

# LTO-5 Tape Drive

LTO-5

LTO-5 Tape Drive User's Guide, PN 6-66786-01 Rev. A, March 2009.  
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# Preface

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## **Audience**

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This guide is written for users of the LTO-5 Tape Drive.

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## **Purpose**

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This guide provides information about the LTO-5 Tape Drive including:

- Installing the drive
- Basic drive operations
- Maintenance
- Specifications
- Troubleshooting

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## **Document Organization**

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This guide is organized as follows:

- [Chapter 1, Introduction](#), provides an overview of LTO and Ultrium technologies, and summarizes the drive's key features.
- [Chapter 2, Installation Procedures](#), describes handling precautions, unpacking tips, and installation instructions.
- [Chapter 3, Operation](#), describes the operation and maintenance of the drive.

- [Chapter 4, Theory](#), describes the theory of operation behind the drive, including the technology used in various drive components.
- [Chapter 5, Specifications](#), provides drive and cartridge specifications.
- [Chapter 6, Troubleshooting Guide](#) provides troubleshooting procedures you can follow if you encounter a problem with your drive.
- [Appendix A, Installation Checklists](#), provides abbreviated quick-start checklists for users who are already familiar with the installation procedures.
- [Appendix B, Disposal of Electrical & Electronic Equipment](#), provides instructions for proper disposal of unwanted electrical and electronic equipment.
- [Appendix C, Regulatory Compliances](#), identifies drive compliance with safety and EMC regulations.

This guide also has an index.

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## Notational Conventions

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This guide uses the following conventions:

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**Note:** Notes emphasize important information related to the main topic.

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**Caution:** Cautions indicate potential hazards to equipment and are included to prevent damage to equipment.

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**WARNING:** Warnings indicate potential hazards to personal safety and are included to prevent injury.

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## Related Documents

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The following subsection identifies the primary documents that are related to the LTO-5 Tape Drive.

## Standards Conformance

The Small Computer System Interface is described in standards that include several versions and a number of individual documents. The original Small Computer System Interface Standard, X3.131-1986, is referred to as SCSI-1. SCSI-1 was revised, resulting in the Small Computer System Interface – 2 (X3.131-1994), referred to as SCSI-2. The set of SCSI-3 standards are collectively referred to as SCSI-3. The applicable ANSI standards are as follows:

- INCITS Technical Committee T10 (SCSI Storage Interfaces) Standards:
  - SCSI Architecture Model – 2 (SAM-2) INCITS 366-2003
  - SCSI Architecture Model – 3 (SAM-3) INCITS 402-2005
  - SCSI Architecture Model – 4 (SAM-4) in development
  - Automation/Drive Interface – Commands (ADC) INCITS 403-2005
  - Automation/Drive Interface Commands (ADC-2) in development
  - Automation/Drive Interface – Transport Protocol (ADT) INCITS 406-2005
  - Automation/Drive Interface – Transport Protocol – 2 (ADT-2) in development
  - Fibre Channel Protocol for SCSI (FCP) INCITS 269-1996
  - Fibre Channel Protocol for SCSI, Second Version - 2 (FCP-2) INCITS 350-2003
  - Fibre Channel Protocol for SCSI, Third Version - 3 (FCP-3) INCITS 416-2006
  - Fibre Channel Protocol for SCSI, Fourth Version - 4 (FCP-3) in development
  - SCSI-3 Medium Changer Commands (SMC) INCITS 314-1998
  - SCSI Media Changer Commands – 2 (SMC-2) INCITS 382-2004
  - SCSI Media Changer Commands – 3 (SMC-3) in development
  - SCSI Parallel Interface – 3 (SPI-3) INCITS 336-2000
  - SCSI Parallel Interface-4 (SPI-4) INCITS 362-2002
  - SCSI Parallel Interface-5 (SPI-5) INCITS 367-2003
  - SCSI-3 Primary Commands (SPC) INCITS 301-1997

- SCSI Primary Commands – 2 (SPC-2) INCITS 351-2001
- SCSI Primary Commands – 3 (SPC-3) INCITS 408-2005
- SCSI Primary Commands – 4 (SPC-4) in development
- SCSI-3 Stream Commands (SSC) INCITS 335-2000
- SCSI Stream Commands – 2 (SSC-2) INCITS 380-2003
- SCSI Stream Commands – 3 (SSC-3) in development
- Serial Attached SCSI – (SAS) INCITS 376-2003
- Serial Attached SCSI – 1.1 (SAS-1.1) INCITS 417-2006
- Serial Attached SCSI – 2 (SAS-2) in development
- INCITS Technical Committee T11 (Device Level Interfaces) Standards
  - Fibre Channel Arbitrated Loop (FC-AL-2) Amendment 1 INCITS 332.1999/AM1-2003 Fibre Channel Generic Services-4 (FC-GS-4) INCITS 387-2004
  - Fibre Channel Generic Services-5 (FC-GS-5) in development
  - Fibre Channel Generic Services-6 (FC-GS-6) in development
  - Fibre Channel - Link Services (FC-LS) in development

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**Note:** The term “SCSI” is used wherever it is not necessary to distinguish between the versions of SCSI.

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# Chapter 1

# Introduction

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This chapter provides an introductory overview of the LTO-5 Tape Drive. Topics include:

- [Overview](#)
- [Drive Models](#)
- [Features](#)

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## Overview

The LTO-5 Tape Drive is a high-performance 16-channel tape drive that complies with the LTO interchange specifications. The drive is suited for mid-range to high-end servers, mainframe systems, and tape library automation systems.

The LTO-5 Tape Drive uses Ultrium data cartridges. Its capacity is maximized using intelligent data compression. The drive has a native capacity of 1500 Gbytes (1.5 TB) or 3000 Gbytes (3.0 TB) assuming 2:1 data compression.

The LTO-5 Tape Drive has a 5¼-inch form factor with automatic electromechanical cartridge soft load. It is available in two models:

- Internal
- Tabletop

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## Drive Models

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### Internal

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The internal model (see [figure 1](#) for the half-height model and [figure 2](#) for the full-height model) is a 5¼-inch drive that you can install inside the drive bay of a:

- Computer workstation or server system
- Rackmount drive enclosure

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### Tabletop

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The tabletop model is a 5¼-inch drive that is already mounted inside a stand-alone external drive enclosure with a built-in power supply.

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Figure 1 Internal LTO-5 Half-Height Tape Drive



Figure 2 Internal LTO-5 Full-Height Tape Drive



## Features

[Table 1](#) describes the key performance features and capabilities of the LTO-5 Half-Height Tape Drive.

Table 1 Performance Features and Capabilities

| Feature          | Description   |
|------------------|---|
| Cartridge memory | Stores pertinent information about the media to enable fast cartridge loading |
| Chassis          | Shock damped and isolated   |
| Data buffering   | 256 Mbytes for high performance   |
| Head positioner  | Patented proprietary mechanism for increased data integrity                   |

| <b>Feature</b>               | <b>Description</b>   |
|------------------------------|--|
| Intelligent data compression | Analyzes compression factors before recording to maximize performance and capacity   |
| Interface                    | Serial-attached SCSI (SAS)   |
| SAS-2 capabilities           | The LTO-5 tape drive supports SAS-2 protocols.   |
| Native data transfer rate    | Up to 140 Mbytes per second  |
| Read channel                 | Third generation for increased maturity and data integrity   |
| RISC processors              | Provide fast, efficient data processing  |
| SmartVerify                  | Includes two levels of ECC for extra data safety and error protection  |
| Supported platforms          | A wide variety of Windows and UNIX systems   |
| TapeAlert                    | Monitors and reports drive performance   |
| Tape picking                 | Enhanced implementation for increased reliability  |
| Variable-speed transfer      | Variable speeds for matching with the host to: <ul style="list-style-type: none"><li>• Optimize data transfers</li><li>• Shorten backup times</li><li>• Increase reliability</li></ul> |

## Chapter 2

# Installation Procedures

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This chapter provides detailed installation instructions for both the internal and tabletop models of the LTO-5 Tape Drive, including:

- [Before Installing the LTO-5 Tape Drive](#), which includes:
  - [Handling Precautions and Installation Guidelines](#)
  - [Preinstallation Requirements](#) on page 7
  - [Unpacking and Inspecting the Drive](#) on page 7
- Detailed procedures for:
  - [Installing the Internal LTO-5 Tape Drive](#) on page 8
  - [Installing the Tabletop LTO-5 Tape Drive](#) on page 15
  - [Installing the LTO Driver Software](#) on page 19, optional/when required

Optionally, experienced users who are familiar with installing the LTO-5 Tape Drive can refer to the quick-start checklists in [appendix](#) on page 73 of this guide. Each checklist provides abbreviated installation instructions, with references to the corresponding detailed procedures in this chapter.

## Before Installing the LTO-5 Tape Drive

### Handling Precautions and Installation Guidelines

Always observe the following precautions and guidelines when handling and installing LTO-5 Tape Drives:

- Internal, at all times
- Tabletop, when removed from its free-standing enclosure

#### Handling Precautions

- Internal drives have exposed components that are sensitive to static electricity. To reduce the possibility of damage from static discharge, the drives are packaged in a protective antistatic bag. Do not remove the drive from the antistatic bag until you are ready to install it.
- Wear an ESD-preventive grounding wrist strap or observe similar ESD precautions when working with the drive. Be sure the wrist strap makes good skin contact. Do not remove the wrist strap until you finish working with the drive.  
Also, avoid contact between the drive, other equipment, and clothing. The wrist strap only protects the equipment from ESD voltages on the body; ESD voltages on clothing can still cause damage.
- Before removing the drive from the antistatic bag, touch a grounded metal surface to discharge any static electricity buildup from your body.

(continued)

|   |  |
|---|--|
| <b>Handling Precautions (continued)</b> | <ul style="list-style-type: none"><li>• Handle the drive by its sides rather than by the top cover to reduce the risk of dropping the drive or damaging it during installation.</li><li>• Either lay the drive on a nonconductive surface or put it back inside the protective antistatic bag to reduce the chance of damage from static discharge</li></ul> |
| <b>Installation Guidelines</b>          | Due to the high speed of the LTO-5 Tape Drive, do not connect more than one LTO-5 drive to the same channel on a host SCSI adapter.  |

## **Preinstallation Requirements**

Before installing the LTO-5 Tape Drive, make sure you have:

- A serial SCSI host bus adapter (HBA) installed and properly configured in the host computer
- Interface components, either:
  - 29-pin SAS SFF-8482 cable for an internal or rackmount drive
  - 26-pin SFF-8088 mini-SAS style interface cable for a tabletop drive
- Backup application software that supports the tape drive. For a list of the backup software applications that have been tested with the LTO-5 Tape Drive, contact your sales representative

## **Unpacking and Inspecting the Drive**

Although each LTO-5 Tape Drive is inspected and carefully packaged at the factory, damage can occur:

- In shipment
- When being unpacked

Observe the handling precautions listed in [Handling Precautions and Installation Guidelines](#) and carefully unpack and inspect the LTO-5 Tape Drive as follows:

- 1 Visually inspect the shipping container and notify your carrier immediately of any damage.
- 2 Place the shipping container on a flat, clean, stable surface and carefully remove the contents.
- 3 Visually inspect the LTO-5 Tape Drive and notify your drive supplier's representative immediately of any damage.
- 4 Always save the shipping container and packing materials for any future reshipment.

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## Installing the Internal LTO-5 Tape Drive

The installation of the internal LTO-5 tape drive differs depending on the drive type: Half-Height or Full-Height. Refer to the following sections for your drive type.

- [Installing the Internal LTO-5 Half-Height Tape Drive](#)
- [Installing the Internal LTO-5 Full-Height Tape Drive](#)

---

### Installing the Internal LTO-5 Half-Height Tape Drive

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To install the internal LTO-5 Half-Height Tape Drive, complete the following procedures in the order presented:

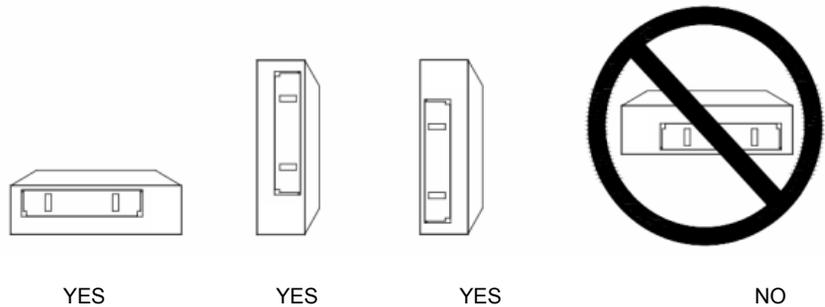
- 1 [Mounting the Internal Half-Height Tape Drive](#) on page 9
- 2 [Connecting the Internal Half-Height Drive Interfaces](#) on page 11
- 3 [Restarting the Internal Half-Height Tape Drive System](#) on page 12
- 4 [Installing the LTO Driver Software](#) on page 19, if required

## Mounting the Internal Half-Height Tape Drive

You can mount the internal LTO-5 Half-Height Tape Drive either horizontally or vertically, but not upside down (see [figure 3](#)).

| IF you mount the drive . . . | THEN the . . .   |
|------------------------------|--|
| horizontally,                | base of the drive must be within 15 degrees of horizontal. |
| vertically,                  | side of the drive must be within 5 degrees of horizontal.  |

Figure 3 Acceptable Mounting Orientations



Mount the internal drive in a 5.25-inch, half-height drive bay as follows:

- 1 As required:
  - a Save and close your open files and terminate all running applications.
  - b Shut down the workstation or server system.
  - c Disconnect the system AC power cord from the facility AC power receptacle.
- 2 Remove the cover from the workstation or server system.

---

**Note:** See your computer manufacturer's instructions for the proper procedures to remove the cover.

---

- 3 Select an available 5.25-inch half-height bay and, if required, remove the bay cover.

- 4 Position the drive in the bay and align either the upper or lower mounting holes—whichever is appropriate—with the holes in the chassis (see [figure 4](#)).
- 5 Secure the drive using two Phillips screws labeled **General Mounting Screws** on each side of the tape drive. If you cannot tighten the Phillips screws, use the washers provided with the **General Mounting Screws**.

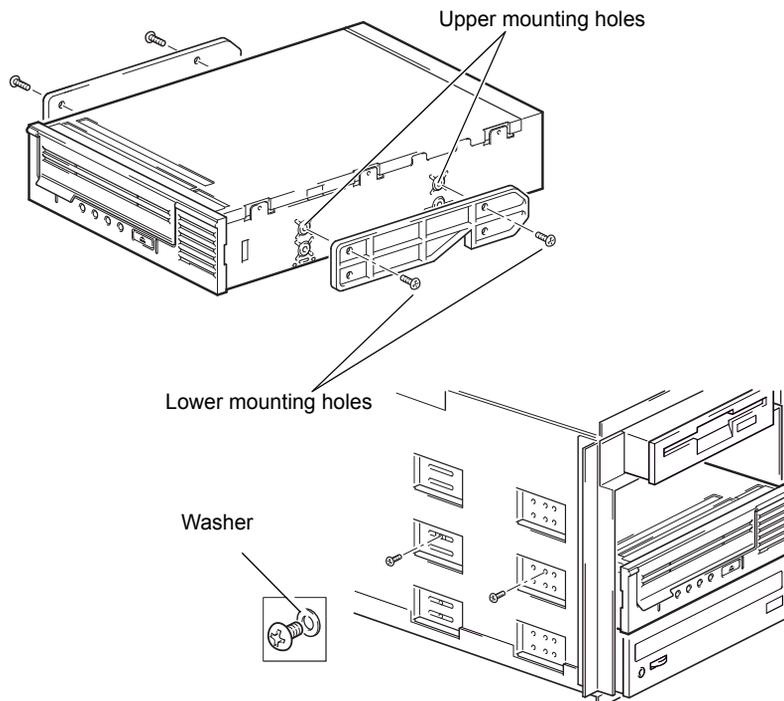
---

**Caution:** Using screws other than the Phillips screws labeled as **General Mounting Screws** can damage the tape drive. **Do not** use screws other than the **General Mounting Screws** to secure the internal LTO-5 Half-Height Tape Drive.

---

After mounting the internal LTO-5 Half-Height Tape Drive, proceed to [Connecting the Internal Half-Height Drive Interfaces](#) in the following subsection.

Figure 4 Internal Tape Drive  
Mounting Hole Locations

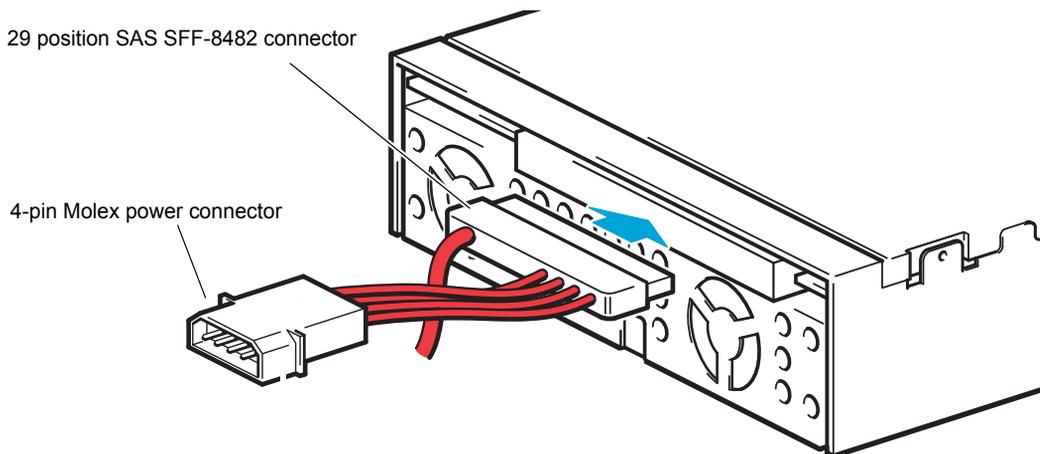


## Connecting the Internal Half-Height Drive Interfaces

As shown in [figure 5](#), the rear panel of the internal LTO-5 Half-Height Tape Drive has connectors for:

- 29-pin SAS SFF-8482 cable

Figure 5 Internal Drive Interfaces



Connect the interface cables to the internal drive as follows:

- 1 Verify that the system is shut down and the AC power cord is disconnected from the facility AC power receptacle.
- 2 Connect the SAS connector on the back of the tape drive to a serial SCSI host bus adapter (HBA) installed in the server.
- 3 Ensure that a 4-pin Molex power connector is plugged into the power inputs of the SAS cable as shown in [figure 5](#).
- 4 Reinstall the system cover.
- 5 Reconnect the system AC power cord to the facility AC power receptacle.

After connecting the internal drive interfaces, proceed to [Restarting the Internal Half-Height Tape Drive System](#) in the following subsection.

## Restarting the Internal Half-Height Tape Drive System

After connecting the internal drive interface and DC power cables:

- 1 Restart the workstation or server system.
- 2 Verify that the internal LTO-5 Half-Height Tape Drive comes on and completes the Power On Self Test (POST) functions.

As required, proceed to [Installing the LTO Driver Software](#) on page 19.

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## Installing the Internal LTO-5 Full-Height Tape Drive

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To install the internal LTO-5 Full-Height Tape Drive, complete the following procedures in the order presented:

- 1 [Mounting the Internal Full-Height Tape Drive](#) on page 12
- 2 [Connecting the Internal Full-Height Drive Interfaces](#) on page 13
- 3 [Restarting the Internal Full-Height Tape Drive System](#) on page 15
- 4 [Installing the LTO Driver Software](#) on page 19, if required

## Mounting the Internal Full-Height Tape Drive

Mount the internal drive in a 5.25-inch, full-height drive bay as follows:

- 1 As required:
  - a Save and close your open files and terminate all running applications.
  - b Shut down the workstation or server system.
  - c Disconnect the system AC power cord from the facility AC power receptacle.
- 2 Remove the cover from the workstation or server system.

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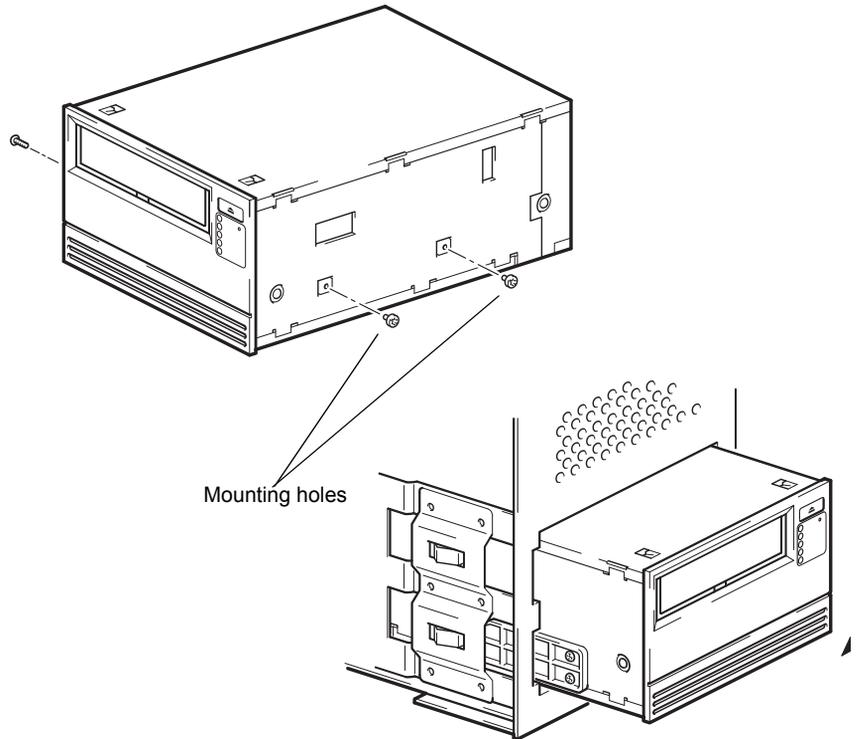
**Note:** See your computer manufacturer's instructions for the proper procedures to remove the cover.

---

- 3 Select an available 5.25-inch full-height bay and, if required, remove the bay cover.
- 4 Position the drive in the bay and align mounting holes with the holes in the chassis (see [figure 6](#)).
- 5 Secure the drive using two screws on each side of the tape drive.

After mounting the internal LTO-5 Full-Height Tape Drive, proceed to [Connecting the Internal Full-Height Drive Interfaces](#) in the following subsection.

Figure 6 Internal Full-Height Tape Drive Mounting Hole Locations

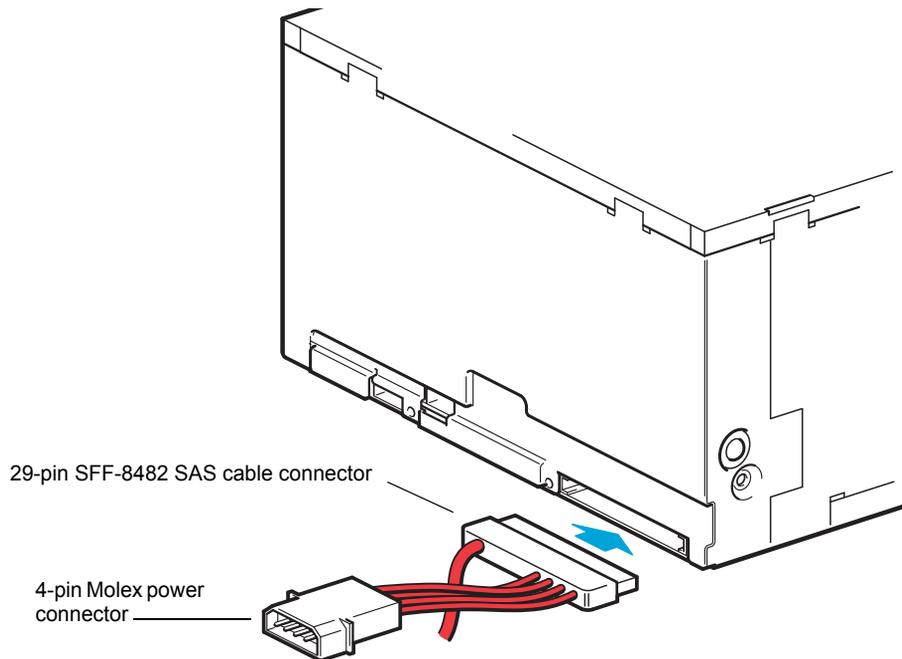


### Connecting the Internal Full-Height Drive Interfaces

As shown in [figure 7](#), the rear panel of the internal LTO-5 Full-Height Tape Drive has connectors for:

- 29-pin SAS SFF-8482 cable

Figure 7 Internal Full-Height  
Drive Interfaces



Connect the interface cables to the internal drive as follows:

- 1 Verify that the system is shut down and the AC power cord is disconnected from the facility AC power receptacle.
- 2 Connect the SAS connector on the back of the tape drive to a serial SCSI host bus adapter (HBA) installed in the server.
- 3 Ensure that a 4-pin Molex power connector is plugged into the power inputs of the SAS cable as shown in [figure 7](#).
- 4 Reinstall the system cover.
- 5 Reconnect the system AC power cord to the facility AC power receptacle.

After connecting the internal drive interfaces, proceed to [Restarting the Internal Full-Height Tape Drive System](#) in the following subsection.

## Restarting the Internal Full-Height Tape Drive System

After connecting the internal drive interfaces:

- 1 Restart the workstation or server system.
- 2 Verify that the internal LTO-5 Full-Height Tape Drive comes on and completes the Power On Self Test (POST) functions.

As required, proceed to [Installing the LTO Driver Software](#) on page 19.

---

# Installing the Tabletop LTO-5 Tape Drive

The installation of the internal LTO-5 tape drive differs depending on the drive type: Half-Height or Full-Height. Refer to the following sections for your drive type.

- [Installing the Tabletop LTO-5 Half-Height Tape Drive](#)
- [Installing the Tabletop LTO-5 Full-Height Tape Drive](#)

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## Installing the Tabletop LTO-5 Half-Height Tape Drive

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To install the tabletop LTO-5 Half-Height Tape Drive, complete the following procedures in the order presented:

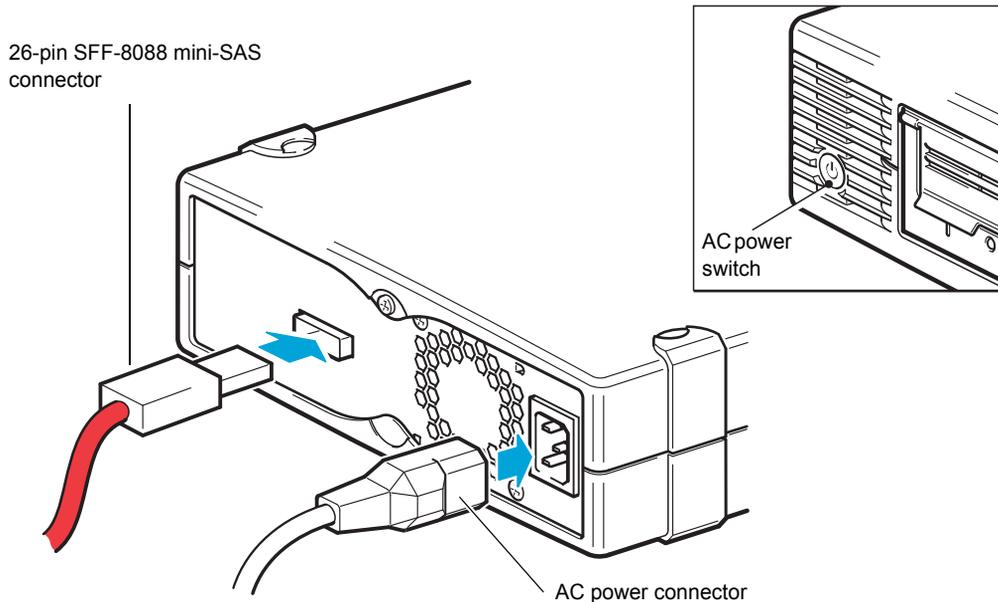
- 1 [Connecting the Tabletop Half-Height Drive Interface and AC Power Cables](#)
- 2 [Restarting the Tabletop Half-Height Tape Drive System](#) on page 17
- 3 [Installing the LTO Driver Software](#) on page 19, if required

## Connecting the Tabletop Half-Height Drive Interface and AC Power Cables

As shown in [figure 8](#), the rear panel of the tabletop LTO-5 Half-Height Tape Drive has connectors for:

- A 26-pin SFF-8088 mini-SAS style interface cable
- The AC power cable

Figure 8 Tabletop Half-Height Drive Interface and AC Power Connectors



Connect the interface and AC power cables to the tabletop drive as follows:

- 1 As required:
  - a Save and close your open files and terminate all running applications.
  - b Shut down the workstation or server system.
  - c Disconnect the system AC power cord from the facility AC power receptacle.
- 2 Attach the external SAS interface cable to the 26-pin SFF-8088 mini-SAS connector on the back of the drive.
- 3 Verify that the tabletop LTO-5 Half-Height Tape Drive AC power switch is set to the off position, and connect the AC power cord to the power connector on the back of the drive.
- 4 Connect the drive AC power cord to the facility AC power receptacle.

- 5 Reconnect the workstation or server system AC power cord to the facility AC power receptacle.

After connecting the tabletop drive interface and AC power cables, proceed to [Restarting the Tabletop Half-Height Tape Drive System](#) in the following subsection.

### Restarting the Tabletop Half-Height Tape Drive System

After connecting the tabletop drive interface and AC power cables:

- 1 Set the tabletop drive AC power switch to the on position.
- 2 Restart the workstation or server system.
- 3 Verify that the tabletop LTO-5 Half-Height Tape Drive comes on and completes the Power On Self Test (POST) functions.

As required, proceed to [Installing the LTO Driver Software](#).

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## Installing the Tabletop LTO-5 Full-Height Tape Drive

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To install the tabletop LTO-5 Full-Height Tape Drive, complete the following procedures in the order presented:

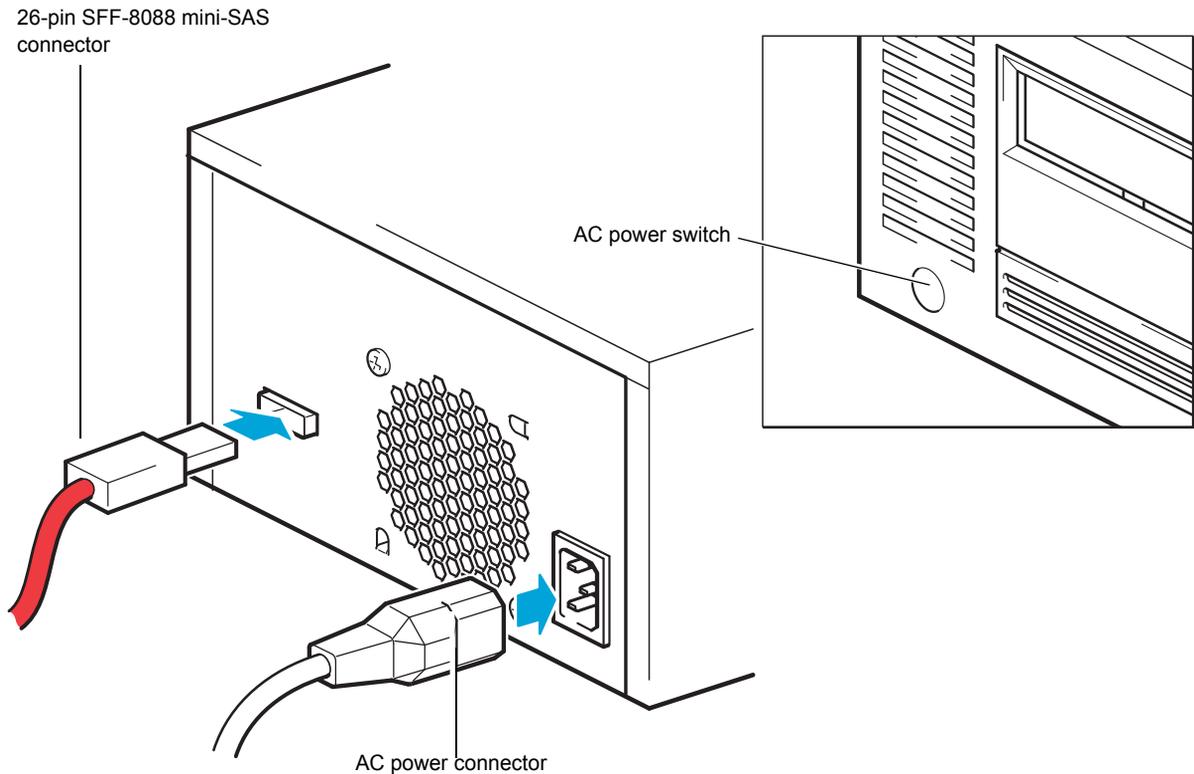
- 1 [Connecting the Full-Height Tabletop Drive Interface and AC Power Cables](#)
- 2 [Restarting the Tabletop Full-Height Tape Drive System](#) on page 19
- 3 [Installing the LTO Driver Software](#) on page 19, if required

### Connecting the Full-Height Tabletop Drive Interface and AC Power Cables

As shown in [figure 9](#), the rear panel of the tabletop LTO-5 Full-Height Tape Drive has connectors for:

- A 26-pin SFF-8088 mini-SAS style interface cable
- The AC power cable

Figure 9 Tabletop Full-Height  
Drive Interface and AC Power  
Connectors



Connect the interface and AC power cables to the tabletop drive as follows:

- 1 As required:
  - a Save and close your open files and terminate all running applications.
  - b Shut down the workstation or server system.
  - c Disconnect the system AC power cord from the facility AC power receptacle.
- 2 Attach the external SAS interface cable to the 26-pin SFF-8088 mini-SAS connector on the back of the drive.

- 3 Verify that the tabletop LTO-5 Full-Height Tape Drive AC power switch is set to the off position, and connect the AC power cord to the power connector on the back of the drive.
- 4 Connect the drive AC power cord to the facility AC power receptacle.
- 5 Reconnect the workstation or server system AC power cord to the facility AC power receptacle.

After connecting the tabletop drive interface and AC power cables, proceed to [Restarting the Tabletop Full-Height Tape Drive System](#) in the following subsection.

### Restarting the Tabletop Full-Height Tape Drive System

After connecting the tabletop drive interface and AC power cables:

- 1 Set the tabletop drive AC power switch to the on position.
- 2 Restart the workstation or server system.
- 3 Verify that the tabletop LTO-5 Half-Height Tape Drive comes on and completes the Power On Self Test (POST) functions.

As required, proceed to [Installing the LTO Driver Software](#).

---

## Installing the LTO Driver Software

If you intend to use the LTO-5 Tape Drive with the Microsoft® native backup applet on a Windows 2000, Windows Server® 2003, Windows 2008 Server®, Windows XP®, or Windows Vista operating system, install the appropriate version of the LTO driver software available at [www.quantum.com](http://www.quantum.com).

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**Note:** The LTO driver software is not necessary with commercial backup application software.

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# Chapter 3

## Operation

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This chapter describes how to operate the LTO-5 Tape Drive.

Topics covered in this chapter are:

- [Understanding the Front Panel Display](#)
- [Using LTO Tape Cartridges](#) on page 28
- [WORM Data Cartridges](#) on page 32
- [LTO-5 Tape Drives and Partitioning](#) on page 32
- [LTO-5 Tape Drives and Encryption](#) on page 32
- [Cleaning the Tape Drive](#) on page 34
- [Performing an Emergency Cartridge Eject](#) on page 36

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## Understanding the Front Panel Display

As shown in [figure 10](#) (half-height) and [figure 11](#) (full-height), the LTO-5 Tape Drive front panel display has five LED indicators that reflect the operating condition of the drive:

The LEDs are either on steady or blinking at different rates in various combinations to indicate the various drive conditions as shown in [table 2](#).

Figure 10 Front Panel Display  
(Half-Height)

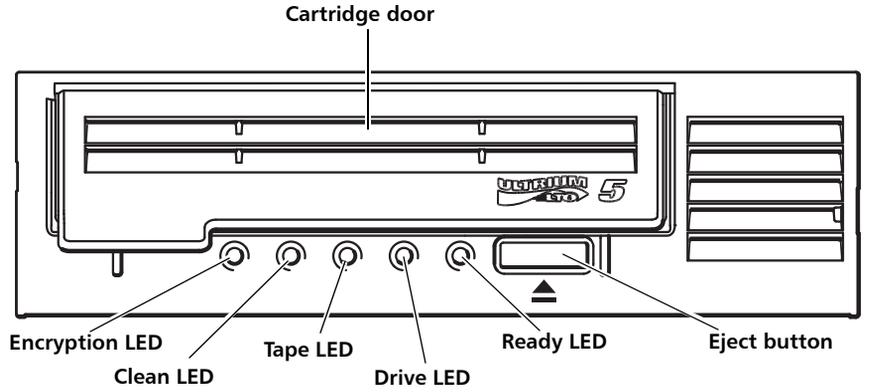
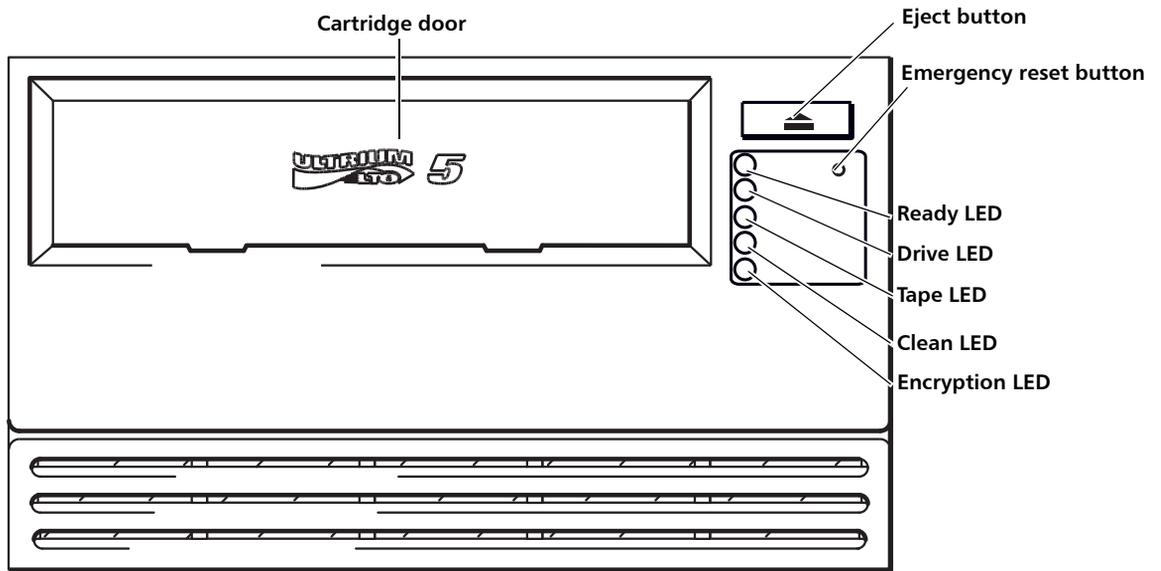


Figure 11 Front Panel Display  
(Full-Height)



|                   |  |  |
|-------------------|--|--|
| <b>Encryption</b> | First LED - Blue or Amber. Indicates whether the encryption status of the drive. |  |
|                   | On   | At power on  |
|                   | Off  | The drive is idle and there is no encryption key.  |
|                   | Off with <b>Ready LED</b> flashing green.  | The tape drive is reading/writing unencrypted data from another host or unloading a cartridge.   |
|                   | On (solid blue)  | The drive is idle but the encryption key is loaded. The drive is ready to read/write encrypted data.   |
|                   | On (solid blue) with <b>Ready LED</b> flashing green                             | The drive is reading/writing encrypted data.   |
|                   | Alternate flashing, blue and amber   | There is an encryption related error. This is cleared after unload executes or successful encryption/decryption resumes. See also "Encryption troubleshooting" on page 71. |

|              |  |  |
|--------------|--|--|
| <b>Clean</b> | Second LED - Orange. Indicates whether the drive needs cleaning. |  |
|              | Off  | Cleaning not required  |
|              | On   | Cleaning cartridge being used. The Ready LED flashes.  |
|              | Flashing   | Cleaning needed. The LED continues to flash if the drive is power cycled, and will only go out after a supported cleaning tape has been used.  |
| <b>Tape</b>  | Third LED - Orange. Indicates tape problems                      |  |
|              | Off  | No fault   |
|              | Flashing   | Current tape is faulty, such as unreadable cartridge memory or unsupported type. Do not use the cartridge; replace it. The LED will go out when a tape load begins.  |
| <b>Drive</b> | Fourth LED - Orange. Indicates drive problems                    |  |
|              | Off  | No fault   |
|              | Flashing   | Unrecoverable hardware failure. A power cycle or successful tape load will turn the LED off, but the LED will start flashing again if the same operation is performed and the hardware fault is still present. |

|              |  |  |
|--------------|--|--|
| <b>Ready</b> | Fifth LED - Green, indicates power and activity: |  |
|              | Off  | Power off or self-test failure   |
|              | On   | Powered on and ready for use, but no activity  |
|              | Flashing   | Engaged in activity, such as responding to Read, Write, or Space commands or performing a self-test. |
|              | Fast flash                                       | Downloading firmware   |
|              | Repeating pattern                                | A repeating pattern of short and long flashes indicates that the drive is in OBDR mode.              |

Table 2 Front Panel Display  
 LED Blink Codes

| LED Condition  | Action Required  |
|--|--|
| <p><b>All LEDs OFF.</b><br/>           Drive may not have power, may be faulty or may have been power cycled or reset during a firmware upgrade.</p>             | <p>Ensure the drive is switched on.<br/>           If the green LED on the power switch is not on, check the power cable and replace it if necessary.<br/>           If the drive has just been switched on or reset, the LED pattern should change after 1 second. If not, the drive has Firmware Image Corruption (caused by being switched off or reset during firmware upgrade). Return it to the factory for repair or reprogramming.<br/>           If power is present and all LEDs remain off, try performing an interface operations (SCSI or ACL). If the drive does not respond, perform an emergency reset press the emergency reset or power-cycle the drive.<br/>           If it still fails, call for service.</p> |
| <p><b>Ready and Clean OFF.</b><br/>           Drive Error and Tape Error FLASHING.<br/>           The drive has failed to execute power-on self test (POST).</p> | <p>Power cycle or reset the drive.<br/>           If the condition reappears, call for service.</p>  |
| <p><b>Ready ON.</b><br/>           The drive is ready for operation.</p>   | <p>None. This is normal.</p>   |
| <p><b>Ready FLASHING.</b><br/>           The drive is carrying out a normal activity (read, write).</p>  | <p>None.<br/>           If the drive is upgrading firmware, do not reset or power cycle it.</p>  |
| <p><b>Ready FLASHES twice, then pauses ON, then FLASHES twice.</b><br/>           The drive is in OBDR mode.</p>   | <p>If you need to exit OBDR mode, power cycle or reset the drive.</p>  |

| LED Condition  | Action Required  |
|--|--|
| <p><b>Ready FLASHING fast.</b> (The other LEDs may be flashing)<br/>The drive is downloading firmware.</p>                                   | <p>None.<br/>Do not reset or power cycle the drive.</p>  |
| <p><b>Ready OFF, others ON.</b><br/>Firmware is being reprogrammed.</p>  | <p>None.<br/>Do not reset or power cycle the drive.</p>  |
| <p><b>Clean FLASHING.</b> (Other LEDs may be flashing.)<br/>The drive requires cleaning.</p>   | <p>Load an Ultrium Universal cleaning cartridge to clean the heads. If the Clean LED is still flashing when you load a new or known data cartridge after cleaning, call for service.</p>   |
| <p><b>Ready FLASHING and Clean ON.</b> (Other LEDs may be flashing.)<br/>Cleaning is in progress.</p>  | <p>None. The cleaning cartridge will eject on completion.<br/>The cleaning cycle can take up to 3 minutes.</p>   |
| <p><b>Tape Error FLASHING.</b> (Other LEDs may be flashing.)<br/>The drive believes the current tape or the tape just ejected is faulty.</p> | <p>Unload the tape cartridge. Make sure that it is a valid format: an Ultrium data cartridge or Ultrium universal cleaning cartridge.<br/>Reload the cartridge. If the Tape Error LED still flashes or starts flashing during the next backup, load a new or known, good cartridge.<br/>If the Tape Error LED is now off, discard the 'suspect' tape cartridge. If it is still on, call for service.</p> |
| <p><b>Tape ejects immediately and Tape Error FLASHES</b><br/>The tape cartridge memory (CM) may be faulty.</p>                               | <p>Write-protect the cartridge by sliding the red switch on the cartridge. The tape can be loaded and the data read. Once the data is recovered, discard the cartridge.</p>  |

| LED Condition  | Action Required  |
|--|--|
| <b>Drive Error FLASHING.</b> (Other LEDs may be flashing.)<br>The drive mechanism has detected an error.                             | Load a new cartridge. If the error persists, power cycle or reset the drive.<br>If the Drive Error LED remains on, call for service. |
| <b>Drive Error and Ready ON with Tape Error and Clean OFF.</b><br>Sequence alternates repeatedly.<br>The drive has a firmware error. | Power cycle or reset the drive. If the sequence reoccurs, upgrade the firmware. If the condition persists, call for service.         |

## Using LTO Tape Cartridges

### Loading a Tape Cartridge

To load an Ultrium tape cartridge into the LTO-5 Tape Drive, gently insert the cartridge into the slot and then either:

- Push the cartridge further into the drive until the drive senses the cartridge and automatically completes the load operation.
- Use a library or host command to complete the load operation.

### Unloading a Tape Cartridge

To unload an Ultrium tape cartridge from the LTO-5 Tape Drive, either:

- Use a library or host command to unload the tape.
- Press the Eject button on the front panel of the drive.

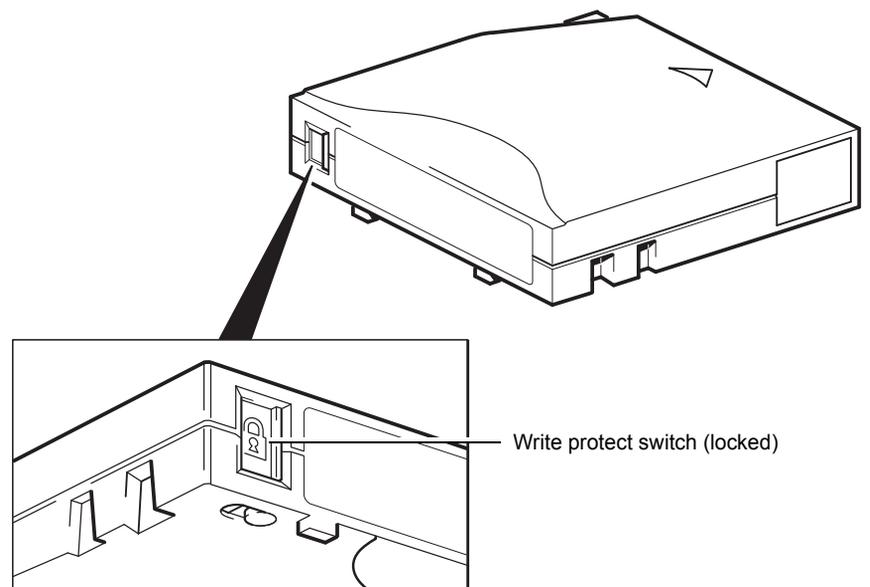
**Caution:** After you press the **Eject** button, several minutes can elapse before the drive ejects the cartridge. Do not power down the tape drive or the host computer until the drive has completely ejected the cartridge.

## Write Protecting a Tape Cartridge

Ultrium tape cartridges have a sliding write-protect switch at the right-rear corner as shown in [figure 12](#).

|  |   |
|--|---|
| <b>Sliding the write-protect switch toward the . . .</b> | <b>Enables data to be . . .</b>   |
| center of the cartridge (the Locked position),           | read from the cartridge, but not written to it. (This is the write-protected position.) |
| corner of the cartridge (the Unlocked position),         | both read from and written to the cartridge. (This is the write-enabled position.)      |

Figure 12 Ultrium Tape Cartridge Write-Protect Switch



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## Tape Cartridge Care and Maintenance

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Observe the following precautions to protect the data on your Ultrium tape cartridges:

---

**Always:**

- Remove the cartridge from the drive when not in use and store it in its protective case.
  - Avoid dropping the cartridge. This can damage components inside the cartridge, possibly rendering the tape unusable. If you drop a tape cartridge, open the cartridge door and make sure that the leader pin is in the correct position.
  - Re-tension a dropped cartridge before using.
  - Keep the cartridge away from:
    - Direct sunlight and heat sources, such as radiators, heaters, or warm air ducts.
    - Sources of electromagnetic fields, such as telephones, computer monitors, dictation equipment, mechanical or printing calculators, motors, magnetic tools, and bulk erasers.
- 

**Do not:**

- Expose the cartridge to dirt, dust or moisture.
- Touch the tape media within the cartridge.
- Bulk erase Ultrium tape cartridges. LTO tape cartridges have prewritten servo patterns that cannot be reformatted by the tape drive. A bulk erase operation would make them unusable.
- Use tape cartridges outside the specified operating conditions: 10° C to 40° C, 20% to 80% relative humidity.

If a tape cartridge has been exposed to conditions outside the specified range, recondition the tape before using in the operating environment by exposing it to the operating environment for a time equal to or greater than the time it was outside the operating environment, up to a maximum of 24 hours. Then re-tension the tape to stabilize the tape pack for better performance.

---

## Data Cartridges

Ultrium tape drives use Ultrium tape cartridges. These are single-reel cartridges that match your drive's format and are optimized for high capacity, throughput and reliability. Compatible media can be recognized by the Ultrium logo, which is the same as the logo on the front of your drive. Do not use other format cartridges in your tape drive and do not use Ultrium cartridges in other format tape drives.

For optimum performance always use a data cartridge that matches the specification of your tape drive, (see table below). A lower specification will have a lower transfer speed and may not support write activities; a higher specification will not support read or write.

### We recommend:

- Ultrium 3TB RW\* and Ultrium 3TB\* WORM tape cartridges for use with LTO-5 tape drives.

Table 3 Data Cartridge  
Compatibility

| Tape Drive Model | Ultrium 200Gb* Data Cartridge | Ultrium 400GB* data cartridge | Ultrium 800GB* data cartridge       | Ultrium 1.6TB* data cartridge       | Ultrium 3TB* data cartridge         |
|------------------|-------------------------------|-------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| LTO-5            | not supported                 | not supported                 | read only                           | read/write and write once/read many | read/write and write once/read many |
| LTO-4            | not supported                 | read only                     | read/write and write once/read many | read/write and write once/read many | not supported                       |
| LTO-3            | read only                     | read/write                    | read/write and write once/read many | not supported                       | not supported                       |
| LTO-2            | read/write                    | read/write                    | not supported                       | not supported                       | not supported                       |

\* Capacity assumes 2:1 compression.

---

## WORM Data Cartridges

The LTO-5 tape drive includes support for both re-writable and Write-Once, Read-Many (WORM), data cartridges. WORM cartridges provide an enhanced level of data security against accidental or malicious alteration of data on the tape cartridge. The WORM data cartridge can be appended to maximize the full capacity of the tape cartridge, but the user will be unable to erase or overwrite data on the cartridge. Any attempt to modify a WORM cartridge to enable writing over existing data will result in the media becoming permanently write protected. It should still be readable in a WORM drive, depending upon the severity of the tampering, but no further appended backups will be possible.

WORM data cartridges are clearly identified by their distinctive, two-tone cartridge color. They can only be used with Ultrium tape drives that support the WORM feature.

---

## LTO-5 Tape Drives and Partitioning

The LTO-5 tape drive supports two tape partitions, when used with Ultrium 3TB R/W cartridges. Tape partitioning is not supported with WORM cartridges or with earlier generations of cartridge. See your backup application's documentation for more information about partitioning media.

---

## LTO-5 Tape Drives and Encryption

The LTO-5 tape drive includes hardware capable of performing data encryption at full speed while writing data, and decrypting when reading.

Encryption is the process of changing data into a form that cannot be read until it is deciphered, protecting the data from unauthorized access

and use. LTO-5 tape drives use the strongest version of the industry-standard AES encrypting algorithm to protect your data.

To make use of this feature you need:

- A backup application that supports hardware encryption
- Ultrium 3TB media or Ultrium 1.6TB media; no encryption will be performed when writing earlier generations of tape

---

### When should I use encryption?

---

Your company policy will determine when you need to use encryption. For example, it may be mandatory for company confidential and financial data, but not for personal data. Company policy will also define how encryption keys should be generated and managed. Backup applications that support encryption will generate a key for you or allow you to enter a key manually.

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**Note:** Encryption with keys that are generated directly from passwords or passphrases may be less secure than encryption using truly random keys. Your application should explain the options and methods that are available. Please refer to your application's user documentation for more information.

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### How do I enable encryption?

---

Hardware encryption is turned off by default and is switched on by settings in your backup application, where you also generate and supply the encryption key. Your backup application must support hardware encryption for this feature to work.

---

### When will I be asked to enter the key?

---

Encryption is primarily designed to protect the media once it is offline and to prevent it being accessed from another machine. You will be able to read and append the encrypted media without being prompted for a key as long as it is being accessed by the machine and application that first encrypted it.

There are two main instances when you will need to know the key:

- If you try to import the media to another machine or another instance of the backup application
- If you are recovering your system after a disaster

---

### What happens if I don't remember the key?

---

If you are unable to supply the key when requested to do so, neither you nor Quantum Support will be able to access the encrypted data.

This guarantees the security of your data, but also means that you must be careful in the management of the encryption key used to generate the tape.

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**Caution:** You should keep a record or backup of your encryption keys and store them in a secure place separate from the computer running the backup software.

---

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### Does encryption affect tape drive performance?

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Hardware encryption can be used with or without compression and without speed or capacity penalties.

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### Does the tape drive encrypt media in an earlier Ultrium format?

---

No. Encryption is supported only on Ultrium 3TB media and Ultrium 1.6TB media.

Encrypted Ultrium 3TB and 1.6TB tapes can be read on any compatible Ultrium tape drive that supports hardware encryption.

LTO-5 tape drives can read Ultrium 800 GB and Ultrium 400 GB media and write Ultrium 800 GB media, but hardware encryption is not supported on these formats.

---

## Cleaning the Tape Drive

Excessive tape debris or other material can accumulate on the tape heads if the drive is:

- Used with non-approved media
- Operated in a hot, dusty environment

When this happens, the drive can:

- Experience excessive errors while reading or writing
- The **Clean LED** is flashing

This means that the drive needs to be cleaned.

The LTO cleaning cartridge has the same dimensions as the tape cartridge and contains an LTO Cartridge Memory (LTO-CM), but is loaded with cleaning media instead of recording media. Always keep the LTO cleaning cartridge in its protective case when not in use.

## Procedure

To clean the LTO-5 Tape Drive:

- 1 Load an Ultrium Universal Cleaning cartridge into the tape drive.
- 2 The drive will carry out its cleaning cycle and eject the cartridge on completion (which can take up to 5 minutes). During the cleaning cycle the orange **Clean LED** will be on solidly and the green **Ready LED** will flash.

Each Ultrium universal cleaning cartridge can be used up to 50 times with Ultrium tape drives. If the cleaning cartridge is ejected immediately with the **Tape LED** on, it has expired.

---

**Note:** If the LTO-5 Tape Drive does not recognize the cartridge as an LTO cleaning cartridge, the drive stops the cleaning process and ejects the cartridge.

---

- 3 After the cleaning process completes, depending on the drive configuration, either:
  - a The drive automatically ejects the Ultrium Universal Cleaning cartridge, or
  - b You must press the **Eject** button to eject the Ultrium Universal Cleaning cartridge.
- 4 Write the date on the Ultrium Universal Cleaning label for future reference.

Always discard used-up Ultrium Universal Cleaning cartridges.

## Performing an Emergency Cartridge Eject

If the LTO-5 Tape Drive stops communicating with the host computer, use the following procedure to eject a cartridge (if necessary).

---

---

**Caution:** When you perform an emergency cartridge eject, any data in the drive or host buffers will not be written to the tape and the tape record may not be correctly terminated with an end-of-data mark. If the end-of-data mark is not written to the tape, you will not be able to append any data to that tape unless you overwrite the existing data on the tape.

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---

To perform an emergency cartridge eject, hold down the Eject button between 5 to 15 seconds, and then release it. The tape drive firmware ignores all outstanding SCSI commands and ejects the tape.

# Chapter 4

## Theory

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This chapter describes operational theories used in the LTO-5 Tape Drive.

The topics covered in this chapter are:

- [Track Layout](#)
- [Recording Method](#) on page 38
- [Data Buffer](#) on page 39
- [Data Integrity](#) on page 39
- [Data Compression](#) on page 41

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## Track Layout

With the LTO-5 Tape Drive, there are 1280 data tracks on the LTO tape, numbered 0 through 1279.

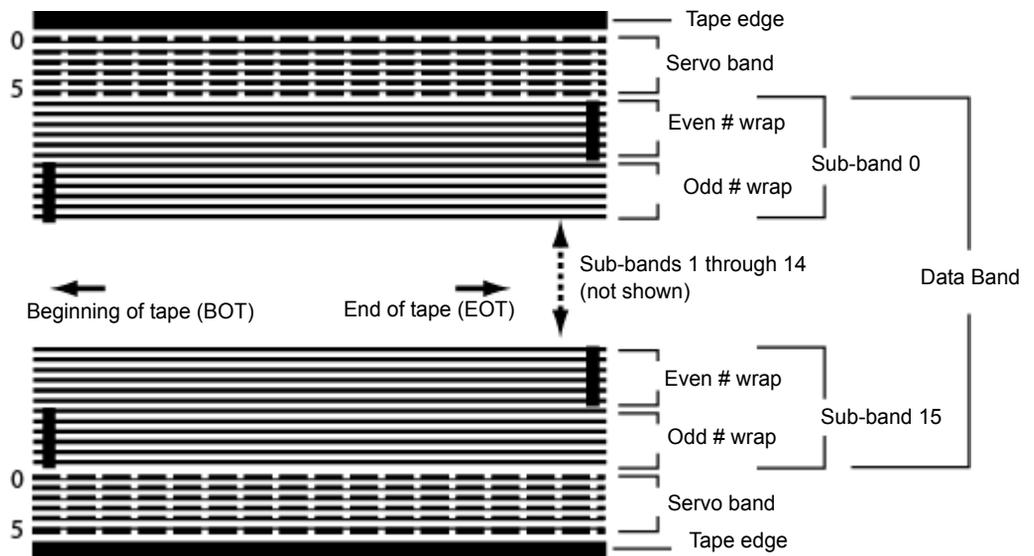
The area between adjacent servo bands is a data band. There are 4 data bands, each of which includes 300 data tracks. The data bands are numbered 3, 1, 0, 2. Data band 2 is closest to the bottom edge of the tape.

A track group is a set of tracks that is recorded concurrently. The sets of 20 data tracks in a data band are data sub-bands. There are 20 data sub-bands per data band. The data tracks are accessed in a serpentine manner.

A wrap is a track group recorded in the physical forward or physical reverse direction. The wraps are recorded in a serpentine fashion starting in data band 0. The tape contains 80 track groups, 40 written in the forward direction and 40 written in the reverse direction. Even-numbered wraps are recorded in the forward direction (BOT to EOT), and odd-numbered wraps are recorded in the reverse direction (EOT to BOT).

[Figure 13](#) shows the layout of data on an LTO tape.

Figure 13 Layout of the Tracks on LTO Ultrium Tapes



## Recording Method

The LTO-5 Tape Drive records data using write-equalized (0,13/11) Run Length Limited (RLL) code. RLL (0,13/11) Data bits are defined as follows:

- **ONE** is represented by a flux transition at the center of a bit-cell.
- **ZERO** is represented by no flux transition in the bit-cell.

---

## Data Buffer

In its default configuration, the LTO-5 Tape Drive has a 256-Mbyte buffer. The buffer controller has a burst transfer rate of 320 Mbytes/sec., and utilizes bank switching to achieve a maximum average bandwidth of nearly 240 Mbytes/sec. The high bandwidth is needed to support look-aside data compression in the case of compressible data being transferred from the SCSI.

---

## Data Integrity

The mechanical and electrical design of the drive ensures that drive performance does not degrade over time. Changes in head alignment, head wear, component drift, and other factors are minimized to ensure that data integrity and interchange capability are not compromised. The drive also incorporates adaptive Finite Impulse Response (FIR) filters that modify the equalization of each read channel dynamically to compensate for many of those changes.

The error rate of the LTO-5 Tape Drive is less than 1 hard error in  $10^{17}$  bits. The undetectable error rate is 1 in  $10^{27}$  bits read.

---

### Error-correction Code (ECC)

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The use of Cyclic Redundancy Checking (CRC), two-level orthogonal Error Correction Coding (ECC) provides a very low probability of encountering a hard error. During the read process, ECC correction is performed on the fly without affecting tape streaming.

There are two levels of Error Correction Coding (ECC). These two levels are orthogonal — that is, an ECC codeword at one level intersects ECC codewords at the other level just once, which means there will be only

one common symbol between them. The two levels are called C1 and C2.

## C1 ECC

As data is written to memory from the data processing unit, the DMA/ECC interface generates C1 ECC bytes and writes them to memory.

As data is written to tape, the C1 ECC is checked and an interrupt generated if there is an error. The C1 ECC read from memory is the ECC that is written to tape.

When data is read from tape and stored into memory, C1 ECC is checked and:

- If the C1 ECC is good, the “Valid” bit for the codeword pair is set.
- Otherwise, a pointer to the invalid codeword pair is passed to the C1 ECC correction engine.
  - If the C1 ECC correction engine can correct the error, then the corrected bytes are written to memory, and the Valid bit is set.
  - Otherwise, the Valid bit is left cleared.

As data is read from memory to the data processor for decompression, the C1 ECC is again checked and an interrupt generated if it is not correct.

## C2 ECC

C2 ECC involves three distinct operations:

- 1 **Encoding:** Generating C2 ECC bytes from data bytes (performed by ECC coprocessor hardware).
- 2 **Decoding:** Generating ECC syndromes from data and ECC bytes, testing for all-zeroes (performed by ECC coprocessor hardware).
- 3 **Correction:** Generating corrected data from syndromes.

The correction depends on the number and types of errors involved:

- For one known C1 codeword pair in error in a subdata set (C2 codeword), the operation is performed by the ECC coprocessor hardware.

- For two or more known C1 codeword pairs in error, the matrix is computed by firmware and the correction is performed by hardware.
- For one or more unknown C1 codeword pairs, syndromes are generated by hardware, error location is computed by firmware, the matrix is computed by firmware and the correction is performed by hardware.

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### Servo-tracking Faults

---

During a write operation, if the servo system detects an error that may result in adjacent data tracks being overwritten, the write operation is aborted. The write operation will not continue until the correct servo tracking is re-established.

---

## Data Compression

Typical data streams of text, graphics, software code, or other forms of data contain repeated information of some sort, whether it is at the text level where you can readily recognize regular repetitions of a single word, or at the binary level where the repetitions are in bits or bytes. Although most data is unique and random, the binary level data exhibits patterns of various sizes that repeat with varying degrees of regularity.

Storage efficiency is increased if the redundancies or repetition in the data are removed before the data is recorded to tape. Data compression technology significantly reduces or eliminates redundancies in data before recording the information to tape. This increases the amount of data that can be stored on a finite medium and increases the overall storage efficiency of the system.

With data compression, the redundant information in a data stream is identified and represented by codewords or symbols that allow the same data to be recorded in a fewer number of bits. These codewords or symbols point back to the original data string, using fewer characters to represent the strings. Because these smaller symbols are substituted for the longer strings of data, more data can be stored in the same physical space.

Some important benefits result from data compression in tape drives:

- The same amount of information can be stored on a smaller length of tape.
- More data can be stored on a given length of tape.
- Performance can more closely parallel to that of high-transfer-rate computers.
- More information can be transferred in the same time interval.

---

## Data Compression Considerations

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In an effective data-compression method, several factors are important:

- The amount of compression, which is measured by the compression ratio. This ratio compares the amount of uncompressed data to the amount of compressed data. It is obtained by dividing the size of the uncompressed data by the size of the compressed data.
- The speed with which data is compressed and decompressed relative to the host transfer rate.
- The types of data to be compressed.
- The data integrity of the compressed data.

The amount of compression possible in a data stream depends on factors such as:

- Data pattern
- Compression algorithm
- Pattern repetition length
- Pattern repetition frequency
- Object size (block of information to be compressed)
- Starting pattern chosen

The transfer rate depends on factors such as:

- Compression ratio
- Drive buffer size
- Host computer input/output (I/O) speed
- Effective disc speeds of the host computer
- Record lengths that the host computer transmits

Data compression algorithms can be tailored to provide maximum compression for specific types of data. Because varying types of data are encountered in normal day-to-day operating circumstances, however, an effective data compression method for a tape drive must serve various data types. Additionally, the data compression method must adapt to different data types, automatically providing optimum handling for all types of data.

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## Intelligent Data Compression

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The compressed capacity of the tape is maximized through the use of intelligent data compression. The intelligent data compression hardware determines the compressibility of each record. If the size of the record is larger after a compression attempt than the native (uncompressed) size, then the record is written in its native form.

The intelligent data compression utilizes two compression schemes:

- Scheme-1 is a LZ1-based compression scheme using a history buffer to achieve data compression.
- Scheme-2 is a pass-through compression scheme designed to pass uncompressible data through with minimal expansion.

There are three specific requirements for compliance with the LTO specification.

- The output data stream must be decompressible following LTO rules to create the input sequence of records and file marks perfectly.
- An LTO compressed data stream may not contain any of the eight reserved control symbols.
- While control symbols allow switching to Scheme 2, this should never be used by operational software because this capability is only for diagnostic and testing purposes.

Software data compression should never be used because the built-in intelligent data compression of the LTO-5 Tape Drive is much more efficient than software data compression.

The LTO-5 Tape Drive uses a derivative of ALDC-2 lossless data compression that includes additional control codes for intelligent data compression.



# Chapter 5

## Specifications

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This chapter provides technical specifications for the LTO-5 Tape Drive.

The topics covered in this chapter are:

- [Physical Specifications](#)
- [Power Specifications](#) on page 50
- [Drive Performance Specifications](#) on page 50
- [Environmental Requirements](#) on page 52
- [Injected Noise Specifications](#) on page 53
- [Reliability Specifications](#) on page 53
- [LTO Cartridge Specifications](#) on page 55

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## Physical Specifications

[Table 4](#) lists the physical specifications of the LTO-5 Half-Height Tape Drive, which is shown in [figure 14](#) and [figure 15](#).

[Table 5](#) lists the physical specifications of the LTO-5 Full-Height Tape Drive, which is shown in [figure 16](#) and [figure 17](#).

Table 4 Physical Specifications  
(Half-Height LTO-5)

| Specification | Internal Drive  |   |
|---------------|---|---|
|               | Without Bezel   | With Bezel  |
| Height        | 1.63 inches<br>(41.65 mm)                                   | 1.68 inches<br>(42.70 mm)                                   |
| Width         | 5.76 inches<br>(146.05)                                     | 5.86 inches<br>(148.99 mm)                                  |
| Length        | 8.43 inches<br>(214.24 mm)<br>(Max. to end of<br>connector) | 8.64 inches<br>(219.47 mm)<br>(Max. to end of<br>connector) |
| Weight        | 3.13 lb.<br>(1.42 kg.)                                      | 3.25 lb.<br>(1.47 kg.)                                      |

Figure 14 LTO-5 Half-Height  
Tape Drive Dimensions (front)

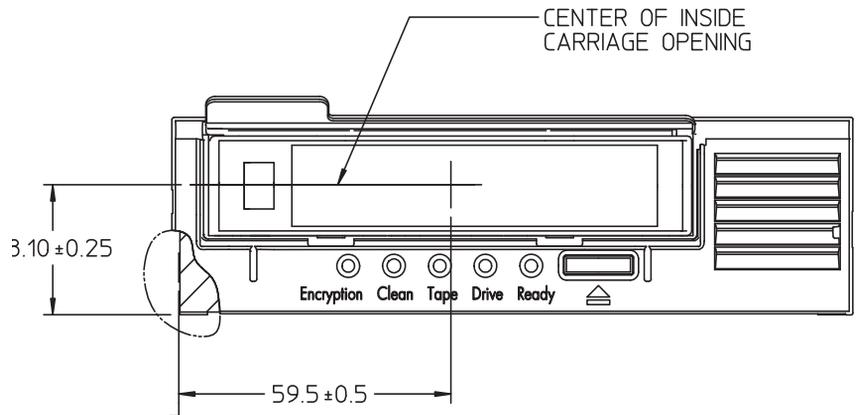


Figure 15 LTO-5 Half-Height Drive Dimensions (side)

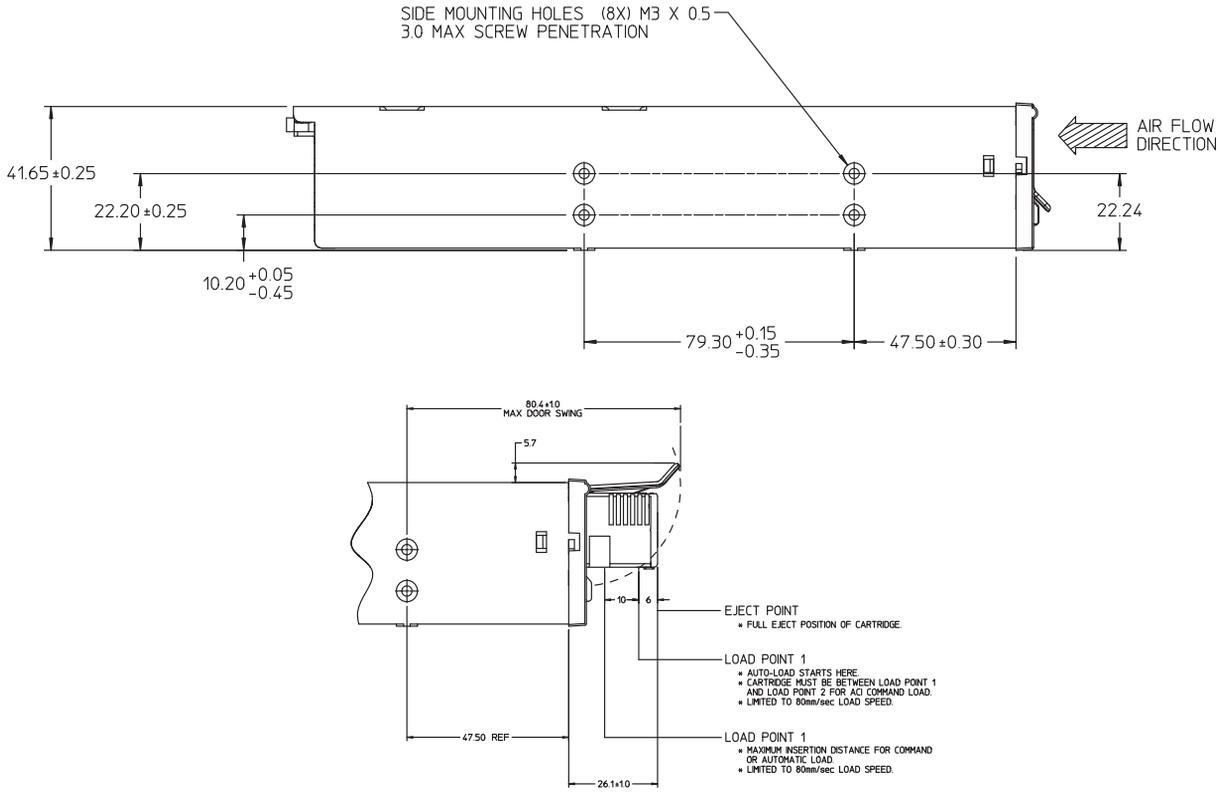


Table 5 Physical Specifications  
(Full-Height LTO-5)

| Specification | Internal Drive            |                           |
|---------------|---------------------------|---------------------------|
|               | Without Bezel             | With Bezel                |
| Height        | 3.24 inches<br>(82.50 mm) | 3.36 inches<br>(85.50 mm) |
| Width         | 5.79 inches<br>(146.07)   | 5.86 inches<br>(149 mm)   |
| Length        | 7.99 inches<br>(203 mm)   | 8.18 inches<br>(208 mm)   |
| Weight        | 5.00 lb.<br>(2.27 kg.)    | 5.15 lb.<br>(2.34 kg.)    |

Figure 16 LTO-5 Full-Height  
Tape Drive Dimensions (front)

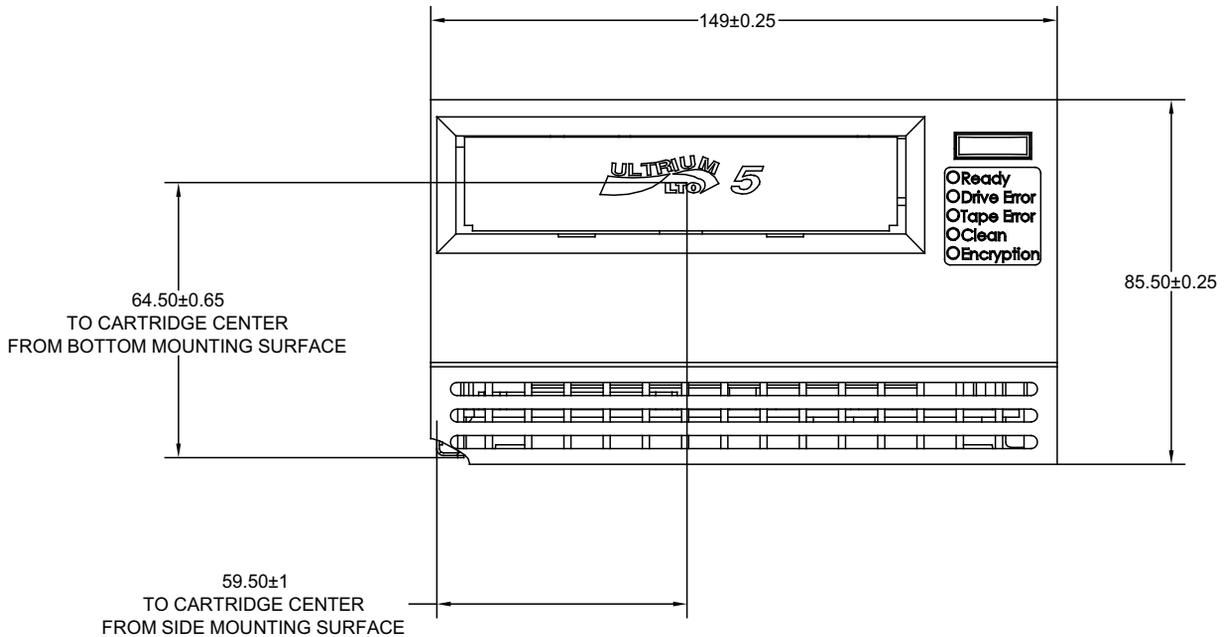
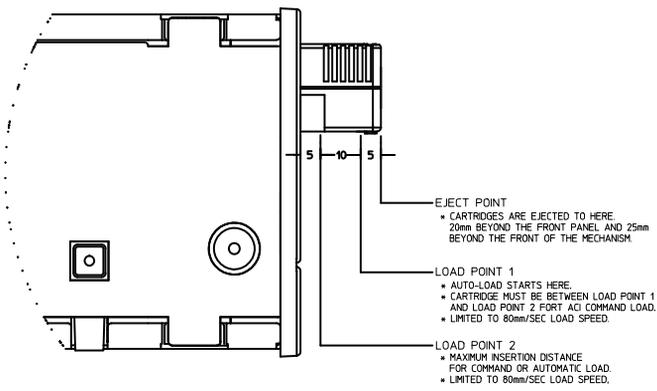
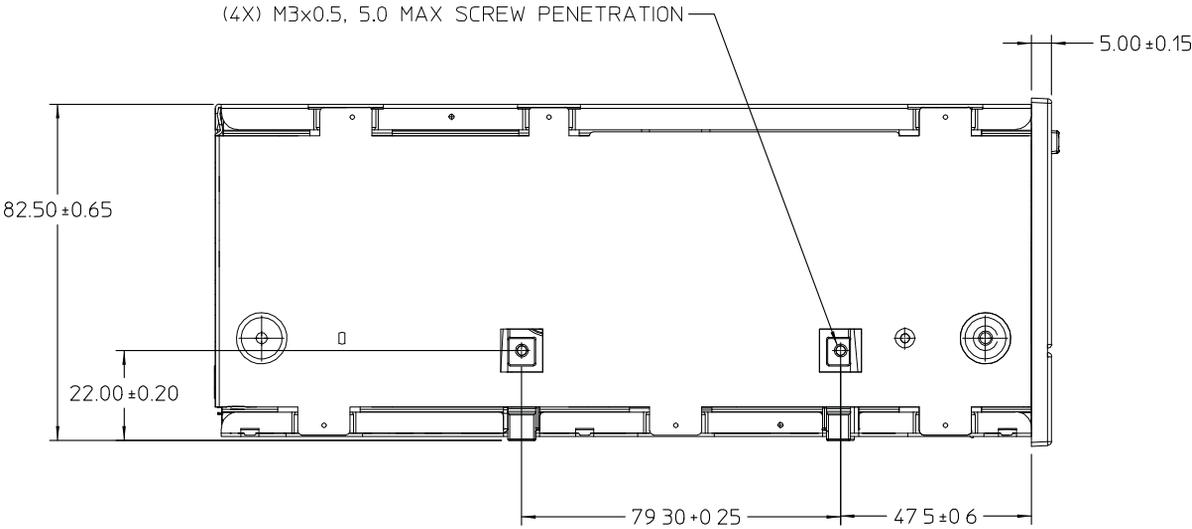


Figure 17 LTO-5 Full-Height Drive Dimensions (side)



## Power Specifications

The tabletop LTO-5 Tape Drive has a built-in 90-260 VAC (47-63 Hz) automatic switching power supply.

Maximum voltage and power specifications for the internal LTO-5 Half-Height Tape Drive are listed in [table 6](#) and [table](#). Specifications are the same as those for other SCSI drives unless otherwise noted.

Table 6 Voltage and Current Specifications

|   | Specifications  |
|---|---|
| <b>Power consumption</b>                        | 7.5 Watts idle,<br>24 Watts typical,<br>40 Watts maximum                                |
| <b>Power requirements</b>                       | +5V @ 3.5A typical<br>+5V @ 3.6A maximum<br>+12V @ 0.51A typical<br>+12V @ 2.3A maximum |
| <b>Power requirements, external tape drives</b> | 100–240 VAC, 50-60 Hz, auto-ranging, 0.8A maximum                                       |

## Drive Performance Specifications

[Table 7](#) lists the performance specifications of the LTO-5 Half-Height Tape Drive.

Table 7 Drive Performance Specifications

| Specification  | Value  |
|--|--|
| Average data access time (846-m tape) from BOW (beginning of wrap) | 52 seconds   |
| Average rewind time (846-m tape)                                   | 47 seconds   |
| Maximum rewind time (846-m tape)                                   | 94 seconds   |
| Capacity<br>LTO Ultrium 5 (846 m)                                  | 1500 Gbytes (native)   |
| Cartridge unload time  | 19 seconds   |
| Error recovery   | Read-after-write Reed Solomon ECC (2 levels)   |
| Flux density   | 15142 cells per mm   |
| Head configuration   | 2 bumps<br>16 thin-film write heads per bump<br>16 MR read heads per bump<br>2 MR servo heads per bump |
| Maximum data access time (650-m tape) from BOW                     | 97 seconds   |
| Recording format   | Ultrium 16-channel (U-516)   |
| Recording undetectable errors                                      | Less than 1 in $10^{27}$ data bits   |
| Recording unrecoverable errors                                     | Less than 1 in $10^{17}$ data bits   |
| Synchronous transfer rate (burst)                                  | 600 Mbytes per sec max (SAS 2.0)   |
| Tape drive type  | LTO (Ultrium)  |
| Tape speed   | Up to 6.04 meters per second (for write/read operations)   |

| Specification             | Value                                      |
|---------------------------|--|
| Track density             | 123.5 tracks per mm (3136 tracks per inch) |
| Transfer rate (sustained) | 140 Mbytes/second (max, native)            |

## Environmental Requirements

[Table 8](#) lists the environmental specifications of the LTO-5 Half-Height Tape Drive.

Table 8 Environmental Requirements

| Specification                         | Operational                        | Nonoperational                     |
|---------------------------------------|------------------------------------|------------------------------------|
| Acoustic level idling (A-wt sum)      | 52 dBA maximum 5.0 LwA Bels        | —                                  |
| Acoustic level operational (A-wt sum) | 57 dBA maximum 5.5 LwA Bels        | —                                  |
| Airflow requirements                  | Internal: 9 CFM (front to back)    | N/A                                |
| Altitude                              | max 10,000 feet MSL (at 25°C)      | 40,000 feet (power off)            |
| Humidity gradient                     | 10% per hour                       | 10% per hour                       |
| Relative humidity                     | 20% to 80% non-condensing          | 10% to 95% non-condensing          |
| Shock (1/2 sine wave)                 | 10 Gs peak, 11 msec                | 40 Gs peak, 11 msec                |
| Temperature                           | +50° to +104°F<br>(+10° to + 40°C) | −40° to +149°F<br>(−40° to + 66°C) |

| Specification          | Operational  | Nonoperational   |
|------------------------|--|--|
| Thermal gradient       | 11°C per hour (10-40°C)  | 11°C per hour (10-40°C)  |
| Vibration (sweep test) | 0.005 inches DA (5-43 Hz)<br>0.50 G peak (43-1000 Hz)<br>sweep rate 5-1000Hz;<br>1.0 octave per minute | 0.1 inches (5--15Hz)<br>1.0 G (15-500 Hz)<br>1.0 octave per minute |

## Injected Noise Specifications

The internal drive operates without degradation of error rates with 100 mV of noise injected between the chassis and 0 V at the power connector at any frequency between 45 Hz and 20 MHz.

## Reliability Specifications

The LTO-5 Tape Drive is designed for maximum reliability and data integrity. [Table 9](#) lists the reliability specifications.

Table 9 Reliability Specifications

| Specification              | Description  |
|----------------------------|--|
| Cartridge load/eject       | 100,000 cartridge load/eject cycles (no thread)  |
| Error recovery and control | <ul style="list-style-type: none"> <li>• Error correction code techniques (C1 and C2 ECC)</li> <li>• Read-after-write (RAW)</li> <li>• Error monitoring and reporting (error log)</li> <li>• Retry on</li> </ul> |

| Specification                     | Description  |
|-----------------------------------|--|
| Mean time between failures (MTBF) | 250,000 hours MTBF at 100% duty cycle: power applied and tape moving continuously (tabletop drive; 50,000 hours at full load and 25°C) |
| Mean time to replace (MTTR)       | Less than 30 minutes   |
| Nonrecoverable error rate         | Less than 1 in $10^{17}$ bits  |

### Mean Time Between Failures

- The mean time between failures (MTBF) for the internal drive is specified at 250,000 hours minimum. This specification includes all power-on and operational time but excludes maintenance periods. Operational time is assumed to be 100% of the power-on time. Operational time is the time the tape is loaded.

The MTBF for the tabletop drive power supply is 50,000 hours with the unit operated at full load and 25°C.

**Note:** The MTBF rating does not represent any particular drive, but is derived from a large database of test samples. Actual rates may vary from unit to unit.

### Mean Time to Replace

The mean time to replace (MTTR) is the average time required by a qualified service technician to diagnose a defective drive and to install a replacement drive. The MTTR for LTO products is less than 0.5 hour (30 minutes).

The LTO drives are field-replaceable units. If a problem occurs with a subassembly or component in the drive, you should replace the entire unit. Return the drive to the factory in its original packaging. Contact your distributor, dealer, your computer system company or your sales representative to arrange the return.

# LTO Cartridge Specifications

## Environmental Considerations

[Table 10](#) lists the basic environmental tolerances for LTO Ultrium cartridges.

Table 10 Environmental Tolerances

| Specification                                       | Value                                    |
|---|--|
| Maximum localized temperature-permanent tape damage | Greater than 52°C                        |
| Operating temperature                               | 10°C to 40°C                             |
| Relative humidity                                   | 10% to 80% storage, 20% to 80% operating |
| Wet bulb temperature                                | 26° C max                                |

If during storage and/or transportation a cartridge has been exposed to conditions outside the specified values, it must be conditioned before use in the operating environment. The conditioning shall be exposure to the operating environment for a time equal to, or greater than, the time away from the operating environment, up to a maximum of 24 hours. There shall be no deposit of moisture anywhere on or in the cartridge.

The stray magnetic field at any point on the tape shall not exceed 4000 A/m.

## Cartridge Memory

Each Ultrium 1, 2, and 3 cartridge has 4 Kbytes of nonvolatile memory:

- 3 Kbytes are used to store tape-directory and hardware specific information.
- 1 Kbyte is available for application and OEM use.

Each Ultrium 4 and 5 cartridge has 8 Kbytes of nonvolatile memory:

- 4 Kbytes are used to store tape-directory and hardware-specific information.

- 128 bytes are used for error information.
- Approximately 4K bytes are not used.

The cartridge memory is powered, read, and written to via a radio-frequency link.

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### **Cartridge Reliability**

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After 5,000 load/eject cycles, replace the cartridge to insure data integrity.

# Chapter 6

## Troubleshooting Guide

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This chapter provides best-practice installation guidelines for getting the most out of your LTO-5 Tape Drive and troubleshooting information you can use to identify and resolve tape drive problems.

Topics covered in this chapter are:

- [Installation Best Practices](#)
- [Troubleshooting Suggestions](#) on page 58

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## Installation Best Practices

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### Following SCSI Best Practices

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Always follow SCSI best practices when installing an LTO-5 Half-Height Tape Drive to ensure trouble-free installation and operation.

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### Using a Serial-attached SCSI Host Bus Adapter

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To achieve the very best performance from your LTO-5 Half-Height Tape Drive and optimize your backup operations, always attach the drive to a serial-attached SCSI controller that supports 3 GBytes per sec. per port transfer rate.

## HBA Preinstallation Checks

Before installing the HBA, check and record your current system configuration. For example:

| In the . . . operating system, | You can find information on any currently installed SCSI HBA by . . .   |
|--------------------------------|---|
| Windows 2000                   | <ol style="list-style-type: none"><li>1 Double-clicking <b>Administrative Tools</b> in the Control Panel</li><li>2 Clicking <b>Computer Management &gt; Device Manager</b></li><li>3 Clicking the SCSI host adapters listed</li><li>4 Clicking <b>Properties</b> to view the <b>Resources</b> tab</li></ol> |
| UNIX/Linux                     | Viewing the boot log text file.   |

Refer to your operating system documentation for specific information on reviewing your system configuration.

After installing the SCSI HBA, restart the system. Then, ensure that the operating system recognizes the HBA and that there are no conflicts with other adapters.

## Troubleshooting Suggestions

If a problem occurs, the first step is to try to establish whether the problem lies with the cartridge, the drive, the host computer and connections, or the way the system is being operated.

### Has the system just been installed?

There could be an installation problem:

- 1 Check through the information in the relevant installation chapter of this guide ([Chapter 2, Installation Procedures](#)).

- 2 Has the system booted? If not, check that all hard disks are correctly seated in the hard disk bay and then check the cabling between the disks and the SAS controller.
- 3 Does an error appear during the boot sequence about a change to the RAID configuration? This error only appears if you have used the supplied cable to replace an existing SAS cable. Check the cabling between the disks and the SAS controller. If the problem persists, you have probably disconnected a hard disk drive bay that was in use.
- 4 Has the system booted but the operating system has not seen the tape drive? Check that the drive has power, the **READY** light should be illuminated. If it is not, check that the power cord is connected correctly to the tape drive. If **READY** is illuminated, check the cabling between the tape drive and the SAS controller. Ensure that the HBA port to which the drive is connected is enabled. If an external drive was powered on after the server, power cycle the server.
- 5 Are appropriate Tape drivers as well as supported application software installed on the host?
- 6 Check the environmental conditions against the specified limits (see [table 11](#)).

Table 11 Environmental Specifications for the LTO-5 Tape Drive

|                  | Temperature Range   | Non-condensing humidity range |
|------------------|---|-------------------------------|
| <b>Operating</b> | 50° to 95° F (10° to 40° C) at a minimum of 8 CFM airflow | 20 to 80% RH (non-condensing) |
| <b>Storage</b>   | -40° to 151° F (-40° to 66° C)                            | 10 to 95% RH (non-condensing) |

**Are you using new cartridges or a different brand of cartridge? Have you been using the particular cartridge for a very long time?**

The problem could lie with the cartridge:

- 1 Check through the [Chapter 3, Operation](#) and [table 3 on page 31](#).
- 2 Check that you are using an Ultrium cartridge. Compatible media can be recognized by the Ultrium logo, which is the same as the logo on the front of your drive.
- 3 Use the correct media type:
  - Ultrium 3TB R/W or Ultrium 3TB WORM cartridges with LTO-5 tape drives
  - Ultrium 1.6TB R/W or Ultrium 1.6TB WORM cartridges with LTO-4 tape drives
  - Ultrium 800 GB R/W or Ultrium 800 GB WORM cartridges with LTO-3 tape drives
  - Ultrium 400 GB R/W cartridges with LTO-2 tape drives
- 4 Has the cartridge been write-protected, see [Write Protecting a Tape Cartridge](#) on page 29?
- 5 Clean the tape heads with the cleaning cartridge, see [Cleaning the Tape Drive](#) on page 34. Make sure you are using the Ultrium Universal cleaning cartridge, C7978A.
- 6 If the **Tape LED** is flashing, the cartridge is probably faulty. Try using a different cartridge.
- 7 Try the operation again.
- 8 If the problem still occurs and you have not yet replaced the cartridge, try using a different cartridge.
- 9 If the problem is still there, the problem probably lies with the drive or the host computer.

**Has the drive been moved recently? Have any cables been disconnected and reconnected? Has the environment changed—unusually hot, cold, damp or dry? Has there been dust or dirt near the drive. Have reasonable precautions against static been taken?**

The problem could lie with the drive:

- 1 Check the cables and connectors.
- 2 Clean the tape heads with the cleaning cartridge.
- 3 If the problem persists, check the environmental conditions against the specified limits, see [table 11](#) on page 59. Perhaps move the drive to a more suitable site.

**Has a new operating system been installed in the host computer? Has new backup software been installed?**

The problem could lie with the host or the software. Consult the computer's operating manuals, the software manual, or seek help from a service engineer.

## Understanding LED Sequences

As shown in [figure 18](#) (half-height) and [figure 19](#) (full-height), the LTO-5 Tape Drive front panel display has five LED indicators that reflect the operating condition of the drive:

The LEDs are either on steady or blinking at different rates in various combinations to indicate the various drive conditions as shown in [table 12](#).

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**Note:** The tape drive LED table below ([table 12](#)) does not include the Encryption LED. Refer to [table 13](#) for encryption LED information.

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Figure 18 Front Panel Display  
(Half-Height)

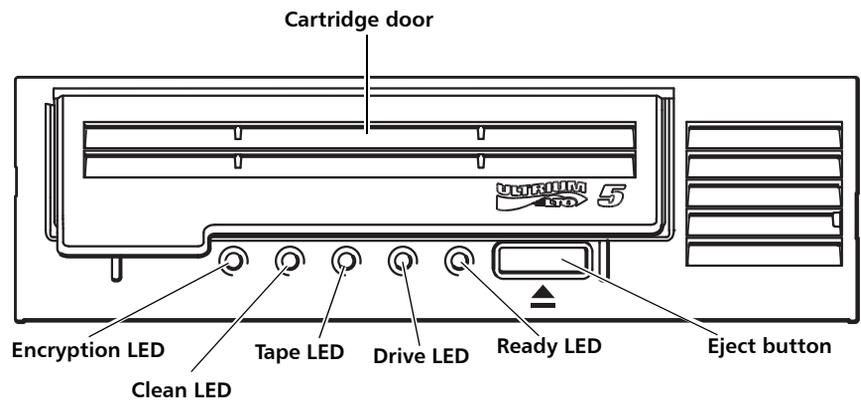


Figure 19 Front Panel Display  
(Full-Height)

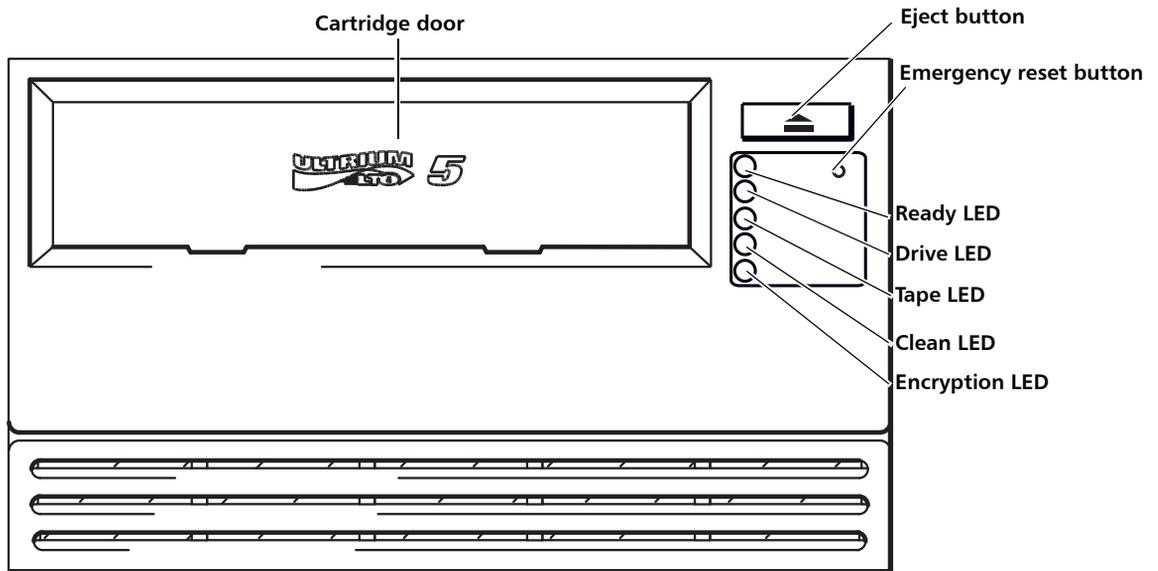
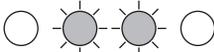
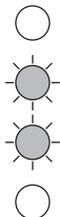
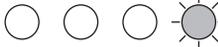
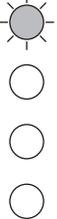
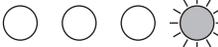
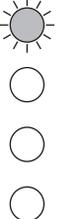
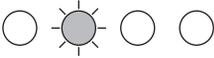
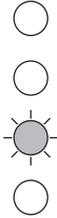
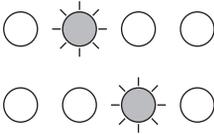
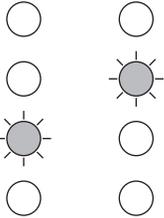


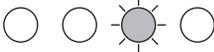
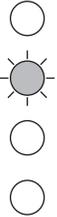
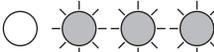
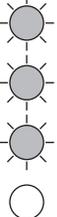
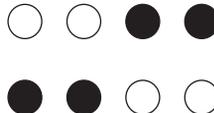
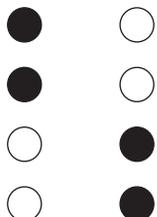
Table 12 Tape Drive LED Sequences

| LED Sequence (Half-Height)   | LED Sequence (Full-Height)   | Cause  | Action Required  |
|--|--|--|--|
|  <p>All LEDs OFF</p>                                |  <p>All LEDs OFF</p>                                | <p>Drive may not have power, may be faulty or may have been power cycled or reset during a firmware upgrade.</p> | <p>Make sure the drive is switched on. The power on/off switch on an external drive incorporates a green LED.</p> <p>Check the power cord connection and replace the cable if necessary. On external drives, you can use the power cord from your monitor or another device to check that the connection is working.</p> <p>If the power supply is present and all LEDs remain off, power cycle or reset the drive. If it still fails, call for service.</p> |
|  <p>Ready and Clean OFF, Drive and Tape FLASH</p> |  <p>Ready and Clean OFF, Drive and Tape FLASH</p> | <p>The drive has failed to execute power-on self test (POST).</p>  | <p>Power cycle or reset the drive.</p> <p>If the error condition reappears, call for service.</p>  |

| LED Sequence<br>(Half-Height)  | LED Sequence<br>(Full-Height)  | Cause   | Action Required  |
|--|--|---|--|
|  <p>Ready is ON.</p>          |  <p>Ready is ON.</p>          | <p>The drive is ready for operation.</p>                          | <p>None. This is normal.</p>   |
|  <p>Ready FLASHES.</p>        |  <p>Ready FLASHES.</p>        | <p>The drive is carrying out a normal activity (read, write).</p> | <p>None.<br/>If the drive is upgrading firmware, do not reset or power cycle it.</p> |
|  <p>Ready FLASHES fast.</p> |  <p>Ready FLASHES fast.</p> | <p>The drive is downloading firmware.</p>                         | <p>None.<br/>Do not reset or power cycle the drive.</p>                              |

| LED Sequence<br>(Half-Height)  | LED Sequence<br>(Full-Height)  | Cause                                  | Action Required   |
|--|--|--|---|
|  <p>Ready is OFF,<br/>others are ON</p>     |  <p>Ready is OFF,<br/>others are ON</p>     | <p>Firmware is being reprogrammed.</p> | <p>None. Do not reset or power cycle the drive.</p>   |
|  <p>Clean FLASHES</p>                       |  <p>Clean FLASHES</p>                       | <p>The drive requires cleaning.</p>    | <p>Load the Ultrium cleaning cartridge, see <a href="#">Cleaning the Tape Drive</a> on page 34.</p> <p>If the <b>Clean LED</b> is still flashing when you load a new or known good data cartridge after cleaning, call for service.</p> |
|  <p>Ready FLASHES<br/>and Clean is ON</p> |  <p>Ready FLASHES and<br/>Clean is ON</p> | <p>Cleaning is in progress.</p>        | <p>None. The cleaning cartridge will eject on completion.</p> <p>The cleaning cycle can take up to 5 minutes to complete.</p>   |

| LED Sequence<br>(Half-Height)   | LED Sequence<br>(Full-Height)   | Cause  | Action Required   |
|---|---|--|---|
|  <p>Tape FLASHES</p>   |  <p>Tape FLASHES</p>   | <p>The drive believes the current tape or the tape just ejected is faulty.</p> | <p>Unload the tape cartridge. Make sure that you are using the correct format cartridge; an Ultrium data cartridge or Ultrium Universal Cleaning Cartridge (see <a href="#">table 3</a> on page 31)</p> <p>Reload the cartridge. If the <b>Tape LED</b> still flashes or starts flashing during the next backup, load a new or known good cartridge.</p> <p>If the <b>Tape LED</b> is now off, discard the 'suspect' tape cartridge. If it is still on, call for service.</p> |
|  <p>The tape is ejected immediately and Tape FLASHES, or Drive FLASHES on unloading tape.</p> |  <p>The tape is ejected immediately and Tape FLASHES, or Drive FLASHES on unloading tape.</p> | <p>The tape cartridge memory (CM) may be faulty.</p>                           | <p>Write protect the cartridge by sliding the switch on the tape cartridge, see <a href="#">Write Protecting a Tape Cartridge</a> on page 29. The tape can be loaded and the data read. Once the data is recovered, the cartridge must be discarded.</p>  |

| LED Sequence (Half-Height)  | LED Sequence (Full-Height)  | Cause   | Action Required  |
|---|---|---|--|
|  <p>Drive FLASHES</p>  |  <p>Drive FLASHES</p>                | <p>The drive mechanism has detected an error.</p> | <p>Load a new cartridge. If the error persists, power cycle or reset the drive.</p> <p>If the <b>Drive LED</b> remains on, call for service.</p> |
|  <p>Drive, Tape, and Ready FLASH</p>   |  <p>Drive, Tape, and Ready FLASH</p> | <p>There is a firmware download problem.</p>      | <p>Insert a cartridge to clear the LED sequence. If the condition persists, call for service.</p>  |
|  <p>Drive and Ready ON with Tape and Clean OFF. Alternates repeatedly.</p> |                                    | <p>The drive has a firmware error.</p>            | <p>Power cycle or reset the drive. Upgrade the firmware. If the condition persists, call for service.</p>  |

## Encryption LED, LTO-5 Tape Drive

The encryption LED can be blue or amber, as described in the following table. The state of the other LEDs depends upon the activity, as described below.

ON (blue or amber) – at power on  
 OFF – drive is idle with no encryption key  
 OFF with Ready LED flashing – drive is reading/writing unencrypted data or unloading cartridge  
 ON (blue) - drive is idle with encryption key  
 ON (blue) with Ready LED flashing – drive is reading/writing encrypted data  
 Blue and Amber flashing alternately – encryption or decryption error

Table 13 Encryption LED States

| Encryption LED (Blue or Amber)                       | State  |
|--|--|
| On   | At power on  |
| Off  | The drive is idle and there is no encryption key.  |
| Off with <b>Ready LED</b> flashing green.            | The tape drive is reading/writing unencrypted data from another host or unloading a cartridge.   |
| On (solid blue)                                      | The drive is idle but the encryption key is loaded. The drive is ready to read/write encrypted data.   |
| On (solid blue) with <b>Ready LED</b> flashing green | The drive is reading/writing encrypted data.   |
| Alternate flashing, blue and amber                   | There is an encryption related error. This is cleared after unload executes or successful encryption/decryption resumes. See also "Encryption troubleshooting" on page 71. |

---

**Note:** The **Encryption LED** only functions if you are using backup software that supports hardware encryption and this feature is enabled in the backup application. See <http://www.hp.com/go/connect> for backup application compatibility.

---

## Problems with cartridges

If you experience any problems using a tape cartridges, check:

- The cartridge case is intact and that it contains no splits, cracks or damage.
- The cartridge has been stored at the correct temperature and humidity. This prevents condensation. See the insert included with the tape cartridge for storage conditions.
- The write-protect switch is fully operational. It should move from side to side with a positive click.
- The World Wide Web site for more detailed troubleshooting information: <http://www.quantum.com/support>.

---

### The cartridge is jammed

---

If the cartridge is jammed or the backup application is unable to eject it, you can force eject the cartridge.

- 1 Attempt a drive unload/eject operation from the backup software.  
Many backup applications will issue a **Prevent Media Removal (PMR)** command to the drive robot in an attempt to prevent human interference during a backup job. If this occurs, the software that issued the PMR must be used to load and unload tapes.
- 2 Shut down backup software and, if in a Windows environment, stop removable storage services.
- 3 Press the **Eject** button on the front of the tape drive.  
Sometimes it is necessary to use the **Eject** button instead of software to unload a tape because software can lose

communication with the product or a rogue application can prevent the software from unloading the tape.

---

---

**Caution:** This can take several minutes in many cases. Ensure that drive activity has stopped before continuing on (waiting 10 minutes is a good rule of thumb). It is important that you allow sufficient time for the drive to complete rewinding the cartridge. If you interrupt it, you may damage the media or the tape drive.

---

---

- 4 Power down the drive.
- 5 Disconnect the data cable.
- 6 After at least 15 seconds, power the drive back up and wait till the drive is idle/ready.

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**Caution:** Use care when disconnecting data cables to ensure that connectors are not reversed, pins are not bent, and so on.

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**Caution:** Powering up with a cartridge in the drive can take several minutes. It is important that you allow sufficient time for the drive to complete rewinding the cartridge. If you interrupt it, you may damage the media or the tape drive.

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---

- 7 Ensure that drive activity has stopped (waiting 10 minutes after power up is a good rule of thumb). Push the **Eject** button.

This step attempts to overcome unload issues due to the drive being in an abnormal state or because **Prevent Media Removal** has been incorrectly left on after being set by a rogue application.

- 8 Initiate a force eject or emergency unload operation by pressing and holding the **Eject** button for 15 seconds. This step causes the drive to try everything possible to unload the tape.

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**Caution:** You may lose data if you force eject a cartridge that is in the middle of a backup. The tape may also become unreadable because an EOD (End of Data) mark may not be properly written.

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- 9 If the cartridge is still jammed, the tape drive has failed. Contact customer support at <http://www.quantum.com/support>.

---

## Encryption Troubleshooting

- Ensure that you are using an LTO-5 tape drive and Ultrium 3TB or 1.6TB media, respectively.
- Ensure that your software supports hardware encryption. It may be necessary to update the software. Consult your software vendor for more information.
- Ensure that the correct key or pass phrase has been entered.
- Ensure that your HBA supports the encryption commands. It may be necessary to update the firmware.

# Appendix A

## Installation Checklists

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Use the following quick-start checklists to get your tape drive up and running as quickly as possible:

- [Internal LTO-5 Tape Drive Quick Start](#)
- [Tabletop LTO-5 Tape Drive Quick Start](#)

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### Internal LTO-5 Tape Drive Quick Start

Use the following quick-start procedure to install the internal LTO-5 Tape Drive. Print this page and check each step as you complete it. If you need more information about a step, see the subsection referenced in the step.

|                          |   |  |
|--------------------------|---|--|
| <input type="checkbox"/> | 1 | Unpack the contents of your drive package, and check for damaged items.<br>See <a href="#">Unpacking and Inspecting the Drive</a> on page 7.                                   |
| <input type="checkbox"/> | 2 | Turn off your computer, remove its covers and power cable, and select a mounting bay for the drive.<br>See <a href="#">Installing the Internal LTO-5 Tape Drive</a> on page 8. |

|                          |   |  |
|--------------------------|---|--|
| <input type="checkbox"/> | 3 | Connect a serial-attached SCSI (SAS) interface cable to the drive.<br>See <a href="#">Connecting the Internal Half-Height Drive Interfaces</a> on page 11 and <a href="#">Connecting the Internal Full-Height Drive Interfaces</a> on page 13. |
| <input type="checkbox"/> | 4 | Replace the computer covers and AC power cable, turn on the computer, and verify that the internal tape drive is operating properly.   |

## Tabletop LTO-5 Tape Drive Quick Start

Use the following quick-start procedure to install tabletop LTO-5 Tape Drive. Print this page and check each step as you complete it. If you need more information about a step, see the subsection referenced in the step.

|                          |   |   |
|--------------------------|---|---|
| <input type="checkbox"/> | 1 | Unpack the contents of your drive package, and check for damaged items.<br>See <a href="#">Unpacking and Inspecting the Drive</a> on page 7.  |
| <input type="checkbox"/> | 2 | Connect a serial-attached SCSI (SAS) interface cable to the drive.<br>See <a href="#">Connecting the Tabletop Half-Height Drive Interface and AC Power Cables</a> on page 15 and <a href="#">Connecting the Full-Height Tabletop Drive Interface and AC Power Cables</a> on page 17 |
| <input type="checkbox"/> | 3 | <ul style="list-style-type: none"><li>• Turn on the computer</li><li>• Turn on the tabletop tape drive</li><li>• Verify that the tabletop tape drive is operating properly.</li></ul>   |

# Appendix B

## Disposal of Electrical & Electronic Equipment

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This symbol on the LTO-5 Tape Drive or on its packaging indicates that the tape drive should not be disposed of with your other waste materials. Instead, it should be submitted to a designated collection point for the recycling of electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal helps conserve natural resources and ensures that the equipment is recycled in a manner that protects human health and the environment.

For more information about properly disposing of your waste equipment for recycling, please contact your local government authority, your household waste disposal service, or the business from which you purchased the product.



# Appendix C

## Regulatory Compliances

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This appendix identifies the LTO-5 Tape Drive regulatory compliances. The topics include:

- [Safety Compliances](#)
- [Electromagnetic Compatibility \(EMC\) Compliances](#) on page 78

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## Safety Compliances

The LTO-5 Tape Drives are safety compliant with the following regulatory codes in the countries indicated:

| Country           | Regulatory Organization   | Compliant to:           |
|-------------------|---|-------------------------|
| Canada            | Canadian Standards Association (CSA)  | UL/CSA 60950-1          |
| EU member nations | Comité Européen de Normalisation Electrotechnique – the European Committee for Electrotechnical Standardization (CENELEC) | EN 60950-1, 1st edition |

| Country               | Regulatory Organization  | Compliant to:   |
|-----------------------|--|---|
| IECEE member nations* | International Electrotechnical Commission on Electrical Equipment (IECEE) for Mutual Recognition of Test Certificates for Electrical Equipment "CB Scheme" | CB Scheme per IEC 60950-1 with details and exceptions for each member country |
| Taiwan                | BSMI   | BSMI certification, CNS 14336   |
| United States         | Underwriters Laboratories (UL)   | UL/CSA 60950-1  |

\* IECEE member nations include: Argentina, Austria, Australia, Belgium, Brazil, Canada, China (PR), Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Ireland, Israel, Italy, Japan, (South) Korea, Montenegro, Netherlands, Norway, Poland, Russian Federation, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Switzerland, Turkey, United Kingdom, and USA.

## Electromagnetic Compatibility (EMC) Compliances

The LTO-5 Tape Drives are EMC compliant with the following regulatory organizations and codes in the countries indicated:

| Country           | Regulatory Organization  | Compliant to:  |
|-------------------|--|--|
| Australia         | Australian Communications and Media Authority (ACMA)                                   | AS/NZS 3548 (same as CISPR 22)                                     |
| Canada            | Industry Canada Digital Apparatus - Interference-Causing Equipment Standard (ICES-003) | ICES-003 Digital Apparatus   |
| EU member nations | CE   | Emissions per CISPR 22, EN55022 and Immunity per CISPR 24, EN55024 |

| Country       | Regulatory Organization                              | Compliant to:  |
|---------------|--|--|
| Israel        | SII  | CISPR 22 and CISPR 24  |
| Japan         | Voluntary Control Council for Interface (VCCI)       | VCCI   |
| New Zealand   | Australian Communications and Media Authority (ACMA) | AS/NZS 3548 (same as CISPR 22)                                       |
| South Korea   | MIC  | CISPR 22 and CISPR 24  |
| Taiwan        | Bureau of Commodity Inspection and Quarantine (BSMI) | BSMI EMC certification, CNS 14338                                    |
| United States | Federal Communications Commission (FCC)              | Title 47: Code of Federal Regulations, Part 15, Subpart B (47CFR15B) |

---

**Note:** Use the LTO-5 Tape Drive only in equipment where the combination has been determined to be suitable by an appropriate certification organization (for example, Underwriters Laboratories Inc. or the Canadian Standards Association in North America).

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Also consider the following safety points:

- Install the drive in an enclosure that limits the user's access to live parts, gives adequate system stability and provides the necessary grounding for the drive.
- Provide the correct voltages (+5 VDC and +12 VDC) based on the regulation applied—Extra Low Voltage (SEC) for UL and CSA, and Safety Extra Low Voltage for BSI and VDE (if applicable)..

사용자 안내문

A 급기기(업무용 정보통신기기)

이 기기는 업무용으로 전자파적합등록을 한 기기이오니 판매자 또는 사용자는 이 점을 주의하시기 바라며 만약 잘못 판매 또는 구입하였을 때에는 가정용으로 교환하시기 바랍니다.

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