 0	Encryption Method	None
IP Addresses (Current)	169.254.0.3/24 fe80::221:5efffed5:e49d/64	Key Management	Default (by Method)
		BOP Encryption	Disabled
MAC Address (VPD)	00:21:5E:D5:E4:9D		
Drive IP Address 1 (VPD)	not set		
Drive IP Address 2 (VPD)	not set		
DHCP (VPD)	disabled		

☑ Drive Statistics		☑ Tape Statistics	
Drive Mounts	45	Volume Serial	
Drive MB Written	280830	Tape Mounts	94
Drive MB Read	948131	Tape MB Written	1894168
Power On Hours (current / VPD)	36 / 35	Tape MB Read	1434841

☐ Error Code Log

a67ru054

Figure 22. Drive Status page - details

Note: The page format can be changed to text-only mode by checking the box at the top of the page.

4. Use the web browser refresh button to update the page with the current drive status.

Drive Maintenance

1. Connect an Ethernet cable to the drive or bridge box.

   Important: The Ethernet port is for Service only. Do not connect the customer network to Service ports.

2. Using a web browser, connect to http://169.254.0.3/service.html. The drive maintenance page is displayed.

Select function:

○ 1: Run Drive Diagnostics
○ 2: Update Drive Firmware from FMR Tape
○ 3: Create FMR Tape
○ 4: Force a Drive Dump
○ 5.1: Copy Drive Dump - copy dump to tape
○ 5.2: Copy Drive Dump - copy dump to flash
○ 5.3: Copy Drive Dump - erase flash memory
○ 6.1: Run Host Interface Wrap Test - primary port
○ 6.2: Run Host Interface Wrap Test - secondary port
○ 6.3: Run Host Interface Wrap Test - both ports
○ 8: Unmake FMR Tape
○ 9: Display Error Code Log
○ A: Clear Error Code Log
○ E: Test Cartridge & Media
○ F: Write Performance Test
○ H: Test Head
○ J: Fast Read/Write Test
○ L: Load/Unload Test

[Run] [Cancel now] [Cancel at end of loop]

Drive response (press refresh to display current drive status):

[Refresh]

Select a test and press run.

Figure 23. Drive Maintenance page

3. Check the appropriate radio button, then press **Run** to run that maintenance function. If the drive is in a library, many of the maintenance functions are disabled. To cancel the maintenance function, press **Cancel**. These functions are the same as those that are executed by using **Unload** on the drive's front panel.

   Note: For more information on Maintenance Function details, see "Selecting a Diagnostic or Maintenance function" on page 28.

Fixing SAS connectivity problems

If there appears to be a problem connecting or communicating with the drive, follow this procedure.

1. Ensure that the power is on to the tape drive.
2. Replace the SAS cable and interposers, if any, and retry the failing operation.
3. If these measures do not correct the problem, contact Dell technical support.

Resolving media-related problems

To resolve problems that are related to media, the tape drive's firmware include

- **Test Cartridge & Media** diagnostic that verifies whether a suspect cartridge and its magnetic tape are acceptable for use.
- **Statistical Analysis and Reporting System** (SARS) to help isolate 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 drive performance history that is kept in the drive's Vital Product Data (VPD) area in Non Volatile Random Access Memory (NVRAM). Any failures that SARS detects are reported as TapeAlert flags on the system. See Table 12 on page 46.

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

Notice: When you run the **Test Cartridge & Media** diagnostic, data on the suspect tape is overwritten. If valuable data is on the tape, be sure to copy the data before this test is run.

1. If possible, run the tape cartridge in a different tape drive. If the operation in the other tape drive fails and ⑥ or ⑦ displays, replace the media. If the operation succeeds, run the Test Cartridge & Media diagnostic (see Function Code E in "Selecting a Diagnostic or Maintenance function" on page 28).
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 the "Cleaning the tape mechanism" on page 27 section and Function Code 1 in "Selecting a Diagnostic or Maintenance function" on page 28).
3. If the tape drive diagnostics fail, contact Dell technical support. If the tape drive diagnostics run successfully, complete the operation that produced the initial media error.

Removing an internal SAS tape drive

To remove an internal SAS tape drive from the system, complete these steps.

1. Ensure that the tape drive does not contain a tape cartridge.
2. Unconfigure the drive from the system. (For instructions, see your system's documentation.)
3. Turn off the power to the system. Disconnect the power cable from the system and the electrical outlet.
4. Remove the system cover.
5. Disconnect the internal SAS cable from the tape drive (see **1** in "Rear panel" on page 10).
6. Remove the tape drive from the system and remove any mounting screws or rails from the side or bottom of the tape drive.
7. To reassemble, reverse these steps.

TapeAlert

TapeAlert is a patented technology and standard of the American National Standards Institute (ANSI) that defines conditions and problems that are experienced by tape drives. The technology enables a system to read TapeAlert flags from a tape drive through the SCSI interface. The system reads the flags from Log Sense Page 0x2E.

TapeAlert Flags

Table 12 on page 46 lists the TapeAlert flags that are supported by the Dell PowerVault Tape Drive.

Table 12. TapeAlert Flags and Descriptions				
TapeAlert Flags Supported by the Tape Drive				
Flag Number	**Flag Parameter (in hex)**	**Flag**	**Description**	**Action Required**

Table 12. TapeAlert Flags and Descriptions (continued)				
TapeAlert Flags Supported by the Tape Drive				
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.)	See 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 tape cartridge.	Contact Dell technical support.
5	05h	Read failure	Set for any unrecoverable read error where isolation is uncertain and failure could be due to a faulty tape cartridge or to faulty drive hardware.	If Flag 4 is also set, the cartridge is defective. Contact Dell technical support. If Flag 4 is not set, see error code 6 in "Descriptions and corrective actions" on page 38.
6	06h	Write failure	Set for any unrecoverable write or positioning error where isolation is uncertain and failure could be due to a faulty tape cartridge or to faulty drive hardware.	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 the "Loading, unloading, and write-protecting cartridges" on page 23 section.) If Flag 4 is also set, the cartridge is defective. Replace the tape cartridge. If Flag 4 is not set, see error code 6 in "Descriptions and corrective actions" on page 38.
8	08h	Not data grade	Set when severe servo errors occur while loading a tape cartridge.	Replace the tape cartridge. If this error occurs with multiple tapes, see error code 6 in "Descriptions and corrective actions" on page 38.
9	09h	Write protect	Set when the tape drive detects that the tape 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 the "Loading, unloading, and write-protecting cartridges" on page 23 section).
10	0Ah	No removal	Set when the tape drive receives an UNLOAD command after the system prevented the tape cartridge from being removed.	Refer to the documentation for your system's operating system.

Table 12. TapeAlert Flags and Descriptions (continued)				
TapeAlert Flags Supported by the Tape Drive				
11	0Bh	Cleaning media	Set when you load a cleaning cartridge into the drive.	No action required.
12	0Ch	Unsupported format	Set when you load an unsupported cartridge type into the drive or when the cartridge format has been corrupted.	Use a supported tape cartridge.
15	0Fh	Cartridge memory chip failure	Set when a cartridge memory (CM) failure is detected on the loaded tape cartridge.	Replace the cartridge. If this error occurs on multiple tapes, see error code 6 in "Descriptions and corrective actions" on page 38.
16	10h	Forced eject	Set when you manually unload the tape cartridge while the drive was reading or writing.	No action required.
18	12h	Tape directory corrupted in the cartridge memory	Set when the drive detects that the tape directory in the cartridge memory has been corrupted.	Reread all data from the tape to rebuild the tape directory.
20	14h	Clean now	Set when the tape drive detects that it needs cleaning.	Clean the tape drive. See the "Cleaning the tape mechanism" on page 27 section.
21	15h	Clean periodic	Set when the drive detects that it needs routine cleaning.	Clean the tape drive as soon as possible. The drive can continue to operate, but you should clean the drive soon. See the "Cleaning the tape mechanism" on page 27 section.
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 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 that requires that you reset the tape drive to recover.	If resetting the drive does not recover the error, use the error code from the single-character display, library user interface, or SCSI drive sense data. See "Descriptions and corrective actions" on page 38.

Table 12. TapeAlert Flags and Descriptions (continued)				
TapeAlert Flags Supported by the Tape Drive				
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 "Descriptions and corrective actions" on page 38.
32	20h	Interface	Set when the tape drive detects a problem with the SCSI or LDI (RS-422) interface.	Locate error code 8 or 9 in "Descriptions and corrective actions" on page 38.
33	21h	Eject media	Set when a failure occurs that requires you to unload the cartridge from the drive.	Unload and reload the tape cartridge.
34	22h	Download fail	Set when a field microcode replacement (FMR) image is unsuccessfully downloaded to the tape drive via the SAS interface.	Ensure that it is the correct image. Download the FMR image again.
35	23h	Drive humidity	Sets when the drive humidity sensor indicates that the drive's humidity exceeds the recommended humidity of the drive.	See error code 1 in "Descriptions and corrective actions" on page 38.
36	24h	Drive temperature	Set when the drive's temperature sensor indicates that the drive's temperature is exceeding the recommended temperature of the system (see "General specifications" on page 51).	See error code 1 in "Descriptions and corrective actions" on page 38.
37	25h	Drive voltage	Set when the drive detects that the externally supplied voltages are either approaching the specified voltage limits or are outside the voltage limits (see "General specifications" on page 51).	See error code 2 in "Descriptions and corrective actions" on page 38.
39	27h	Diagnostics required	Set when the drive detects a failure that requires diagnostics to isolate the problem.	See error code 6 in "Descriptions and corrective actions" on page 38.
51	33h	Tape directory invalid at unload	Set when the tape directory on the tape cartridge that was previously unloaded is corrupted. The file-search performance is degraded.	Rebuild the tape directory by reading all the data.

Table 12. TapeAlert Flags and Descriptions (continued)

TapeAlert Flags Supported by the Tape Drive				
52	34h	Tape system area write failure	Set when the tape cartridge that was previously unloaded could not write its system area successfully.	Copy the data to another tape cartridge, then discard the old cartridge
53	35h	Tape system area read failure	Set when the tape system area could not be read successfully at load time.	Copy the data to another tape cartridge, then discard the old cartridge

Recovering a tape cartridge

If problem-determination procedures identify the tape drive as the source of the problem and you are unable to eject the tape cartridge by using **Eject**, complete the following steps to reset the drive to recover the cartridge:

1. Press and hold **Eject** for 10 seconds, then release.

   • The fault LED turns on and the drive starts through its hardware test process.

   • When the hardware test completes, the ready/activity LED turns on.
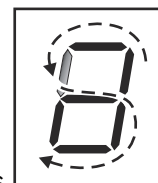
   • If a cartridge is in the drive, the ready/activity LED flashes green and the SCD flashes until the cartridge is rewound.
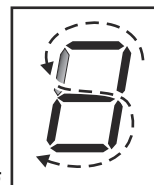
   • The ready/activity LED turns on solid and the SCD stops flashing when the rewind is complete and the tape drive is ready.

   Note: Allow at least 10 minutes for the rewind process to complete.

2. To eject the cartridge, push **Eject** one more time. If the tape cartridge still does not eject, contact trained service personnel for assistance.

   Notice: If you are not a trained service person, do not attempt to open the drive for repairs as this action voids your warranty.

Chapter 5. Specifications

General specifications

Table 13. General specifications

General	
Manufacturer	Dell
Model Number (Internal, External, RackMount)	Dell PowerVault tape drive LTO Ultrium 9-H LTO Ultrium 8-H LTO Ultrium 7-H LTO Ultrium 6-H LTO Ultrium 5-H LTO Ultrium 4-H LTO Ultrium 3-H CSEH 001, LTO4-EH1, LTO3-EH1 2U Storage Rack A
Interface Type	6 Gb SAS interface (12 Gb for LTO9)

Internal drive

Table 14. Internal drive specifications

Physical Specifications	
Width (without bezel)	146.0 mm (5.75 in)
Width (with bezel)	148.0 mm (5.83 in)
Length (without bezel)	205.0 mm (8.09 in)
Length (with bezel)	210.0 mm (8.29 in)
Height (without bezel)	41.0 mm (1.63 in) without bezel
Height (with bezel)	42.7 mm (1.69 in) with bezel
Weight (without a cartridge)	1.61 kg (3 lb 9 oz)
Performance	
Interfaces	6 Gb SAS (12 Gb for LTO9)
Recording format	LTO Ultrium Generation

Table 14. Internal drive specifications (continued)	
Physical Specifications	
Media	LTO Ultrium
Capacity	LTO9-18 TB (Native) 45 TB (compressed, assuming 2.5:1 compression)
	LTO8-12 TB (Native) 30 TB (compressed, assuming 2.5:1 compression)
	LTO M8-9 TB (Native) 22.5 TB (compressed, assuming 2.5:1 compression)
	LTO7-6 TB (Native) 15 TB (compressed, assuming 2.5:1 compression)
	LTO6-2.5 TB (Native) 6.25 TB (compressed, assuming 2.5:1 compression)
	LTO5-1.5 TB (Native) 3 TB (compressed, assuming 2:1 compression)
	LTO4-800 Gb (Native) 1.6 TB (compressed, assuming 2:1 compression)
	LTO3-400 Gb (Native) 800 Gb (compressed, assuming 2:1 compression)
Data transfer rate (maximum)	LTO9-300 Mb/sec Native
	LTO8-300 Mb/sec Native
	LTO M8-300 Mb/sec Native
	LTO7-300 Mb/sec Native
	LTO6-160 Mb/sec Native
	LTO5-140 Mb/sec Native
	LTO4-120 Mb/sec Native
	LTO3-80 Mb/sec Native

Table 15. Equipment environment specification								
Equipment environment specification								
Product power off[1]								
Dry-bulb temperature			**Relative humidity**			**Maximum wet-bulb temperature**		
5 to 45°C (40 to 113°F)			8% to 80% RH			26°C (79°F)		
Product operation (equipment is powered on)								
Dry-bulb temperature			**Humidity range, non-condensing**			**Maximum dew point temperature[4]**	**Maximum wet-bulb temperature[5]**	**Maximum elevation**
Allowable[2]	**Recommended[3]**	**Maximum rate of change**	**Allowable**	**Recommended**	**Maximum rate of change**	22°C (72°F) for LTO 9	26°C (79°F)	3050 m (10,000 feet)
15 to 35°C (59 to 95°F)	15 to 25°C (59 to 77°F)	5°C/hour (9°F/hour)	20% to 80% RH	20% to 50% RH	5% RH/hour with no condensation			

Note:

1. Product equipment is removed from the original shipping container and installed but not in use - for example, during repair, maintenance, or upgrade.
2. Derate maximum dry-bulb temperature 1°C/300 m above 900 m (1.8°F/1,000 feet above 3,000 feet).
3. Derate maximum recommended dry-bulb temperature 1°C/300 m above 1,800 m (1.8°F/1,000 feet above 6,000 feet).
4. Applies to LTO 9 drives
5. Applies to LTO drive generations 1 through 8.

External drive

Table 16. External drive specifications	
Physical Specifications	
Width	22.2 cm (8.74 in)
Length	32.7 cm (12.87 in)
Height	6.5 cm (2.56 in)
Weight	4.4 kg (9.7 lb)
Power Requirements	
AC line voltage	100 - 240 VAC
Line frequency	50 - 60 Hz, auto-ranging
Line current at 100 VAC	0.48 A
Line current at 240 VAC	0.20 A

External drive specifications, continued	
Performance	
Interface	6 Gb SAS (12 Gb for LTO9)
Recording format	LTO Ultrium Generation
Media	LTO Ultrium
Capacity	LTO9-18 TB (Native) 45 TB (compressed, assuming 2.5:1 compression)
	LTO8-12 TB (Native) 30 TB (compressed, assuming 2.5:1 compression)
	LTO M8-9 TB (Native) 22.5 TB (compressed, assuming 2.5:1 compression)
	LTO7-6 TB (Native) 15 TB (compressed, assuming 2.5:1 compression)
	LTO6-2.5 TB (Native) 6.25 TB (compressed, assuming 2.5:1 compression)
	LTO5-1.5 TB (Native) 3 TB (compressed, assuming 2:1 compression)
	LTO4-800 Gb (Native) 1.6 TB (compressed, assuming 2:1 compression)
	LTO3-400 Gb (Native) 800 Gb (compressed, assuming 2:1 compression)
Data transfer rate (maximum)	LTO9-300 Mb/sec Native
	LTO8-300 Mb/sec Native
	LTO M8-300 Mb/sec Native
	LTO7-300 Mb/sec Native
	LTO6-160 Mb/sec Native
	LTO5-140 Mb/sec Native
	LTO4-120 Mb/sec Native
	LTO3-80 Mb/sec Native

Table 17. Equipment environment specification								
Equipment environment specification								
Product power off[1]								
Dry-bulb temperature			**Relative humidity**			**Maximum wet-bulb temperature**		
5 to 45°C (40 to 113°F)			8% to 80% RH			26°C (79°F)		
Product operation (equipment is powered on)								
Dry-bulb temperature			**Humidity range, non-condensing**			**Maximum dew point temperature[4]**	**Maximum wet-bulb temperature[5]**	**Maximum elevation**
Allowable[2]	**Recommended[3]**	**Maximum rate of change**	**Allowable**	**Recommended**	**Maximum rate of change**	22°C (72°F) for LTO 9	26°C (79°F)	3050 m (10,000 feet)
15 to 35°C (59 to 95°F)	15 to 25°C (59 to 77°F)	5°C/hour (9°F/hour)	20% to 80% RH	20% to 50% RH	5% RH/hour with no condensation			

Note:

1. Product equipment is removed from the original shipping container and installed but not in use - for example, during repair, maintenance, or upgrade.
2. Derate maximum dry-bulb temperature 1°C/300 m above 900 m (1.8°F/1,000 feet above 3,000 feet).
3. Derate maximum recommended dry-bulb temperature 1°C/300 m above 1,800 m (1.8°F/1,000 feet above 6,000 feet).
4. Applies to LTO 9 drives
5. Applies to LTO drive generations 1 through 8.

Rack mount drive

Table 18. Rack mount drive specifications	
Physical Specifications	
Width	48.3 cm (19.0 in)
Length	44.0 cm (17.32 in)
Height	9.0 cm (3.54 in)
Weight	10.23 kg (22.55 lb) Chassis empty
Power Requirements	
AC line voltage	100 - 240 VAC
Line frequency	50 - 60 Hz, auto-ranging
Line current at 100 VAC	1.9 A
Line current at 240 VAC	0.8 A

Table 18. Rack mount drive specifications (continued)	
Physical Specifications	
Performance	
Interface	6 Gb SAS interface (12 Gb for LTO9)
Recording format	LTO Ultrium Generation
Media	LTO Ultrium
Capacity	LTO9-18 TB (Native) 45 TB (compressed, assuming 2.5:1 compression)
	LTO8-12 TB (Native) 30 TB (compressed, assuming 2.5:1 compression)
	LTO M8-9 TB (Native) 22.5 TB (compressed, assuming 2.5:1 compression)
	LTO7-6 TB (Native) 15 TB (compressed, assuming 2.5:1 compression)
	LTO6-2.5 TB (Native) 6.25 TB (compressed, assuming 2.5:1 compression)
	LTO5-1.5 TB (Native) 3 TB (compressed, assuming 2:1 compression)
	LTO4-800 Gb (Native) 1.6 TB (compressed, assuming 2:1 compression)
	LTO3-400 Gb (Native) 800 Gb (compressed, assuming 2:1 compression)
Data transfer rate (maximum)	LTO9-300 Mb/sec Native
	LTO8-300 Mb/sec Native
	LTO M8-300 Mb/sec Native
	LTO7-300 Mb/sec Native
	LTO6-160 Mb/sec Native
	LTO5-140 Mb/sec Native
	LTO4-120 Mb/sec Native
	LTO3-80 Mb/sec Native

Table 19. Equipment environment specification

Equipment environment specification								
Product power off[1]								
Dry-bulb temperature			**Relative humidity**			**Maximum wet-bulb temperature**		
5 to 45°C (40 to 113°F)			8% to 80% RH			26°C (79°F)		
Product operation (equipment is powered on)								
Dry-bulb temperature			**Humidity range, non-condensing**			**Maximum dew point temperature[4]**	**Maximum wet-bulb temperature[5]**	**Maximum elevation**
Allowable[2]	**Recommended[3]**	**Maximum rate of change**	**Allowable**	**Recommended**	**Maximum rate of change**	22°C (72°F) for LTO 9	26°C (79°F)	3050 m (10,000 feet)
15 to 35°C (59 to 95°F)	15 to 25°C (59 to 77°F)	5°C/ hour (9°F/ hour)	20% to 80% RH	20% to 50% RH	5% RH/ hour with no condensation			

Note:

1. Product equipment is removed from the original shipping container and installed but not in use - for example, during repair, maintenance, or upgrade.

2. Derate maximum dry-bulb temperature 1°C/300 m above 900 m (1.8°F/1,000 feet above 3,000 feet).

3. Derate maximum recommended dry-bulb temperature 1°C/300 m above 1,800 m (1.8°F/1,000 feet above 6,000 feet).

4. Applies to LTO 9 drives

5. Applies to LTO drive generations 1 through 8.

Chapter 6. Contacting Dell

Dell provides several online and telephone-based support and service options. If you do not have an active internet connection, you can find contact information about your purchase invoice, packing slip, bill, or Dell product catalog. Availability varies by country and product, and some services might not be available in your area. To contact Dell for sales, technical assistance, or customer service issues:

1. Go to Dell.com/support.
2. Select your country from the drop-down menu on the lower right corner of the page.
3. For customized support:

    a. Enter your system Service Tag in the **Enter your Service Tag** field.

    b. Click **Submit**. The support page that lists the various support categories is displayed.

4. For general support:

    a. Select your product category.

    b. Select your product segment.

    c. Select your product. The support page that lists the various support categories is displayed.

5. For contact details of Dell Global Technical Support:

    a. Click Global Technical Support.

    b. The Contact Technical Support page is displayed with details to call, chat, or email the Dell Global Technical Support team.

Appendix A. Regulatory Information

Regulatory Information for Taiwan

BSMI 通告（僅限於台灣）

大多數的 IBM Taiwan 電腦系統被 BSMI（經濟部標準檢驗局）劃分為乙類數位裝置。但是，使用某些選件會使有些組態的等級變成甲類。若要確定您的電腦系統適用等級，請檢查所有位於電腦底部或背面板、擴充卡安裝托架，以及擴充卡上的 BSMI 註冊標籤。如果其中有一甲類標籤，即表示您的系統為甲類數位裝置。如果只有 BSMI 的檢磁號碼標籤，則表示您的系統為乙類數位裝置。

一旦確定了系統的 BSMI 等級，請閱讀相關的 BSMI 通告。請注意，BSMI 通告規定凡是未經 IBM Taiwan Inc. 明確批准的擅自變更或修改，將導致您失去此設備的使用權。

此裝置符合 BSMI（經濟部標準檢驗局）的規定，使用時須符合以下兩項條件：

- 此裝置不會產生有害干擾。
- 此裝置必須能夠接受所接收到的干擾，包括可能導致無法正常作業的干擾。

甲類

此設備經測試證明符合 BSMI（經濟部標準檢驗局）之甲類數位裝置的限制規定。 這些限制的目的是為了在商業環境中使用此設備時，能提供合理的保護以防止有害的干擾。此設備會產生、使用並散發射頻能量；如果未遵照製造廠商的指導手冊來安裝和使用，可能會干擾無線電通訊。請勿在住宅區使用此設備。

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警告使用者：
這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，
在這種情況下，使用者會被要求採取某些適當的對策。
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公司連絡詳情（僅限於臺灣）

根據商品檢驗法(Commodity Inspection Act) 第 11 條的規定， IBM 臺灣軟體技術支援（IBM Taiwan, Inc.）就本文件所指的產品提供台灣地區認證機構的連絡詳情如下：

IBM 臺灣軟體技術支援
110 臺北市信義區松仁路 7 號 4 樓

Figure 17. Taiwan Contact Information Statement

Glossary

This glossary defines the special terms, abbreviations, and acronyms that are used in this publication. If you do not find the term you are looking for, refer to the index or to the *Dictionary of Computing,* 1994.

Numbers

2.5:1 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 2.5:1 compression, two and a half times as much data can be stored with compression as can be stored without compression.

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, two times as much data can be stored with compression as can be stored without compression.

A

A.
See **ampere**.

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.
A circuit board that adds function to a computer.

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

B

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

backward compatible.
Capable of being used with a previous product that was designed for a similar purpose. For example, a tape cartridge that is designed to be used with a modern tape drive but can also be used with certain older tape drives. Synonymous with *downward compatible*.

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

burst data transfer rate.
The maximum speed at which data is transferred.

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

C.
See **Celsius**.

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**.

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 process of eliminating gaps, empty fields, redundancies, and unnecessary data to shorten the length of records or blocks.

configure.
>To describe to a server 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.

D

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

data cartridge.
>A tape cartridge 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**.

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.

drive sense data.
See **SCSI drive sense data**.

dump.
See **drive dump**.

E

eject.
To remove or force out from within.

enclosure.
A device, such as a desktop unit, tape cartridge autoloader, or tape library, into which you can install the tape drive.

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.

F

F.
See **Fahrenheit**.

Fahrenheit (F).
Of or relating to a temperature scale that registers the freezing point of water as 32 degrees and the boiling point as 212 degrees at one atmosphere of pressure.

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

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.

G

GB.
See **gigabyte**.

Generation 1.
The informal name for the Ultrium tape drive, which is the predecessor of the tape drive (Generation 2). The Generation 1 drive has a native storage capacity of up to 100 GB per cartridge and a native sustained data transfer rate of 15 MB per second.

Generation 2.
 The informal name for the Ultrium 2 Tape Drive, which is the second-generation version of the Ultrium tape drive (Generation 1). The Generation 2 drive has a native storage capacity of up to 200 GB per cartridge and a native sustained data transfer rate of 35 MB per second.

Generation 3.
 The informal name for the Ultrium 3 Tape Drive, which is the third-generation version of the Ultrium tape drive (Generation 1, 2). The Generation 3 drive has a native storage capacity of up to 400 GB per cartridge and a native sustained data transfer rate of 80 MB per second.

Generation 4.
 The informal name for the Ultrium 4 Tape Drive, which is the fourth-generation version of the Ultrium tape drive (Generation 1, 2, 3). The Generation 4 drive has a native storage capacity of up to 800 GB per cartridge and a native sustained data transfer rate of 120 MB per second.

Generation 5.
 The informal name for the Ultrium 5 Tape Drive, which is the fifth-generation version of the Ultrium tape drive (Generation 1, 2, 3, 4). The Generation 5 drive has a native storage capacity of up to 1500 GB per cartridge and a native sustained data transfer rate of 140 MB per second.

Generation 6.
 The informal name for the Ultrium 6 Tape Drive, which is the sixth-generation version of the Ultrium tape drive (Generation 1, 2, 3, 4, 5). The Generation 6 drive has a native storage capacity of up to 2500 GB per cartridge and a native sustained data transfer rate of 160 MB per second.

Generation 7.
 The informal name for the seventh-generation version of the Ultrium Tape Drive. The Generation 7 drive has a native storage capacity of up to 6000 GB per cartridge and a native sustained data transfer rate of 300 MB per second.

Generation 8.
 The informal name for the eighth-generation version of the Ultrium Tape Drive. The Generation 8 drive has a native storage capacity of up to 12000 GB per cartridge and a native sustained data transfer rate of 300 MB per second.

Generation 9.
 The informal name for the ninth-generation version of the Ultrium Tape Drive. The Generation 9 drive has a native storage capacity of up to 18000 GB per cartridge and a native sustained data transfer rate of 300 MB per second.

gigabyte.
 1,000,000,000 bytes.

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

H

hardware.
 The physical equipment or devices that form a computer.

head.
 See **drive head**.

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*.

I

ID.
 Identifier.

in.
> See **inch**.

inch.
> 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 server 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**.

J

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.

L

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.
> See **light-emitting diode**.

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 originally developed by the IBM Corporation, Hewlett-Packard, and Seagate. LTO technology is an "open format" technology, which means that its users 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.

load.
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.

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

M

M8.
LTO 8 Type M Cartridge.

MB.
See **megabyte**.

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.

media.
The plural of *medium*.

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

megabyte (MB).
1,000,000 bytes. Expressed as data rate in MB/s or MB/second.

N

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

O

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 abamper per 4 pi centimeters of axial length. .

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

online.
The operating condition that the tape drive is in when the server'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.

P

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.

R

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 server 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 server 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.

S

SAS.
Serial Attached SCSI (SAS) Interface.

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

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

SCSI log sense data.
In response to inquiry from the server 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 server 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 server 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 server, a print server, 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 (servers). 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 MBps.
- 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 MBps.
- Ultra2 SCSI: Uses an 8- or 16-bit bus and supports data rates of 40 or 80 MBps.
- Ultra3 SCSI: Uses a 16-bit bus and supports data rates of 80 or 160 MBps.
- Ultra160 SCSI: Uses a 16-bit bus and supports data rates of 80 or 160 MBps.

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 server. Speed matching improves system performance and reduces backhitch.

T

TapeAlert.
A 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 server'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 Dell PowerVault tape drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 1500 GB per cartridge; with 2:1 compression, its capacity is up to 3000 GB.

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

V

VDC.
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.

W

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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