

LTO Tape Drive User's Guide



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Overland-Tandberg
4542 Ruffner Street, Suite 250
San Diego, CA 92111 USA
TEL 1.800.729.8725 (toll free)
1.858.571.5555
FAX 1.858.571.3664

Tandberg Data GmbH
Feldstraße 81
44141 Dortmund, Germany
TEL +49 231 5436 0
FAX +49 231 5436 111



www.overlandtandberg.com



Preface

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- [General Warnings](#)
- [Product Warranty Cautions](#)
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- [Regulatory Information](#)
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- [Firmware Updates and Technical Support](#)
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Audience and Purpose

This guide provides information on the installation, configuration, operation, service, and maintenance of LTO tape drives.

Warnings

- Only trained personnel should operate this equipment.
- Read all documentation and procedures before installation or operation.
- Only personnel with technical and product-safety training should be provided access to the tape drive.
- Do not insert any tools or any parts of your body into drive bay openings or any other openings of an operating system.

Avertissement

- Cet équipement ne doit être utilisé que par un personnel formé.
- Lisez la totalité de la documentation et des procédures avant toute installation ou utilisation.
- Seul un personnel avec la formation technique et de sécurité des produits est autorisé à accéder à la lecteur de bande.
- Les pièces mobiles dangereuses existent à l'intérieur de ce produit. N'insérez pas d'outils ni partie du corps dans les ouvertures d'un système en marche.

Warnungen

- Nur geschultes Personal sollte dieses Gerät bedienen.
- Lesen Sie die gesamte Dokumentation und die Verfahren vor der Installation oder dem Betrieb.

- Der Zugriff auf das Bandlaufwerk sollte nur Personal gewährt werden, das über eine technische und Produktsicherheitsschulung verfügt.
- Führen Sie keine Werkzeuge oder Körperteile in die Öffnungen des Laufwerkschachts oder in andere Öffnungen eines im Betrieb befindlichen Systems ein.

General Warnings

To prevent damaging the system, be aware of the precautions you need to follow when setting up the system or handling parts. A discharge of static electricity from a finger or other conductor may damage system boards or other static-sensitive devices. This type of damage may reduce the life expectancy of the device.

Preventing Electrostatic Damage

To prevent electrostatic damage, observe the following precautions:

- Avoid hand contact by transporting and storing products in static-safe containers.
- Keep electrostatic-sensitive parts in their containers until they arrive at static-free workstations.
- Place parts on a grounded surface before removing them from their containers.
- Avoid touching pins, leads, or circuitry.
- Always be properly grounded when touching a static-sensitive component or assembly. See the next section.

Grounding Methods

There are several methods for grounding. Use one or more of the following methods when handling or installing electrostatic-sensitive parts:

- Use a wrist strap connected by a ground cord to a grounded workstation or computer chassis. Wrist straps are flexible straps with a minimum of 1 megohm (± 10 percent) resistance in the ground cords. To provide proper ground, wear the strap snug against the skin.
- Use heel straps, toe straps, or boot straps at standing workstations. Wear the straps on both feet when standing on conductive floors or dissipating floor mats.
- Use conductive field service tools.
- Use a portable field service kit with a folding static-dissipating work mat.

If you do not have any of the suggested equipment for proper grounding, have an authorized reseller install the part. For more information on static electricity, or assistance with product installation, contact your authorized reseller.

Product Warranty Cautions

The customer should only perform the service and repair actions on the tape drive components as described in this document. Any other actions needed should only be performed by an authorized service center.

Warranty becomes immediately void in the event of unauthorized repairs or modifications.

Conventions

This document exercises several alerts and typographical conventions.

Alerts

There are four different types of alerts used in this guide. All warnings are translated into German and French.

| Alert | Description & Usage |
|----------------------|---|
| NOTE: | A Note indicates neutral or positive information that emphasizes or supplements important points of the main text. A note supplies information that may apply only in special cases, for example, memory limitations or details that apply to specific program versions. |
| IMPORTANT | An Important note is a type of note that provides information essential to the completion of a task or that can impact the product and its function. |
| CAUTION | A Caution contains information that the user needs to know to avoid damaging or permanently deleting data or causing physical damage to the hardware or system. |
| WARNING | A Warning contains information concerning personal safety. Failure to follow directions in the warning could result in bodily harm or death. |
| WARNUNG | Eine <i>Warnung</i> enthält Informationen zur persönlichen Sicherheit. Das Nichtbeachten der Anweisungen in der Warnung kann zu Verletzungen oder zum Tod führen. |
| AVERTISSEMENT | Un Canadien avertissement comme celui-ci contient des informations relatives à la sécurité personnelle. Ignorer les instructions dans l'avertissement peut entraîner des lésions corporelles ou la mort. |

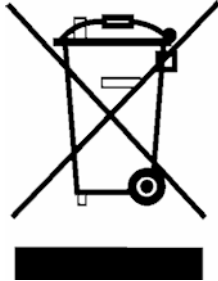
Typographical Conventions

| Convention | Description & Usage |
|-------------------------|--|
| Button_name | Words in this special boldface font indicate command buttons found in the Remote Management Interface (RMI) or Operator Control Panel (OCP). |
| Ctrl-Alt-R | Denotes the keys that you press simultaneously. In this example, hold down the Ctrl and Alt keys and press the R key. |
| Menu Flow Indicator (>) | Words with a greater than sign between them indicate the flow of actions to accomplish a task. For example, Setup > Passwords > User indicates that you should press the Setup button, then the Password button, and finally the User button to accomplish a task. |
| <i>Courier Italic</i> | Used to exemplify a variable for which you must substitute a value. |
| Courier Bold | Represents commands or text in a command-line interface (CLI). |

Information contained in this guide has been reviewed for accuracy, but not for product warranty because of the various environments, operating systems, or settings involved. Information and specifications may change without notice.

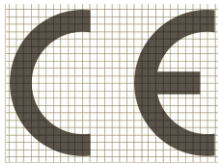
Regulatory Information

Disposal of Waste Equipment by Users in Private Households in the European Union and Norway



This symbol on the product or on its packaging indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of your equipment by handling it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at this time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service, or the shop where you purchased the product.

CE Mark



The CE mark is a mandatory conformity mark on many products placed on the single market in the European Economic Area (EEA). The CE marking certifies that a product has met EU consumer safety, health or environmental requirements.

CCL Mark



CSA C22-2 No. 60950-1 – Electrical safety – UL 60950-1
68475

FCC (United States)



The computer equipment described in this manual generates and uses radio frequency (RF) energy. If the equipment is not installed and operated in strict accordance with the manufacturer's instructions, interference to radio and television reception might result.

This equipment complies with Part 15 of the FCC Rules. Operation is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Part 15, Class A, of the FCC Rules, is designed to provide reasonable protection against radio and television interference in a residential installation. Although the equipment has been tested and found to comply with the allowed RF emission limits, as specified in the above-cited Rules, there is no guarantee that interference will not occur in a particular installation. Interference can be determined by turning the equipment off and on while monitoring radio or television reception. The user may be able to eliminate any interference by implementing one or more of the following measures:

- Reorient the affected device and/or its receiving antenna.
- Increase the distance between the affected device and the computer equipment.
- Plug the computer and its peripherals into a different branch circuit from that used by the affected device.
- If necessary, consult an experienced radio/television technician for additional suggestions.

Canadian Verification

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations (ICES-003, Class A).

Product Documentation

LTO drive product documentation and additional literature are available online at the Overland-Tandberg Knowledge Base:

<https://www.overlandtandberg.com/knowledgebase/>

Use the these options to access the information you need for LTO drives:

- Product Type = Library and Tape
- Product Family = Standalone tape drives
- Model = IBM drive
- Document Type = (select your document)

Firmware Updates and Technical Support

The latest release of Overland-Tandberg LTO tape drive firmware and additional technical support information can be obtained from the *Service & Support* page:

<https://www.overlandtandberg.com/service-support/>

Follow the appropriate instructions to download the **latest** software file.

Contact Us

You can get additional technical support information on the [Contact Us](#) web page at:

<https://www.overlandtandberg.com/company-info/contact-us/>



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Appendix C: Servicing Tape Drives

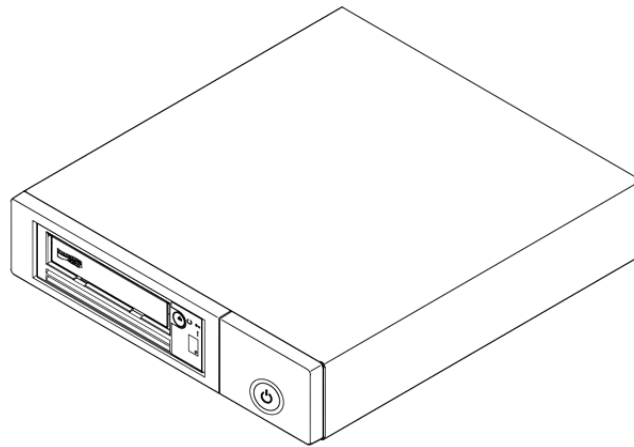
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Product Overview

The IBM LTO Tape Drive is a high-performance, high-capacity data-storage device that is designed to back up and restore open systems applications. The drives are equipped with either 6 Gb SAS or 8 Gb FC interface.



They support all the SCSI commands described in the Ultrium SCSI command specification: *IBM® TotalStorage® LTO Ultrium Tape Drive SCSI Reference*.

Topics in Product Overview:

- [Drive Features](#)
- [Front and Rear Panels](#)
- [Drive Performance](#)
- [Cartridges](#)
- [Speed Matching](#)
- [Channel Calibration](#)
- [Encryption](#)
- [Inhibiting Firmware Down-Leveling](#)
- [SAS Interface](#)
- [Supported Device Drivers](#)
- [Ethernet Port](#)
- [Specifications](#)
- [Installation](#)

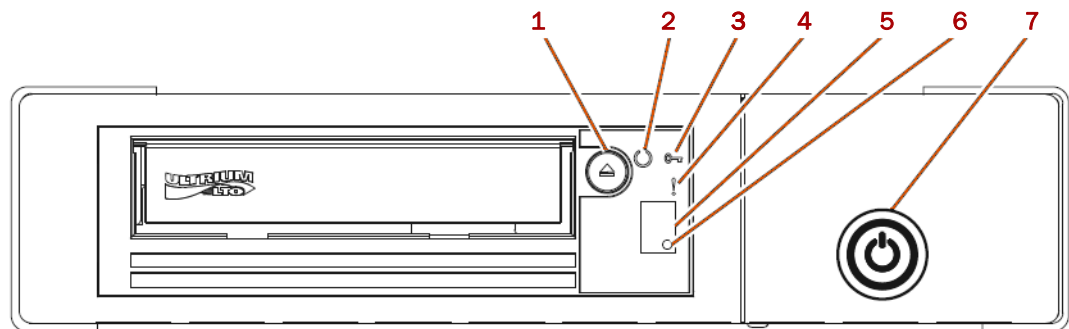
Drive Features

| | LTO-8 | LTO-7 | LTO-6 |
|----------------------------|---|---|---|
| Capacity (native) | 12 TB | 9 TB | 6 TB |
| Capacity (compressed) | 30 TB | 15 TB | 6.25 TB |
| Transfer Rate (native) | 300 MB/s (1TB/hr.) | 300 MB/s (1TB/hr.) | 160 MB/s (576GB/hr.) |
| Transfer Rate (compressed) | 750 MB/s (2.7TB/hr.) | 750 MB/s (2.7TB/hr.) | 400 MB/s (1.4TB/hr.) |
| Interface / Connector | 6 Gb SAS / Int SFF-8482, Ext, Dual SF-8088; 8 Gb Fibre Channel / LC Optical | 6 Gb SAS / Int SFF-8482, Ext, Dual SF-8088; 8 Gb Fibre Channel / LC Optical | 6 Gb SAS / Int SFF-8482, Ext, Dual SF-8088; 8 Gb Fibre Channel / LC Optical |
| Form Factor | Half-height | Half-height | Half-height |
| Buffer Size | 1024 MB | 1024 MB | 512 MB |
| LTFS Capable | IBM Spectrum Archive | IBM Spectrum Archive | IBM Spectrum Archive |

Front and Rear Panels

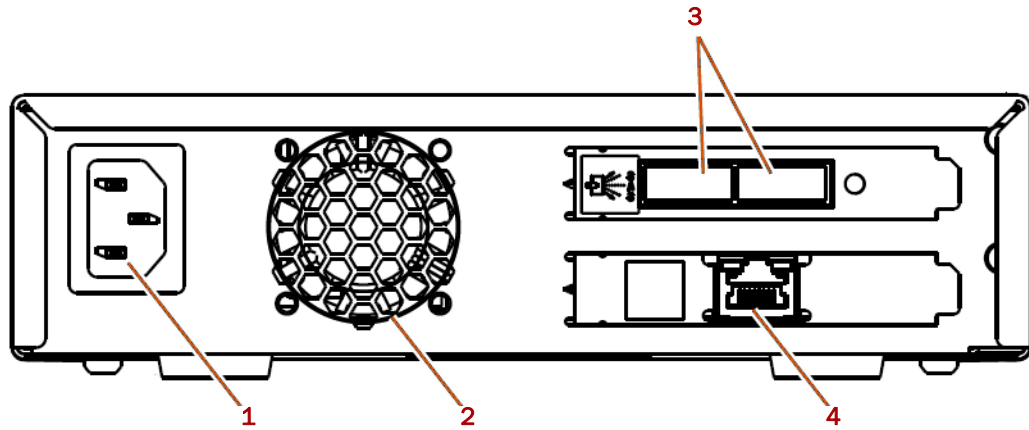
Both the internal and external LTO tape drives have an operator panel on the front consisting of LED indicators, eject button, and a Single-Character Display. The external drive also has a Drive Power button.

External Drive



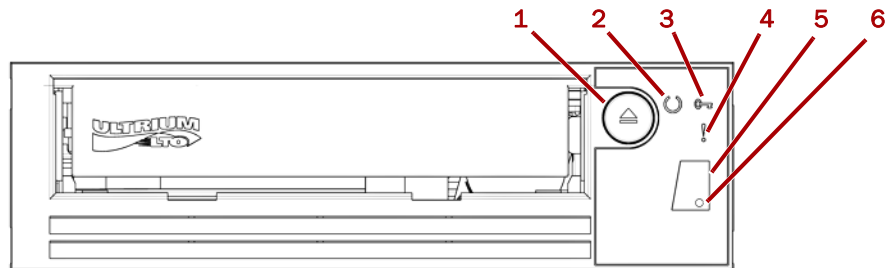
| Element | Description | Element | Description |
|---------|--------------------------|---------|--------------------------------|
| 1 | Cartridge eject button | 5 | Single Character Display (SCD) |
| 2 | Ready light (green) | 6 | SCD dot |
| 3 | Encryption light (white) | 7 | Drive power button |
| 4 | Fault light (amber) | | |

The connect jacks and plugs are located at the rear of the LTO tape drive. This is an example of a dual SAS port model.



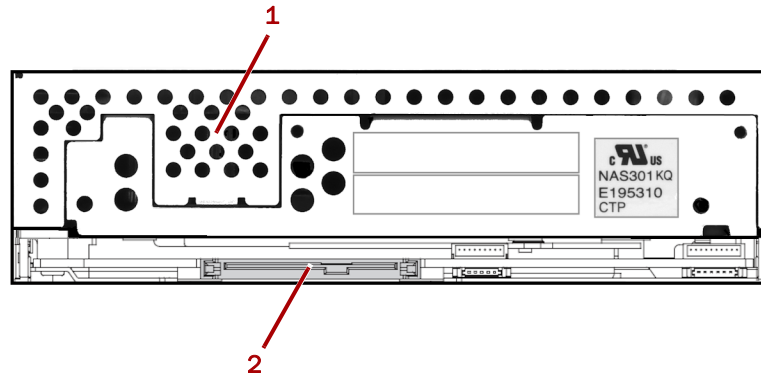
| Element | Description |
|---------|--|
| 1 | Power receptacle |
| 2 | Fan vent |
| 3 | SAS connectors |
| 4 | Ethernet connector (for drive status and service only) |

Internal Drive



| Element | Description | Element | Description |
|---------|--------------------------|---------|--------------------------------|
| 1 | Cartridge eject button | 4 | Fault light (amber) |
| 2 | Ready light (green) | 5 | Single Character Display (SCD) |
| 3 | Encryption light (white) | 6 | SCD dot |

The connect jacks and plugs are located at the rear of the LTO tape drive. This is an example of a dual SAS port model.



| Element | Description |
|---------|----------------|
| 1 | Fan vent |
| 2 | SAS connectors |

Drive Performance

The following table shows the high performance for the LTO tape drive.

| Performance Characteristics | LTO-8 Tape Drive | LTO-7 Tape Drive | LTO-6Tape Drive |
|--|-------------------------------|-------------------------------|-------------------------------|
| Native data rate | 300 MB/s (Ultrium 8 media) | 300 MB/s (Ultrium 7 media) | 160 MB/s (Ultrium 6 media) |
| Maximum sustained data rate (at maximum compression)* | 750 MB/s | 750 MB/s | 400 MB/s |
| Burst data rate | 800 MB/s | 800 MB/s | 800 MB/s |
| Nominal load-to-ready time | 15 seconds | 15 seconds | 12 seconds |
| Nominal eject time | 24 seconds | 20 seconds | 17 seconds |
| Average rewind time | 59 seconds | 56 seconds | 62 seconds |

* NOTE: All sustained data rates depend on the capabilities of the interconnect.

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

Cartridges

Capacities

This table covers the different capacities for the supported LTO media cartridges.

| LTO Gen. | Tape Length (m) | Data Capacity (native GB) | Data Capacity (compressed* GB) |
|----------|-----------------|---------------------------|--------------------------------|
| 8 | 960 | 12000 | 30000 |
| 7 | 960 | 6000 | 15000 |
| 6 | 846 | 2500 | 6250 |

* Compression Ratio = 2.5 to 1 for LTO-6/7/8.

Compatibility

Each LTO tape drive is compatible with that generation of Ultrium data cartridge and also its predecessor as shown in this table. The code “–” means not supported. The LTO-7 and LTO-6 are also able to read cartridges that are two generations back.

| Cartridge Gen. | LTO-8 Drive | LTO-7 Drive | LTO-6 Drive |
|----------------|-------------|-------------|-------------|
| 4 | – | – | Read Only |
| 5 | – | Read Only | Read/Write |
| 6 | – | Read/Write | Read/Write |
| 7 | Read/Write | Read/Write | – |
| 8 | Read/Write | – | – |

Speed Matching

To improve system performance, the drive uses a technique that is called speed matching to dynamically adjust its native (uncompressed) data rate to the slower data rate of a server. With speed matching, the drive operates at different speeds when it is reading or writing. This applies to any Ultrium 4 or later cartridge format.

| Speed matching data rates (MB/sec) | |
|------------------------------------|--------------------|
| Generation 8 media | Generation 7 media |
| 300.0 | 300.0 |
| 273.0 | 231.86 |
| 249.5 | 213.06 |
| 226.0 | 194.26 |
| 203.0 | 175.46 |
| 180.0 | 157.67 |

| Speed matching data rates (MB/sec) | |
|------------------------------------|--------------------|
| Generation 8 media | Generation 7 media |
| 157.5 | 138.52 |
| 135.0 | 120.11 |
| 112.0 | 101.46 |

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

Channel Calibration

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

Encryption

The IBM LTO tape drive all support the T10 Defined encryption capabilities for AME and out-of-band encryption.

Minimal latency for encryption setup is necessary. However, host transfer through put is not affected. The hardware encryption and decryption core and control code resides in the LTO tape drive. It has the following characteristics:

- It utilizes AES-256 standards-based strong symmetric data encryption with GCM formatting.
- It utilizes a secret 256-bit Data Key to perform the encryption and decryption which is programmed to the hardware in a secure fashion by the drive control firmware. The key is not retrievable in any manner from the encryption core (even by the drive firmware which programmed it) and is automatically erased during the eject process.
- It performs the encryption after host data is received and compressed and thus does not alter the compression ratio of incoming data. Encryption is done at full line speed in hardware in the tape device with no impact on throughput performance.
- During write operations, it automatically decrypts after encrypting to provide on-the-fly checking that data is in fact encrypted correctly.
- No host processor MIPS are required as for software host-based encryption solutions.

Inhibiting Firmware Down-Leveling

The drive provides the capability to prevent loading and installing drive microcode by way of a Field Microcode Replace (FMR tape) if the firmware level contained in the FMR tape is older than the code level already installed. This option is controlled by the host application. No checking is done if the firmware level is loaded by way of the host interface or the library interface.

Interfaces

Depending on the model, LTO drives have either a SAS or FC interface.

SAS Interface

NOTE: For a current list of compatible SAS and FC HBAs, refer to the matrix on our website: https://ftp1.overlandtandberg.com/website/website/TDOVRL_SAS&FC_HBA_Compatibility_Matrix.pdf

The certain models have a dual port 6 Gbps SAS (Serial Attached SCSI) host interface using a SFF-8088 SAS connector.

A drive with a SAS interface can be connected directly to a host server SAS HBA. SAS is a performance improvement over traditional SCSI because SAS enables multiple devices (up to 128) of different sizes and types to be connected simultaneously with thinner and longer cables; its full-duplex signal transmission supports 6.0 Gb/s. In addition, SAS drives can be hot-plugged.

SAS drives auto-negotiate speed. There are no configurable topologies thus no feature switches associated with SAS.

FC Interface

A drive with an FC interface can be connected directly to a fibre channel HBA in a host server or to a fibre channel switch. The FC tape drives uses a multi-mode Fibre Optic interface which supports up to 8.0 Gb/s. FC tape drives can use auto-negotiate speeds or fixed speeds and topologies. When used with a fibre switch, it is recommended to configure a fibre zone to include the port or WWNN of the tape drive and host server HBA in that same zone.

Supported Device Drivers

Device drivers enable the drive to interact with various servers. To properly install an IBM device driver (if required), refer to the *IBM Tape Device Drivers Installation and User's Guide*. Refer to your tape backup or archive application's documentation to determine which drivers to use, if any.

For device drivers and driver documentation for your drive, you can access these materials at the Overland-Tandberg Support & Service website. Refer to [Firmware Updates and Technical Support](#) on [page 7](#).

NOTE: If you do not have Internet access and you need information about device drivers, contact Overland-Tandberg Technical Support directly. See [Contact Us](#) on [page 7](#).

Ethernet Port

The Ethernet port is used only for servicing the drive, not for data transmission.

Specifications

Specifications for the tape drive. Specifications for tape cartridges are given in “[Environmental and Shipping Specifications for Tape Cartridges](#)” on page 43.

| Physical Specifications | | | |
|--|--|---------------------------------|---------------------------------|
| Specification | Dimensions | | |
| Height | 42.7 mm (1.68 in.) | | |
| Width | 148 mm (5.83 in.) | | |
| Length | SAS=210 mm (8.27 in.) / FC=228 mm (8.98 in.) | | |
| Weight | 4.3 kg (9.4 lbs.) | | |
| Power Requirements for Internal Drives | | | |
| Power Supply voltage | 5 Vdc / 10 Vdc | | |
| Tolerance | 10% / 10% | | |
| Voltage Ripple / Noise (50 Hz – 20 MHz) | 100 mV pp / 125 mV pp | | |
| Supply current | | | |
| Minimum (steady state) | 2.0 A / 0.0 A | | |
| Maximum (steady state) | 4.0 A / 1.2 A | | |
| Peak (instantaneous power by power supply) | 4.5 A < 1ms / 4.0 A < 1ms | | |
| Power Specifications for External Drives | | | |
| AC line voltage | 100 - 240 Vac | | |
| Line frequency | 50 - 60 Hz, auto-ranging | | |
| Line current at | 100 Vac 0.48 A | | |
| Line current at | 240 Vac 0.20 A | | |
| Other Specifications | | | |
| Maximum altitude | 3048 m (10,000 ft) | | |
| Maximum altitude for shipping | 12192 m (40,000 ft) | | |
| Environmental Specifications | | | |
| Environmental Factor | Operating | Storage | Shipping |
| Temperature | -40 to 60 °C (-40 to 140 °F) | -40 to 60 °C (-40 to 140 °F) | -40 to 60 °C (-40 to 140 °F) |
| Relative humidity | 20 - 80% | 10 - 90% | 10 - 90% |
| Maximum wet bulb temperature | Non-condensing | Non-condensing | Non-condensing |

Installation

This section describes how to setup and install an IBM LTO tape drive from Overland-Tandberg.



CAUTION: While working with the unit, observe standard Electrostatic Discharge (ESD) precautions to prevent damage to micro-circuitry or static-sensitive devices.

NOTE: Before continuing, verify you are able to connect to the host SAS controller via an installed host bus adapter (HBA) and you have the correct cable (available separately) to attach the tape drive to the HBA.

Register Your Product

It is **essential** that you activate your warranty. Technical and warranty support are **not available** until that is done:

1. Go to <https://www.overlandtandberg.com/service-support/customer-product-registration/>.
2. Click **Register**.
3. At the **Registering Your Product** page, enter the information requested (including serial number) and click **Submit**.

Your warranty certificate will be emailed to you. Follow the instructions included in the email to complete the process.

Position Your External Tape Drive

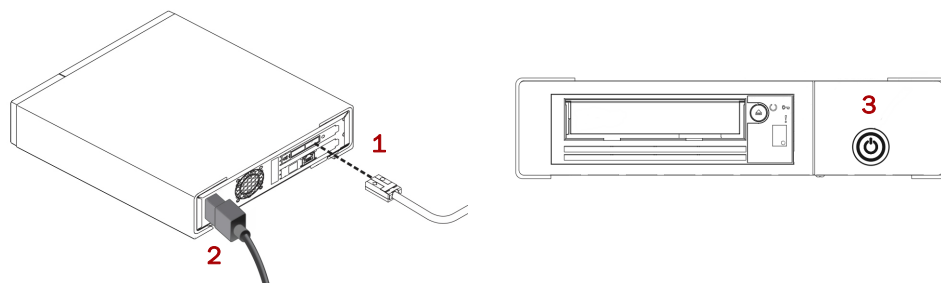
Position the unit so it is convenient to the server. The only restrictions are the length of the power cord and the length of the cable to the server. Recommended locations are:

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

The unit should not be stacked. Do not place anything on top of the unit.

Install Your External LTO Tape Drive

To connect your new LTO External tape drive to your computer, follow these steps:




1. Plug your **host interface cable** into the external tape drive and the other end into the server.
2. Connect the **power cord** to the tape drive.
3. Press the **power button** on the front panel to power ON the external tape drive and then power on the server.

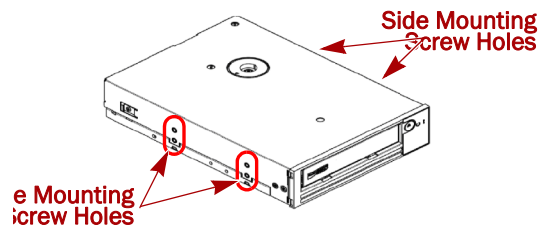
Install Your Internal LTO Tape Drive

To connect your new LTO Internal tape drive to your computer, follow these steps.

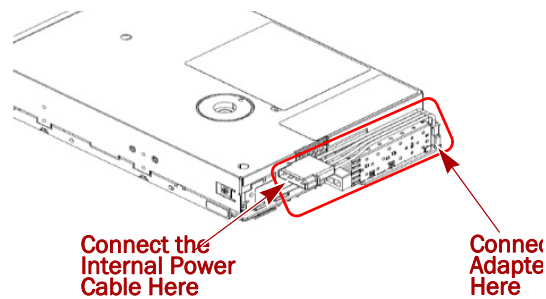
NOTE: The following illustration shows one method of mounting hardware; it does not apply to all servers. Please refer to your server documentation.

1. Slide the LTO tape drive into an **empty drive bay**.

 **IMPORTANT:** If cable access for the tape drive bay is awkward, it may be easier to access power and other connections if the tape drive is installed in the top bay. To do so, you may need to move other devices to lower drive bays.

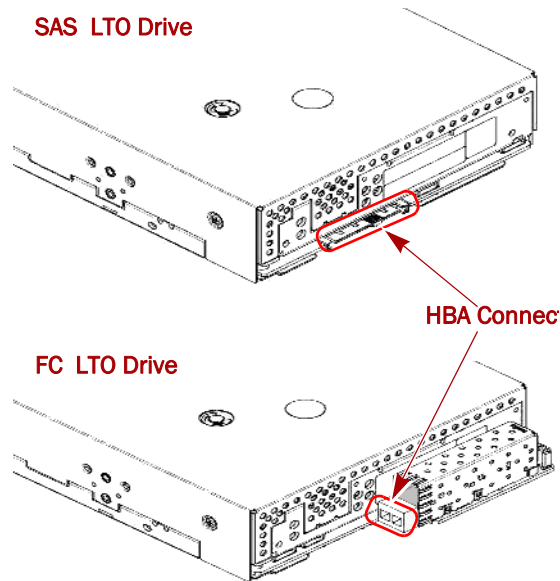


2. Use the **supplied screws** in the appropriate holes to secure the drive. The holes may be on both sides or on the bottom.
3. For an FC drive, attach the supplied **Power Connector Adapter** between the internal power supply and drive.



NOTE: A SAS drive gets its power through the SAS cable.

4. Connect the **HBA card** to the rear of the LTO drive.



5. Power up the **server**.

Watch the boot screen carefully to verify that the new LTO tape drive is listed in the boot sequence.

NOTE: If there are any errors or unexpected messages, go back and check the cabling carefully.

6. If required, install Windows **drivers**.

For Windows systems, download the latest drivers from the [Overland-Tandberg Drivers and Downloads website](#).

NOTE: For other operating systems, patch the latest version of the operating system, following the instructions in the patch documentation.

7. Upgrade your **backup software**.

Always upgrade your backup software to ensure it works correctly with the tape drive. Some backup applications require you to use their own drivers. Refer to the documentation of your software application to ensure you are using the recommended driver.



IMPORTANT: Overland-Tandberg does NOT recommend native backup applications, such as Windows Backup, because they do not support the full features of the tape drive and may cause performance problems.

Verify Firmware & Drivers

Check online for the latest versions for the firmware and drivers for your Overland-Tandberg LTO tape drive. Refer to [Firmware Updates and Technical Support](#) on [page 7](#). If needed, the tape drive diagnostic tool with instructions for use is also available at the same site.

Overland-Tandberg also recommends upgrading your software application to ensure it works correctly with your tape drive.

2

Tape Drive Operation

This section covers the general operation of an LTO tape drive.

Topics in Tape Drive Operation:

- [Operating Modes](#)
- [Operator Panel](#)
- [Eject Button](#)
- [Power Button \(External Drive\)](#)
- [Single-Character Display \(SCD\)](#)
- [Operator Panel](#)
- [Operator Panel](#)
- [Front Panel Operations](#)
- [Loading and Unloading Cartridges](#)
- [Cleaning Cartridge Usage](#)
- [Diagnostic and Maintenance](#)

Operating Modes

The drive functions in these modes:

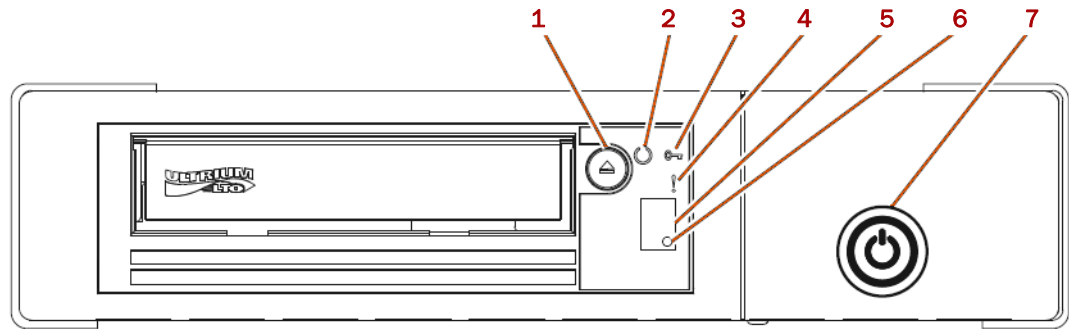
- Operation mode - functions include reading and writing data, cartridge manipulation, error reporting, and updating firmware with an FMR cartridge. For more information, see [“Status Lights” on page 24](#).
- Maintenance mode - functions include drive diagnostic, creation/unmake FMR cartridge, and drive dump manipulation (force to RAM, copy to tape, copy to flash memory, and erase flash). For more information, see [“Diagnostic and Maintenance” on page 31](#).

The Eject button is used to switch between modes. For information, see [“Eject Button” on page 26](#).

Operator Panel

Both the internal and external LTO tape drives have an operator panel on the front consisting of LED indicators, eject button, and a Single-Character Display (SCD). The external drive also has a Drive Power button.

Tape Drive Operator Panel Layout



| Element | Description |
|---------|--|
| 1 | Cartridge eject button |
| 2 | Ready light (green) |
| 3 | Encryption light (white) |
| 4 | Fault light (amber) |
| 5 | Single Character Display (SCD) |
| 6 | SCD dot |
| 7 | Drive power button (External drive only) |

Status Lights

The drive contains a dual-color Ready status LED. When it is illuminated, the LED either flashes or is solid. This table lists the meaning of the various status LEDs.

| Ready Status LED | Encryption LED | SCD Panel | SCD Dot | Meaning |
|------------------|----------------|-----------|---------|---|
| Off | Off | Off | Off | The tape drive has no power or is powered off. |
| Solid Green | Off | Off | Off | <i>Media not loaded:</i> The tape drive is powered on. <i>If media loaded:</i> For Generation 8/7 media only, at least one block other than the label is <i>not</i> encrypted or state is unknown. |
| Solid Green | On | Off | Off | Generation 8/7 media is loaded and all data on the cartridge, not including the label, is encrypted. |

| Ready Status LED | Encryption LED | SCD Panel | SCD Dot | Meaning |
|-----------------------------------|----------------|---|---------|--|
| Flashing Green (once per second) | Off | Off | Off | The tape drive is reading from the tape, writing to the tape, rewinding the tape, locating data on the tape, loading the tape, or unloading the tape. For Generation 8/7 media only, at least one block other than the label is <i>not</i> encrypted or state is unknown. The status light also flashes green if the tape drive contains a cartridge during the power on cycle. In this case, the drive completes POST and slowly rewinds the tape (the process may take approximately 13 minutes). The light stops blinking when the drive completes the recovery and is ready for a read or write operation. To eject the cartridge, press the Eject button. |
| Flashing Green (once per second) | On | Off | Off | All data on a Generation 8/7 cartridge, not including the label, is encrypted and the tape drive is reading from the tape, writing to the tape, rewinding the tape, locating data on the tape, or unloading the tape. |
| Solid Amber | Off | Displaying an error code or Maintenance mode function | On/Off | The drive is displaying error codes from the error code log on the SCD. For more information, see “Function Code 9: Display Error Code Log” on page 54 and the “Error Codes Table” on page 62. |
| Solid Amber | Off | Flashing display of 0 | On/Off | The drive is entering or exiting from Maintenance mode. For more information, see “Function Code 0: Maintenance Mode” on page 48. |
| Solid Amber | Off | Flashing selected function | On/Off | Executing the selected option while in Maintenance mode. |
| Flashing Amber (once per second) | Off | Displaying error code | Off | An error occurred and the tape drive or media may require service or it may require cleaning. Note the code on the SCD, and then go to the “Error Codes Table” on page 62 to determine the action required. If C is displayed, it requires that a cleaner cartridge be loaded. |
| Flashing Amber (once per second) | Off | Displaying Function Code 2 | Off | The drive is updating microcode firmware.* For more information, see “Function Code 2: Update Drive Firmware from FMR Tape” on page 49. |
| Flashing Amber (twice per second) | Off | Off | Off | The drive detected an error and is performing a microcode recovery. It resets automatically. |
| Solid Amber | Off | Flashing C | Off | The drive is requesting a cartridge to be loaded. |
| Flashing Amber (twice per second) | Off | Off | On | There is a drive memory dump in flash memory. |

* Note: Power should not be removed from the drive until the microcode update is complete. The drive indicates that the update is complete by resetting and performing POST.

For any condition other than the preceding, the Ready light is not illuminated.

The SCD Dot is only illuminated if the LTO tape drive is both in Maintenance mode AND there is a drive dump available.

Status Lights During Power-on or Reset

During power-on, or a drive reset, the drive front panel displays drive progress as follows:


1. SCD displays random segments (no lights ON).
2. SCD displays random segments (Ready light ON).
3. SCD displays random segments (Fault light ON).
4. SCD displays **8** (Ready, Fault, Encryption, and SCD dot lights are all ON).
5. SCD goes blank (with Ready light ON) after a successful power-on or reset.

If an error is detected during the power-on or reset, the tape drive posts an error code to the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#).

Eject Button

The Eject button is used to perform the following functions:

| Function | How to Initiate the Function |
|--|---|
| Rewind the tape into the cartridge and eject the cartridge from the tape drive | <p>Press the Eject button once.</p> <p>The Ready light flashes green while the tape drive is rewinding and unloading.</p> <p>NOTE: During a rewind and eject operation, the tape drive does not accept SCSI or Fibre Channel commands from the server.</p> |
| Place the tape drive in Maintenance mode | <p>Ensure that the tape drive is unloaded. Then, press the Eject button three times within two seconds. You are in Maintenance mode when the Ready light flashes and 0 appears in the SCD.</p> <p>NOTE: While in Maintenance mode, the tape drive does not accept SCSI or Fibre Channel interface commands.</p> <p>If you attempt to enter Maintenance mode with a cartridge in the drive, the drive rewinds and ejects the cartridge. Remove the cartridge and repeat the steps for entering Maintenance mode.</p> |
| Scroll through the maintenance functions | <p>While in Maintenance mode, push the Eject button once per second to increment the display characters by one. When you reach the character of the diagnostic or maintenance function that you want (see “Error Codes” on page 28), press and hold the Eject button for three seconds.</p> |
| Exit Maintenance mode | <p>Press the Eject button once per second until 0 displays. Then press and hold the Eject button for 3 seconds. Maintenance mode is exited when the Ready light becomes solid green and the SCD becomes blank.</p> |

| Function | How to Initiate the Function |
|---|---|
| Force a drive dump (part of the Maintenance mode) | <p> CAUTION: If the tape drive detects a permanent error and displays an error code, it automatically forces a drive dump (also known as a save of the firmware trace). If you force a drive dump, the existing dump will be overwritten and data will be lost. After you force a drive dump, do not turn off the power to the tape drive or you may lose the dump data.</p> <ul style="list-style-type: none"> • If the tape drive is in Maintenance mode (Ready light is flashing and the SCD displays 0), select Function Code 4. • If the tape drive is in operating mode (Ready light is solid or flashing green), press and hold the Eject button for 10 seconds. <p>If captured dump data exists, the tape drive places the data into a dump area. (For information about retrieving the data, see “Procedure 1: Determining Firmware Level and Capturing Drive Dump” on page 67).</p> |
| Reset the drive | <p>Press and hold Eject until the drive begins the reset procedure (Fault light turns on when reset starts).</p> <p>NOTE: If a tape cartridge is loaded in the drive, it unloads the tape. Repeat the “Reset the drive” procedure after the tape is unloaded. The drive saves a memory dump of the current drive state, then reboots to allow communication. Do not cycle power as this action erases the contents of the memory dump.</p> |

Power Button (External Drive)

The Power button is a push button that turns the tape drive on or off. This button is on the front panel (see Callout 7 in [“Tape Drive Operator Panel Layout”](#) on page 24). When Power is in the off position, the primary electrical power within the enclosure is still active. To remove all electrical power to the enclosure, unplug the power cord from the receptacle at the rear of the drive.

When the unit is powered-on but idle, the Ready light (see Callout 2 in [“Tape Drive Operator Panel Layout”](#) on page 24) is solid green. When it is completing a function, the Ready light is flashing green.

Single-Character Display (SCD)

The drive has a Single-Character Display which displays the characters **0** through **U** with special moving characters. The display indicates errors, messages and diagnostic, and maintenance functions.

NOTE: The SCD does not indicate the characters B, D, G, I, O and Z to prevent misinterpretation as the characters (8, 0, 6, 1, 0 & 2 respectively).

[“Error Codes Table”](#) on page 62 lists the codes for error conditions and informational messages. If multiple errors occur, the code with the highest priority (represented by the lowest number) displays first. When the error is corrected, the code with the next highest priority displays, until no errors remain.

Refer to [Maintenance Mode Diagnostics](#) in [Chapter 4, "Maintenance,"](#) on [page 47](#) lists the single-character codes that represent diagnostic or maintenance functions. To initiate a function, the unit must be in Maintenance mode. The SCD is blank during normal operation.

SCD Dot

If a drive memory dump is present while the drive is in Maintenance mode, a single dot illuminates in the lower right corner of the SCD (see [Callout 6](#) in ["Tape Drive Operator Panel Layout"](#) on [page 24](#)). To copy the memory dump, see ["Function Code 5: Copy Drive Dump"](#) on [page 51](#).

The SCD dot is on solid if the memory dump is in RAM memory. The SCD dot flashes if the memory dump is in flash memory.

The SCD dot turns off when you obtain a dump (by using ITDT or a SCSI command) or update the drive firmware.

NOTE: If the drive memory dump is stored in RAM memory (SCD dot on solid), the memory dump is lost when you turn OFF the power or reset the drive.

Error Codes

The drive indicates an error by displaying an error code. The error and informational codes indicated by the SCD are set and cleared as indicated in priority (lowest number) displays. The code numbers are listed in priority order, from highest to lowest. If multiple error conditions occur, the code with the highest priority (lowest number) displays.

Refer to the ["Error Codes Table"](#) on [page 62](#) for a table showing the error codes and definitions.

Front Panel Operations

Maintenance operations can be performed using the Eject button while observing the status LED and the SCD.

Maintenance Mode

While in Maintenance mode, the drive indicates the maintenance or diagnostic function that is to be executed by displaying one of the codes shown in the table of Maintenance Codes.

Enter Maintenance Mode

To enter Maintenance mode (if the drive is not already in Maintenance mode and no cartridge is loaded), press the Eject button three times within two second. While the drive is in Maintenance mode, the status LED is illuminated solid amber and the operator may perform maintenance or diagnostic functions. In Maintenance mode, the tape drive is offline to SCSI commands.

NOTE: If a tape is loaded, the Eject button is interpreted as an eject request. The drive cannot be put into Maintenance mode while a tape is loaded.

Scroll through Maintenance Options

If the drive is in Maintenance mode, when the Eject button is pressed at a rate greater than once per second, the SCD code increments by one each time the Eject button is pressed.

After the last maintenance function is reached, the display code wraps around to **0**.

NOTE: The unassigned digits (B, D, and G) are not displayed when the options are incremented.



IMPORTANT: The Eject button must not be pressed more frequently than once per second while scrolling through the maintenance choices. If the button is pressed more frequently, the currently selected maintenance option is executed instead of the desired scrolling operation.

Execute a Maintenance Function

The drive executes the maintenance function indicated by the character on the SCD when you press and hold the Eject button for three (3) or more seconds. If the drive executes the function successfully, the SCD indicates **0**. If the function fails, the status LED indicates continuous amber and the SCD indicates the reason for the error by displaying an error code (reference [“Error Codes” on page 28](#)) from priority (lowest number) displays.

For a complete list of functions available, refer to [“Maintenance Mode Diagnostics” on page 47](#).

Exit Maintenance Mode

The drive exits Maintenance mode when the Eject button is pressed twice within one second while the SCD indicates **0** or when the selected maintenance function is completed either successfully or unsuccessfully or when the Eject button is pressed during any currently executing maintenance function.

Execute a Dump Operation When Not in Maintenance Mode

The drive performs a dump operation when the Eject button is pressed and held for 10 or more seconds. The microcode goes to its initialized state after a dump operation.

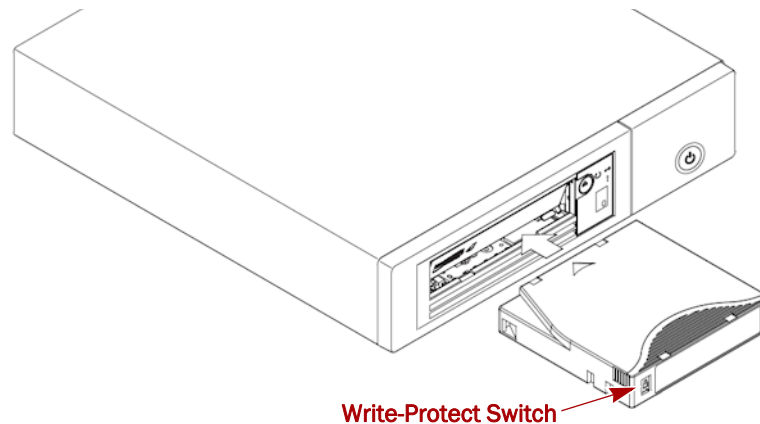
NOTE: Data from a dump is for use by trained personnel for problem determination or engineering debug.

Loading and Unloading Cartridges

If the Eject button is pressed while a tape is loaded, the drive will complete any operation in process, then rewind and eject the cartridge. The beginning of the operation is indicated by the status LED flashing green. Completion of the operation is indicated by the status LED changing from flashing green to non-illuminated.

Inserting a Tape Cartridge

To insert a tape cartridge:



1. Ensure that the drive is powered On.
2. Ensure that the write-protect switch on the tape cartridge is properly set (see [“Cartridge Write-Protect Switch”](#) on page 36).
3. Grasp the cartridge so that the write-protect switch faces you.
4. Slide the cartridge into the tape load compartment.

Note the following:

- If the cartridge is already in an ejected position and you want to reinsert it, completely remove the cartridge, then reinsert it again.
- If the cartridge is already loaded and you cycle the power (turn it Off, then On), the tape reloads.
- Do not attempt to load a cartridge when the drive is in Maintenance mode until the drive requests it.

Removing a Tape Cartridge

To remove a tape cartridge:

1. Ensure that the drive is powered-on.
2. Press Eject.
The drive rewinds the tape and partially ejects the cartridge. The Ready light flashes while the tape rewinds, then goes out before the cartridge partially ejects.
3. After the cartridge partially ejects, grasp the cartridge and remove it.

NOTE: Always remove an ejected cartridge before it is reinserted.

Whenever you eject a tape cartridge, the drive writes any pertinent information to the cartridge memory.

Mid-tape Recovery

If a reset occurs while a cartridge is loaded, the drive slowly rewinds the tape and ejects the cartridge. If a power cycle occurs while a cartridge is loaded, the drive slowly rewinds the tape but does not automatically eject the cartridge.

The Ready light flashes and the SCD counts down from **9** to **0**, indicating the approximate cartridge rewinding status. Between the counts, the SCD displays random segments while the tape is rewinding into the cartridge. Push Eject to eject the cartridge when the Ready light stops flashing.

Cleaning Cartridge Usage

Clean the drive head whenever **C** displays on the SCD and the Fault light flashes once per second. It is not recommended that you clean the drive head on a periodic basis; only when the drive requests to be cleaned.

NOTE: In Maintenance mode, a flashing **C** with the Fault light On, means to insert a cartridge, not to clean the drive head.

To clean the head, insert the cleaning cartridge into the tape load compartment. The drive completes the cleaning automatically in less than 3 minutes, then ejects the cartridge. The drive completes a short load/eject test while the cartridge is ejected. Wait for the drive to finish before the cartridge is removed.

NOTE: The drive automatically ejects an expired cleaning cartridge.

A Cleaning Cartridge is valid for 50 uses, and then must be replaced.

Diagnostic and Maintenance

See [Maintenance Mode Diagnostics](#) in [Chapter 4, "Maintenance."](#)

The drive can:

- Run diagnostics
- Test write and read functions
- Test a suspect tape cartridge
- Update firmware
- Perform other diagnostic and maintenance functions

The drive must be in Maintenance mode to perform these functions.



IMPORTANT: Maintenance functions cannot be performed concurrently with read or write operations. While in Maintenance mode, the tape drive does not accept host interface commands from the server. The tape drive does accept LDI or RS-422 commands.

3 |

Tape Media

The LTO tape drives support Ultrium cartridges. This chapter covers the details regarding those cartridges.

Topics in Tape Media:

- [Cartridge and Media](#)
- [Cleaning Cartridge](#)
- [Barcode Label](#)
- [Cartridge Write-Protect Switch](#)
- [Handling Cartridges](#)
- [Repositioning or Reattaching a Leader Pin](#)
- [Cartridge Memory \(LTO-CM\)](#)
- [Environmental and Shipping Specifications for Tape Cartridges](#)
- [Handling and Shipping](#)
- [Inspecting for Damage](#)
- [Disposing of Tape Cartridges](#)

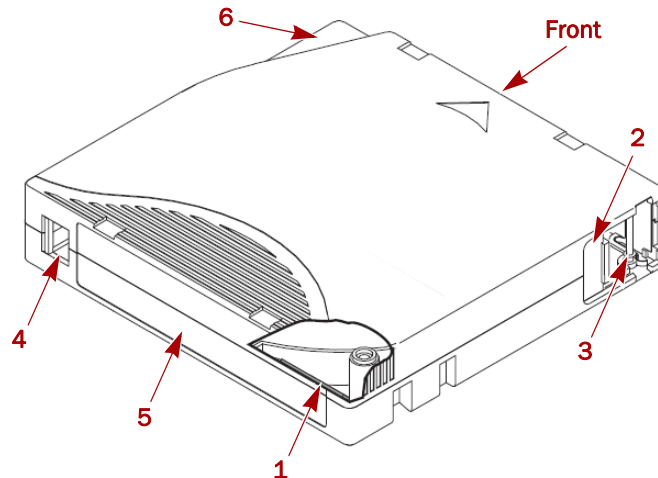
Cartridge and Media

All generations contain 1/2-inch, dual-coat, magnetic tape made of Barium Ferrite (BaFe). The media is available in the following types of cartridges:

- Data cartridge
- WORM (Write Once, Read Many) cartridge
- Cleaning cartridge

The media is housed in a cartridge, which is 102.0mm (4.02 in.) long, 105.4mm (4.15 in.) wide, and 21.5mm (0.85 in.) high.

The following shows the LTO Ultrium data cartridge and its components.



| Number | Component |
|--------|----------------------|
| 1 | LTO cartridge memory |
| 2 | Cartridge door |
| 3 | Leader Pin |
| 4 | Write-protect Switch |
| 5 | Label area |
| 6 | Insertion guide |

Cartridge Generation Colors

The different generations of IBM Ultrium data cartridges are identified by color:

| Type | Cartridge Color |
|--------------|-----------------|
| Generation 8 | Burgundy |
| Generation 7 | Purple |
| Generation 6 | Black |
| Generation 5 | Burgundy |
| Generation 4 | Green |

Recording Formats and Capacities

LTO tape drives use a linear, serpentine recording format. The native data capacity and recording format of Ultrium data cartridges is as follows:

| Type | Native Data Capacity | Recording Format |
|------------------|---|---|
| Ultrium 8 | 12000 GB (30000 GB at 2.5:1 compression) | Reads and writes data on 6656 tracks, 32 tracks at a time. |
| Ultrium 7 | 6000 GB (15000 GB at 2.5:1 compression) | Reads and writes data on 3584 tracks, 32 tracks at a time. |

| Type | Native Data Capacity | Recording Format |
|-----------|---|---|
| Ultrium 6 | 2500 GB (6250 GB at 2.5:1 compression) | Reads and writes data on 2176 tracks, 16 tracks at a time. |
| Ultrium 5 | 1500 GB (3000 GB at 2:1 compression) | Reads and writes data on 1280 tracks, 16 tracks at a time. |
| Ultrium 4 | 800 GB (1600 GB at 2:1 compression) | Reads and writes data on 896 tracks, 16 tracks at a time. |

The first set of tracks is written from near the beginning of the tape almost to the end of the tape. The head then repositions to the next set of tracks for the return pass. This process continues until all tracks are written and the cartridge is full, or until all data is written.

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

The write-protect switch prevents data from being written to the tape cartridge. For more information, see [“Cartridge Write-Protect Switch” on page 36](#).

The label area provides a location to place a label. For more information, see [“Barcode Label” on page 35](#).

The insertion guide is a large, notched area that prevents the cartridge from being inserted incorrectly.

Each cartridge has a life span of 20,000 load/eject cycles.

Cartridge Compatibility by Drive Type

This table illustrates the different cartridge generations supported based on the drive generation in which they can be used. The code “–” means not supported.

| Cartridge Gen. | LTO-8 Drive | LTO-7 Drive | LTO-6 Drive |
|----------------|--------------|--------------|--------------|
| 4 | – | – | Read Only |
| 5 | – | Read Only | Read / Write |
| 6 | – | Read / Write | Read / Write |
| 7 | Read / Write | Read / Write | – |
| 8 | Read / Write | – | – |

Cleaning Cartridge

A specially labeled LTO Cleaning Cartridge is used to clean the drive head. The drive itself determines when a head must be cleaned. It alerts you by the SCD flashing a **C**. To clean the head manually, insert a cleaning cartridge into the tape load compartment. The drive completes the cleaning automatically. When the cleaning is finished, the drive ejects the cartridge, and the SCD is blank.

NOTE: The drive automatically ejects an expired cleaning cartridge without running the cleaning process. Replace the expired cleaning cartridge with a new cleaning cartridge and insert it into the drive.

The IBM cleaning cartridges are valid for 50 uses. The cartridge's LTO-CM chip tracks the number of times that the cartridge is used. After 50 uses, the cleaning cartridge expires. It is no longer usable, and must be replaced.

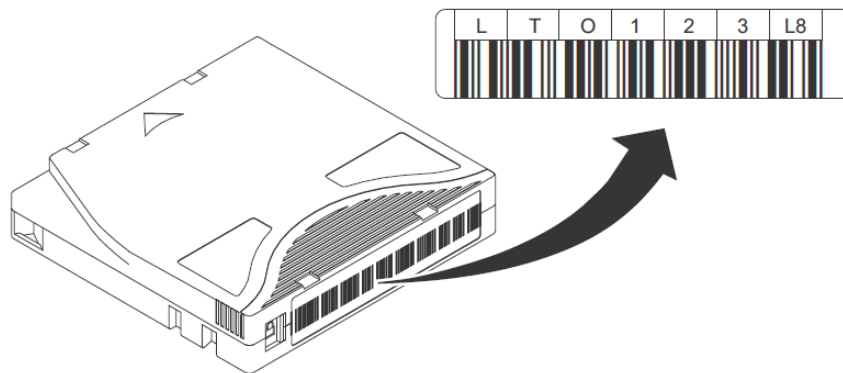
Barcode Label

A barcode label contains:

- A volume serial number (VOLSER) that is human-readable.
- A barcode that the library can read.

NOTE: The LTO tape drives do not require barcode labels, but you might choose to use labels for tape cartridge identification purposes.

When read by a library's barcode reader, the barcode identifies the cartridge's VOLSER to the library. The barcode also tells the library whether the cartridge is a data cartridge or cleaning cartridge. In addition, the barcode includes the two-character media-type identifier Lx, where x equals 1, 2, 3, 4, 5, 6, 7 or 8. The L identifies the cartridge as an LTO cartridge and the number represents the generation of cartridge for that cartridge type. This graphic shows a sample barcode label for the LTO Tape Cartridge.



Guidelines for Barcode Labels

Apply the following guidelines whenever using barcode labels:

- Use only approved barcode labels on cartridges to be used in an LTO tape drive.
- Do not reuse a label or reapply a used label over an existing label.
- Before you apply a new label, remove the old label by slowly pulling it at a right angle to the cartridge case.
- Use peel-clean labels that do not leave a residue after it is removed. If there is glue residue on the cartridge, remove it by gently rubbing it with your finger. Do not use a sharp object, water, or a chemical to clean the label area.
- Examine the label before it is applied to the cartridge. Do not use the label if it has voids or smears in the printed characters or barcode. A library's inventory operation takes much longer if the barcode label is not readable.

- Remove the label from the label sheet carefully. Do not stretch the label or cause the edges to curl.
- Position the label within the recessed label area.
- With light finger pressure, smooth the label so that no wrinkles or bubbles exist on its surface.
- Verify that the label is smooth and parallel, and has no roll-up or roll-over. The label must be flat to within 0.5mm (0.02 in.) over the length of the label and have no folds, missing pieces, or smudges.
- Do not place other machine-readable labels on other surfaces of the cartridge. They might interfere with the ability of the drive to load the cartridge.

Cartridge Write-Protect Switch

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

- If the switch is slid to the right and shows the lock icon, data cannot be written to the tape.
- If the switch is slid to the left to unlock, data can be written to the tape.

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

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

Handling Cartridges



IMPORTANT: Do not insert a damaged tape cartridge into the drive. A damaged cartridge can interfere with the reliability of a drive and might void the warranties of the drive and the cartridge. Before a tape cartridge is inserted, inspect the cartridge case, cartridge door, and write-protect switch for breaks.

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

Providing Training

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

Ensuring Proper Packaging

- When a cartridge is shipped, use the original or better packaging.
- Always ship or store a cartridge in a jewel case.
- Use only a recommended shipping container that securely holds the cartridge in its jewel case during transportation. Turtlecases (by Perm-A-Store) are tested and found to be satisfactory. They are available at <http://www.turtlecase.com>.



- Never ship a cartridge in a commercial shipping envelope. Always place it in a box or package.
- If you ship the cartridge in a cardboard box or a box of a sturdy material, ensure that you:
 - Place the cartridge in polyethylene plastic wrap or bags to protect it from dust, moisture, and other contaminants.
 - Pack the cartridge snugly; do not allow it to move around.
 - Double-box the cartridge (place it inside a box, then place that box inside the shipping box) and add padding between the two boxes.

Proper Acclimation and Environmental Conditions

- Before you use a tape cartridge, acclimate it to the operating environment for 24 hours or the time necessary to prevent condensation in the drive. The time varies, depending on the environmental extremes to which the cartridge was exposed.
- Ensure that all surfaces of a cartridge are dry before it is inserted.
- Do not expose the cartridge to moisture or direct sunlight.
- Do not expose recorded or blank cartridges to stray magnetic fields of greater than 100 Oersteds (for example, terminals, motors, video equipment, X-ray equipment, or fields that exist near high-current cables or power supplies). Such exposure causes the loss of recorded data or makes the blank cartridge unusable.
- Maintain the conditions that are described in “[Environmental and Shipping Specifications for Tape Cartridges](#)” on page 43.

Completing a Thorough Inspection

After a cartridge is purchased and before it is used, complete the following steps:

- Inspect the cartridge's packaging to determine potential rough handling.
- When a cartridge is inspected, open only the cartridge door. Do not open any other part of the cartridge case. The upper and lower parts of the case are held together with screws; separating them destroys the usefulness of the cartridge.
- Inspect the cartridge for damage before it is used or stored.
- Inspect the rear of the cartridge (the part that loads first into the tape load compartment) and ensure that there are no gaps in the seam of the cartridge case. If there are gaps in the seam, the leader pin might be dislodged. Go to [“Repositioning or Reattaching a Leader Pin” on page 39](#).
- Check that the leader pin is properly seated.
- If you suspect that the cartridge was mishandled but it appears usable, copy any data onto a good cartridge immediately for possible data recovery. Discard the mishandled cartridge.
- Review handling and shipping procedures.

Handle the Cartridge Carefully

- Do not drop the cartridge. If the cartridge drops, slide the cartridge door back and ensure that the leader pin is properly seated in the pin-retaining spring clips. If the leader pin becomes dislodged, go to [“Repositioning or Reattaching a Leader Pin” on page 39](#).
- Do not handle tape that is outside the cartridge. Handling the tape can damage the tape's surface or edges, which might interfere with read or write reliability. Pulling on tape that is outside the cartridge can damage the tape and the brake mechanism in the cartridge.
- Do not stack more than six cartridges.
- Do not degauss a cartridge that you intend to reuse. Degaussing makes the tape unusable.

Examples of Cartridge Problems

Example 1. Split cartridge case.

The cartridge's case is damaged. There is a high possibility of media damage and potential loss.

1. Look for cartridge mishandling.
2. Use the IBM Leader Pin Reattachment Kit (part number 08L9129) to correctly seat the pin (see “Repositioning or reattaching a leader pin”).
Then, immediately use data recovery procedures to minimize chances of data loss.
3. Review media-handling procedures.

Example 2. Improper placement of leader pin.

The leader pin is misaligned.

1. Look for cartridge damage.
2. Use the IBM Leader Pin Reattachment Kit (part number 08L9129) to correctly seat the pin (see “Repositioning or reattaching a leader pin”).
Then, immediately use data recovery procedures to minimize chances of data loss.

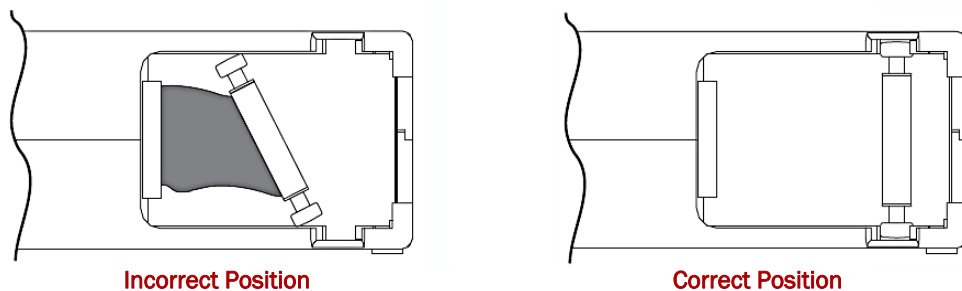
Repositioning or Reattaching a Leader Pin

CAUTION: Use a repaired tape cartridge only to recover data and move it to another cartridge. Continued use of a repaired cartridge might void the warranties of the drive and the cartridge.

If the leader pin in your cartridge becomes dislodged from its pin-retaining spring clips or detaches from the tape, you must use the IBM Leader Pin Reattachment Kit (part number 08L9129) to reposition or reattach it. (Do not reattach the pin if you must remove more than 7 meters (23 feet) of leader tape.) The sections that follow describe each procedure.

Repositioning a Leader Pin

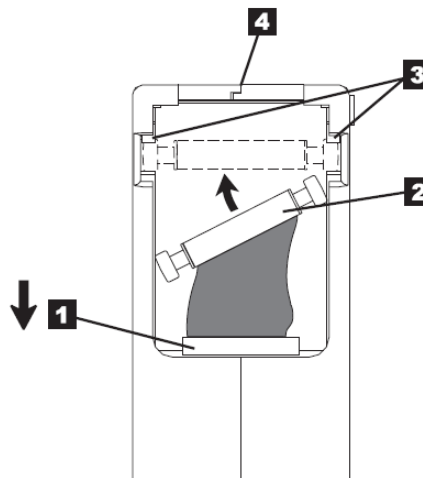
A leader pin that is improperly seated inside a cartridge interferes with the operation of the drive.



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

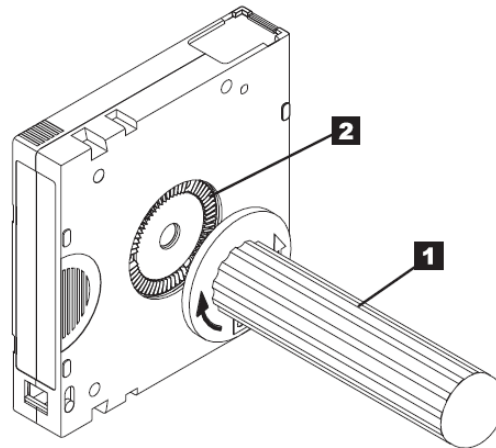
- Plastic or blunt-end tweezers
- Cartridge manual rewind tool (from Leader Pin Reattachment Kit, part number 08L9129)

To reposition the leader pin:



1. Slide open the cartridge door **(1)** and locate the leader pin (you might need to shake the cartridge gently to roll the pin toward the door).
2. With plastic or blunt-end tweezers, grasp the leader pin **(2)** and position it in the pin-retaining spring clips.

3. Press the leader pin gently into the clips (3) until it snaps into place and is firmly seated.
4. Close the cartridge door (4).
5. To rewind the tape, insert the cartridge manual rewind tool (1) into the cartridge's hub (2) and turn it clockwise until the tape becomes taut.

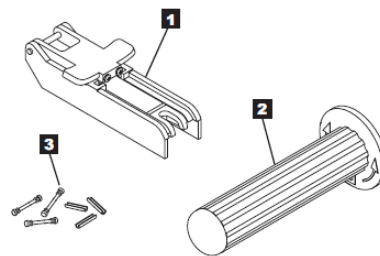


6. Remove the rewind tool by pulling it away from the cartridge.
7. If you suspect that the cartridge was mishandled but it appears usable, copy any data onto a good cartridge immediately for possible data recovery. Discard the mishandled cartridge.

Reattaching a Leader Pin

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

The Leader Pin Reattachment Kit contains three parts:



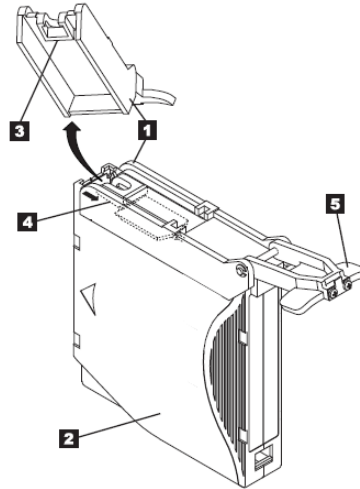
- Leader pin attach tool – A plastic brace that holds the cartridge door open.
- Cartridge manual rewind tool. – A device that fits into the cartridge's hub and enables you to wind the tape into and out of the cartridge.
- Pin supplies – Leader pins and C-clips.

Pay close attention to the following:

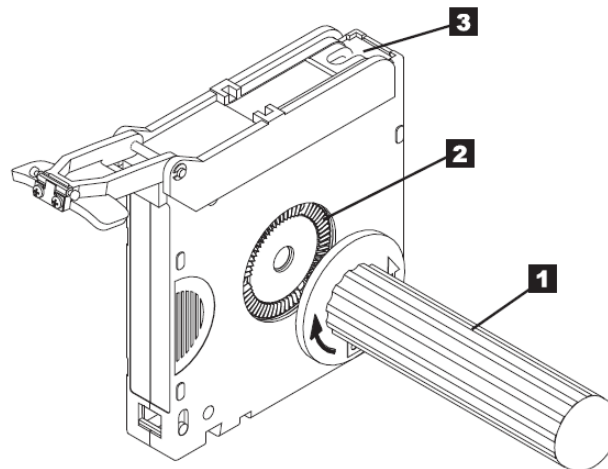
- Use only the IBM Leader Pin Reattachment Kit to reattach the leader pin to the tape. Other methods of reattaching the pin damages the tape, the drive, or both.

- Use this procedure on your tape cartridge only when the leader pin detaches from the magnetic tape and you must copy the cartridge's data onto another cartridge. Destroy the damaged cartridge after you copy the data. This procedure might affect the performance of the leader pin during threading and unloading operations.
- Touch only the end of the tape. Touching the tape in an area other than the end can damage the tape's surface or edges, which might interfere with read or write reliability.

To reattach a leader pin with the IBM leader pin reattachment kit:

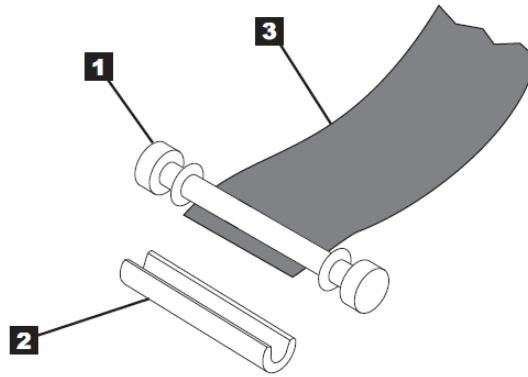


1. Attach the leader pin attach tool (1) to the cartridge (2) so that the tool's hook (3) latches into the cartridge's door (4).
2. Pull the tool back to hold the door open, then slide the tool onto the cartridge.
3. Open the tool's pivot arm (5).
4. To find the end of the tape inside the cartridge:

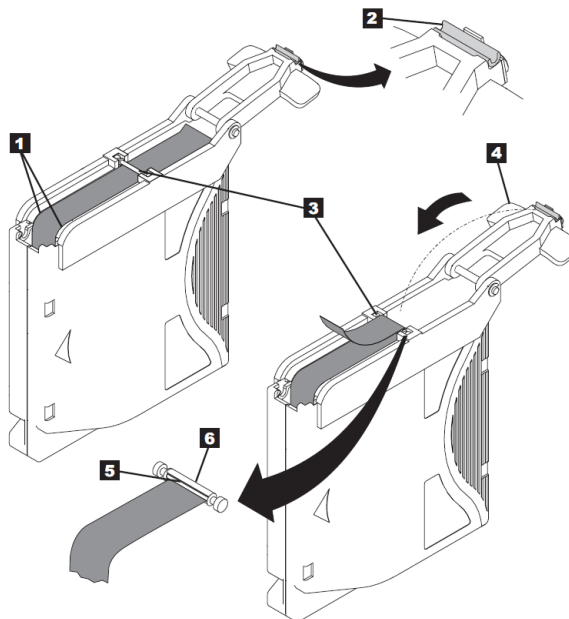


- a. Attach the cartridge manual rewind tool (1) to the cartridge's hub (2) by fitting the tool's teeth between the teeth of the hub.
- b. Turn the tool clockwise until you see the end of the tape inside the cartridge.
- c. Then, slowly turn the rewind tool counterclockwise to bring the tape edge toward the cartridge door (3).

5. Continue to turn the rewind tool counterclockwise until approximately 13cm (5 in.) of tape hangs from the cartridge door.
If necessary, grasp the tape and pull gently to unwind it from the cartridge.
6. Remove the rewind tool by pulling it away from the cartridge and set the tool and the cartridge aside.
7. On the leader pin (1):



- a. Locate the open side of the C-clip (2).
The C-clip is a small black part that secures the tape (3) to the pin.
 - b. Remove the C-clip from the leader pin by using your fingers to push the clip away from the pin.
Set the pin aside and discard the clip.
8. Attach the new leader pin:



- a. Position the tape in the alignment groove of the leader pin attach tool (1).
- b. Place a new C-clip into the retention groove (2) on the leader pin attachment tool and make sure that the clip's open side faces up.

- c. Place the leader pin (Step 7 on page 42) into the cavity (3) of the leader pin attach tool.
- NOTE:** To prevent the leader pin from rolling into the cartridge, in the following step use care when the tape is folded over the pin.
- d. Fold the tape over the leader pin (3) and hold it with your fingers.
 - e. Close the pivot arm (4) of the leader pin attach tool by swinging it over the leader pin so that the C-clip snaps onto the pin and the tape.
 - f. Swing the pivot arm open and trim the excess tape (5) so that it is flush with the reattached leader pin (6).
 - g. Use your fingers to remove the leader pin from the cavity (3) in the leader pin attach tool.
 - h. Use the cartridge manual rewind tool to wind the tape back into the cartridge (wind the tape clockwise).
Ensure that the leader pin is latched by the pin-retaining spring clips on each end of the leader pin.
 - i. Remove the rewind tool.
 - j. Remove the leader pin attach tool by lifting its end away from the cartridge.

Cartridge Memory (LTO-CM)

The LTO cartridge contains a contact-less silicon storage device that is physically part of the cartridge. This device is known as the LTO-CM (Linear Tape Open - Cartridge Memory). The U832 standard provides a description of the cartridge memory.

The LTO-CM holds information about that specific cartridge, the media in the cartridge, and the data on the media. The LTO-CM is located in the left rear corner of the cartridge.

Fields within the LTO-CM are used to enhance drive performance (such as locating records rapidly), store information usable by application programs, and aid serviceability (such as through the use of TapeAlert flags). The drive is required to update information in the LTO-CM as a normal part of drive operation.

There is a section of memory in the LTO-CM reserved for application program use. This section is available through SCSI READ ATTRIBUTE command and WRITE ATTRIBUTE command. See the *Ultrium 8 SCSI Reference* for more details.

Communication between the drive and the LTO-CM is via a low-level RF field transmitted by the drive to the cartridge. This field is modulated by the drive to query the LTO-CM and to write data into the LTO-CM. The field is modulated by the cartridge in response to commands received from the drive. The LTO-CM is powered by the RF field; it requires no additional power source.

Environmental and Shipping Specifications for Tape Cartridges

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

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

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

The following table gives the environment for operating, storing, and shipping LTO Ultrium Tape Cartridges.

| Environmental Factor | Environmental Specifications | | | |
|---------------------------------------|------------------------------|----------------------------|----------------------------|--------------------------------|
| | Operating | Operational Storage* | Archival Storage† | Shipping |
| Temperature | 10 - 45 °C (50 - 113 °F) | 16 - 32 °C (61 - 90 °F) | 16 - 25 °C (61 - 77 °F) | -23 to 49 °C (-9 to 120 °F) |
| Relative humidity (non-condensing) | 10 - 80% | 20 - 80% | 20 - 50% | 5 - 80% |
| Maximum wet bulb temperature | 26 °C (79 °F) | 26 °C (79 °F) | 26 °C (79 °F) | 26 °C (79 °F) |

* The short term or operational storage environment is for storage durations of up to six months.

† The long term or archival storage environment is for durations of six months up to 10 years.

Handling and Shipping

The following recommendations minimize damage to the cartridge during transportation:

- Avoid mechanical loads that would distort the cartridge shape.
- Avoid dropping the cartridge.
- Place cartridges in individual cartridge containers, so called jewel cases, and latch them properly.
- Fit cartridges (in containers) into a rigid shipping box containing adequate shock-absorbent material.
- Assure that the cartridges in their containers will not be loose or come loose in the shipping box.
- Assure that the final box has a clean interior and a construction that provides sealing to prevent the ingress of dirt and water, in shipping environments where dirt and water may be encountered.
- Assure that the orientation of the cartridges within the final box is such that the axes of the tape reels are horizontal.
- Clearly mark the final box to indicate correct orientation

Whenever a cartridge is received, remove film wrap from cartridge and condition it to the operating environment for a period of at least 24 hours before it is used.

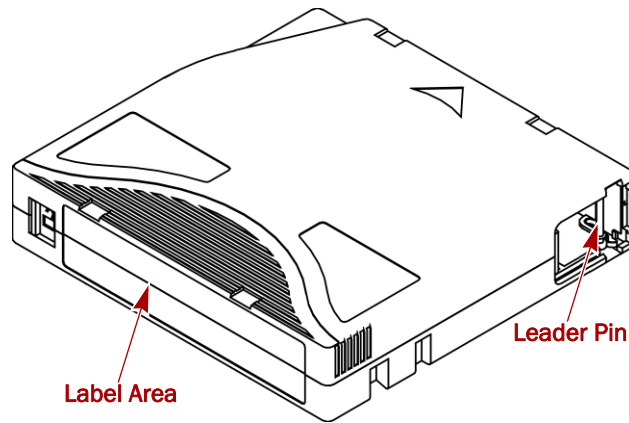
During shipping or storage, do not expose the cartridge to a field in excess of 50 Oersteds of magnetic field intensity.

Inspecting for Damage

When a cartridge is received, inspect it for damage prior to inserting it into the drive.

The cartridge should show no evidence of:

- Leader pin in any position other than fully seated into its cartridge location.
- Separated, cracked, chipped, deformed, or damaged outer shell.
- Moisture or condensation on or in the cartridge shell or media.
- Labels affixed in a manner that could adversely affect drive operation.
- Missing leader pin.



Disposing of Tape Cartridges

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

If your local, state, country (non-US), or regional regulations are more restrictive than EPA 40CFR261, you must review them before you dispose of a cartridge. Contact your account representative for information about the materials that are in the cartridge.

If a tape cartridge must be disposed of in a secure manner, you can erase the data on the cartridge with a high-energy ac degausser (use a minimum of 4000 Oersted peak field over the entire space that the cartridge occupies). The tape must make two passes through the field at 90 degree orientation change for each pass to achieve complete erasure. Some commercial degaussers have two magnetic field regions offset 90 degrees from each other to accomplish complete erasure in one pass for higher throughput. Degaussing makes the cartridge unusable.

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

4

Maintenance

The diagnostic routines test the functions of the drive and report the results to the operator or service representative. Error details are available to isolate error conditions between the media and drive. The routines are:

- Power-on self test.
- Maintenance mode tests, such as a Tape Write/Read test.
- Isolation diagnostics to isolate between media and hardware when an error occurs.

The power-on self test (POST) is executed automatically. The Maintenance mode test routines isolate errors during operation and at drive installation. Isolation diagnostics isolate errors during operation in addition to the diagnostic routines provided by the drive, host diagnostics can be executed to exercise various functions of the drive.

Topics in Maintenance:

- [Power-On Self Test \(POST\)](#)
- [Maintenance Mode Diagnostics](#)
- [Send Diagnostics](#)
- [Isolation Diagnostics](#)
- [Reliability, Availability, and Serviceability \(RAS\)](#)
- [Hardware Detection of Errors](#)
- [Error Isolation](#)
- [Error Reporting](#)
- [Error Recording](#)
- [Logs](#)
- [SARS](#)

Power-On Self Test (POST)

The drive performs the following self tests upon application of power to the drive:

- Memory tests
- Module tests
- Data channel test
- Servo channel test
- A subset of Sensor Tests
- Motor tests

Power-on self test performs a functional test of the drive. It initializes the microprocessor working memory, the external Interface chips, and the drive electronics. If media is not present at power-on, the entire POST sequence is executed.

If the cartridge is in the drive at power-on, portions of POST are not executed.

If possible (doesn't apply to power off), the drive responds with CHECK CONDITION status (sense = Not Ready – Logical Unit has not Self-Configured) until all tests have completed successfully.

If an error condition occurs and if possible (as above), an error code (reference the “[Error Codes Table](#)” on page 62) is displayed on the SCD and is transferred through the Fibre Channel or SAS bus in response to the next command.

Maintenance Mode Diagnostics

This section provides a summary of the Maintenance mode options.

| Display Code | Maintenance Function |
|--------------|--|
| None | Normal Mode |
| 0 | Function Code 0: Maintenance Mode: Causes the drive to become available for reading and writing data. |
| 1 | Function Code 1: Run Drive Diagnostics: Runs tests to determine whether the drive can properly load and eject cartridges, and read and write data. |
| 2 | Function Code 2: Update Drive Firmware from FMR Tape: Loads updated firmware from a field microcode replacement (FMR) tape. |
| 3 | Function Code 3: Create FMR Tape: Copies its field microcode replacement (FMR) data to a customer-supplied scratch (blank) data cartridge. |
| 4 | Function Code 4: Force a Drive Dump: Same as Eject button pressed for 10 or more seconds, except it doesn't cause a Reset. |
| 5 | Function Code 5: Copy Drive Dump Copies data from a drive dump (captured by using Function Code 4) to the beginning of a customer-supplied scratch (blank) data cartridge, copies a drive dump to flash memory, or erases a dump from flash memory. |
| 6 | Function Code 6: Run Host Interface Wrap Test: Performs a check of the circuitry from and to the connector. |
| 7 | Function Code 7: Run RS-422 Wrap Test: This test causes the drive to perform a check of the circuitry and connector for the RS-422 interface. |
| 8 | Function Code 8: Unmake FMR Tape: Erases the FMR data on a customer-supplied scratch (blank) data cartridge and rewrite the cartridge memory on the tape. This turns the cartridge into a valid customer-supplied scratch data cartridge. |
| 9 | Function Code 9: Display Error Code Log: Displays the last 10 error codes, one at a time (the codes are ordered; the most recent is presented first and the oldest (tenth) is presented last). |
| A | Function Code A: Clear Error Code Log: Erases the contents of the error code log. |
| C | Function Code C: Insert Cartridge into Tape Drive: This function cannot be selected by itself, but is a part of other maintenance functions (such as Run Tape Drive Diagnostics and Create FMR Tape) that require a tape cartridge to be loaded. |
| E | Function Code E: Test Cartridge and Media: Performs tests to ensure that a suspect cartridge and its magnetic tape are acceptable. |
| F | Function Code F: Write Performance Test: Performs tests to ensure that the drive can read from and write to tape. |

| Display Code | Maintenance Function |
|--------------|---|
| H | Function Code H: Test Head: Performs tests to ensure that the tape drive's head and tape-carriage mechanics are working correctly. |
| J | Function Code J: Fast Read/Write Test: Performs tests to ensure that the drive can read from and write to tape. |
| L | Function Code L: Load/Eject Test: Tests the drive's ability to load and eject a tape cartridge. |
| P | Function Code P: POST Error Reporting Enabled: When selected, deferred-check conditions are reported to the host. |
| U | Function Code U: POST Error Reporting Disabled: When selected, deferred-check conditions are NOT reported to the host. |

Entering Maintenance Mode

The drive must be in Maintenance mode to run drive diagnostics or maintenance functions. To place the unit in Maintenance mode:

1. Make sure that no cartridge is in the drive.
2. Press the Eject button three (3) times within two (2) seconds.
A zero (0) appears in the SCD, and the Status Light turns amber.

NOTE: If a cartridge is in the tape drive, it will eject the first time that you press the Eject button and the drive will not be placed in Maintenance mode. To continue placing the drive in Maintenance mode, perform the step again.

Maintenance functions cannot be performed concurrently with read or write operations. While in Maintenance mode, the drive does not receive SCSI commands from the server (does not respond to SCSI commands).

Exiting Maintenance Mode

The drive must be in Function Code **0** to exit Maintenance mode. To exit Maintenance mode and return to normal operating mode, press and hold the Eject button for three (3) or more seconds.

- If no error was detected, **0** temporarily appears in the SCD, and then goes blank. The drive then exits Maintenance mode and the Status Light returns to green.
- If an error was detected, the SCD shows an error code but still exits Maintenance mode.

To determine the error, locate the code in the “[Error Codes Table](#)” on page 62. To clear the error, turn the power off, then on again.

NOTE: The drive also exits Maintenance mode automatically after it completes a maintenance function or after 10 minutes if no action has occurred.

Function Code 0: Maintenance Mode

Function Code **0** makes the drive available for running drive either diagnostic tests or maintenance functions, or exiting from Maintenance mode.

See “[Entering Maintenance Mode](#)” and “[Exiting Maintenance Mode.](#)”

Function Code 1: Run Drive Diagnostics

Approximate Run Time = 5 minutes per loop

Total Number of Loops = 1

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

Record the time that it takes for the test to complete. Compare the recorded time with the Approximate Run Time. If the test runs successfully but the execution time is longer than the Approximate Run Time, run [“Function Code F: Write Performance Test” on page 56](#). If the Write Performance Test fails, replace the media and exit Maintenance mode.



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

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

Steps to Run Drive Diagnostic Tests:

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press Eject once per second until **1** displays in the SCD.
If you cycle past the wanted code, press the Eject button once per second until the code reappears.
3. Press and hold Eject for three (3) or more seconds, then release it to select function **1**.
Wait for the SCD to change to a flashing **C**, requesting a cartridge.
4. Insert a scratch (blank) data cartridge.
The SCD changes to a flashing **1** and the test begins. During the test, the drive unloads and loads the cartridge. Do not remove the cartridge during the test.
 - If no error is detected, the diagnostic test loops and begin again. To stop the loop, press Eject for one second and release. When the loop ends, **0** temporarily displays in the SCD, and the tape drive exits Maintenance mode.
 - If an error is detected, the Fault light flashes and the drive posts an error code to the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#). To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding Eject for 10 seconds.

Function Code 2: Update Drive Firmware from FMR Tape



CAUTION: When updating drive firmware, do not power off the drive until the update is complete or the firmware may be lost (new firmware may not be applied).

Function Code **2** loads drive firmware from a field microcode replacement (FMR) tape.

The FMR tape must have been created from an LTO tape drive of the same Generation with the same host interface (SAS or Fibre Channel).

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.

2. Press the Eject button once per second until **2** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function.
The SCD changes to a flashing **C**, requesting a cartridge.
4. Insert the FMR tape cartridge.
The SCD changes to a flashing **2**. The Fault light is ON and solid during tape movement and flashing while code is being loaded. The Ready light is OFF. The tape drive loads the updated firmware from the FMR tape into its erasable programmable read-only memory (EPROM) area.
 - If the update completes successfully, the tape drive rewinds and unloads the FMR tape, resets itself, and is ready to use the new firmware. The drive automatically reboots.
 - If the update fails, the tape drive posts an error code to the SCD. To determine the error, locate the code in the “[Error Codes Table](#)” on page 62. The drive then unloads the FMR tape and exits Maintenance mode after the cartridge is removed from the drive. Contact Overland-Tandberg Technical Support for problem determination or machine replacement.

Function Code 3: Create FMR Tape

Function Code **3** copies the drive's field microcode replacement (FMR) data to a scratch data cartridge. The resulting FMR tape can only be used to update the firmware on an LTO tape drive of the same Generation with the same host interface (SAS or Fibre Channel).



CAUTION: For this function, insert only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the drive overwrites the data on the cartridge.

- NOTE:** If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.
1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
 2. Press the Eject button once per second until **3** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
 3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **3**.
The SCD changes to a flashing **C**, requesting a cartridge.
 4. Insert a scratch (blank) data cartridge that is not write protected (otherwise, the tape drive exits Maintenance mode).
The SCD changes to a flashing **3**. The tape drive copies the FMR data to the scratch data cartridge.
 - If the tape drive creates the FMR tape successfully, it rewinds and unloads the new tape, exits Maintenance mode, and the tape is ready to use.

- If the tape drive fails to create the FMR tape, it displays an error code. To determine the error, see the “[Error Codes Table](#)” on page 62. The tape drive then unloads the FMR tape and exits Maintenance mode after the cartridge is removed from the drive.

Function Code 4: Force a Drive Dump

Function Code 4 performs a dump of data collected by the drive (this process is also known as saving a microcode trace).

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until **4** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **4**.

The drive performs the dump. The SCD shows **0**, and then goes blank.

To access the contents of the dump, see “[Function Code 5: Copy Drive Dump](#).”

NOTE: You can also force a drive dump when the tape drive is in normal operating mode. Simply press and hold the Eject button for ten (10) seconds. This causes the drive to reboot.

Function Code 5: Copy Drive Dump

Function Code 5 copies data from a drive dump (captured in Function Code 4) to the beginning of a scratch (blank) data cartridge.



CAUTION: For this function, insert only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the drive overwrites the data on the cartridge.

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until **5** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **5**.
4. Press the Eject button once per second to cycle through the following functions:
 - **5 + 0:** no function
 - **5 + 1:** copy dump to tape; clears RAM memory dump
 - **5 + 2:** copy dump to flash memory; clears RAM memory dump
 - **5 + 3:** erase flash memory

If you cycle past the desired code, press the Eject button once per second until the code reappears.

5. Press and hold the Eject button for three (3) or more seconds, then release it to select one of the above functions.
 - If you selected **5 + 0**, the drive will exit Maintenance mode.
 - If you selected **5 + 1**, the SCD will change to a flashing **C** indicating that a data cartridge is to be inserted.
 - If you selected **5 + 2** or **5 + 3**, the SCD will change to a flashing **5** while the appropriate procedure is being performed. After the procedure is completed the drive will exit Maintenance mode.
6. Insert a scratch (blank) data cartridge that is not write protected (otherwise, the tape drive exits Maintenance mode).
The SCD flashes the selection number while performing the function.
 - If the copy operation completes successfully, the tape drive rewinds, unloads the tape, and exits Maintenance mode after the cartridge is removed from the drive.
 - If the copy operation fails, an error code appears in the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#). The tape drive unloads the tape cartridge and exits Maintenance mode after the cartridge is removed from the drive.

Function Code 6: Run Host Interface Wrap Test

Approximate Run Time = 10 seconds per loop

Total Number of Loops = This test runs until stopped by pressing Eject.

Function Code **6** performs a check of the host interface circuitry and host connector on the drive.

1. Make sure that the host interface wrap plug is connected to the host interface connector at the rear of the drive.
 - For Fibre Channel drives, make sure the wrap plug is connected to an SFP in the ports to be tested.
 - For SAS drives, make sure a SFF-8482 SAS cable/connector is connected to the rear of the drive. Connect the wrap plug to the SAS connector port to be tested.
2. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
3. Press the Eject button once per second until **6** appears in the SCD.
4. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **6**.
5. For a drive with two interface ports, press the Eject button once per second to cycle through the following functions:
 - **6 + 0**: exit
 - **6 + 1**: test the primary port (Port 0)
 - **6 + 2**: test the secondary port (Port 1)
 - **6 + 3**: test both primary and secondary ports at the same time (requires a wrap plug in both ports)

6. To select one of the above functions, press and hold the Eject button for three (3) or more seconds and then release it.

The drive automatically starts the test. If you cycle past the desired code, press the Eject button once per second until the code reappears.

The SCD displays a flashing **6** during the test.

- If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Eject button for one (1) second and release. When the loop ends, **0** temporarily appears in the SCD and the tape drive exits Maintenance mode.
- If an error is detected, the Fault light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#). To clear the error, either turn the power off and then on again or reboot the drive by pressing and holding the Eject button for 10 seconds.

Function Code 7: Run RS-422 Wrap Test

NOTE: This function is described here for information only. It is not supported on the LTO-6/7/8 tape drives.

This test causes the drive to perform a check of the circuitry and connector for the RS-422 interface. This connector supports the Library Drive Interface (LDI) and the Automation Drive Interface (ADI).

Before selecting this function, attach an LDI or RS-422 wrap plug to the drive's LDI or RS-422 connector (in place of the LDI or RS-422 cable).

1. Make sure that no cartridge is in the drive, and the appropriate wrap plug is attached to the RS-422 connector.
2. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
3. Press the Eject button once per second until **7** appears in the SCD.

If you cycle past the desired code, press the Eject button once per second until the code reappears.

4. Press and hold the Eject button for three (3) or more seconds, then release it to select the function.

The SCD changes to a flashing **7** and the drive automatically starts the test.

- If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Eject button for one second and release. When the loop ends, **0** temporarily appears in the SCD and the tape drive exits Maintenance mode.
- If an error is detected, the Fault light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#). To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Eject button for 10 seconds.

Function Code 8: Unmake FMR Tape

Function Code **8** erases the field microcode replacement (FMR) data and rewrites the cartridge memory on the tape. This converts the cartridge into a valid scratch (blank) data cartridge.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.

2. Press the Eject button once per second until **8** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **8**.
The SCD changes to a flashing **C**, requesting a cartridge.
4. Insert FMR data cartridge (otherwise, the tape drive exits Maintenance mode).
The SCD changes to a flashing **8**. The tape drive erases the firmware on the tape and rewrites the header in the cartridge memory to change the cartridge to a valid scratch (blank) data cartridge.

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

- If the tape drive creates the scratch tape successfully, it rewinds and unloads the new tape, exits Maintenance mode, and the tape is ready to use.
- If the tape drive fails to create the scratch tape, it displays an error code. To determine the error, locate the code in the “[Error Codes Table](#)” on page 62. The tape drive then unloads the FMR tape, and exits Maintenance mode after the cartridge is removed from the drive.

Function Code 9: Display Error Code Log

Function Code **9** displays the last 10 error codes, one at a time with the most recent presented first and the oldest presented last. If there are no errors in the log, Function Code **0** displays in the SCD and it exits Maintenance mode.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until **9** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to view the most recent error code.
4. Press the Eject button again to view successive error codes.
Allow two to three seconds to pass between each depression. The Ready light and Fault light flash On/Off once for each successive error code. The SCD will display **0** when all the error codes have been displayed.
5. After viewing all error codes, exit this function by pressing the Eject button again.
The SCD displays **0** and exits Maintenance mode.

Function Code A: Clear Error Code Log

Function Code **A** erases the contents of the error code log.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.

2. Press the Eject button once per second until **A** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **A**.
An **A** flashes in the SCD, followed by **0**. The tape drive erases all errors from the error code log and exits Maintenance mode.

Function Code C: Insert Cartridge into Tape Drive

This function cannot be selected by itself, but is part of other maintenance functions (such as Run Tape Drive Diagnostics and Create FMR Tape) that require a tape cartridge to be inserted.

Function Code E: Test Cartridge and Media

Approximate Run Time = 15 minutes per loop

Total Number of Loops = 10

Function Code **E** performs tests that determine whether a suspect cartridge and its magnetic tape are acceptable.

Press the Eject button to stop the diagnostic and exit Maintenance mode.

- Pressing the Eject button once will abort the test at the end of the current test loop.
- Pressing the Eject button twice will abort the test immediately.

Wait for the drive to rewind the tape and eject the cartridge.



CAUTION: When you perform this test, data on the suspect tape will be overwritten.

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until **E** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **E**.
The SCD changes to a flashing **C**, requesting a cartridge.
4. Ensure that the write-protect switch on the suspect cartridge is off (otherwise, the tape drive exits Maintenance mode), then insert the cartridge into the tape drive.
The SCD changes to **E**. The tape drive runs the tests.
 - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Eject button for one (1) second and release. When the loop ends, **0** temporarily appears in the SCD and the tape drive exits Maintenance mode.

- If an error is detected, the Fault light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#). To clear the error, either turn the power off and then on again or reboot the drive by pressing and holding the Eject button for 10 seconds.

Function Code F: Write Performance Test

Approximate Run Time = 7 minutes per loop

Total Number of Loops = 10

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

Press the Eject button to stop the diagnostic and exit Maintenance mode.

- Pressing the Eject button once will abort the test at the end of the current test loop.
- Pressing the Eject button twice will abort the test immediately.

Wait for the drive to rewind the tape and eject the cartridge.



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

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until **F** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **F**.
The SCD changes to a flashing **C**, requesting a cartridge.
4. Insert a scratch (blank) data cartridge.
The SCD changes to **F**. The tape drive runs the tests.
 - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Eject button for one (1) second and release. When the loop ends, **0** temporarily appears in the SCD and the tape drive exits Maintenance mode.
 - If an error is detected, the Fault light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#). To clear the error, either turn the power off and then on again or reboot the drive by pressing and holding the Eject button for 10 seconds.

Function Code H: Test Head

Approximate Run Time = 12 minutes per loop

Total Number of Loops = 10

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

Once you begin this test, the diagnostic test begins the loop sequence. Time the first loop by pressing the Eject button once after the completion of the first loop to stop the diagnostic. Record the time it takes for the test to complete. Compare the recorded time with the Approximate Run Time. If the test runs successfully but the execution time is significantly longer than the Approximate Run Time, run the [Function Code F: Write Performance Test](#). If the Write Performance Test fails, replace the media and exit Maintenance mode.

Press the Eject button to stop the diagnostic and exit Maintenance mode.

- Pressing the Eject button once will abort the test at the end of the current test loop.
- Pressing the Eject button twice will abort the test immediately.

Wait for the drive to rewind the tape and eject the cartridge.



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

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until **H** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **H**.
The SCD changes to a flashing **C**, requesting a cartridge.
4. Insert a scratch (blank) data cartridge.
The SCD changes to **H**. The tape drive runs the tests.
 - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Eject button for one (1) second and release. When the loop ends, **0** temporarily appears in the SCD and the tape drive exits Maintenance mode.
 - If an error is detected, the Fault light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in the “[Error Codes Table](#)” on [page 62](#). To clear the error, either turn the power off and then on again or reboot the drive by pressing and holding the Eject button for 10 seconds.

Function Code J: Fast Read/Write Test

Approximate Run Time = 7 minutes per loop

Total Number of Loops = 10

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

When you begin this test, the diagnostic test begins the loop sequence. Time the first loop by pressing Eject once to stop the diagnostic test after the completion of the first loop, then record the time that it takes for the test to complete. Compare the recorded time with the Approximate Run Time above. If the test runs successfully but the execution time is longer than the Approximate Run Time, run [Function Code F: Write Performance Test](#). If the Write Performance Test fails, replace the media and exit Maintenance mode.

Press the Eject button to stop the diagnostic and exit Maintenance mode.

- Pressing the Eject button once will abort the test at the end of the current test loop.
- Pressing the Eject button twice will abort the test immediately.

Wait for the drive to rewind the tape and eject the cartridge.



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

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press Eject once per second until **J** displays in the SCD.
If you cycle past the wanted code, press Eject once per second until the code reappears.
3. Press and hold Eject for three (3) or more seconds, then release it to select the function.
The SCD changes to a flashing **C**, requesting a cartridge.
4. Insert a scratch (blank) data cartridge.
The SCD changes to a flashing **J** and the tape drive runs the tests.
 - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Eject button for one (1) second and release. When the loop ends, **0** temporarily appears in the SCD and the tape drive exits Maintenance mode.
 - If an error is detected, the Fault light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in the “[Error Codes Table](#)” on [page 62](#). To clear the error, either turn the power off and then on again or reboot the drive by pressing and holding the Eject button for 10 seconds.

Function Code L: Load/Eject Test

Approximate Run Time = 30 seconds per loop

Total Number of Loops = 10

Function Code **L** performs tests the drive’s ability to load and eject a tape cartridge.

Press the Eject button to stop the diagnostic and exit Maintenance mode.

- Pressing the Eject button once will abort the test at the end of the current test loop.
- Pressing the Eject button twice will abort the test immediately.

Wait for the drive to rewind the tape and eject the cartridge.



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

NOTE: If you inserted an invalid tape cartridge, error code **J** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility, error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed from the drive.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until **L** appears in the SCD.
If you cycle past the desired code, press the Eject button once per second until the code reappears.
3. Press and hold the Eject button for three (3) or more seconds, then release it to select the function **L**.
The SCD changes to a flashing **C**, requesting a cartridge.
4. Insert a scratch (blank) data cartridge.
The SCD changes to **L**. The tape drive runs the tests.
 - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Eject button for one (1) second and release. When the loop ends, **0** temporarily appears in the SCD and the tape drive exits Maintenance mode.
 - If an error is detected, the Fault light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in the [“Error Codes Table” on page 62](#). To clear the error, either turn the power off and then on again or reboot the drive by pressing and holding the Eject button for 10 seconds.

Function Code P: POST Error Reporting Enabled

Function Code **P** enables Post Error Reporting. Deferred-check conditions are reported to the host, and temporary errors are reported in the sense data. This selection is normally used as a request from support personnel.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.
2. Press the Eject button once per second until either **P** or **U** appears in the SCD indicating the current setting for Post Error Reporting.
If you cycle past the desired code, press the Eject button once per second until the code reappears.

NOTE: If you do not want to change the current setting for Post Error Reporting, exit Maintenance mode at this time.

3. To disable Post Error Reporting (when **P** shows in the SCD), press and hold the Eject button for three (3) or more seconds.
The SCD changes to **U** after you release the Eject button.

You can then do one of the following:

- Press the Eject button once per second to select another Maintenance mode function.
- Exit Maintenance mode normally.

Function Code U: POST Error Reporting Disabled

Function Code **U** disables Post Error Reporting. Deferred-check conditions are not reported to the host, and temporary errors are not reported in the sense data. This is the normal (default) setting for the drive. The drive defaults to Post Error Reporting Disabled after a reboot or power off/on cycle.

1. Place the drive in Maintenance mode by pressing the Eject button three (3) times within two (2) seconds.

2. Press the Eject button once per second until either **P** or **U** appears in the SCD indicating the current setting for Post Error Reporting.
If you cycle past the desired code, press the Eject button once per second until the code reappears.

NOTE: If you do not want to change the current setting for Post Error Reporting, exit Maintenance mode at this time.

3. To enable Post Error Reporting (when **U** shows in the SCD), press and hold the Eject button for three seconds.
The SCD changes to **P** after you release the Eject button.

You can then do one of the following:

- Press the Eject button once per second to select another Maintenance mode function.
- Exit Maintenance mode normally.

Send Diagnostics

POST can be initiated by means of a Send Diagnostics command. The drive will queue all commands, except Inquiry, when running a Send Diagnostics initiated POST. The queued commands will be executed when the POST phase has completed.

Other diagnostics are available through the Send Diagnostics command.

The results of the diagnostics are reported upon receipt of the Receive Diagnostics Results command unless the self-test bit was set.

Isolation Diagnostics

If a drive encounters a permanent error, the drive may run isolation diagnostics to test the drive hardware. These tests may include memory tests, module tests, data channel tests and servo channel tests. These tests are invoked automatically; they cannot be invoked by the customer.

Reliability, Availability, and Serviceability (RAS)

RAS Objectives

LTO tape drive RAS permits isolating tape drive problems from the cartridge/media, power, cooling, RS-422, and Fibre or SAS attachment. Problem isolation minimizes the knowledge required by the Customer Engineer (CE) or customer to service the drive.

Isolation comprises operational and maintenance microcode, hardware diagnostic tools such as wrap plugs, service guide procedures, and a customer supplied scratch tape.

The drive provides indicators and user test capability to allow the CE to determine if the drive requires service. The requirements of this section are verified using RAS testing.

Error Detection

The drive detects errors by the use of:

- Power-On Self Test
- Microcode detection of errors during operation
- Hardware detection of errors during operation

The drive maintains an internal record of error information until it receives verification that the error information was received by the controlling system, or the drive is power cycled.

Microcode Detection of Errors

The drive microcode is designed to check for logic errors, to handle hardware detected errors, and to detect and report microcode related errors.

Fencing

The drive will fence (prevent certain operations) when errors are detected that could endanger customer data if further usage is allowed. The operations which are prevented depend on the nature of the error encountered and the current drive state. The drive will post a FSC error for the original error that caused the fence condition. Then, fencing FSCs will be reported as status to the attempted host commands that are not allowed due to the fence.

The following table describes the type of operations prevented based on the fence /error state of the drive.

| Error Condition | Operation | | | | | Note |
|--|-----------|--------|--------|--------|--------|--|
| | Load | Eject | Write | Read | Motion | |
| Code (Microcode detected error), Panic (Reset) case, or user initiated 10 second Eject button press. | | | | | | Drive will automatically reset and will enter Mid-Tape Recovery (MTR) if a cartridge is present. See Mid-tape Recovery error condition below. |
| Code (Microcode Detected Error) No Panic (Reset) | Fenced | | Fenced | Fenced | Fenced | |
| Loader Error | Fenced | | Fenced | Fenced | Fenced | Drive will stop in failed state; eject will be attempted if requested. Loaded errors will clear when the cartridge is unloaded and removed. |
| Tension or motor | Fenced | | Fenced | Fenced | Fenced | Must reset or power down to clear. Will allow eject. |
| Mid-tape recovery | | | Fenced | Fenced | | No commands allowed until drive successfully recovers and unloads or a successful reposition to a specific block is achieved. All fence conditions are cleared when the cartridge is removed or the tape is repositioned to a specific address. |
| Write Perm | | | Fenced | Fenced | Fenced | Locate/Rewind operation will clear the write fence. |
| Read Perm | | | Fenced | Fenced | Fenced | Locate/Rewind operation will clear the read fence. |
| POST (severe) | Fenced | Fenced | Fenced | Fenced | Fenced | Will not load tape. |

| Error Condition | Operation | | | | | Note |
|--------------------|-----------|-------|--------|--------|--------|--|
| | Load | Eject | Write | Read | Motion | |
| Media error | | | Fenced | Fenced | Fenced | Failure occurs which cause the drive to make the volume read-only. |
| Write Protect | | | Fenced | | | Will not write. |
| Diagnostic Failure | Fenced | | Fenced | Fenced | Fenced | If data path diagnostic fails, medium access commands are fenced. |

Hardware Detection of Errors

The drive contains sensors and circuits to detect errors. A temperature sensor monitors the temperature of the drive electronics. Voltage sensors detect when the power supply is out of tolerance. Other errors, such as tape velocity checks, read/write data integrity checks, and servo checks are performed using circuitry and sensors.

Error Codes Table

The following table details the single-character error codes:

| Error Code | Description | Display Conditions |
|------------|---|--|
| 0 | No Error | Unused. |
| 1 | Cooling Problem | Drive detected an over-temperature condition. Error condition clears when drive is powered off. |
| 2 | Power Problem | Drive detected that the externally supplied power is outside of specified voltage limits. Error condition clears when drive is powered off. |
| 3 | Microcode Problem | Drive determined that a microcode error has occurred. Drive dump is required prior to drive being powered off. |
| 4 | Microcode or Drive Problem | Drive determined that a drive hardware or microcode failure has occurred. Drive dump is required prior to drive being powered off. |
| 5 | Drive Error | Drive determined that a drive hardware failure has occurred. Drive replacement is required. |
| 6 | Drive or Media Error | Drive determined that an error occurred, but cannot isolate it to faulty hardware or media. Error condition clears when cartridge is unloaded. |
| 7 | Media Error | Drive determined that an error occurred because of faulty media. Drive dump is required prior to unloading tape in the drive. |
| 8 | SCSI Bus Interface or Fibre Channel Error | Drive determined that a primary port interface error or Fibre Channel failure has occurred. The error condition clears after 10 seconds if the error condition does not reoccur. |
| 9 | RS-422 Error | Drive determined that an interface or library interface failure has occurred. The error condition clears after 10 seconds if the error condition does not reoccur. |

| Error Code | Description | Display Conditions |
|--------------------------|---|---|
| A | Drive Error | Drive determined that a drive hardware failure has occurred, most likely as a result of performance degradation. Error condition clears when drive is powered off. Drive is not disabled. |
| C | Drive needs to be cleaned | Drive determines that it needs to be cleaned. Also set during a Cleaner Cartridge load and subsequent clean operation. This condition clears when drive has been cleaned and the cleaner cartridge is removed. |
| E | External interface Port offline | Fiber/SAS port is offline. |
| F | Drive or Fiber Channel Error – NO LIGHT | Displayed if dip switch 3 is 'on' and the drive does not see light, or when a fiber wrap diagnostic fails because drive did not see light. |
| H | Reserved for future use | |
| J | Incompatible Media | Media not supported. |
| P | Write Protect | Write operation to a write protected cartridge has been attempted. |
| c | Reserved for future use | |
| d | Fiber AL_PA conflict | Two drives on fiber loop have the same AL_PA. |
| e | Encryption Error | The drive detected a configuration or set-up error prior to an encryption operation. A problem may exist with the key manager communication path. If this error appears immediately after power-on, there is a hardware failure or the necessary cryptographic certificate is missing or corrupted - drive replacement is required for this case only. |
| h | Reserved for future use | |
| n | Reserved for future use | |
| u | Microcode update is in progress | The drive is in the process of uploading and flashing new Firmware. |
| o Bouncing Up/Down | Broke or excessive slack tape | Drive has encountered a condition where it cannot eject the tape or determine that tape is in the path of the head. Manual intervention required. |
| Figure 8 | MTR Recovery | Drive is recovering from power cycle with tape in drive. The "figure 8" is broken up with a countdown indicating progress in ten's percentage to completion. 9,8,7,6,5,4,3,2,1 |

Error Isolation

Errors are isolated using wrap plugs, a scratch tape, and procedures. When an error occurs, the tape drive tries to automatically isolate errors using diagnostic and statistical data.

Error Reporting

The drive reports failures by the following:

- Operator panel

- SCSI error sense data
- TapeAlert flags in SCSI Log Sense page code 0x2E

When a failure occurs, the status LED indicates that an error has occurred and the SCD indicates the error code, as described in the “[Error Codes Table](#)” on page 62.

When a failure occurs and sense information is retrieved, byte 14 of the sense information (Field Replaceable Unit Code) contains a code that indicates which component is responsible for the error. This code is the same error code displayed by the SCD.

The drive maintains the TapeAlert flags as described in the T10 SCSI-2 Stream Commands-2 specification and the IBM Library/Drive Interface Specification. The status of these flags is reported when requested by the SCSI log sense command.

Error Recording

The error recording that is performed by the host operating system is determined by that system. System error recording that is performed by IBM-supplied device drivers is described in the *IBM SCSI Tape Drive, Medium Changer, and Library Device Drivers – Installation and User's Guide* and in the *IBM SCSI Tape Drive, Medium Changer, and Library Device Drivers – Programming Reference*.

Logs

The drive maintains logs to assist engineering, service and CSP repair personnel. The logs are included in drive dumps and are accessible using the SCSI Read Buffer command. The log format is provided to CSP personnel to aid in understanding the log data.

Error Code (Engineering) Log

The tape drive displays the 10 most recent error codes when the Display Error Code Log function is selected in Maintenance mode. The error code (engineering) log information is intended to assist the customer or service representative in isolating failures.

SCSI Log

A log with Command Description Blocks (CDBs) and return codes for the 10 most recent SCSI commands ending in Sense Key 3 or 4 is available to CSP personnel.

RS-422 Log

A log with information describing the 10 most recent RS-422 interactions is available to CSP personnel.

SARS

The tape drive uses the Statistical Analysis and Reporting System (SARS) to assist in isolating failures between media and hardware. The SARS uses the cartridge performance history saved in the cartridge memory (CM) module and the drive performance history kept in

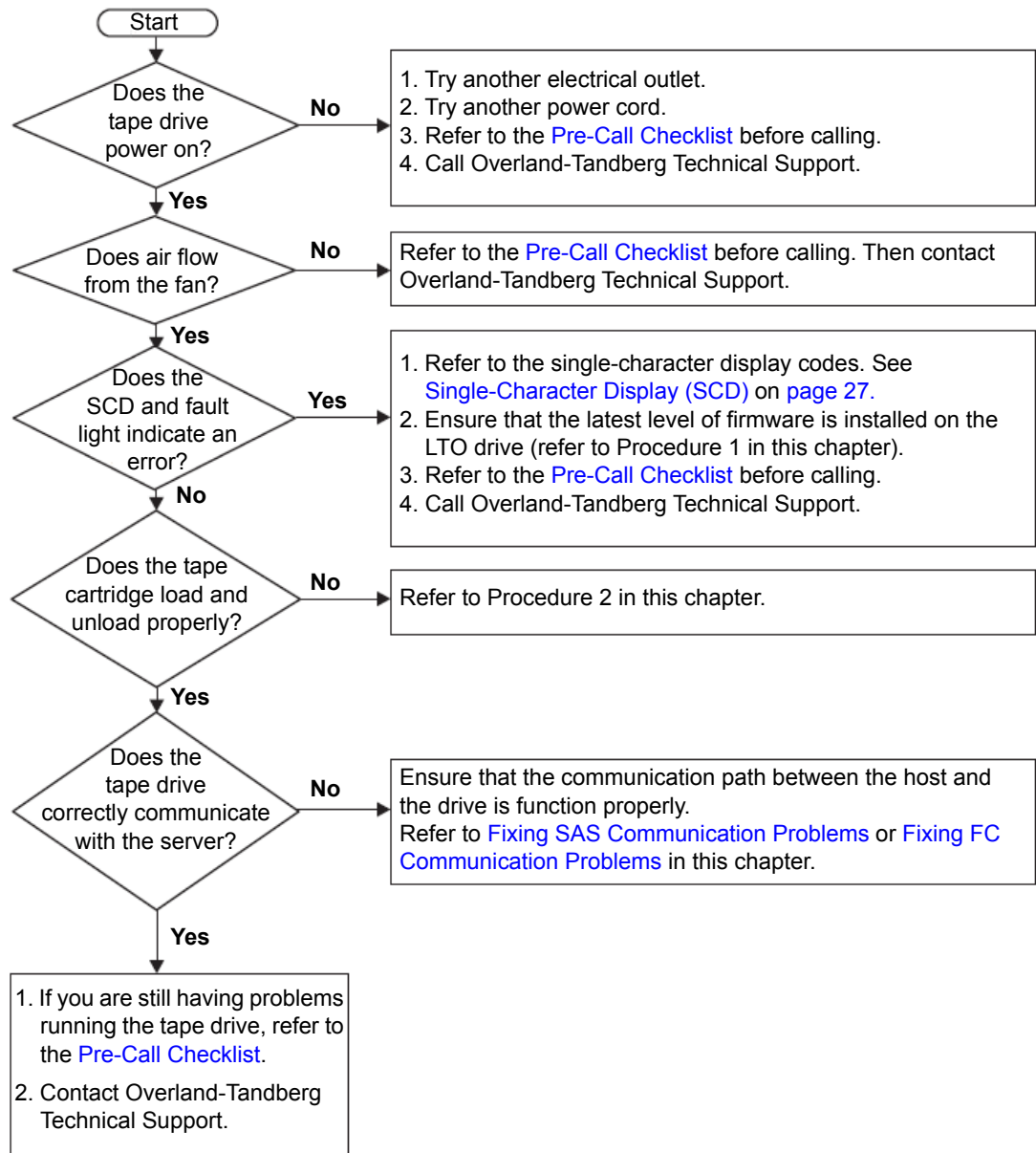
the drive flash EEPROM to determine the more likely cause of failure. SARS can cause the drive to request a cleaner tape, to mark the media as degraded, and to indicate that the hardware has degraded.

SARS information is reported through Sense Data and the TapeAlert flags, and also at the SCD (Single Character Display).

5

Troubleshooting

If you encounter problems when running the LTO tape drive, refer to this flowchart:



For explanations of codes on the SCD, see “[Single-Character Display \(SCD\)](#)” on page 27. Review the “[Pre-Call Checklist](#)” on page 70 before calling technical support.

Topics in Troubleshooting:

- [Procedure 1: Determining Firmware Level and Capturing Drive Dump](#)
- [Procedure 2: Inspecting a Cartridge for Damage](#)
- [Procedure 3: Checking Host Connections](#)
- [Procedure 4: Verifying Host Interface Communications](#)
- [Resolving Problems Reported by the Server](#)
- [Pre-Call Checklist](#)
- [Replacing the LTO Tape Drive](#)

Procedure 1: Determining Firmware Level and Capturing Drive Dump

Customers are responsible for updating the LTO tape drive firmware. For optimum performance, the customer must obtain the current level of firmware for the unit by downloading the firmware from the Overland-Tandberg website. See [Firmware Updates and Technical Support](#) on [page 7](#).

The ITDT utility is used to update the firmware level and to capture a drive memory dump that might be requested by technical support to aid in problem analysis.

For instructions about updating firmware from a server that uses an IBM tape device driver, refer to the *IBM Tape Device Drivers Installation and User's Guide*.

To update firmware from a server that uses a non-IBM tape device driver, refer to the documentation for that device driver.

Complete the following steps to determine the current firmware level that is installed on the drive.

1. Use the ITDT utility to view the current drive firmware level.
The utility is available on the web at the Overland-Tandberg website. See [Firmware Updates and Technical Support](#) on [page 7](#).
2. Compare this level with the current available firmware level by going to the same website.
For information about the ITDT utility, see the Overland-Tandberg website. Refer to [Firmware Updates and Technical Support](#) on [page 7](#).

NOTE: The ITDT utility is used to either update drive firmware to the current level or to capture drive memory dumps from a drive that might be experiencing problems.

Procedure 2: Inspecting a Cartridge for Damage

If the cartridge fails to load or eject properly, complete the following steps:

1. Check that the leader pin is attached and properly seated (see [“Repositioning or Reattaching a Leader Pin”](#) on [page 39](#)) by opening the cartridge door and observing the pin's placement.
2. Inspect the cartridge case, the cartridge door, and the write-protect switch for damage.

3. Inspect the rear of the cartridge (the part that you load first into the tape load compartment).
Ensure that there are no gaps in the seam of the cartridge case. If there are gaps, the leader pin might be dislodged. Go to [“Repositioning or Reattaching a Leader Pin” on page 39](#).
4. Try loading or unloading another tape cartridge.
 - If it fails, contact your service representative for problem determination.
 - If it is successful, discard the cartridge that originally failed.

Addition notes:

- If a damaged or mishandled cartridge is the problem, see [“Handling Cartridges” on page 36](#) for instructions about handling the media. It is possible that your other cartridges might also be damaged.
- If your cartridge does not eject properly, contact your service representative.

Procedure 3: Checking Host Connections

If your server is not communicating with the drive, the problem might be with the cable, host adapter, or host adapter setup. Check the host connections for your drive by following these steps.

1. Verify the SAS or Fibre Channel host adapter is supported by the tape drive.
2. Check whether the LTO tape drive power is On.
For Fibre Channel, if the tape drive is attached to a fibre switch, make sure the switch is powered on.
3. Verify that the cable is connected properly to the server and to the tape drive.
For SAS drives, the interface is a mini-SAS SFF-8088. For FC drives, the interface is an LC multi-mode Fibre Optic.
4. If using a Fibre Channel switch, make sure that the host server and tape drive have an FC link on the fibre ports of the switch. Also, make sure the FC switch is configured correctly to include zoning for both the host server and tape drive.
5. Make sure the Host server has the proper HBA drivers installed and parameters are properly configured.
6. Ensure that there is a point-to-point connectivity between the server and the tape drive. SAS connectivity does not support multiple drive connections (daisy-chaining of devices).
7. Check the length of the SAS or Fibre Channel cable does not exceed 5.5m (18 ft.).

Procedure 4: Verifying Host Interface Communications

The Wrap Diagnostic tests the communication function at the device interface. However, to thoroughly verify host-to-device communications, it is highly recommended to exercise activity over the SAS interface bus from the host to the drive and back. A recommended utility to complete this test is the ITDT utility available on the web at the Overland-Tandberg website. See [Firmware Updates and Technical Support on page 7](#).

Complete these steps:

1. If the ITDT utility is not installed on your system, download the appropriate operating system version from the web into a directory or folder of your choice.
2. When installation is complete, run the SCAN option to determine whether your system can detect all of the LTO tape drive devices (including any libraries or autoloaders that might be on the bus).
3. Select the drive that is to be tested or to have firmware that is downloaded.
4. For testing, select the Test Device option.

NOTE: This option completes a series of LOADS, UNLOADS, and WRITE/READ operations. Both tape drive control commands and data are sent to the device over the interface bus.

5. If allowed to complete, the test runs for at least 30 minutes.
At any time an ABORT is entered to end the device test early if it is determined that interface communications are satisfactorily achieved.

Resolving Problems Reported by the Server

The procedure for fixing interface bus errors varies, depending on whether the error is consistent or intermittent, and on your configuration. These sections describe how to fix an error.

Fixing SAS Communication Problems

1. Check whether the tape drive power is On.
2. Verify that the SAS cable is connected to the host server and to the tape drive.
3. Verify the host server's SAS HBA is using the latest drivers.
4. Make sure all the settings and parameters for the SAS HBA are configured properly. Refer to the HBA manufacturer user guide for additional information.
5. Replace the SAS cable if shows any signs of damage.

Fixing FC Communication Problems

1. Check whether the tape drive power is On.
2. Verify that the FC cable is connected to the host server and to the tape drive.
3. If using a fibre channel switch, make sure both host server and tape drives are connected and the ports have a link. Make sure proper FC zoning is configured for the host server and tape drive. Additional troubleshooting can be found from the manufacture of the fibre channel switch user guide.
4. Verify the host server's FC HBA is using the latest drivers.
5. Make sure all the settings and parameters for the FC HBA are configured properly. Refer to the HBA manufacturer user guide for additional information.
6. Replace the FC cable or Fibre Channel SFP on the switch if they shows any signs of damage.

Resolving Media-Related Problems

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

- Test Cartridge & Media diagnostic test that verifies whether a suspect cartridge and its magnetic tape are acceptable for use.
- Statistical Analysis and Reporting System (SARS) to help with isolating failures between media and hardware.

To determine the cause of failure, SARS uses the cartridge performance history that is saved in the cartridge memory (CM) and the drive performance history that is kept in the drive's VPD (Vital Product Data) area in NVRAM. Any failures that SARS detects are reported as TapeAlert flags on the server (see *IBM LTO Ultrium Tape Drive SCSI Reference*).

If you encounter a media-related problem, refer to [“Function Code E: Test Cartridge and Media” on page 55](#).

Pre-Call Checklist

If you have questions or problems, go through this checklist before technical support is contacted.

Complete these steps before you call technical support. Where instructions refer you to the web, visit the Overland-Tandberg website. See [Firmware Updates and Technical Support on page 7](#).

1. Perform a general checkup of the hardware and connections:
 - Verify that all cables are connected properly at both ends.
 - Before the SAS cables are attached, ensure that the connector does not contain bent or recessed pins.
 - Ensure that all retention screws for the SAS cable are securely tightened.
 - Ensure that the total SAS cable length does not exceed 5.5m (18 ft).
 - Verify for FC that there is a fibre link between host and device, or that the host and device are attached to a fibre switch.
 - Verify for FC that the proper zoning between host and device is configured correctly.
2. Verify that the drive's firmware is at the most recent level. To determine the latest release of firmware, visit the Overland-Tandberg website. See [Firmware Updates and Technical Support on page 7](#).
3. Verify that your device drivers are at the most recent level:
 - For IBM device drivers, visit the web.
 - For the device drivers of independent software vendors (ISVs), visit the appropriate third-party website.
4. Verify whether your hardware and software configuration is supported. To determine the latest supported attachments, visit the Overland-Tandberg website. See [Firmware Updates and Technical Support on page 7](#).
5. Review “Frequently Asked Questions” and “Hints and Tips” on the web.
6. Run one of these diagnostic methods:
 - Run one of the local diagnostic tests listed below followed by [“Function Code 6: Run Host Interface Wrap Test” on page 52](#).

- “[Function Code 1: Run Drive Diagnostics](#)” on page 49 to determine whether the drive can properly load and eject cartridges, and read and write data.
- “[Function Code E: Test Cartridge and Media](#)” on page 55 to determine whether a suspect cartridge and its magnetic tape are acceptable.
- “[Function Code F: Write Performance Test](#)” on page 56 to ensure that the drive can read from and write to tape.
- “[Function Code H: Test Head](#)” on page 56 to ensure that the tape drive’s head and tape-carriage mechanics work correctly.
- “[Function Code J: Fast Read/Write Test](#)” on page 57 to ensure that the drive can read from and write to tape.
- “[Function Code L: Load/Eject Test](#)” on page 58 to test the drive’s ability to load and eject a tape cartridge.
- Run the remote diagnostic test [Procedure 1: Determining Firmware Level and Capturing Drive Dump](#) using the ITDT utility.

Replacing the LTO Tape Drive

To replace your LTO tape drive, following the instructions that came with the replacement drive.




Error Codes and Acronyms

This appendix details the event codes and key acronyms for the LTO tape drive.

If the drive detects a permanent error, it displays the error code on the SCD and flashes the Fault light (Ready light is Off).

- Make note of the SCD error code before a cartridge is removed or the SCD error code is cleared.
- If an error occurred with a cartridge in the drive, push Eject to eject the cartridge.
- To clear the SCD error code and power cycle the drive, press Eject for 10 seconds. A drive memory dump is created.

 **CAUTION:** If the drive detects a permanent error, and displays an error code other than **0**, it automatically completes a drive memory dump. If you force a drive memory dump, the existing memory dump is overwritten and data is lost. After you force a drive memory dump, do not turn off the power to the drive or you might lose the memory dump data.

Topics in Error Codes and Acronyms:

- [Error Codes](#)
- [Acronyms and Abbreviations](#)

Error Codes


The following table lists the possible error codes along with the cause and action necessary.

| Error Code | Cause and Action |
|------------|--|
| 0 | <p>No error occurred and no action is required. This code displays when diagnostic tests are finished running and no error occurred.</p> <p>NOTE: The SCD is blank during normal operation of the tape drive.</p> |
| 1 | <p>Temperature problem. The tape drive detected that the recommended operating temperature was exceeded. Complete one or more of these actions:</p> <ul style="list-style-type: none"> • Ensure that the cooling fan is rotating and is quiet. If not, refer to your enclosure documentation. • Remove any blockage that prevents air from flowing freely through the tape drive. • Ensure that the operating temperature and airflow is within the specified range (see “Specifications” on page 19). <p>Clear the error code by power-cycling the tape drive or placing the drive in Maintenance mode. If the operating temperature and airflow are within the specified range, and the problem persists, replace the drive.</p> |
| 2 | <p>Power problem. The tape drive detected that the externally supplied power is outside the specified voltage limits (the tape drive is not operating). Complete this action:</p> <ol style="list-style-type: none"> 1. Ensure that the power connector is properly seated. 2. Turn power off/on the tape drive to see whether the problem repeats. 3. Replace the tape drive if the problem persists. <p>The error code clears when you place the tape drive in Maintenance mode.</p> |
| 3 | <p>Firmware problem. The tape drive determined that a firmware error occurred. Complete this action:</p> <ol style="list-style-type: none"> 1. Collect a drive memory dump. <p>NOTE: Do not force a new memory dump; the tape drive created one.</p> <ul style="list-style-type: none"> • Server's host interface with a device driver utility or system tool such as ITDT. For instructions about ITDT, visit the Overland-Tandberg website. See Firmware Updates and Technical Support on page 7. • Ultrium tape drive (to copy and read a drive memory dump, use “Function Code 5: Copy Drive Dump” on page 51 <ol style="list-style-type: none"> 2. Power the tape drive off and on, then retry the operation that produced the error. 3. If the problem persists, download new firmware and retry the operation. 4. If the problem persists, send the drive memory dump that you collected in Step 1 to technical support. <p>The error code clears when you place the LTO tape drive in Maintenance mode.</p> |

| Error Code | Cause and Action |
|------------|---|
| 4 | <p>Firmware or hardware problem. The tape drive determined that a firmware or tape drive hardware failure occurred. Complete this action:</p> <ol style="list-style-type: none">1. Collect a drive memory dump. <p>NOTE: Do not force a new memory dump; one exists.</p> <ul style="list-style-type: none">• Server's host interface with a device driver utility or system tool such as ITDT. For instructions about ITDT, visit the Overland-Tandberg website. See Firmware Updates and Technical Support on page 7.• Ultrium tape drive (to copy and read a drive memory dump, use "Function Code 5: Copy Drive Dump" on page 51) <ol style="list-style-type: none">2. Power the tape drive off and on, then retry the operation that produced the error. The error code clears when you place the tape drive in Maintenance mode.3. If the problem persists, download new firmware and retry the operation. If new firmware is not available, replace the drive. |
| 5 | <p>Tape drive hardware problem. The drive determined that a tape path or read/write error occurred. To prevent damage to the drive or tape, you cannot insert a cartridge if the current cartridge was successfully ejected. The error code might clear when you cycle power to the tape drive or place it in Maintenance mode. If the problem persists, replace the drive.</p> <p>NOTE: Copy the drive memory dump to flash memory before the drive is returned. For instructions, refer to "Function Code 5: Copy Drive Dump" on page 51.</p> |

| Error Code | Cause and Action |
|------------|--|
| 6 | <p>Tape drive or media error. The tape drive determined that an error occurred, but it cannot isolate the error to faulty hardware or to the tape cartridge. Ensure that the tape cartridge is the correct media type:</p> <ul style="list-style-type: none"> • Some cartridges are not supported in the LTO tape drive (see “Cartridge Compatibility by Drive Type” on page 34). • Drive does not accept an expired Cleaning Cartridge. • Drive does not accept a WORM cartridge when diagnostic tests are run in Maintenance mode. • Drive does not write over existing data sets on a WORM cartridge. Ensure that you are appending data sets on WORM media rather than attempting to write over existing data sets. <p>If the tape cartridge is the correct media type, complete this action:</p> <p>Problems with Writing Data</p> <p>If the problem occurred while the tape drive was writing data to the tape, retry the operation with a different cartridge:</p> <ul style="list-style-type: none"> • If the operation succeeds, the original cartridge was defective. Copy data from the defective cartridge and discard it. • If the operation fails and another tape drive is available, insert the cartridge into the other unit and retry the operation. <ul style="list-style-type: none"> – If the operation fails, discard the defective cartridge. – If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function Code 1: Run Drive Diagnostics” on page 49. <ul style="list-style-type: none"> - If the diagnostic tests fail, replace the tape drive. - If the diagnostic tests succeed, the error was temporary. • If the operation fails and another tape drive is not available, insert a scratch data cartridge into the unit and run “Function Code 1: Run Drive Diagnostics” on page 49. <ul style="list-style-type: none"> – If the diagnostic tests fail, replace the tape drive. – If the diagnostic tests succeed, discard the cartridge. <p>If the problem occurs with multiple tape cartridges, run “Function Code 1: Run Drive Diagnostics” on page 49.</p> <ul style="list-style-type: none"> • If the diagnostic tests fail, replace the tape drive. • If the diagnostic tests succeed, run “Function Code H: Test Head” on page 56. <ul style="list-style-type: none"> – If the diagnostic test fails, replace the tape drive. – If the diagnostic test succeeds, replace the cartridges that caused the problem. <p>The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.</p> |

| Error Code | Cause and Action |
|---------------|--|
| 6 (continued) | <p data-bbox="558 247 862 275">Problems with Reading Data</p> <p data-bbox="558 285 1370 342">If the problem occurred while the tape drive was reading data from the tape, complete one of these procedures:</p> <ul data-bbox="558 352 1443 720" style="list-style-type: none"> <li data-bbox="558 352 1443 409">• If another tape drive is available, insert the cartridge into the other unit and retry the operation. <ul style="list-style-type: none"> <li data-bbox="586 420 1162 447">– If the operation fails, discard the defective cartridge. <li data-bbox="586 457 1443 514">– If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function Code 1: Run Drive Diagnostics” on page 49. <li data-bbox="586 525 1133 552">– If the diagnostic tests fail, replace the tape drive. <li data-bbox="586 562 1214 590">– If the diagnostic tests succeed, the error was temporary. <li data-bbox="558 600 1443 657">• If another tape drive is not available, insert a scratch data cartridge into the unit and run “Function Code 1: Run Drive Diagnostics” on page 49. <ul style="list-style-type: none"> <li data-bbox="586 667 1133 695">– If the diagnostic tests fail, replace the tape drive. <li data-bbox="586 705 1162 732">– If the diagnostic tests succeed, discard the cartridge. <p data-bbox="558 743 1443 800">If the problem occurs with multiple tape cartridges, run “Function Code 1: Run Drive Diagnostics” on page 49.</p> <ul data-bbox="558 810 1443 930" style="list-style-type: none"> <li data-bbox="558 810 1101 837">• If the diagnostic tests fail, replace the tape drive. <li data-bbox="558 848 1443 930">• If the diagnostic tests succeed, run “Function Code H: Test Head” on page 56. <ul style="list-style-type: none"> <li data-bbox="586 877 1133 905">– If the diagnostic test fails, replace the tape drive. <li data-bbox="586 915 1443 942">– If the diagnostic test succeeds, replace the cartridges that caused the problem. <p data-bbox="558 953 1443 991">The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.</p> |

| Error Code | Cause and Action |
|------------|--|
| 7 | <p>Media error. The tape drive determined an error occurred because of a faulty tape cartridge or an invalid tape cartridge. Ensure that the tape cartridge is the correct media type:</p> <ul style="list-style-type: none"> • Some cartridges are not supported in the LTO tape drive (see “Cartridge Compatibility by Drive Type” on page 34). • Drive does not accept an expired Cleaning Cartridge. • Drive does not accept a WORM cartridge when diagnostic tests are run in Maintenance mode. • Drive does not write over existing data sets on a WORM cartridge. Ensure that you are appending data sets on WORM media rather than attempting to write over existing data sets. • Drive does not accept an FMR tape unless the drive is completing “Function Code 8: Unmake FMR Tape” on page 53. • Drive does not Create an FMR Tape (“Function Code 3: Create FMR Tape” on page 50) with a cartridge that is already an FMR tape. Use another cartridge or run “Function Code 8: Unmake FMR Tape” on page 53. • Drive does not Unmake FMR tape (“Function Code 8: Unmake FMR Tape” on page 53) with a cartridge that is not an FMR tape. <p>If the tape cartridge is the correct media type, try another tape cartridge. If the problem occurs with multiple tape cartridges, use this procedure:</p> <ol style="list-style-type: none"> 1. If possible, run the tape cartridge in a different tape drive. • If the operation in the other unit fails and 6 or 7 displays, replace the media. • If the operation succeeds, run “Function Code E: Test Cartridge and Media” on page 55. <hr/> <p> CAUTION: When you run the Test Cartridge & Media diagnostic test, data on the suspect tape is overwritten. Use only a scratch data cartridge to run the test.</p> <hr/> <ul style="list-style-type: none"> • If the diagnostic test fails, replace the media. • If the diagnostic test succeeds, clean the drive head (see “Cleaning Cartridge Usage” on page 31) and run “Function Code 1: Run Drive Diagnostics” on page 49. <ul style="list-style-type: none"> – If the drive diagnostic test fails, replace the drive. – If the drive diagnostic test succeeds, complete the operation that produced the initial media error. <p>The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.</p> |
| 8 | <p>Interface problem. The tape drive determined that a failure occurred in the tape drive's hardware or in the host bus. See Chapter 5, “Troubleshooting.”</p> <p>If 8 displays while “Function Code 6: Run Host Interface Wrap Test” on page 52 was running:</p> <ol style="list-style-type: none"> 1. Verify that the correct interface wrap tool was attached in the correct interface port during the test. <p>The test fails if the correct interface wrap tool is not attached.</p> <p>NOTE: The interface wrap test is not supported on the USB port and displays an invalid error if run.</p> 2. If the correct interface wrap tool was attached during the test, replace the drive. <p>The error code clears when you place the tape drive in Maintenance mode.</p> |

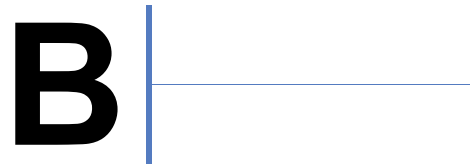
| Error Code | Cause and Action |
|------------|--|
| 9 | <p>Tape drive or RS-422 error. The tape drive determined that a failure occurred in the tape drive's hardware or in the RS-422 connection. See "Function Code 7: Run RS-422 Wrap Test" on page 53 or refer to the library procedures to isolate the problem to the drive. The error code clears when you place the tape drive in Maintenance mode.</p> |
| A | <p>Degraded operation. The tape drive determined that a problem occurred which degraded the operation of the tape drive, but it did not restrict continued use. If the problem persists, determine whether the problem is with the drive or the media.</p> <p>NOTE: The drive is usable, though the SCD continues to indicate an error and the Fault light flashes. The error code might clear when you cycle power to the tape drive or place it in Maintenance mode.</p> <p>To determine whether the problem is with the drive hardware, or the tape media, complete these procedures:</p> <ol style="list-style-type: none"> If possible, run the tape cartridge in a different tape drive. <ul style="list-style-type: none"> If the operation in the other unit fails and 6 or 7 displays, replace the media. If the operation succeeds, run "Function Code E: Test Cartridge and Media" on page 55. <ul style="list-style-type: none"> If the Test Cartridge & Media diagnostic test fails, replace the media. If it runs successfully, clean the failing drive and run the drive diagnostic tests. See "Cleaning Cartridge Usage" on page 31 and "Function Code 1: Run Drive Diagnostics" on page 49. <p>Once you begin this test, the diagnostic test begins the loop sequence. Time the first loop by pressing the Eject button once after the completion of the first loop to stop the diagnostic. Record the time it takes for the test to complete. Compare the recorded time with the Approximate Run Time. If the test runs successfully but the execution time is significantly longer than the Approximate Run Time, run the "Function Code F: Write Performance Test" on page 56. If the Write Performance Test fails, replace the media and exit Maintenance mode.</p> <ol style="list-style-type: none"> If the problem persists, replace the drive. <p>If it is not possible to run the tape cartridge in a different drive, complete these procedures:</p> <ol style="list-style-type: none"> Clean the failing drive and run the drive diagnostic tests. <p>See "Cleaning Cartridge Usage" on page 31 and "Function Code 1: Run Drive Diagnostics" on page 49.</p> <p>Once you begin this test, the diagnostic test begins the loop sequence. Time the first loop by pressing the Eject button once after the completion of the first loop to stop the diagnostic. Record the time it takes for the test to complete. Compare the recorded time with the Approximate Run Time. If the test runs successfully but the execution time is significantly longer than the Approximate Run Time, run the "Function Code F: Write Performance Test" on page 56. If the Write Performance Test fails, replace the media and exit Maintenance mode. If the drive diagnostic tests run successfully, run the Test Cartridge & Media diagnostic test (see "Function Code E: Test Cartridge and Media" on page 55).</p> <ul style="list-style-type: none"> If the Test Cartridge & Media diagnostic test fails, replace the media. If it runs successfully, complete the operation that produced the initial error. If the problem persists, replace the LTO tape drive. |
| C | <p>The tape drive must be cleaned. Clean the tape drive. See "Cleaning Cartridge Usage" on page 31.</p> <p>The error code clears when you clean the tape drive or place it in Maintenance mode.</p> |

| Error Code | Cause and Action |
|------------|--|
| d | Fiber AL_PA conflict. Two drives on fiber loop have the same AL_PA. Modify the tape drive AL_PA to eliminate the conflict. NOT SUPPORTED ON THIS DRIVE. |
| e | <p>Encryption Error. Displayed when the drive detects an error that is associated with an encryption operation. If the problem occurred while the tape drive was writing data to, or reading data from, tape:</p> <ol style="list-style-type: none"> 1. Check the host application to ensure that the host application is providing the correct encryption key. <ul style="list-style-type: none"> • Refer to the IBM LTO Ultrium Tape Drive SCSI Reference documentation for the sense data that is returned for an encryption operation. • Retry the encryption operation after the host application problems are resolved. 2. Check the operation of the tape drive by resetting the drive and running POST. <p>See “Eject Button” on page 26.</p> <ul style="list-style-type: none"> • Refer to the error code displayed on the SCD if the drive reset and POST fails. • Retry the encryption operation if the drive reset and POST complete without errors. 3. Check the media. <ul style="list-style-type: none"> • Ensure that the correct media is used. Data encryption is supported by LTO-4 and later data cartridges only. • Retry the encryption operation with the tape cartridge in another encryption enabled drive. Replace the media if the problem repeats with the same tape cartridge in multiple drives. <p>If the problem occurred while the tape drive was running POST or diagnostic tests, replace the drive.</p> <p>The error code clears with the first attempted write/read after the encryption key is changed, or when the drive is placed in Maintenance mode.</p> |
| E | Fiber Port offline. NOT SUPPORTED ON THIS DRIVE. |
| F | Fibre Channel error. NOT SUPPORTED ON THIS DRIVE. |
| J | Incompatible media. The tape drive detected that an unsupported cartridge was loaded or the cartridge that is loaded has an incompatible format. |
| P | Write operation to a write protected cartridge was attempted (includes any attempt to overwrite a WORM protected tape). Ensure that the tape cartridge is the correct media type. If the tape cartridge is the correct media type, check the write-protect switch on the cartridge. The drive does not write to a write-protected cartridge. The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode. |

Acronyms and Abbreviations

| Acronym | Meaning |
|---------|--------------------------|
| FC | Fibre Channel |
| FH | Full Height |
| GUI | Graphical User Interface |
| HBA | Host Bus Adapter |
| HH | Half Height |
| LUN | Logical Unit Number |
| OCP | Operator Control Panel |

| Acronym | Meaning |
|----------------|------------------------------------|
| RMI | Remote Management Interface |
| SAN | Storage Area Network |
| SAS | Serial Attached SCSI |
| SNMP | Simple Network Management Protocol |
| SSH | Secure Shell |
| SSL | Secure Socket Layer |
| UID | Unit Identification |
| USB | Universal Serial Bus |
| WORM | Write Once, Read Many |
| WWPN | World-Wide Port Name |



TapeAlert Codes

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

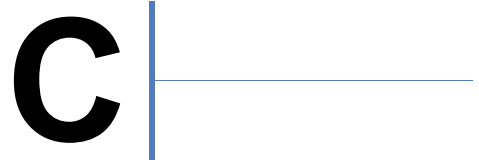
| Code | Description | Set | Clear* | Type |
|-------|----------------------------------|-----|--------|---------------|
| 0001h | Read Warning | | R | Warning |
| 0002h | Write Warning | | R | Warning |
| 0003h | Hard Error | | R | Warning |
| 0004h | Media | | R | Critical |
| 0005h | Read Failure | | R | Critical |
| 0006h | Write Failure | | R | Critical |
| 0007h | Media Life | | L | Warning |
| 0008h | Not Data Grade | | R | Warning |
| 0009h | Write Protect | | R | Critical |
| 000Ah | No Removal | | R | Informational |
| 000Bh | Cleaning Media | | R | Informational |
| 000Ch | Unsupported Format | | R | Informational |
| 000Eh | Unrecoverable Snapped Tape | | R | Critical |
| 000Fh | Memory Chip in Cartridge Failure | | R | Warning |
| 0010h | Forced Eject | | L | Critical |
| 0011h | Read Only Format | | R | Warning |
| 0012h | Tape Directory Corrupted | | R | Warning |
| 0013h | Nearing Media Life | | R | Informational |
| 0014h | Clean Now | | C | Critical |
| 0015h | Clean Periodic | | C | Warning |
| 0016h | Expired Cleaning Media | C | C | Critical |
| 0017h | Invalid cleaning tape | C | R | Critical |
| 0019h | Host Channel Failure | | | Warning |
| 001Ah | Cooling Fan Failure | S | | Warning |
| 001Bh | Power Supply Failure | S | | Warning |
| 001Eh | Hardware A | | | Critical |
| 001Fh | Hardware B | | | Critical |
| 0020h | Interface | | | Warning |

| Code | Description | Set | Clear* | Type |
|-------|--------------------------------------|-----|--------|---------------|
| 0021h | Eject Media | | U,R | Critical |
| 0022h | Download Fault | | | Warning |
| 0024h | Drive Temperature | S | | Warning |
| 0025h | Drive Voltage | S | | Warning |
| 0026h | Predictive Failure | | | Critical |
| 0027h | Diagnostics Required | | | Warning |
| 0029h | Loader Stray Tape | | | Critical |
| 002Ah | Loader Hardware | | | Warning |
| 002Dh | Loader Magazine | | | Critical |
| 0031h | Diminished Native Capacity | B | L, R | Informational |
| 0032h | Lost Statistics | | R | Warning |
| 0033h | Tape Directory Invalid at Eject | | L,R | Warning |
| 0034h | Tape System Area Write Failure | | L,R | Critical |
| 0035h | Tape System Area Read Failure | | R | Critical |
| 0036h | No Start of Data | | R | Critical |
| 0037h | Loading Failure | | R | Critical |
| 0038h | Unrecoverable Eject Failure | | R | Critical |
| 0039h | Automation Interface Failure | | | Critical |
| 003Ah | Firmware Failure | | | Warning |
| 003Bh | WORM Medium - Integrity Check Failed | | R | Warning |
| 003Ch | WORM Medium - Overwrite Attempted | | R | Warning |
| 003Dh | Encryption Policy Violation | P | L | Warning |

* A TapeAlert flag may be cleared when the condition no longer exists

Legend

- Not set/supported
- L Load - medium is loaded
- C Clean - cleaner tape is loaded
- U Eject - medium is ejected
- E Error - error code is posted
- R Removal - medium is FULLY removed
- S Sensor - sensor check
- B Write from BOP 0 and condition exists
- P A primary port is set online, or when there is an attempted write while there is an encryption policy required but there is no encryption policy established



Servicing Tape Drives

This appendix details the information for trained service personnel to assist them in servicing LTO tape drives.

Topics in Servicing Tape Drives:

- [Removing a Stuck Cartridge](#)

Removing a Stuck Cartridge



IMPORTANT: Disassembly of tape drives to remove stuck cartridges are done by service personnel. We do not recommend customers disassemble tape drives to remove cartridges as further damage to the drive or tape can occur.

Here are some options you can try.

- Press the Eject button on tape drive.
- Try the Eject/Unload operation from your backup software application.
- Put the tape drive in Maintenance Mode (see [“Entering Maintenance Mode” on page 48](#)). When an attempt to get into Maintenance Mode is made, the tape drive forces an unload of a cartridge.
- Customer can download and install the IBM Tape Diagnostic Tool (ITDT). Once ITDT sees the tape drive, try the Stuck Tape/Eject Test.
- Reset the tape drive and try the Eject button again.

Otherwise, replace the tape drive through Technical Support as an RMA with a stuck cartridge.

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