

IBM LTO Ultrium 4 Half-High Tape Drive



# Setup, Operator, and Service Guide

*Model T1600V*



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*Model T1600V*

**Note!**

Before using this information and the product it supports, be sure to read the general information in "Notices" located in the back of this publication.

To ensure that you have the latest publications, visit the web at <http://www.ibm.com/storage/lto>.

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This edition applies to the *IBM LTO Ultrium 4 Half-High Tape Drive*, GC27-2150-00, and to the subsequent releases and modifications until otherwise indicated in new editions.

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## Read this First

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### Accessing Online Technical Support

It is the customer's responsibility to set up this tape drive or library and to ensure that the drive and library have the latest firmware (unless you have purchased a service contract).

For online Technical Support:

1. Visit <http://www.ibm.com>.
2. Click **Get Support**.
3. Click **Customer Support** and follow on-screen instructions.

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### Registering for Support Notification

Support Notification registration provides email notification when new firmware levels have been updated and are available for download and installation. To register for Support Notification, visit the web at <http://www-304.ibm.com/jct01004c/systems/support/storage/news/05072007SupportNotif.html>.

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## Safety and Environmental Notices

When using this product, observe the danger, caution, and attention notices that are contained in this guide. The notices are accompanied by symbols that represent the severity of the safety condition.

Most danger or caution notices contain an identification number (Dxxxx or Cxxxx). Use the identification number to view a translation of the notice in the *IBM Translated Safety Notices* publication included on the Documentation CD in your ship group.

The sections that follow define each type of safety notice and give examples.

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### Regulatory Name

The regulatory name for the *IBM LTO Ultrium 4 Half-High Tape Drive* is the *LTO Ultrium 4-H*.

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### Danger Notices








A danger notice calls attention to a situation that is potentially lethal or extremely hazardous to people. A lightning bolt symbol always accompanies a danger notice to represent a dangerous electrical condition

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### Caution Notices

A caution notice calls attention to a situation that is potentially hazardous to people because of some existing condition. A caution notice can be accompanied by one of several symbols:

If the symbol is...	It means....
	A hazardous electrical condition with less severity than electrical danger.
	A generally hazardous condition not represented by other safety symbols.
 Class I	A hazardous condition from the use of a laser in the product. Laser symbols are always accompanied by the classification of the laser as defined by the U. S. Department of Health and Human Services (for example, Class I, Class II).
	A hazardous condition because of mechanical movement in or around the product.

If the symbol is...	It means....
	<p>A hazardous condition because of the weight of the unit. Weight symbols are accompanied by an approximation of the product's weight.</p>

## Tape drive ac grounding inspection

1. Power off the drive.
2. Disconnect all cables.
3. See Figure 1 which is provided for reference only. Disconnect the power cord from its source.
4. Inspect the power cable for visible cracks, wear, or damage.

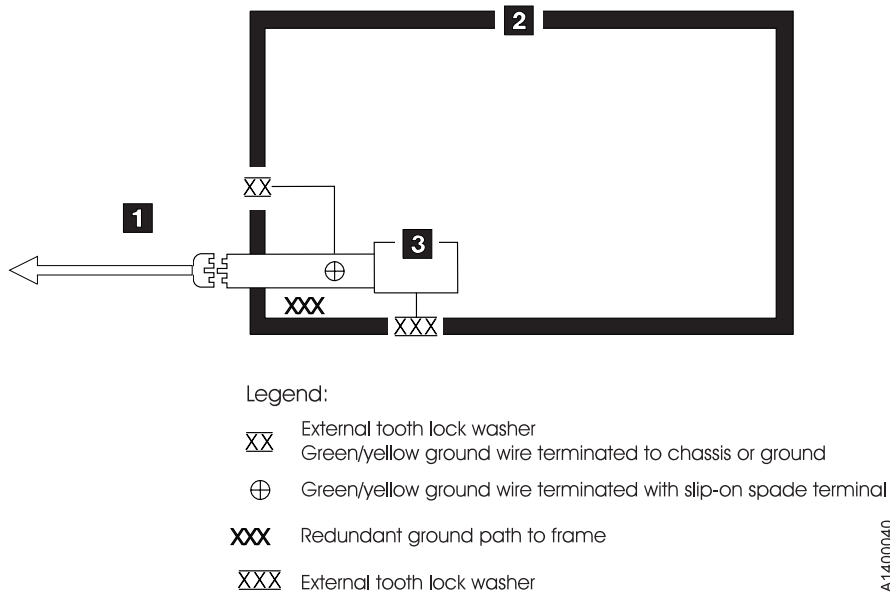


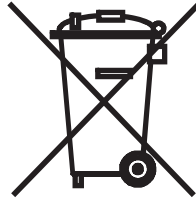
Figure 1. AC grounding diagram (50 Hz and 60 Hz)

## Product Recycling and Disposal

This unit must be recycled or discarded according to applicable local and national regulations. IBM encourages owners of information technology (IT) equipment to responsibly recycle their equipment when it is no longer needed. IBM offers a variety of product return programs and services in several countries to assist equipment owners in recycling their IT products. Information on IBM product recycling offerings can be found on IBM's Internet site at <http://www.ibm.com/ibm/environment/products/prp.shtml>.

Esta unidad debe reciclarse o desecharse de acuerdo con lo establecido en la normativa nacional o local aplicable. IBM recomienda a los propietarios de equipos de tecnología de la información (TI) que reciclen responsablemente sus equipos cuando éstos ya no les sean útiles. IBM dispone de una serie de programas y servicios de devolución de productos en varios países, a fin de ayudar a los propietarios de equipos a reciclar sus productos de TI. Se puede encontrar

información sobre las ofertas de reciclado de productos de IBM en el sitio web de IBM <http://www.ibm.com/ibm/environment/products/prp.shtml>.



**Notice:** This mark applies only to countries within the European Union (EU) and Norway.

Appliances are labeled in accordance with European Directive 2002/96/EC concerning waste electrical and electronic equipment (WEEE). The Directive determines the framework for the return and recycling of used appliances as applicable throughout the European Union. This label is applied to various products to indicate that the product is not to be thrown away, but rather reclaimed upon end of life per this Directive.

In accordance with the European WEEE Directive, electrical and electronic equipment (EEE) is to be collected separately and to be reused, recycled, or recovered at end of life. Users of EEE with the WEEE marking per Annex IV of the WEEE Directive, as shown above, must not dispose of end of life EEE as unsorted municipal waste, but use the collection framework available to customers for the return, recycling and recovery of WEEE. Customer participation is important to minimize any potential effects of EEE on the environment and human health due to the potential presence of hazardous substances in EEE. For proper collection and treatment, contact your local IBM representative.

### **Battery Return Policy**

This product may contain sealed lead acid, nickel cadmium, nickel metal hydride, lithium, or a lithium ion battery. Consult your user manual or service manual for specific battery information. The battery must be recycled or disposed of properly. Recycling facilities may not be available in your area. For information on disposal of batteries outside the United States, go to <http://www.ibm.com/ibm/environment/products/batteryrecycle.shtml> or contact your local waste disposal facility.

In the United States, IBM has established a return process for reuse, recycling, or proper disposal of used IBM sealed lead acid, nickel cadmium, nickel metal hydride, and other battery packs from IBM Equipment. For information on proper disposal of these batteries, contact IBM at 1-800-426-4333. Please have the IBM part number listed on the battery available prior to your call.

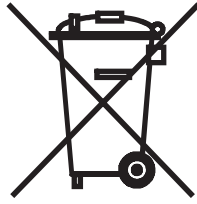
For Taiwan:



Please recycle batteries

## 廢電池請回收

For the European Union:



Batteries or packaging for batteries are labeled in accordance with European Directive 2006/66/EC concerning batteries and accumulators and waste batteries and accumulators. The Directive determines the framework for the return and recycling of used batteries and accumulators as applicable throughout the European Union. This label is applied to various batteries to indicate that the battery is not to be thrown away, but rather reclaimed upon end of life per this Directive.

In accordance with the European Directive 2006/66/EC, batteries and accumulators are labeled to indicate that they are to be collected separately and recycled at end of life. The label on the battery may also include a chemical symbol for the metal concerned in the battery (Pb for lead, Hg for mercury and Cd for cadmium). Users of batteries and accumulators must not dispose of batteries and accumulators as unsorted municipal waste, but use the collection framework available to customers for the return, recycling and treatment of batteries and accumulators. Customer participation is important to minimize any potential effects of batteries and accumulators on the environment and human health due to the potential presence of hazardous substances. For proper collection and treatment, contact your local IBM representative.

For California:

Perchlorate Material - special handling may apply. See <http://www.dtsc.ca.gov/hazardouswaste/perchlorate>.

The foregoing notice is provided in accordance with California Code of Regulations Title 22, Division 4.5 Chapter 33. Best Management Practices for Perchlorate Materials. This product/part may include a lithium manganese dioxide battery which contains a perchlorate substance.

### **Flat Panel Display**

The fluorescent lamp or lamps in the liquid crystal display contain mercury. Dispose of it as required by local ordinances and regulations.

### **Monitors**

Connecticut - Please see the web site of the Department of Environmental Protection at <http://www.ct.gov/dep> for information about recycling covered electronic devices in the State of Connecticut, or telephone the Connecticut Department of Environmental Protection at 1-860-424-3000.



Washington - Please see the web site of the Department of Ecology at <http://1800recycle.wa.gov/> for information about recycling covered electronic devices in the State of Washington, or telephone the Washington Department of Ecology at 1-800Recycle.

---

## **End of Life (EOL) Plan**

This library or drive is a purchased unit. Therefore, it is the sole responsibility of the purchaser to dispose of it in accordance with local laws and regulations at the time of disposal.

This library or drive contains recyclable materials. The materials should be recycled where facilities are available and according to local regulations. In some areas IBM provides a product take-back program that ensures proper handling of the product. For more information, contact your IBM representative.



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## About This Book

This guide describes how to install and use the IBM LTO Ultrium 4 Half-High Tape Drive in the following chapters:

Chapter 1, “Introduction,” on page 1-1 describes the product, discusses supported servers, operating systems, and device drivers, and lists hardware specifications.

Chapter 2, “Installing the drive,” on page 2-1 gives unpacking, set up, and configuration information.

Chapter 3, “Operating the Drive,” on page 3-1 describes the Power Button, Unload Button, and Status Lights and explains the function of the Single-character Display. It gives instruction on inserting and removing a tape cartridge, describes methods of updating drive firmware, and explains how to clean the tape drive. It also lists diagnostic and maintenance functions.

Chapter 4, “Using Ultrium Media,” on page 4-1 describes the types of tape cartridges to use and defines the conditions for storing and shipping them. It also describes how to handle the cartridges, how to set a cartridge’s write-protect switch, and how to order additional cartridges.

Chapter 5, “Troubleshooting,” on page 5-1 gives tips for solving problems with the drive.

Chapter 6, “Ordering Optional Features, Replacement Parts, and Media,” on page 6-1 lists parts and supplies and provides information about the power cords that are used in different countries or regions.

Appendix A, “TapeAlert flags,” on page A-1 lists TapeAlert messages that are supported and that may aid during problem determination.

Appendix B, “Repairing a Cartridge,” on page B-1 describes how to repair a tape cartridge.

Appendix C, “Information for Trained Service Personnel,” on page C-1 gives the procedure for removing a tape cartridge that will not eject from the drive and other servicing procedures.

### Related Publications

- *IBM System Storage™ LTO Ultrium Tape Drive SCSI Reference*, GA32-0450, gives information about the supported SCSI commands and protocol that govern the behavior of the SCSI interface for LTO drives. The SCSI reference also includes information about the TapeAlert flags that are supported.
- *IBM Ultrium Device Drivers Installation and User’s Guide*, GC27-2130, provides instructions for attaching IBM-supported hardware to open-systems operating systems. It indicates what devices and levels of operating systems are supported, gives the requirements for adapter cards, and tells how to configure servers to use the device driver with the Ultrium family of devices. You can obtain this reference via File Transfer Protocol (FTP) at <ftp://ftp.software.ibm.com/storage/devdrv>.

- *IBM Ultrium Device Drivers Programming Reference*, GA32-0566, supplies information to application developers who want to integrate their open-systems applications with IBM-supported Ultrium hardware. The reference contains information about the application programming interfaces (APIs) for each of the various supported operating-system environments. You can obtain this reference via File Transfer Protocol (FTP) at <ftp://ftp.software.ibm.com/storage/devdrv>.
- *IBM Translated Safety Notices*, 96P0851, provides translation of danger and caution notices.
- *IBM Tape Device Drivers: Encryption Support*, GA32-0565-00, provides information for implementing tape encryption.

---

## Chapter 1. Introduction

The IBM LTO Ultrium 4 Half-High Tape Drive is a high-performance, high-capacity data-storage device that is designed to backup and restore open systems applications. The drive can be integrated into an enclosure, such as a desktop unit, tape autoloader, or tape library. It is the fourth generation in the Ultrium series of products, and is available with a Serial Attached SCSI interface (SAS).

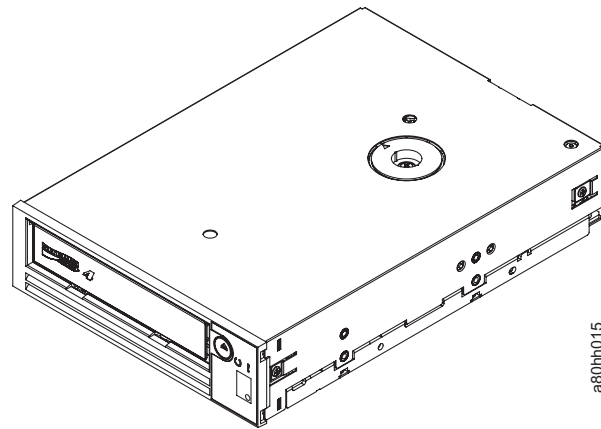


Figure 1-1. View of the drive

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### Drive features

The drive offers the following features:

- Dual port 3 Gbps Serial Attached Small Computer Systems Interface (SAS)
- Half height form factor
- Native storage capacity of 800 GB per cartridge (1600 GB at 2:1 compression)
- Maximum native data transfer rate of up to 120 MB per second
- Burst data transfer rate of 300 MB per second
- 256 MB read-and-write cache
- Support for encryption on Ultrium 4 tape cartridges
- Single Character Display (SCD) operator panel
- Ready and Fault status lights
- Maintenance Mode functions

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## Front panel of the drive

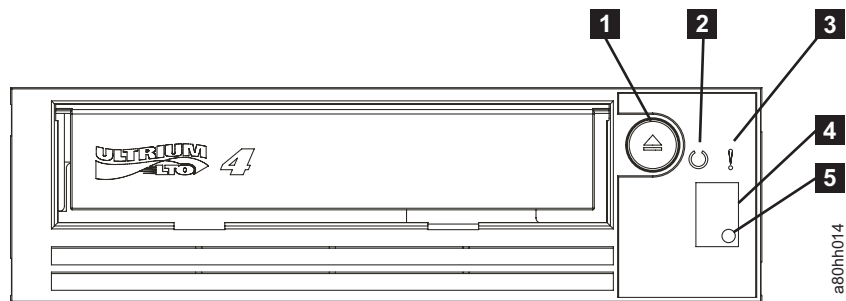


Figure 1-2. Front panel element descriptions

- |          |   |          |                                |
|----------|---|----------|--------------------------------|
| <b>1</b> | Unload button                           | <b>4</b> | Single character display (SCD) |
| <b>2</b> | Ready/Activity status light (green LED) | <b>5</b> | SCD dot                        |
| <b>3</b> | Fault status light (amber LED)          |          |                                |

---

## Rear panel of the SAS drive

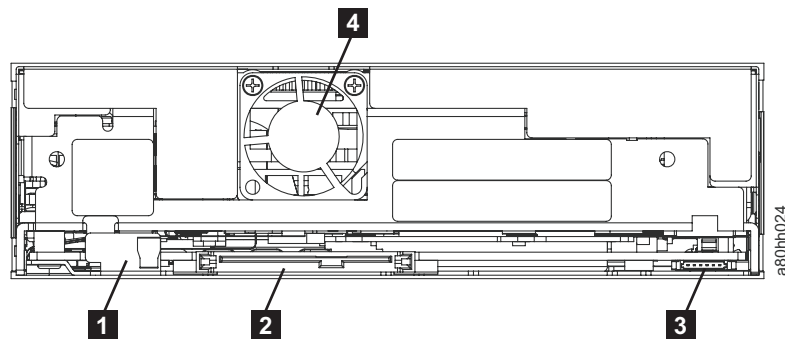


Figure 1-3. SAS drive rear panel element descriptions

- |          |  |          |  |
|----------|--|----------|--|
| <b>1</b> | Feature block switch (on the underside of the drive) | <b>3</b> | RS-422 connector for library interfaces (LDI or ADI) selectable via Feature Switch 5 |
| <b>2</b> | SAS/Power connector                                  | <b>4</b> | Fan  |

---

## SAS interface

The drive has a dual-port 3 Gbps SAS (Serial Attached SCSI) host interface.

A drive with a SAS (Serial Attached SCSI) interface can be linked directly to controllers. 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 3.0 Gb/s. In addition, SAS drives can be hot-plugged.

SAS drives will auto-negotiate speed. There are no configurable topologies thus no setup is required for SAS interface.

## Physical Characteristics

The drive contains a dual-port, SFF-8482 SAS connector. The SAS connector conforms to the Device Free (Plug) Connector form of the SFF-8482 standard “Unshielded Dual Port Serial Attachment Connector” as defined by the SFF standards body. For more information go to <http://www.sffcommittee.org> or see <ftp://ftp.seagate.com/sff/SFF-8482.pdf> for connector details.

---

## Cartridge compatibility

The drive uses the IBM TotalStorage® LTO Ultrium 800 GB Data Cartridge and is compatible with the cartridges of its predecessor, the IBM LTO Ultrium 3 Half-High Tape Drive. The drive performs the following functions:

- Reads and writes Generation 4 cartridges to Generation 4 format
- Reads and writes Generation 3 cartridges to Generation 3 format
- Reads Generation 2 cartridges
- Does not write Generation 4 cartridge to Generation 3 format
- Does not write Generation 3 cartridges to Generation 2 format
- Does not write Generation 2 cartridges
- Does not read or write Generation 1 cartridges

The drive reads tapes that have been written by other licensed Ultrium 4 drives. It also writes to tapes that can be read by other licensed Ultrium 4 drives.

In addition to using the IBM TotalStorage LTO Ultrium Data Cartridge with up to 800 GB capacity, the drive also offers read/write capability for certified LTO Ultrium tape cartridges.

---

## Speed Matching

To improve system performance, the drive uses a technique 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 one of six speeds when reading or writing the Ultrium 3 or Ultrium 4 cartridge format. Native data rates are as follows:

- Ultrium 4 (Read/Write): 30, 48, 66, 84, 103, or 120 MB per second (MB/s)
- Ultrium 3 (Read/Write): 30, 40, 50, 60, 70, or 80 MB per second (MB/s)
- Ultrium 2 (Read only): 15, 19, 22, 26, or 30 MB per second (MB/s)

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

---

## Channel Calibration

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

---

## Data cartridge capacity scaling

The SET CAPACITY SCSI command enables a customer to capacity scale a data cartridge to enable faster random access. As an example, a customer could capacity scale a data cartridge to 20% of its normal length which improves the average access time by almost a factor of 5; however, it also reduces the native capacity of the tape to 80 GB.

---

## Encryption

IBM LTO Ultrium 4 Half-High Tape Drive supports host Application Managed Encryption (AME), using T10 encryption methods. Data encryption is supported with LTO Ultrium 4 Data Cartridges only.

The encryption enabled drive contains the necessary hardware and firmware to encrypt and decrypt host tape application data. Encryption policy and encryption keys are provided by the host application and there is no encryption setup required (or available) for this drive. A drive digital certificate is installed at manufacturing time. Each drive receives a unique serial number and certificate. The T10 Application may validate each drive instance by checking the drive's digital certificate.

Application-managed encryption is supported on AIX<sup>®</sup>, Windows Server 2003, Linux<sup>®</sup>, and Solaris. Encryption requires the latest device drivers available on the ftp download site: <ftp://ftp.software.ibm.com/storage/devdrv/>.

For more details, see the IBM Tape Device Drivers Encryption Support documentation, and the IBM LTO Ultrium Tape Drive SCSI Reference documentation.

---

## Inhibit firmware down-leveling

The drive provides the capability to prevent loading and installing drive microcode via 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 will be performed if the firmware level is loaded via the host interface or the library interface.

---

## Feature Switches

This drive contains eight factory-set feature switches by which the drive is configured for unique function. The feature switches are preset at the factory but are described here in case the feature switch settings need to be inspected for your application.

The feature switch is located on the rear panel of the tape drive. Refer to "Rear panel of the SAS drive" on page 1-2 for the location of the switch. The switch positions are labeled 1 through 8 (see Table 1-1 on page 1-5). The on and off positions are marked on the switch. The default settings for the feature switches



are all switches placed in the “OFF” position.

Table 1-1. Feature Switch Definitions

Switch Position	“On” Function	“Off” Function
1	Library interface at 9600 baud / polled	Library interface at 38,400 baud / non-polled
2	Library interface uses two stop bits	Library interface uses one stop bit
3	Reserved	Reserved
4	Library interface at 115,000 baud rate	Switch #1 active
5	Enable ADI Interface protocol	Enable LDI Interface protocol
6	Reserved	Reserved
7	Disable head brush ERP	Allows head brush ERP
8	Reserved	Reserved

The head brush error recovery procedure (ERP) will cause the cartridge to temporarily extend beyond the front of the bezel. This is not acceptable in some automation environments. For these automation environments the head brush error recovery procedure (ERP) is disabled.

---

## Library Interface

Using the RS-422 Connector for library interfaces, the drive supports the Library Drive Interface (LDI) protocol or the Automation Drive Interface (ADI) protocol.

LDI is an IBM proprietary Library Drive Interface protocol.

ADI is an Automation Drive Interface protocol that supports the International Committee for Information Technology Standards (INCITS) T10 SCSI Storage Device Automation Drive Interface protocol.

---

## Supported servers and operating systems

To determine the latest supported attachments, visit the web at [http://www-1.ibm.com/support/us/all\\_download-drivers.html](http://www-1.ibm.com/support/us/all_download-drivers.html). For specific instructions about attaching the drive, see Chapter 2, “Installing the drive,” on page 2-1.

---

## Supported device drivers

Device drivers enable the drive to interact with a variety of servers. To properly install an IBM device driver (if required), refer to the *IBM Ultrium Device Drivers Installation and User’s Guide*. For applications that use other device drivers, see the application’s documentation to determine which drivers to use.

IBM maintains the latest levels of device drivers and driver documentation for the drive on the Internet. You can access this material by performing one of the following procedures.

**Note:** If you do not have Internet access and you need information about device drivers, contact your Marketing Representative.

- Using a browser, type one of the following:
  - <http://www.ibm.com/storage>
  - <ftp://ftp.software.ibm.com/storage/devdrv>
  - <ftp://207.25.253.26/storage/devdrv>
- Using an IBM FTP site, enter the following specifications:
  - FTP site: ftp.software.ibm.com
  - IP Addr: 207.25.253.26
  - Userid: anonymous
  - Password: (use your current e-mail address)
  - Directory: /storage/devdrv/

IBM provides PostScript- and PDF-formatted versions of its documentation in the /storage/devdrv/doc directory:

- IBM\_ultrium\_tape\_IUG.ps and IBM\_ultrium\_tape\_IUG.pdf contain the current version of the *IBM Ultrium Device Drivers Installation and User's Guide*
- IBM\_ultrium\_tape\_PROGREF.ps and IBM\_ultrium\_tape\_PROGREF.pdf contain the current version of the *IBM Ultrium Device Drivers Programming Reference*

A list of device drivers for each supported server appears at /storage/devdrv/.

**Note:** The device driver for System i™ servers is included in the OS/400® operating system.

---

## Specifications

The sections below give the physical, power, and environmental specifications for the drive. Specifications for tape cartridges are given in “Environmental specifications” on page 1-7.

### Physical specifications

Specification	Measurement
Width	146.0 mm (5.74 in.) without bezel
	148.6 mm (5.85 in.) with bezel
Length	205.0 mm (8.07 in.) without bezel
	210.0 mm (8.26 in.) with bezel
Height	41.0 mm (1.6 in.) without bezel
	42.7 mm (1.7 in.) with bezel
Weight (without a cartridge)	1.6 kg (3 lb. 5 oz.)

### Power specifications

Power Supply	5 V dc	12 V dc
Tolerance	± 10%	± 10%
Voltage Ripple/Noise(50 Hz - 20 MHz)	100 mV pp	125 mV pp
Minimum supply current (steady state)	1.9 A	0.2 A

<b>Power Supply</b>	<b>5 V dc</b>	<b>12 V dc</b>
Maximum supply current (steady state)	3.6 A	1.1 A
Peak Supply Current (instantaneous power by power supply)	3.7 A for 100 ms (18 W)	4.10 A for 2 ms (49.20 W)

<b>Power Measurements</b>	<b>SAS Drive</b>
Idle Mode (no cartridge)	12W
Idle Mode (Cartridge loaded)	15W
Reading and Writing	26W

## Environmental specifications

<b>Specification</b>	<b>Measurement</b>		
	<b>Operating(see Note 3)</b>	<b>Storage</b>	<b>Shipping</b>
Drive temperature	10 to 40°C(50 to 104°F)	-40 to 60°C(-40 to 140°F)	-40 to 60°C(-40 to 140°F)
Relative humidity (noncondensing)	20 to 80%	10 to 90%	10 to 90%
Wet bulb temperature (maximum)	26°C(78.8°F)	26°C(78.8°F)	26°C(78.8°F)

**Note:** Measured in front of the bezel, near the air intake area (refer to Figure 2-1 on page 2-2).

## Other specifications

<b>Specification</b>	<b>Measurement</b>
Maximum altitude for operating and storage	3048 m (10,000 ft)
Maximum altitude for shipping	12192 m (40,000 ft)



---

## Chapter 2. Installing the drive

Before starting this installation, read these instructions and compare them to the drive installation instructions for your enclosure.

---

### Avoiding drive damage

To avoid static electricity damage when handling the drive, use the following precautions:

- Limit your movement. Movement can cause static electricity to build around you.
- Always handle the drive carefully. Never touch exposed circuitry.
- Prevent others from touching the drive.
- Before unpacking and installing the drive into an enclosure, touch its static-protective packaging to an unpainted metal surface on the enclosure for at least two seconds. This reduces static electricity in the packaging and your body.
- When possible, remove the drive from its static-protective packaging and install it directly into an enclosure without setting it down. When this is not possible, place the drive's packaging on a smooth, level surface and place the drive on the packaging.
- Do not place the drive on the cover of the enclosure or on any other metal surface.

---

### Installation overview

1. "Unpack and acclimate the drive"
2. "Power off the enclosure" on page 2-2
3. "Set the Feature switches" on page 2-2
4. "Install the SAS drive connector" on page 2-3
5. "Mount the drive into an enclosure" on page 2-3
6. "Connect and test power to the drive" on page 2-4
7. "Connect the internal LDI cable (optional)" on page 2-5
8. "Run drive diagnostics" on page 2-5
9. "Install device drivers" on page 2-5
10. "Connect the enclosure's external SAS interface to the server" on page 2-5
11. "Connect the external LDI interface to the server (optional)" on page 2-5
12. "Configure the drive to the server" on page 2-6

---

### Unpack and acclimate the drive

Unpack the drive and store the packaging for future moves or shipping.

Acclimation time is required if the temperature of the drive when unpacked is different than the temperature of its operating environment (measured at the front of the bezel near the air intake area ( **1** ) as shown in Figure 2-1 on page 2-2). The recommended acclimation time is four hours after the drive has been unpacked or one hour after any condensation that you can see has evaporated, whichever is greater. When acclimating the drive, apply the following measures:

- If the drive is colder than its operating environment and the air contains sufficient humidity, condensation may occur in the drive and damage it. When the drive has warmed to the operating temperature range (greater than 10°C or 50°F) and no danger of condensation is present (the air is dry), warm the drive more quickly by powering it on for 30 minutes. Use a diagnostic tape to test the drive before inserting a tape that contains data.
- If the drive is hotter than its operating environment, the tape can stick to the drive head. When the drive has cooled to the operating temperature range (less than 40°C or 104°F), cool the drive more quickly by applying airflow for 30 minutes. Power-on the drive and use a diagnostic tape to test it before inserting a tape that contains data.

If you are uncertain about whether the temperature of the drive is within the recommended operating range or the humidity is sufficient to cause condensation, acclimate the drive for the full four hours.

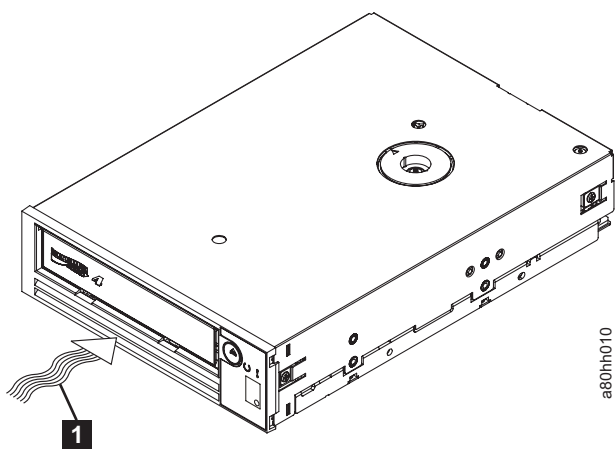


Figure 2-1. Temperature of the Half-high drive is taken near the air intake area

## Power off the enclosure

1. Power-off the enclosure (or the unit that provides power to the drive)
2. Disconnect the power cord from both the electrical outlet and the enclosure.

## Set the Feature switches

The drive contains eight factory set feature switches (see **1** in Figure 1-3 on page 1-2) by which the drive can be configured for unique function. The switch positions are labeled 1 through 8. The on and off positions are marked on the switch. See Feature Switch Definitions in the following table.

Table 2-1. Feature Switch Definitions

Switch	"On" Function	"Off" Function
1	Library interface at 9600 baud / polled	Library interface at 38,400 baud / non-polled
2	Library interface uses two stop bits	Library interface uses one stop bit
3	Reserved	Reserved
4	Library interface at 115,000 baud rate	Switch #1 active
5	Enable ADI Interface	Enable LDI Interface
6	Reserved	Reserved

Table 2-1. Feature Switch Definitions (continued)

Switch	"On" Function	"Off" Function
7	Disable head brush ERP*	Allows head brush ERP*
8	Reserved	Reserved
<p><b>Note:</b> The default settings for the feature switches are all switches placed in the "OFF" position.</p> <p>*The head brush error recovery procedure (ERP) is a last ditch effort the drive makes in some cases to recover from what would otherwise become a permanent read or write error by removing any debris which may have accumulated on the read/write head by use of the brush. To brush the head requires that the tape be unthreaded to expose the head. This forces the loader to be cycled to enable re-thread. During the loader cycling, the back of the cartridge will temporarily extend beyond the front of the bezel and this is not acceptable in some automation environments, which is why it can be disabled. Disabling the head brush ERP prevents this last ditch effort by the drive to prevent a permanent error and as a result, if the drive ever would invoke the head brush ERP (because of some error condition), it will instead immediately report that permanent error.</p>		

---

## Install the SAS drive connector

Install the customer-supplied SAS drive connector to the rear panel of the drive (2 in Figure 1-3 on page 1-2). The SAS connector also includes the power connector for the drive.

---

## Mount the drive into an enclosure

### When mounting the drive into an enclosure:

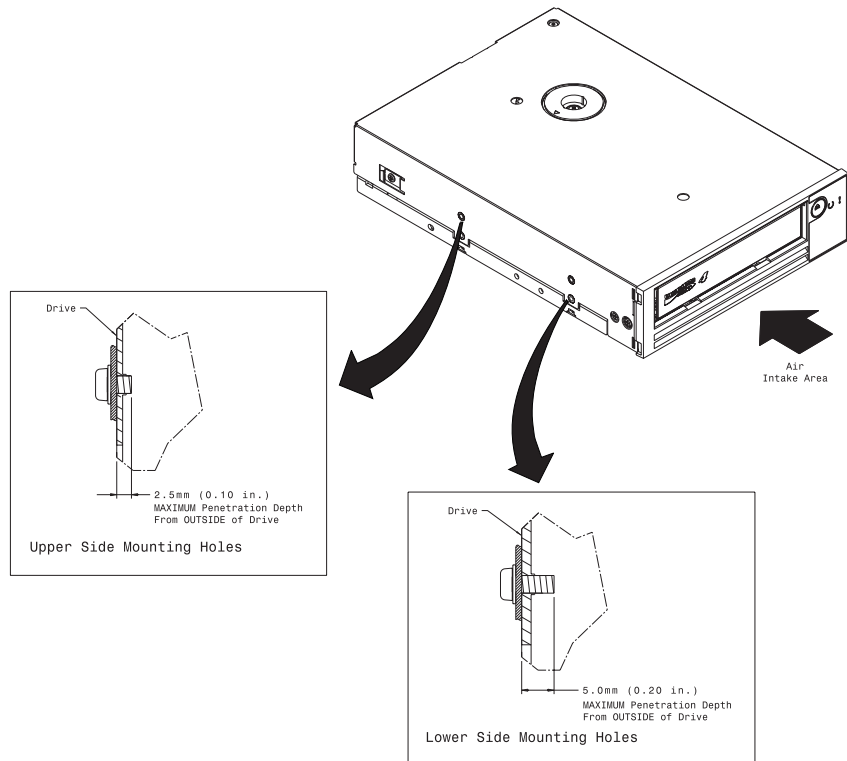
- Use an appropriate screw length.
- Ensure that no objects such as screw heads, cables, or adjacent devices, are pressing against the frame.
- Do not obstruct the ventilation slots at the rear of the drive.
- Allow sufficient space for accessing the drive's front panel controls.

### To mount the drive into an enclosure:

1. Remove the cover of your enclosure (refer to the instructions in the documentation provided with your enclosure).
2. Place the drive into the enclosure so that the tape load compartment of the drive faces the tape load compartment of the enclosure.
3. Insert two screws into the top mounting holes and two screws into the lower mounting holes (2 in Figure 2-2 on page 2-4) of the side brackets located on the left and right sides of the chassis.

### Attention

When inserted into the drive, the length of the mounting screws must not exceed 2.5 mm (0.10 in.) for the upper mounting holes and 5.0 mm (0.20 in.) for the lower mounting holes inside the chassis. If the length exceeds this measurement, the drive may become damaged.



a80hh023

Figure 2-2. Mounting holes on the drive. The holes are located on both sides of the drive. The drive is shown with a front bezel.


## Connect and test power to the drive

The drive does not contain its own power source; it must be powered externally.

### To connect and test power to the drive:

1. Ensure that the enclosure (or unit that supplies power to the drive) is powered off.
2. Ensure that the power cord is disconnected from both the enclosure and the power outlet.
3. Connect the enclosure's internal power cable to the power connector on the drive (see **2** in Figure 1-3 on page 1-2).

**Note:** The customer-supplied SAS connector contains the power connector for the SAS drive.

4. Connect the power cord to the enclosure and to the electrical outlet.
5. Power on the drive. During power on, or a drive reset, the drive front panel will display drive progress as follows:
  - a. SCD will display random segments (status lights - Green OFF, Amber OFF).
  - b. SCD will go blank (status lights - Green ON, Amber OFF).
  - c. SCD will display random segments (status lights - Green OFF, Amber ON).
  - d. SCD will display  (status lights - Green OFF, Amber ON).
  - e. SCD will go blank (status lights - Green ON, Amber OFF).



6. After POST has completed, verify that the green Ready/Activity status light is ON.
7. Power-off the enclosure.
8. Disconnect the power cord from both the enclosure and the electrical outlet.

---

## Connect the internal LDI cable (optional)

**Note:** Use this step only if you are installing the drive into a library control system. The drive uses the Library/Drive Interface (LDI) to communicate with a tape library.

Connect the enclosure's internal LDI cable to the LDI connector on the drive (see **3** in Figure 1-3 on page 1-2).

---

## Run drive diagnostics

1. Replace the cover on the enclosure.
2. Connect the power cord to both the enclosure and the electrical outlet.
3. Power-on the enclosure.
4. Run the Standalone Diagnostic (see "Function Code 1: Run Drive Diagnostics" on page 3-9).

**Note:** Optionally, you can use the ITDT tool to verify host to drive communications and to run a device test that will send data across the bus. For more information on ITDT, see "ITDT Firmware Update, Dump Retrieval and Library/Drive Test Tool" on page 3-23

5. Power-off the enclosure.
6. Disconnect the power cord from both the enclosure and the electrical outlet.

---

## Install device drivers

For information about installing device drivers, refer to the documentation for your enclosure.

---

## Connect the enclosure's external SAS interface to the server

To connect the enclosure to the server:

1. Connect an external SAS cable to both the enclosure and the server (for the location of the connectors, refer to the documentation for your enclosure and server).
2. Run the appropriate SAS attachment verification procedure from your server (for instructions, refer to the *IBM Ultrium Device Drivers Installation and User's Guide*). If an error occurs, refer to "Using sense data" on page 5-8.

If you want to power a device on or off while it is connected to the same bus as a drive, you can do so if, during the power-on cycle, you quiesce all devices (including the drive) on the bus.

---

## Connect the external LDI interface to the server (optional)

Use this step only if your enclosure requires an LDI interface.

To check the drive, connect the enclosure's external LDI cable to the server (for the location of the external LDI connector, refer to the documentation for the enclosure).

---

## **Configure the drive to the server**

To configure the drive to the server, refer to the documentation for that server.

The drive is now ready for use.

---

## Chapter 3. Operating the Drive

Operating the drive involves using the following front panel items:

- Single-character Display (SCD)
- SCD Dot
- Status Lights
- Unload Button

---

### Single-character Display (SCD)

The SCD ( **4** in “Front panel of the drive” on page 1-2) presents a single-character code for:


- Error conditions and informational messages
- Diagnostic or maintenance functions (while in maintenance mode only)

“Error Codes and Messages” on page 5-3 lists the codes for error conditions and informational messages. If multiple errors occur, the code with the highest priority (represented by the lowest number) displays first. When the error is corrected, the code with the next highest priority displays, and so on until no errors remain.

“Diagnostic and Maintenance Functions” on page 3-7 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 dump is present while the drive is in maintenance mode, a single red dot illuminates in the lower right corner of the SCD (  ). To copy the dump, see “Function Code 5: Copy Drive Dump” on page 3-12.

The SCD Dot ( **5** in “Front panel of the drive” on page 1-2) is on solid if the dump is in RAM memory. The SCD Dot flashes if the dump is in FLASH memory.

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

**Note:** If the drive dump is stored in RAM memory (SCD Dot on solid), the dump will be lost when you turn OFF the power or reset the drive.

---

### Status Lights

The Status Lights ( **2** and **3** in “Front panel of the drive” on page 1-2) are light-emitting diodes (LEDs) that provides information about the state of the drive. The Ready status light is green and the Fault status light is amber, and (when lit) solid or flashing.

Table 3-1. Status Light Modes

Mode	SCD	Ready LED (green)	Fault LED (amber)
Operational	blank	On	Off

Table 3-1. Status Light Modes (continued)

Mode	SCD	Ready LED (green)	Fault LED (amber)
Activity (tape movement) in Operational Mode	blank	Flashing	Off
Maintenance	solid character	Off	On
Executing Maintenance Selection	flashing character	Off	On
Error Condition	solid character	Off	Flashing
Power-On / Reset Initialization	random segments	Off	On

Table 3-2 lists the conditions of the Status Lights and Single-character Display (SCD) and provides an explanation of what each condition means.

Table 3-2. Meaning of Status Lights and Single-character Display (SCD)

If the green Ready Status Light is...	and the amber Fault Status Light is...	and the SCD is...	and the SCD Dot is...	Meaning
Off	Off	Off	Off	The drive has no power or is powered off.
Green/Solid	Off	Off	Off	The drive is powered on and in an idle state.
Flashing Green (once per second)	Off	Off	Off	The 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.
Flashing Green (once per second)	Off	Off	Off	If the drive contains a cartridge during the power-on cycle, the drive completes POST and slowly rewinds the tape (the process may take up to thirteen minutes). The light stops blinking and becomes solid when the drive completes the recovery and is ready for read or write operation. To eject the cartridge, press the unload button.
Off	Amber/Solid	Displaying an error code or Maintenance Mode Function	On/Off	The drive is displaying error code(s) from the error code log on the SCD. For more information, see "Function Code 9: Display Error Code Log" on page 3-15 and "Error Codes and Messages" on page 5-3.

Table 3-2. Meaning of Status Lights and Single-character Display (SCD) (continued)







If the green Ready Status Light is...	and the amber Fault Status Light is...	and the SCD is...	and the SCD Dot is...	Meaning
Off / On	Off / On	Displaying random segments/ Blank/ displaying random segments/ displaying  /Blank	Off	During power on, or a drive reset, the drive front panel will display drive progress as follows: <ol style="list-style-type: none"> <li>1. SCD will display random segments (no LEDs ON).</li> <li>2. SCD will go blank (LEDs - Green ON, Amber OFF)</li> <li>3. SCD will display random segments (LEDs - Green OFF, Amber ON)</li> <li>4. SCD will display [8] (LEDs - Green OFF, Amber ON)</li> <li>5. SCD will go blank (LEDs - Green ON, Amber OFF) after a successful power on or reset.</li> </ol> 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 "Error Codes and Messages" on page 5-3
Off	Amber/Solid		On/Off	The drive is entering or exiting from maintenance mode. For more information, see "Function Code 0: Maintenance Mode" on page 3-9.
Off	Amber/Solid	Flashing selected function	On/Off	The drive is executing the selected function while in maintenance mode.
Off	Flashing Amber (once per second)	Displaying error code	Off	An error occurred and the drive or media may require service, or it may require cleaning. Note the code on the SCD, then go to "Error Codes and Messages" on page 5-3 to determine the action that is required.
Off	Flashing Amber	Displaying 	Off	The drive needs cleaning.
Off	Flashing Amber	Displaying Function Code  or Flashing	Off	The drive is updating firmware. <sup>1</sup> The SCD will display a  if using an FMR cartridge. The SCD will be off if using the SCSI interface. For more information, see "Updating Firmware" on page 3-22.
Off	Flashing Amber (twice per second)	Off	Off	The drive detected an error and is performing a firmware recovery. It will reset automatically.
Off	Solid Amber	Flashing 	Off	The drive is requesting a cartridge to be loaded.
Off	Flashing Amber (twice per second)	Off	On	There is a drive dump in flash memory.

Table 3-2. Meaning of Status Lights and Single-character Display (SCD) (continued)

If the green Ready Status Light is...	and the amber Fault Status Light is...	and the SCD is...	and the SCD Dot is...	Meaning
<sup>1</sup> 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.				

## Unload Button

The Unload Button ( **1** in “Front panel of the drive” on page 1-2) performs the following functions:

Table 3-3. Functions that the Unload Button performs



Unload Button Function	How to Initiate the Function
Rewind the tape into the cartridge and eject the cartridge from the drive	Press the Unload Button once. The Ready/Activity status light flashes green while the drive is rewinding and unloading. <b>Note:</b> During a rewind and eject operation, the drive does not accept SCSI commands from the server.
Place the drive in maintenance mode	Ensure that the drive is unloaded. Then, within two seconds, press the Unload Button three times. The drive is in maintenance mode when the Fault status light becomes solid amber and  appears in the SCD. <b>Note:</b> While in maintenance mode, the drive does not accept SCSI interface commands. <b>Note:</b> If you attempt to enter Maintenance Mode with a cartridge in the drive, the drive will rewind and eject the cartridge. Remove the cartridge and repeat the steps for entering Maintenance Mode.
Scroll through the maintenance functions	While in maintenance mode, press the Unload 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 “Diagnostic and Maintenance Functions” on page 3-7), press and hold the Unload Button for three seconds.
Exit maintenance mode	Press the Unload Button once per second until  displays. Then press and hold the Unload Button for three seconds. Maintenance mode is exited when the Ready/Activity status light becomes solid green and the SCD becomes blank.
Force a drive dump (part of the maintenance mode)	<b>Attention:</b> If the 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 drive or you may lose the dump data.  Choose one of the following procedures: <ul style="list-style-type: none"> <li>• If the drive is in maintenance mode (Fault status light is solid amber), refer to “Function Code 4: Force a Drive Dump” on page 3-11.</li> <li>• If the drive is in operating mode (Ready/Activity status light is solid or flashing green), press and hold the Unload Button for ten seconds.</li> </ul> If captured dump data exists, the drive places it into a dump area (for information about retrieving the data, see ).

Table 3-3. Functions that the Unload Button performs (continued)

Unload Button Function	How to Initiate the Function
Reset the drive	Press and hold the Unload Button until the drive begins the reset procedure (Fault status light will be amber). <b>Note:</b> If a tape cartridge is loaded in the drive the drive will unload the tape. Repeat the "Reset the drive" procedure after the tape is unloaded. The drive saves a dump of the current drive state, then reboots to allow communication. Do not cycle power as this will erase the contents of the dump.

## 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 "Write-Protect Switch" on page 4-2).
3. Grasp the cartridge so that the write-protect switch faces you (see **1** in Figure 3-1).
4. Slide the cartridge into the tape load compartment.

**Note:**

- a. If the cartridge is already in an ejected position and you want to reinsert it, remove the cartridge then insert it again.
- b. If the cartridge is already loaded and you cycle the power (turn it off, then on), the tape will reload.

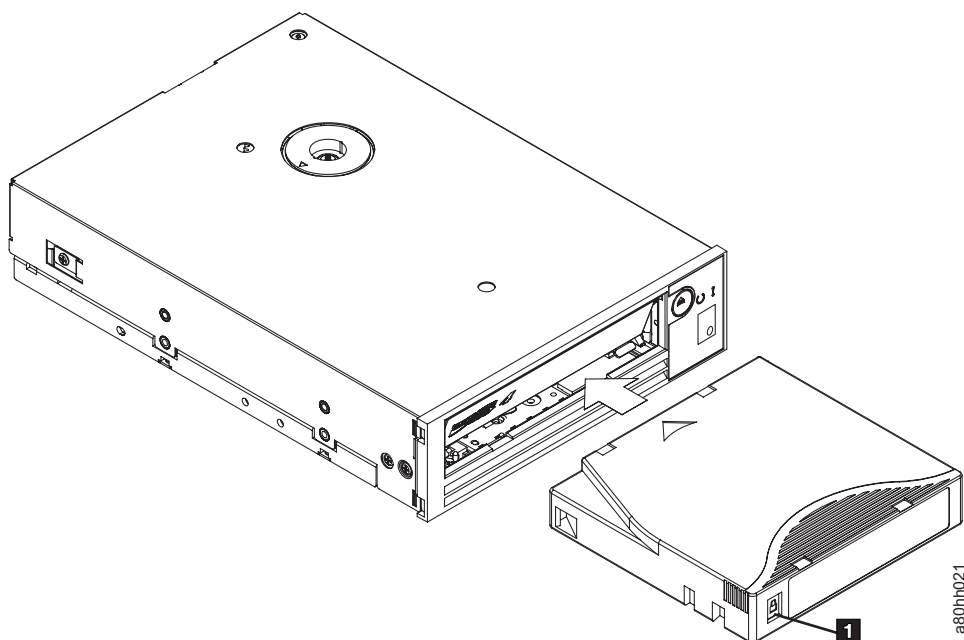


Figure 3-1. Inserting a cartridge into the drive

---

## Removing a Tape Cartridge

To remove a tape cartridge:

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

**Important:** Always remove an ejected cartridge before reinserting.

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

---

## Mid-tape Recovery


If reset occurs while a cartridge is loaded, the drive will slowly rewind the tape and eject the cartridge. If a power cycle occurs while a cartridge is loaded, the drive will slowly rewind the tape. The drive will not automatically eject the cartridge.


The Ready/Activity status light flashes during tape movement. Push the Unload Button to eject the cartridge.

---

## Cleaning the Drive Head

**Attention:** When cleaning the drive head, use the IBM LTO Ultrium Cleaning Cartridge (see “Media Supplies” on page 6-1). You may use another LTO cleaning cartridge, but it may not meet the standards of reliability established by IBM.

Clean the drive head whenever  displays on the Single-character Display and the Fault status light is flashing amber 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  with the **solid** amber Fault status light, means to insert a cartridge, not clean the drive head.

To clean the head, insert the cleaning cartridge into the tape load compartment (see “Front panel of the drive” on page 1-2). The drive performs the cleaning automatically in less than two minutes then ejects the cartridge. The drive will perform a short Load/Unload Test while ejecting the drive. Wait for the drive to finish before removing the cartridge.

**Note:** The drive will automatically eject an expired cleaning cartridge.

The IBM LTO Ultrium Cleaning Cartridge is valid for 50 uses.



## Diagnostic and Maintenance Functions

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.

**Attention:** Maintenance functions cannot be performed concurrently with read or write operations. While in maintenance mode, the tape drive does not accept SCSI commands from the server.












Table 3-4 describes each diagnostic and maintenance function that the drive can perform, gives the function code which appears on the Single-character Display (SCD), and directs you to the instructions for performing the function. It is recommended that you use a customer-supplied scratch (blank) data cartridge for diagnostic testing.

**Note:** During normal operation the fan only runs when cooling is required. The fan will be turned on/off during the POST and Run Drive Diagnostics to demonstrate the fan is operational.

Table 3-4. Diagnostic and maintenance functions


Function Code	Diagnostic or Maintenance Function	Instructions Location
0	<b>Exit Maintenance Mode:</b> Causes the drive to become available for reading and writing data.	"Function Code 0: Maintenance Mode" on page 3-9
1	<b>Run Drive Diagnostics:</b> Runs tests to determine whether the drive can properly load and unload cartridges, and read and write data.	"Function Code 1: Run Drive Diagnostics" on page 3-9
2	<b>Update Tape Drive Firmware from FMR Tape:</b> Loads updated firmware from a field microcode replacement (FMR) tape.	"Function Code 2: Update Drive Firmware from FMR Tape" on page 3-10
3	<b>Create FMR Tape:</b> Copies its field microcode replacement (FMR) data to a customer-supplied scratch (blank) data cartridge.	"Function Code 3: Create FMR Tape" on page 3-11
4	<b>Force a Drive Dump:</b> Performs a dump of data (also known as saving a microcode trace).	"Function Code 4: Force a Drive Dump" on page 3-11
5	<b>Copy Drive Dump:</b> 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.	"Function Code 5: Copy Drive Dump" on page 3-12
6	<b>Run Host Interface Wrap Test:</b> Performs a check of the circuitry from and to the connector.	"Function Code 6: Run Host Interface Wrap Test" on page 3-13
7	<b>Run RS-422 Wrap Test:</b> This test causes the drive to perform a check of the circuitry and connector for the RS-422 interface.	"Function Code 7: Run RS-422 Wrap Test" on page 3-14

Table 3-4. Diagnostic and maintenance functions (continued)


Function Code	Diagnostic or Maintenance Function	Instructions Location
	<b>Unmake FMR Tape:</b> 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.	“Function Code 8: Unmake FMR Tape” on page 3-15
	<b>Display Error Code Log:</b> 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).	“Function Code 9: Display Error Code Log” on page 3-15
	<b>Clear Error Code Log:</b> Erases the contents of the error code log.	“Function Code A: Clear Error Code Log” on page 3-16
	<b>Insert Cartridge into Tape Drive:</b> 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.	“Function Code C: Insert Cartridge into Tape Drive” on page 3-16
	<b>Test Cartridge &amp; Media:</b> Performs tests to ensure that a suspect cartridge and its magnetic tape are acceptable.	“Function Code E: Test Cartridge & Media” on page 3-16
	<b>Write Performance Test:</b> Performs tests to ensure that the drive can read from and write to tape.	“Function Code F: Write Performance Test” on page 3-17
	<b>Test Head:</b> Performs tests to ensure that the tape drive’s head and tape-carriage mechanics are working correctly.	“Function Code H: Test Head” on page 3-18
	<b>Fast Read/Write Test:</b> Performs tests to ensure that the drive can read from and write to tape.	“Function Code J: Fast Read/Write Test” on page 3-19
	<b>Load/Unload Test:</b> Tests the drive’s ability to load and unload a tape cartridge.	“Function Code L: Load/Unload Test” on page 3-20
	<b>Enable Post Error Reporting:</b> When selected, deferred-check conditions are reported to the host.	“Function Code P: Post Error Reporting Enabled” on page 3-21
	<b>Disable Post Error Reporting:</b> When selected, deferred-check conditions are NOT reported to the host.	“Function Code U: Post Error Reporting Disabled” on page 3-21

## 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 Unload Button three times within two seconds.  appears in the Single-character Display (SCD), and the Fault Light turns amber.


**Note:** If a cartridge is in the tape drive, it will eject the first time that you press the Unload Button and the drive will not be placed in maintenance mode. To continue placing the drive in maintenance mode, perform the preceding step. While in Maintenance Mode, the drive will not accept a

cartridge unless the drive requests it. The SCD will display a flashing  to indicate a cartridge needs to be inserted.

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

## Exiting Maintenance Mode

The drive must be in maintenance mode to run drive diagnostics or maintenance functions. To exit maintenance mode:

1. Press and hold the Unload Button for 3 or more seconds then release the button to take the drive out of maintenance mode. If no error is detected,  temporarily appears in the SCD, then goes blank. The drive then exits maintenance mode and the Ready/Activity status light will return to Green.
2. If an error is detected, the SCD shows an error code but still exits maintenance mode. To determine the error, locate the code in "Error Codes and Messages" on page 5-3. 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  makes the drive available for running drive diagnostics or maintenance functions.


1. Place the drive in Maintenance Mode. For instructions, see "Entering Maintenance Mode" on page 3-8.
2. To exit Maintenance Mode, see "Exiting Maintenance Mode."

**Note:** The drive exits Maintenance Mode automatically after it completes a maintenance function or after 10 minutes if no action has occurred.

## Function Code 1: Run Drive Diagnostics


Approximate Run Time = 5 minutes per loop


Total Number of Loops = 1

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






Record the time 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 significantly longer than the "Approximate Run Time", run "Function Code F: Write Performance Test" on page 3-17. If the Write Performance Test fails, replace the media.

**Attention:** 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 (e.g. Gen 1, WORM media, or FMR cartridge), error code  appears in the SCD and the amber Fault status


light flashes. If you inserted a write-protected cartridge, or the media has read-only compatibility (e.g., Gen2 media), error code  appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.




#### Steps to Execute Run Drive Diagnostics:

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select function . Wait for the SCD to change to a flashing .
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing  and the test begins. During the test, the drive will Unload/Load the cartridge. Do not remove the cartridge during the test.
  - If no error is detected, the diagnostic will exit Maintenance Mode,  temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)
  - If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in “Error Codes and Messages” on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload Button for 10 seconds.

## Function Code 2: Update Drive Firmware from FMR Tape

**Attention:** When updating drive firmware, do not power-off the drive until the update is complete or the firmware may be lost.

Function Code  loads drive firmware from a field microcode replacement (FMR) tape. The FMR tape must have been created from a LTO Ultrium 4 Half-High tape drive with the same host interface.

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing .
4. Insert the FMR tape cartridge. The SCD changes to a flashing . The amber Fault status light will be ON solid during tape movement and flashing while code is being loaded. The green Ready/Activity status light will be 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 “Error Codes and Messages” on page 5-3. Push the Unload Button to eject the cartridge. The drive exits Maintenance Mode after the cartridge is removed. Contact IBM 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 other LTO Ultrium 4 Half-High tape drives with the same host interface.

**Attention:** 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 (e.g. Gen 1 or WORM media), error code **7** appears in the SCD and the amber Fault status light flashes. If you inserted a write-protected cartridge, or the media has read-only

compatibility (e.g., Gen2 media), error code **P** appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until **3** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing **C**.
4. Insert a scratch (blank) data cartridge that is not write protected (or 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 “Error Codes and Messages” on page 5-3. The tape drive then unloads the FMR tape, and exits Maintenance Mode after the cartridge is removed.

## 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. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until  $\boxed{4}$  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The drive performs the dump. The SCD shows  $\boxed{0}$ , then goes blank, and the drive exits Maintenance Mode. 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 Unload Button for ten seconds. This causes the drive to reboot.

## Function Code 5: Copy Drive Dump

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

**Attention:** 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 (e.g. Gen 1, WORM media, or FMR cartridge), error code  $\boxed{7}$  appears in the SCD and the amber Fault status light flashes. If you inserted a write-protected cartridge, or the media has read-only compatibility (e.g., Gen2 media), error code  $\boxed{P}$  appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.

1. Place the drive in Maintenance Mode. (For instructions, see “Entering Maintenance Mode” on page 3-8.) Cycle through the Maintenance Mode options until  $\boxed{5}$  is displayed on the SCD. Press and hold the Unload Button for three seconds to select Function Code  $\boxed{5}$ . After selecting Function Code  $\boxed{5}$  the SCD will display option  $\boxed{5} - \boxed{1}$ . Press the Unload Button within 5 seconds to make a different selection. If no other selection is made, the drive will perform option  $\boxed{5} - \boxed{1}$ .
2. Press the Unload Button once per second to cycle through the following functions:
  - $\boxed{5} - \boxed{1}$  : copy dump to tape; clears RAM dump
  - $\boxed{5} - \boxed{2}$  : copy dump to flash memory; clears RAM dump
  - $\boxed{5} - \boxed{3}$  : erase flash memory
  - $\boxed{5} - \boxed{0}$  : no function

If you cycle past the desired code, press the Unload Button once per second until the code reappears.

3. Press and hold the Unload Button for three or more seconds, then release it to select one of the above functions.
4. If you selected  $\boxed{5} - \boxed{0}$  the drive will exit Maintenance Mode. If you selected  $\boxed{5} - \boxed{2}$  or  $\boxed{5} - \boxed{3}$  the SCD will change to a flashing  $\boxed{5}$  while the procedure is being performed. After the procedure is completed the drive will exit Maintenance Mode. If you selected  $\boxed{5} - \boxed{1}$  the SCD will change to a flashing  $\boxed{E}$  indicating that a data cartridge is to be inserted.
5. Insert a scratch (blank) data cartridge within 60 seconds, or the drive will exit Maintenance Mode. Ensure the scratch cartridge is not write protected (or 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 and unloads the tape, and exits Maintenance Mode after the cartridge is removed.
  - If the copy operation fails, an error code appears in the SCD. To determine the error, locate the code in "Error Codes and Messages" on page 5-3. The tape drive unloads the tape cartridge and exits Maintenance Mode after the cartridge is removed.

## Function Code 6: Run Host Interface Wrap Test

Approximate Run Time = 10 seconds per loop

Number of Loops = This test runs until stopped by pressing the Unload Button.

Function Code  $\boxed{6}$  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.
2. Place the drive in Maintenance Mode. For instructions, see "Entering Maintenance Mode" on page 3-8.
3. For SAS drives:
  - a. Press the Unload Button once per second until  $\boxed{6}$  appears in the SCD. Cycle through the Maintenance Mode options until  $\boxed{6}$  is displayed on the SCD. Press and hold the Unload Button for three seconds to select Function Code  $\boxed{6}$ . After selecting Function Code  $\boxed{6}$  the SCD will display option  $\boxed{6} - \boxed{1}$ . Press the Unload Button within 5 seconds to make a different selection. If no other selection is made, the drive will perform option  $\boxed{6} - \boxed{1}$ .
  - b. Continue to press the Unload Button once per second to cycle through the following functions:
    - $\boxed{6} - \boxed{1}$ : test the primary SAS port

- $\boxed{6}$  -  $\boxed{2}$  : test the secondary SAS port
  - $\boxed{6}$  -  $\boxed{3}$  : test both primary and secondary SAS ports at the same time (requires a wrap plug in both ports)
  - $\boxed{6}$  -  $\boxed{0}$  : exit
- c. Press and hold the Unload Button for three or more seconds, then release it to select one of the above functions. The drive automatically starts the test. If you cycle past the desired code, press the Unload Button once per second until the code reappears.
4. The SCD will display a flashing  $\boxed{6}$  during the test.
- If no error is detected, the diagnostic will exit Maintenance Mode,  $\boxed{0}$  temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)
  - If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in "Error Codes and Messages" on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload Button for 10 seconds.

## Function Code 7: Run RS-422 Wrap Test

Approximate Run Time = 10 seconds per loop

Number of Loops = This test runs until stopped by pressing the Unload Button.

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. For instructions, see "Entering Maintenance Mode" on page 3-8.

3. Press the Unload Button once per second until  $\boxed{7}$  appears in the Single-character Display (SCD). If you cycle past  $\boxed{7}$ , continue to press the Unload Button until it displays again.

4. To select the function, press and hold the Unload Button for three seconds.

After you select the function,  $\boxed{7}$  flashes and the drive automatically starts the test.

- If no error is detected, the diagnostic will exit Maintenance Mode,  $\boxed{0}$  temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)



- If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in “Error Codes and Messages” on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload 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. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until **8** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select function **8**. The SCD changes to a flashing **8**.
4. Insert the FMR data cartridge (or 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. The drive then ejects the cartridge and exits Maintenance Mode.


**Note:** If you inserted an invalid tape cartridge (e.g. Gen 1, WORM media, or non-FMR cartridge), error code **7** appears in the SCD and the amber Fault status light flashes. If you inserted a write-protected cartridge, or the media has read-only compatibility (e.g., Gen2 media), error code **P** appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.

## Function Code 9: Display Error Code Log


Function Code **9** displays the last ten error codes, one at a time (the codes are ordered; the most recent is presented first and the oldest is presented last). If there are no errors in the log, function code **0** displays in the Single-character Display (SCD) and exits Maintenance Mode.




1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until **9** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press the Unload Button, then release it to view the most recent error code.
4. Press and release the Unload Button again to view successive error codes. Let two to three seconds pass between each depression. The green Ready/Activity

status light and amber Fault status light will flash On/Off once for each successive error code. The SCD will display  when all the error codes have been displayed.

5. After viewing all error codes, exit this function by pressing the Unload Button again. The SCD will display  and exit Maintenance Mode.

## Function Code A: Clear Error Code Log

Function Code  erases the contents of the error code log.

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function.  flashes in the SCD, followed by . 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 & Media



Approximate Run Time = 15 minutes per loop

Total Number of Loops = 10

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

Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately. Wait for the drive to rewind the tape and unload the cartridge.

**Attention:** When you perform this test, data on the tape will be overwritten.

**Note:** If you inserted an invalid tape cartridge (e.g. Gen 1, WORM media, or FMR cartridge), error code  appears in the SCD and the amber Fault status light flashes. If you inserted a write-protected cartridge, or the media has read-only compatibility (e.g., Gen2 media), error code  appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until  $\boxed{E}$  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing  $\boxed{C}$  requesting a cartridge.
4. Ensure that the write-protect switch on the cartridge is off, then insert the cartridge (or the tape drive exits maintenance mode). The SCD changes to flashing  $\boxed{E}$ . The tape drive runs the tests.
  - If no error is detected, the diagnostic will exit Maintenance Mode,  $\boxed{D}$  temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)
  - If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in “Error Codes and Messages” on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload Button for 10 seconds.

## Function Code F: Write Performance Test

Approximate Run Time = 5 minutes per loop

Total Number of Loops = 10

Function Code  $\boxed{F}$  performs tests to ensure that the drive can read from and write to tape.

Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately. Wait for the drive to rewind the tape and unload the cartridge.

**Attention:** 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 (e.g. Gen 1, WORM media, or FMR cartridge), error code  $\boxed{7}$  appears in the SCD and the amber Fault status light flashes. If you inserted a write-protected cartridge, or the media has read-only compatibility (e.g., Gen2 media), error code  $\boxed{P}$  appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.

2. Press the Unload Button once per second until **F** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing **E**.
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing **F** and the tape drive runs the tests.
  - If no error is detected, the diagnostic will exit Maintenance Mode, **D** temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)
  - If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in "Error Codes and Messages" on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload Button for 10 seconds.

## Function Code H: Test Head

Approximate Run Time = 10 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.

Record the time 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 significantly longer than the "Approximate Run Time", run "Function Code F: Write Performance Test" on page 3-17. If the Write Performance Test fails, replace the media.

Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately. Wait for the drive to rewind the tape and unload the cartridge.

**Attention:** 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 (e.g. Gen 1, WORM media, or FMR cartridge), error code **7** appears in the SCD and the amber Fault status light flashes. If you inserted a write-protected cartridge, or the media has read-only compatibility (e.g., Gen2 media), error code **P** appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.

1. Place the drive in Maintenance Mode. For instructions, see "Entering Maintenance Mode" on page 3-8.

2. Press the Unload Button once per second until **H** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing **L**.
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing **H**. The tape drive runs the tests.
  - If no error is detected, the diagnostic will exit Maintenance Mode, **L** temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)
  - If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in "Error Codes and Messages" on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload Button for 10 seconds.

## Function Code J: Fast Read/Write Test

Approximate Run Time = 5 minutes per loop

Total Number of Loops = 10

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





Record the time 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 significantly longer than the "Approximate Run Time", run "Function Code F: Write Performance Test" on page 3-17. If the Write Performance Test fails, replace the media.

Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately. Wait for the drive to rewind the tape and unload the cartridge.

**Attention:** 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 (e.g. Gen 1, WORM media, or FMR cartridge), error code **7** appears in the SCD and the amber Fault status light flashes. If you inserted a write-protected cartridge, or the media has read-only compatibility (e.g., Gen2 media), error code **P** appears in the SCD. Press the Unload Button. The tape drive unloads the cartridge and exits Maintenance Mode after the cartridge is removed.


1. Place the drive in Maintenance Mode. For instructions, see "Entering Maintenance Mode" on page 3-8.

2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing .
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing  and the tape drive runs the tests.
  - If no error is detected, the diagnostic will exit Maintenance Mode,  temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)
  - If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in “Error Codes and Messages” on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload Button for 10 seconds.

## Function Code L: Load/Unload Test





Approximate Run Time = 15 seconds per loop

Total Number of Loops = 10

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

Press the Unload Button to stop the diagnostic and exit maintenance mode. Pressing the Unload Button once will abort the test at the end of the current test loop. Pressing the Unload Button twice will abort the test immediately. Wait for the drive to rewind the tape and unload the cartridge.

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

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing .
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing  and the tape drive runs the tests.
  - If no error is detected, the diagnostic will exit Maintenance Mode,  temporarily appears in the SCD, and the drive returns to Operational Mode (SCD blank, Green Ready/Activity status light ON, and the Amber Fault status light is OFF)







- If an error is detected, the Fault status light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in “Error Codes and Messages” on page 5-3. To clear the error either turn the power off and then on again, or reboot the drive by pressing and holding the Unload Button for 10 seconds.

## Function Code P: Post Error Reporting Enabled

When Post Error Reporting is enabled, deferred-check conditions are reported to the host and temporary errors are reported in the sense data. Function Code

 will be displayed in Maintenance Mode when the drive has Post Error Reporting enabled.





This selection is normally used as a request from IBM support personnel.



1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until either  or  appears in the SCD.  or  will appear in the SCD to indicate the current setting for Post Error Reporting. If you cycle past the desired code, press the Unload Button once per second until the code reappears.
3. Exit Maintenance Mode if you do not want to change the current setting for Post Error Reporting. For instructions, see “Exiting Maintenance Mode” on page 3-9.
4. To disable Post Error Reporting, Press and hold the Unload Button for three seconds while  appears in the SCD. The SCD changes to  after you release the Unload Button.
5. Press the Unload Button once per second to select another Maintenance Mode Function. To exit Maintenance Mode, refer to “Exiting Maintenance Mode” on page 3-9.

## Function Code U: Post Error Reporting Disabled

When Post Error Reporting is disabled, 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. When the drive has Post Error Reporting

disabled, Function Code  will be displayed in Maintenance Mode. The drive will default to Post Error Reporting disabled after a reboot or power off/on cycle.

1. Place the drive in Maintenance Mode. For instructions, see “Entering Maintenance Mode” on page 3-8.
2. Press the Unload Button once per second until either  or  appears in the SCD.  or  will appear in the SCD to indicate the current setting for Post Error Reporting. If you cycle past the desired code, press the Unload Button once per second until the code reappears.
3. Exit Maintenance Mode if you do not want to change the current setting for Post Error Reporting. For instructions, see “Exiting Maintenance Mode” on page 3-9.

4. To disable Post Error Reporting, Press and hold the Unload Button for three seconds while  appears in the SCD. The SCD changes to  after you release the Unload Button.
5. Press the Unload Button once per second to select another Maintenance Mode Function. To exit Maintenance Mode, refer to “Exiting Maintenance Mode” on page 3-9.

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## Updating Firmware

**Attention:** When updating firmware, do not power-off the drive until the update is complete, or the firmware may be lost.

It is the customer’s responsibility to ensure that this drive has the latest firmware. Periodically check for updated levels of drive firmware by visiting the web at <http://www.ibm.com/storage/lto>. Update drive firmware using:

- The host interface
- The LDI or RS-422 interface
- The ITDT tool
- A field microcode replacement (FMR) tape cartridge

For instructions on obtaining a new firmware image or FMR tape, visit <http://www.ibm.com/storage/lto>. To update the firmware, refer to the following sections.

### Updating Firmware through the Host Interface

When updating drive firmware by using the host interface, the procedure varies depending on whether your server uses an IBM tape device driver or a non-IBM tape device driver (such as a driver from Sun, Hewlett-Packard, or Microsoft®).

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.

### Updating Firmware through the Library/Drive Interface

The drive includes a firmware update feature that allows a tape library to download firmware to the drive by using the Library/Drive Interface (LDI) while the drive performs normal host operations on logical unit number (LUN) 0 of the SCSI Protocol Interface. The command may be received by the host interface or the LDI (RS-422) interface. For specific instructions about updating the drive firmware in a library, refer to the library documentation and procedures.

**Note:** If a Power-on Reset command is received while a cartridge is loaded in the drive, the drive will respond with a Check Condition. It will not activate the new code level until you cycle power, or until a Power-on Reset command is received and the drive does not contain a cartridge.



## ITDT Firmware Update, Dump Retrieval and Library/Drive Test Tool

ITDT is a tool with multiple functional capability and is a very quick, convenient, and efficient method for drive firmware updates. As a note, drive dump retrievals can be performed by the tool as well.

Below are some of the capabilities of this tool:

- Firmware update capability to all IBM LTO Tape Drives.
- The tool does not require any special device drivers.
- The tool is available for most major platforms (Windows®, AIX®, SUN, Linux™, NetWare, AS/400).
- The tool is capable of uploading drive dump files.
- The tool's primary function is thoroughly testing a drive. However, if the library is online to the server/host where the tool resides, ITDT will communicate with the drive through the library to load and unload a test cartridge thereby exercising some library functions.
- The tool scans the host bus and will find and display for selection all IBM LTO devices. The tool will not display and allow for selection any non-IBM device.
- Each function has "Help" selection which explains the required syntax as well as a brief explanation of the particular function.
- A Readme text file will be posted with the .exe for a thorough explanation of initial tool download information from the web as well as explanation of tool capabilities. Refer to the ITDT Readme text file for information on tool usage. You can also refer to the web at <http://www.ibm.com/storage/lto> and look for information about the ITDT site.
- The tool is currently a "command line" tool with a simple entry by keying in the executable name, `itdt`, from the directory where the tool is located.


## Updating the Firmware with an FMR Tape Cartridge

**Attention:** A SAS drive requires a SAS firmware image. Other types of firmware images will not load on the SAS drive.

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

1. Create an FMR tape (see "Function Code 3: Create FMR Tape" on page 3-11). A single FMR tape can be used to update multiple drives if the drives are the same drive type (e.g. LTO Ultrium 4 Half-High) and host interface (e.g. SAS).
2. Update the drive firmware (see "Function Code 2: Update Drive Firmware from FMR Tape" on page 3-10).

After updating the drive firmware, the FMR tape can be used as a data cartridge by using the "Unmake FMR Tape" function (see "Function Code 8: Unmake FMR Tape" on page 3-15).

The SCD presents a series of random characters during the firmware download and update. The SCD briefly displays , then becomes blank (not lit) when the firmware download and update is complete and there are no errors. An error code will be displayed if a firmware download or update error has been detected. The Ready/Activity status light is off and the Fault status light flashes amber during the firmware download and update. The Ready/Activity status light is solid green after the firmware download and update are complete.



## Chapter 4. Using Ultrium Media

To ensure that your IBM Ultrium Tape Drive conforms to IBM's specifications for reliability, use only IBM LTO Ultrium tape cartridges. You may use other LTO-certified data cartridges, but they may not meet the standards of reliability that are established by IBM. The IBM LTO Ultrium Data Cartridge can not be used in other IBM non-LTO Ultrium tape products.

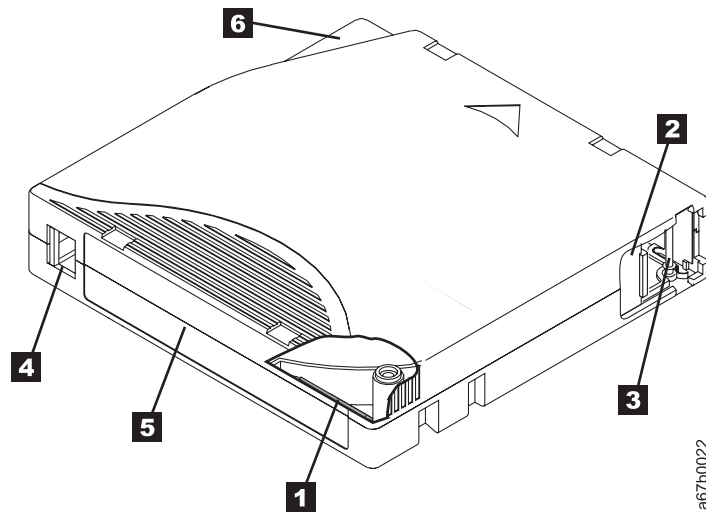


Figure 4-1. The IBM LTO Ultrium Data Cartridge

<b>1</b>	LTO cartridge memory	a chip that contains information about the cartridge and the tape, as well as statistical information about the cartridge's use (For more information, see "Cartridge Memory Chip (LTO-CM)" on page 4-2.)
<b>2</b>	Cartridge door	protects the tape from contamination when the cartridge is out of the drive
<b>3</b>	Leader Pin	The tape is attached to a leader pin, behind the cartridge 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.
<b>4</b>	Write-protect Switch	prevents data from being written to the tape cartridge (For more information, see "Write-Protect Switch" on page 4-2.)
<b>5</b>	Label area	provides a location to place a label.
<b>6</b>	Insertion guide	a large, notched area that prevents the cartridge from being inserted incorrectly

## Types of Cartridges

IBM Ultrium media is available in the following types:

- “Data Cartridge”
- “WORM (Write Once, Read Many) Cartridge” on page 4-3
- “Cleaning Cartridge” on page 4-4

### Data Cartridge

All generations of IBM Ultrium data cartridges contain 1/2-inch, dual-coat, metal-particle tape. When processing tape in the cartridges, Ultrium Tape Drives use a linear, serpentine recording format.

Each generation of data cartridge is identified by case color, native data capacity, recording format and nominal cartridge life.

Data Cartridge	Case Color	Native Data Capacity	Recording Format*	Nominal Cartridge Life (load/unload cycles)
Ultrium 4	Green	800 GB (1600 GB at 2:1 compression)	Reads and writes data on 896 tracks, sixteen tracks at a time.	20,000
Ultrium 3	Slate Blue	400 GB (800 GB at 2:1 compression)	Reads and writes data on 704 tracks, sixteen tracks at a time	20,000
Ultrium 2	Purple	200 GB (400 GB at 2:1 compression)	Reads and writes data on 512 tracks, eight tracks at a time	10,000
Ultrium 1	Black	100 GB (200 GB at 2:1 compression)	Reads and writes data on 384 tracks, eight tracks at a time	5,000

\* The first set of tracks (sixteen for Ultrium 4 and 3; eight for Ultrium 2 and 1) is written from near the beginning of the tape to near the end of the tape. The head then repositions to the next set of tracks for the return pass. This process continues until all tracks are written and the cartridge is full, or until all data is written.


### Cartridge Memory Chip (LTO-CM)

All generations of the IBM LTO Ultrium Data Cartridges include a Linear Tape-Open Cartridge Memory (LTO-CM) chip ( **1** in Figure 4-1 on page 4-1), that contains information about the cartridge and the tape (such as the name of the manufacturer that created the tape), as well as statistical information about the cartridge’s use. The LTO-CM enhances the efficiency of the cartridge. For example, the LTO-CM stores the end-of-data location which, when the next time this cartridge is inserted and the WRITE command is issued, enables the drive to quickly locate the recording area and begin recording. The LTO-CM also aids in determining the reliability of the cartridge by storing data about its age, how many times it has been loaded, and how many errors it has accumulated. Whenever a tape cartridge is unloaded, the tape drive writes any pertinent information to the cartridge memory.

The storage capacity of the LTO Generation 4 LTO-CM is 8160 bytes. LTO Generations 1, 2, and 3 have an LTO-CM capacity of 4096 bytes.

### Write-Protect Switch

The position of the write-protect switch on the tape cartridge (see **4** in Figure 4-1 on page 4-1) determines whether you can write to the tape. If the switch is set to:

- The locked position  (solid red), data cannot be written to the tape.

- The unlocked position (black void), data can be written to the tape.

If possible, use your server's application software to write-protect your cartridges (rather than manually setting the write-protect switch). This 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 will not be able to write new data to them.

If you must manually set the write-protect switch, slide it left or right to the desired position.

## Capacity Scaling

To control the capacity of the cartridge (for example, to obtain a faster seek time) issue the SCSI command SET CAPACITY. For information about this command, refer to the *IBM TotalStorage Ultrium Tape Drive SCSI Reference*.

## WORM (Write Once, Read Many) Cartridge

Certain records retention and data security applications require a Write Once, Read Many (WORM) method for storing data on tape. The LTO Ultrium generation 3 and 4 drives enable WORM support when a WORM tape cartridge is loaded into the drive.

Because standard read/write media are incompatible with the WORM feature, a specially formatted WORM tape cartridge (see Figure 4-2) is required. Each WORM cartridge has a unique, worldwide cartridge identifier (WWCID), which comprises the unique CM chip serial number and the unique tape media serial number. See *Ordering Media Supplies* for information on how to choose and purchase the appropriate WORM tape cartridges for your library.

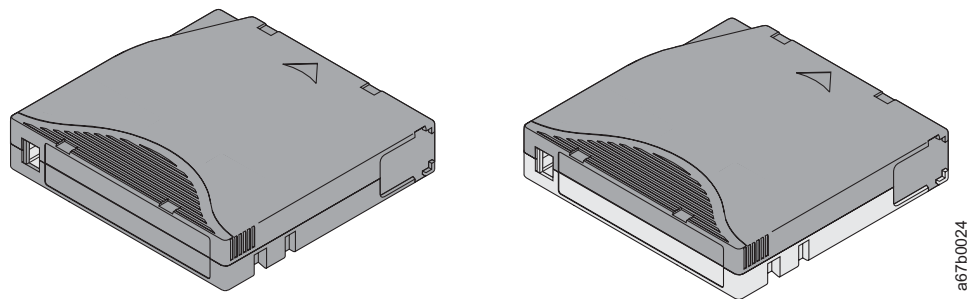


Figure 4-2. Ultrium Data Cartridge on the left; WORM Cartridge on the right

Type of Cartridge	Case Color	Native Data Capacity	Recording Format*
Ultrium 4 WORM	Green and Silvery gray	800 GB (1600 GB at 2:1 compression)	Reads and writes data on 896 tracks, sixteen tracks at a time.
Ultrium 3 WORM	Slate Blue and Silvery gray	400 GB (800 GB at 2:1 compression)	Reads and writes data on 704 tracks, sixteen tracks at a time

\* The first set of tracks (sixteen for Ultrium 4 and 3; eight for Ultrium 2 and 1) is written from near the beginning of the tape to near the end of the tape. The head then repositions to the next set of tracks for the return pass. This process continues until all tracks are written and the cartridge is full, or until all data is written.

## Data Security on WORM Media

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

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

## WORM Media Errors

The following conditions cause WORM media errors to occur:

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

## Requirements for WORM Capability

To add WORM capability to your LTO Ultrium generation 3 or generation 4 drive(s), drive firmware must be at the correct code level, and you must use either Ultrium 3 400 GB WORM tape cartridges or Ultrium 4 800 GB WORM tape cartridges (see "Media Supplies" on page 6-1).

## Cleaning Cartridge

With each library, a specially labeled IBM LTO Ultrium Cleaning Cartridge is supplied to clean the drive head. The drive itself determines when a head needs to be cleaned. To clean the head, insert the cleaning cartridge into the tape load compartment of the drive or the Input/Output (I/O) Station of the library. The cleaning is performed automatically. When the cleaning is finished, the cartridge is ejected.

**Note:** The drive will automatically eject an expired cleaning cartridge.

IBM Cleaning Cartridges are valid for 50 uses. The cartridge's LTO-CM chip tracks the number of times that the cartridge is used.

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## Cartridge Compatibility

Table 4-1. Ultrium cartridge compatibility with Ultrium tape drives

IBM Ultrium Tape Drive	IBM LTO Ultrium Data Cartridges			
	800 GB (Ultrium 4)	400 GB (Ultrium 3)	200GB (Ultrium 2)	100GB (Ultrium 1)
Ultrium 4	Read/Write	Read/Write	Read only	
Ultrium 3		Read/Write	Read/Write	Read only

Table 4-1. Ultrium cartridge compatibility with Ultrium tape drives (continued)

IBM Ultrium Tape Drive	IBM LTO Ultrium Data Cartridges			
	800 GB (Ultrium 4)	400 GB (Ultrium 3)	200GB (Ultrium 2)	100GB (Ultrium 1)
Ultrium 2			Read/Write	Read/Write
Ultrium 1				Read/Write

## Bar Code Labels

A bar code label contains:

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

**Note:** The tape drive does not require bar code labels, but you may choose to use labels for tape cartridge identification purposes.

Table 4-2. Bar code label requirements for Ultrium tape drives and libraries

Ultrium Tape Drive/Library	Bar Code Label Requirements
3573	Not required
3576	Recommended
3580	Not required
3581	Required with optional Bar Code Reader
3582	Required
3583	Required
3584	Required

When read by a library's bar code reader, the bar code identifies the cartridge's VOLSER to the library. The bar code also tells the library whether the cartridge is a data cartridge, WORM cartridge or cleaning cartridge. In addition, the bar code includes the two-character media-type identifier Lx, where x equals 1, 2, 3, 4, T or U. Figure 4-3 on page 4-6 shows a sample bar code label for the LTO Ultrium Tape Cartridge.

Table 4-3. Cartridges and VOLSERs

Cartridges	VOLSER
Ultrium 4 Data Cartridge	xxxxxxL4
Ultrium 4 WORM Cartridge	xxxxxxLU
Ultrium 3 Data Cartridge*	xxxxxxL3
Ultrium 3 WORM Cartridge	xxxxxxLT
Ultrium 2 Data Cartridge	xxxxxxL2
Ultrium 1 Data Cartridge (READ ONLY)	xxxxxxL1
IBM LTO Ultrium Cleaning Cartridge	CLNxxxLx

\*An Ultrium 3 Tape Drive must have a minimum firmware level of 54xx for it to be compatible with the WORM cartridge.

Tape cartridges can be ordered with the labels included or with custom labels. To order tape cartridges and bar code labels, see Ordering Media Supplies. The bar code for usage in IBM tape libraries must meet predefined specifications. They include (but are not limited to):

- Eight uppercase alphanumeric characters, where the last two characters must be L4, L3, L2, L1, LT, or LU
- Label and printing to be non-glossy
- Nominal narrow line or space width of 0.423 mm (0.017 in.)
- Wide to narrow ratio of 2.75:1
- Minimum bar length of 11.1 mm (0.44 in.)

To determine the complete specifications of the bar code and the bar code label, visit the web at <http://www.ibm.com/storage/lto> (select **LTO Support**), or contact your IBM Sales Representative.

When attaching a bar code label to a tape cartridge, place the label only in the recessed label area (see **4** in Figure 4-1 on page 4-1). A label that extends outside of the recessed area can cause loading problems in the drive.

**Attention:** Do not place any type of mark on the white space at either end of the bar code. A mark in this area may prevent the library from reading the label.

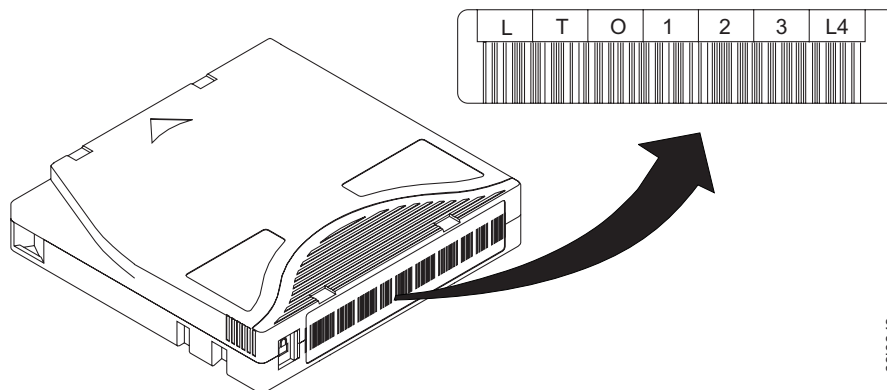


Figure 4-3. Sample bar code label on the LTO Ultrium 4 Tape Cartridge. The volume serial number (LTO123), cartridge type (L4), and bar code are printed on the label.

## Guidelines for Using Bar Code Labels

Apply the following guidelines whenever using bar code labels:

- Use only IBM-approved bar code labels on cartridges to be used in an IBM tape library.
- 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 being removed. If there is glue residue on the cartridge, remove it by gently rubbing it with your finger. Do not use a sharp object, water, or a chemical to clean the label area.
- Examine the label before applying it to the cartridge. Do not use the label if it has voids or smears in the printed characters or bar code (a library's inventory operation will take much longer if the bar code 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 (see **5** in Figure 4-1 on page 4-1).
- With light finger pressure, smooth the label so that no wrinkles or bubbles exist on its surface.
- Verify that the label is smooth and parallel, and has no roll-up or roll-over. The label must be flat to within 0.5 mm (0.02 in.) over the length of the label and have no folds, missing pieces, or smudges.
- Do not place other machine-readable labels on other surfaces of the cartridge. They may interfere with the ability of the drive to load the cartridge.

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## Handling Cartridges

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

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 IBM LTO Ultrium Tape Drives, use the following guidelines.

### Provide Training

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

### Provide Proper Acclimation and Environmental Conditions

- Before using a cartridge, let it acclimate to the normal operating environment for 1 hour. If condensation is visible on the cartridge, wait an additional hour.
- Ensure that all surfaces of a cartridge are dry before inserting it.
- Do not expose the cartridge to moisture or direct sunlight.
- Do not expose recorded or blank cartridges to stray magnetic fields of greater than 100 oersteds (for example, terminals, motors, video equipment, X-ray equipment, or fields that exist near high-current cables or power supplies). Such exposure can cause the loss of recorded data or make the blank cartridge unusable.
- Maintain the conditions that are described in Table 4-4 on page 4-10.

### Perform a Thorough Inspection

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

- Inspect the cartridge's packaging to determine potential rough handling.
- When inspecting a cartridge, open only the cartridge door. Do not open any other part of the cartridge case. The upper and lower parts of the case are held together with screws; separating them destroys the usefulness of the cartridge.

- Inspect the cartridge for damage before using or storing it.
- Inspect the rear of the cartridge (the part that loads first into the tape load compartment) and ensure that there are no gaps in the seam of the cartridge case (see **1** in Figure 4-4 and **4** in Figure B-2 on page B-2). If there are gaps in the seam (see Figure 4-4), the leader pin may be dislodged. Go to Appendix B, “Repairing a Cartridge,” on page B-1.

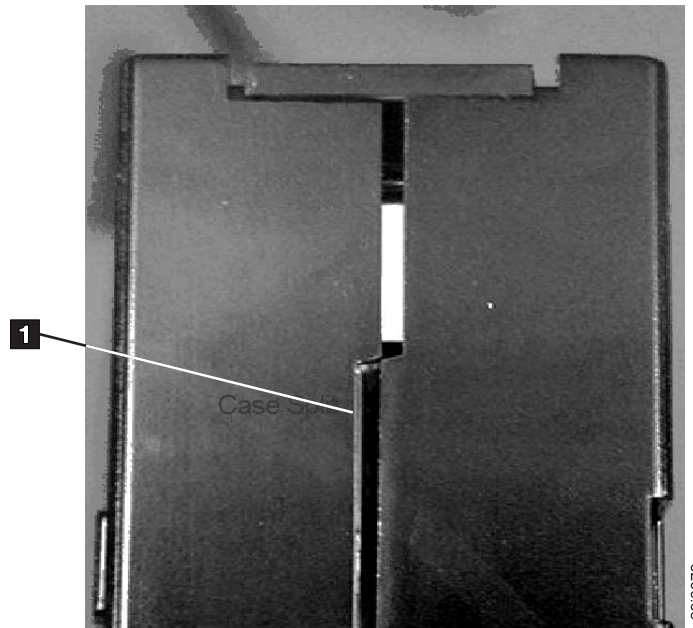


Figure 4-4. Checking for gaps in the seams of a cartridge

- Check that the leader pin is properly seated (see **2** in Figure B-2 on page B-2).
- If you suspect that the cartridge has been mishandled but it appears usable, copy any data onto a good cartridge immediately for possible data recovery. Discard the mishandled cartridge.
- 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 (see **2** in Figure B-1 on page B-2). If the leader pin has become dislodged, go to “Repositioning a Leader Pin” on page B-1.
- Do not handle tape that is outside the cartridge. Handling the tape can damage the tape’s surface or edges, which may interfere with read or write reliability. Pulling on tape that is outside the cartridge can damage the tape and the brake mechanism in the cartridge.
- Do not stack more than six cartridges.
- Do not degauss a cartridge that you intend to reuse. Degaussing makes the tape unusable.

### Ensure Proper Packaging

- When shipping a cartridge, 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. Ultrium Turtlecases (by Perm-A-Store) have

been tested and found to be satisfactory . They are available at <http://www.turtlecase.com>.



Figure 4-5. Tape cartridges in a Turtlecase

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



Figure 4-6. Double-boxing tape cartridges for shipping

## Environmental and Shipping Specifications for Tape Cartridges

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

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

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

Table 4-4. Environment for operating, storing, and shipping the LTO Ultrium Tape Cartridge

Environmental Factor	Environmental Specifications			
	Operating	Operational Storage <sup>1</sup>	Archival Storage <sup>2</sup>	Shipping
Temperature	10 to 45°C(50 to 113°F)	16 to 32°C(61 to 90°F)	16 to 25°C(61 to 77°F)	-23 to 49°C(-9 to 120°F)
Relative humidity (non-condensing)	10 to 80%	20 to 80%	20 to 50%	5 to 80%
Maximum wet bulb temperature	26°C(79°F)	26°C(79°F)	26°C(79°F)	26°C(79°F)
<b>Note:</b>				
1. The short term or operational storage environment is for storage durations of up to six months.				
2. The long term or archival storage environment is for durations of six months up to ten years.				

## Disposing of Tape Cartridges

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

If your local, state, country (non-U.S.A.), or regional regulations are more restrictive than EPA 40CFR261, you must review them before you dispose of a cartridge. Contact 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 by using a high-energy ac degausser (use a minimum of 4000 oersted peak field over the entire space that the cartridge occupies). The tape should 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.

## Chapter 5. Troubleshooting

If you encounter problems when running the drive, refer to Table 5-1. The states of the status lights may also indicate a problem.

Table 5-1. Half-high drive troubleshooting tips

If the problem is this....	Do this....
The amber Fault status light is flashing slowly.	This indicates one of the following failures has occurred: <ul style="list-style-type: none"> <li>• Unrecoverable drive failure (see "Removing/reinstalling a SAS Drive from/in an enclosure" on page C-1)</li> <li>• Firmware upgrade failure - Retry the firmware upgrade. If it still fails, see "Removing/reinstalling a SAS Drive from/in an enclosure" on page C-1.</li> <li>• Media failure (See "The amber Fault status light is flashing slowly." below for more information.)</li> <li>• Incorrect media (See "The amber Fault status light is flashing slowly." below for more information.)</li> </ul>
The amber Fault status light is solid ON.	This indicates that the drive has reached its maximum operating temperature. Power OFF the drive until the temperature of the drive has returned to the normal operating temperature range (see "Environmental specifications" on page 1-7).
The amber Fault status light is flashing slowly.	Perform one of the following: <ul style="list-style-type: none"> <li>• This indicates that incorrect media has been inserted into the drive. If the drive does not eject the cartridge press the Unload button to eject the cartridge from the drive and replace with the correct media (see "Cartridge compatibility" on page 1-3).</li> <li>• This indicates a media failure. Press the Unload button to eject the cartridge from the drive. Remove the cartridge from the drive and inspect it for damage and debris. Verify that the Write-Protect Switch on the cartridge is in the unlocked position (see "Write-Protect Switch" on page 4-2).</li> </ul>
The green Ready/Activity status light never turns ON.	The drive has no power. Check the power at the power source. Connect power to the drive (see "Connect and test power to the drive" on page 2-4). If the problem persists, replace the drive.
The drive will not load a tape cartridge.	One of the following has occurred: <ul style="list-style-type: none"> <li>• A tape cartridge is already inserted. To remove the cartridge, press the Unload button. If the cartridge does not eject, turn off the power to the drive, then turn it back on. After the green Ready/Activity status light becomes solid ON, press the Unload button to eject the cartridge.</li> <li>• The tape cartridge was inserted incorrectly. To properly insert a cartridge, see "Inserting a Tape Cartridge" on page 3-5.</li> <li>• The tape cartridge may be defective. Insert another tape cartridge. If the problem exists for multiple cartridges, the drive is defective. Replace the defective drive with a new drive.</li> <li>• The drive has no power. Connect power to the drive (see "Connect and test power to the drive" on page 2-4).</li> <li>• The drive has exceeded its maximum operating temperature. Power OFF the drive until the temperature of the drive has returned to the normal operating temperature range (see "Environmental specifications" on page 1-7).</li> </ul>

Table 5-1. Half-high drive troubleshooting tips (continued)

If the problem is this....	Do this....
The drive will not unload the tape cartridge.	The tape cartridge is stuck or is broken. Press the Unload button. If the cartridge does not eject, turn off the power to the drive, then turn it back on (note that the mid-tape recovery could take up to ten minutes to complete). If the cartridge still does not eject, contact IBM Support.
Log sense data and drive sense data at the server console.	See "Using sense data" on page 5-8.
The library reported an LDI or RS-422 communication problem with the drive.	The LDI or RS-422 circuitry may be defective. See "Function Code 1: Run Drive Diagnostics" on page 3-9 or "ITDT Firmware Update, Dump Retrieval and Library/Drive Test Tool" on page 3-23 for information on running the drive diagnostic. If the test runs successfully but the problem persists, refer to your library's service documentation.
The drive does not respond to server commands.	Press and hold the Unload button on the drive for 12 seconds to force a drive dump. The drive will save the dump and then reboot to allow communication to the drive to occur. Do not cycle power, as this will erase the contents of the dump.
The enclosure's display (if the drive is enclosed in a library)	Refer to the documentation for the enclosure.
Drive sense data sent to a library (if the drive is enclosed in a library).	Refer to the documentation for the library.

## Methods of Receiving Errors and Messages

Use this section as a guide for identifying error codes and message codes reported by the drive, its enclosure (if applicable), or the server.

**Note:** The codes on the Single-character Display (SCD) have different meanings, depending on whether they display during normal operations or while the drive is in maintenance mode. Codes that occur during normal operations are defined in "Error Codes and Messages" on page 5-3. Codes that occur while in maintenance mode are defined in "Diagnostic and Maintenance Functions" on page 3-7.

Table 5-2. Methods of receiving errors and messages

If the error or message was presented by....	Do this....
The enclosure's display (if the drive is enclosed in a library or autoloader)	Refer to the documentation for the enclosure.
The drive's SCD and the Fault status light flashes amber	See "Error Codes and Messages" on page 5-3. To determine the meaning of Status Light activity, see "Status Lights" on page 3-1.
The drive's SCD and the Fault status light is solid amber	See "Diagnostic and Maintenance Functions" on page 3-7. To determine the meaning of Status Light activity, see "Status Lights" on page 3-1.
SCSI log sense data (such as TapeAlert flags) and SCSI drive sense data at the server console	See "Error Codes and Messages" on page 5-3, or "Using sense data" on page 5-8.
Drive sense data sent to a library (if the drive is enclosed in a library)	Refer to your library's documentation, then see "Error Codes and Messages" on page 5-3.
The drive's error log	See "Error Codes and Messages" on page 5-3 and "Viewing the Drive Error Log" on page 5-13.

## Error Codes and Messages

If the drive detects a permanent error, it will display the error code on the SCD and flash the Amber Fault status light (Green Ready/Activity status light will be Off).

- Make note of the error code displaying on the SCD prior to removing a cartridge or clearing the SCD error code.
- If an error occurred with a cartridge in the drive, push the Unload Button to eject the cartridge.
- To clear the error code displayed on the SCD and power cycle the drive, press the Unload Button for ten seconds. A drive dump will be created.


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

Table 5-3. Error codes on the Single-character Display




Error Code	Cause and Action
	<p><b>No error occurred and no action is required.</b> This code displays when diagnostics have finished running and no error occurred.</p> <p><b>Note:</b> The Single-character Display is blank during normal operation of the tape drive.</p>
	<p><b>Temperature problem.</b> The tape drive detected that the recommended operating temperature was exceeded. Perform one or more of the following actions:</p> <ul style="list-style-type: none"> <li>• Ensure that the cooling fan is rotating and is quiet. If not, refer to your enclosure documentation.</li> <li>• Remove any blockage that prevents air from flowing freely through the tape drive.</li> <li>• Ensure that the operating temperature and airflow is within the specified range (see “Specifications” on page 1-6).</li> </ul> <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>
	<p><b>Power problem.</b> The tape drive detected that the externally supplied power is outside the specified voltage limits (the tape drive is not operating). Perform the following action:</p> <ol style="list-style-type: none"> <li>1. Ensure that the power connector is properly seated.</li> <li>2. Ensure that the proper dc voltages are being applied within the tolerances allowed (see “Specifications” on page 1-6).</li> <li>3. If the proper voltages are not being applied, service the power supply.</li> <li>4. If the proper voltages are being applied, power off/on the tape drive to see if the problem repeats.</li> <li>5. Replace the tape drive if the problem persists.</li> </ol> <p>The error code clears when you place the tape drive in maintenance mode.</p>

Table 5-3. Error codes on the Single-character Display (continued)

Error Code	Cause and Action
3	<p><b>Firmware problem.</b> The tape drive determined that a firmware error occurred. Perform the following action:</p> <ol style="list-style-type: none"> <li>1. Collect a drive dump from one of the following:           <p><b>Note:</b> Do not force a new dump; the tape drive has already created one.</p> <ul style="list-style-type: none"> <li>• Server's host interface by using a device driver utility or system tool (for instructions about reading a drive dump from tape, visit the Web at <a href="http://www.ibm.com/storage/lto">http://www.ibm.com/storage/lto</a>)</li> <li>• Ultrium Tape Drive (to copy and read a drive dump, use "Function Code 5: Copy Drive Dump" on page 3-12)</li> </ul> </li> <li>2. Power the tape drive off and on, then retry the operation that produced the error.</li> <li>3. If the problem persists, download new firmware and retry the operation.</li> <li>4. If the problem persists, send the drive dump that you collected in step 1 to your IBM Support Center.</li> </ol> <p>The error code clears when you place the tape drive in maintenance mode.</p>
4	<p><b>Firmware or hardware problem.</b> The tape drive determined that a firmware or tape drive hardware failure occurred. Perform the following action:</p> <ol style="list-style-type: none"> <li>1. Collect a drive dump from one of the following:           <p><b>Note:</b> Do not force a new dump; one already exists.</p> <ul style="list-style-type: none"> <li>• Server's host interface by using a device driver utility or system tool (for instructions about reading a drive dump from tape, visit the Web at <a href="http://www.ibm.com/storage/lto">http://www.ibm.com/storage/lto</a>)</li> <li>• Ultrium Tape Drive (to copy and read a drive dump, use "Function Code 5: Copy Drive Dump" on page 3-12)</li> </ul> </li> <li>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.</li> <li>3. If the problem persists, download new firmware and retry the operation; if new firmware is not available, replace the drive.</li> </ol>
5	<p><b>Tape drive hardware problem.</b> The drive determined that a tape path or read/write error occurred. To prevent damage to the drive or tape, the tape drive will not allow you to insert a cartridge if the current cartridge was successfully ejected. The error code may clear when you cycle power to the tape drive or place it in maintenance mode. If the problem persists, replace the drive.</p> <p><b>Note:</b> Copy the drive dump to flash memory before returning the drive. For instructions, refer to "Function Code 5: Copy Drive Dump" on page 3-12.</p>
6	<p><b>Tape drive or media error.</b> The tape drive determined that an error occurred, but it cannot isolate the error to faulty hardware or to the tape cartridge. Ensure the tape cartridge is the correct media type:</p> <ul style="list-style-type: none"> <li>• Ultrium -1 tape cartridges are not supported in LTO 4 Half-High tape drives.</li> <li>• Drive will not accept an expired Cleaning Cartridge.</li> <li>• Drive will not accept a WORM cartridge when running diagnostic tests in Maintenance Mode.</li> <li>• Drive will not write over existing datasets on a WORM cartridge. Ensure you are appending datasets on WORM media rather than attempting to write over existing datasets.</li> </ul> <p>If the tape cartridge is the correct media type, perform the following action:</p>



Table 5-3. Error codes on the Single-character Display (continued)

Error Code	Cause and Action
	<p><b><u>For Problems with Writing Data:</u></b></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"> <li>• If the operation succeeds, the original cartridge was defective. Copy data from the defective cartridge and discard it.</li> <li>• 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"> <li>– If the operation fails, discard the defective cartridge.</li> <li>– If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function Code 1: Run Drive Diagnostics” on page 3-9. <ul style="list-style-type: none"> <li>- If the diagnostics fail, replace the tape drive.</li> <li>- If the diagnostics succeed, the error was temporary.</li> </ul> </li> </ul> </li> <li>• 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 3-9. <ul style="list-style-type: none"> <li>– If the diagnostics fail, replace the tape drive.</li> <li>– If the diagnostics succeed, discard the cartridge.</li> </ul> </li> </ul> <p>If the problem occurs with multiple tape cartridges, run “Function Code 1: Run Drive Diagnostics” on page 3-9:</p> <ul style="list-style-type: none"> <li>• If the diagnostics fail, replace the tape drive.</li> <li>• If the diagnostics succeed, run “Function Code H: Test Head” on page 3-18. <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, replace the cartridges that caused the problem.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p> <p><b><u>For Problems with Reading Data:</u></b></p> <p>If the problem occurred while the tape drive was reading data from the tape, perform one of the following procedures:</p> <ul style="list-style-type: none"> <li>• If another tape drive is available, insert the cartridge into the other unit and retry the operation: <ul style="list-style-type: none"> <li>– If the operation fails, discard the defective cartridge.</li> <li>– If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function Code 1: Run Drive Diagnostics” on page 3-9: <ul style="list-style-type: none"> <li>- If the diagnostic fails, replace the tape drive.</li> <li>- If the diagnostic succeeds, the error was temporary.</li> </ul> </li> </ul> </li> <li>• 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 3-9: <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, discard the cartridge.</li> </ul> </li> </ul> <p>If the problem occurs with multiple tape cartridges, run “Function Code 1: Run Drive Diagnostics” on page 3-9:</p> <ul style="list-style-type: none"> <li>• If the diagnostic fails, replace the tape drive.</li> <li>• If the diagnostic succeeds, run “Function Code H: Test Head” on page 3-18. <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, replace the cartridges that caused the problem.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p>

Table 5-3. Error codes on the Single-character Display (continued)

Error Code	Cause and Action
<p style="text-align: center;">7</p>	<p><b>Media error.</b> The tape drive determined an error occurred because of a faulty tape cartridge or an invalid tape cartridge. Ensure the tape cartridge is the correct media type:</p> <ul style="list-style-type: none"> <li>• Ultrium -1 tape cartridges are not supported in Ultrium-4 tape drives.</li> <li>• Drive will not accept an expired Cleaning Cartridge.</li> <li>• Drive will not accept a WORM cartridge when running diagnostic tests in Maintenance Mode.</li> <li>• Drive will not accept an FMR tape unless the drive is performing “Function Code 8: Unmake FMR Tape” on page 3-15.</li> <li>• Drive will not write over existing datasets on a WORM cartridge. Ensure you are appending datasets on WORM media rather than attempting to write over existing datasets.</li> </ul> <p>If the tape cartridge is the correct media type, try another tape cartridge. If the problem occurs with multiple tape cartridges, use the following procedure:</p> <ol style="list-style-type: none"> <li>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 &amp; Media” on page 3-16.</li> </ol> <p><b>Attention:</b> When you run the Test Cartridge &amp; Media diagnostic, data on the suspect tape is overwritten. Use only a scratch data cartridge to run the test.</p> <ul style="list-style-type: none"> <li>• If the diagnostic fails, replace the media.</li> <li>• If the diagnostic succeeds, clean the drive head (see “Cleaning the Drive Head” on page 3-6) and run “Function Code 1: Run Drive Diagnostics” on page 3-9. <ul style="list-style-type: none"> <li>– If the drive diagnostic fails, replace the drive.</li> <li>– If the drive diagnostic succeeds, perform the operation that produced the initial media error.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p>
<p style="text-align: center;">8</p>	<p><b>Interface problem.</b> The tape drive determined that a failure occurred in the tape drive’s hardware or in the host bus. See Chapter 5, “Troubleshooting,” on page 5-1. If 8 was displayed while running “Function Code 6: Host Interface Test”:</p> <ol style="list-style-type: none"> <li>1. Verify the correct interface wrap tool was attached during the test. The test will fail if the correct interface wrap tool is not attached.</li> <li>2. If the correct interface wrap tool was attached during the test, replace the drive. The error code clears when you place the tape drive in maintenance mode.</li> </ol>
<p style="text-align: center;">9</p>	<p><b>Tape drive or RS-422 error.</b> 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 3-14 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>

Table 5-3. Error codes on the Single-character Display (continued)






Error Code	Cause and Action
	<p><b>Degraded operation.</b> 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><b>Note:</b> The drive is usable, though the Single-character Display continues to indicate an error and the Fault status light flashes amber. The error code may clear when you cycle power to the tape drive or place it in maintenance mode.</p> <p>To determine if the problem is with the drive hardware, or the tape media, perform the following procedures:</p> <ol style="list-style-type: none"> <li>1. If possible, run the tape cartridge in a different drive. If the operation in the other drive fails and  or  displays, replace the media. If the operation succeeds, run the Test Cartridge &amp; Media diagnostic (see "Function Code E: Test Cartridge &amp; Media" on page 3-16).</li> <li>2. If the Test Cartridge &amp; Media diagnostic fails, replace the media. If it runs successfully, clean the failing drive and run the drive diagnostics (see "Cleaning the Drive Head" on page 3-6 and "Function Code 1: Run Drive Diagnostics" on page 3-9). Record the time 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 significantly longer than the "Approximate Run Time", run "Function Code F: Write Performance Test" on page 3-17. If the Write Performance Test fails, replace the media. If the drive diagnostics run successfully, perform the operation that produced the initial drive error.</li> <li>3. If the problem persists replace the drive.</li> </ol> <p>If it is not possible to run the tape cartridge in a different drive, perform the following procedures:</p> <ol style="list-style-type: none"> <li>1. Clean the failing drive and run the drive diagnostics (see "Cleaning the Drive Head" on page 3-6 and "Function Code 1: Run Drive Diagnostics" on page 3-9). Record the time 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 significantly longer than the "Approximate Run Time", run "Function Code F: Write Performance Test" on page 3-17. If the Write Performance Test fails, replace the media. If the drive diagnostics run successfully, run the Test Cartridge &amp; media diagnostic (see "Function Code E: Test Cartridge &amp; Media" on page 3-16).</li> <li>2. If the Test Cartridge &amp; Media diagnostic fails, replace the media. If it runs successfully, perform the operation that produced the initial drive error.</li> <li>3. If the problem persists replace the drive.</li> </ol>
	<p><b>The tape drive needs to be cleaned.</b> Clean the tape drive. See "Cleaning the Drive Head" on page 3-6.</p> <p>The error code clears when you clean the tape drive or place it in maintenance mode.</p>
	<p><b>Fiber AL_PA conflict.</b> NOT SUPPORTED ON THIS DRIVE.</p>

Table 5-3. Error codes on the Single-character Display (continued)

Error Code	Cause and Action
<p><b>E</b></p>	<p><b>Encryption Error.</b> Displayed when the drive detects an error associated with a 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"> <li>1. Check the host application to ensure the host application is providing the correct encryption key. <ul style="list-style-type: none"> <li>• Refer to the <i>IBM Tape Device Drivers Encryption Support</i> documentation and the <i>IBM LTO Ultrium Tape Drive SCSI Reference</i> documentation for the Sense Data returned for an encryption operation.</li> <li>• Retry the encryption operation after the host application problems have been resolved.</li> </ul> </li> <li>2. Check the operation of the tape drive by resetting the drive and running POST. See Table 3-3 on page 3-4. <ul style="list-style-type: none"> <li>• Refer to the error code displayed on the SCD if the drive reset and POST fails.</li> <li>• Retry the encryption operation if the drive reset and POST complete without errors.</li> </ul> </li> <li>3. Check the media. <ul style="list-style-type: none"> <li>• Ensure the correct media is being used. Data encryption is supported with LTO Ultrium 4 Data Cartridges only.</li> <li>• 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.</li> </ul> </li> </ol> <p>If the problem occurred while the tape drive was running POST or diagnostics, 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>
<p><b>E</b></p>	<p><b>Fiber Port offline.</b> NOT SUPPORTED ON THIS DRIVE.</p>
<p><b>F</b></p>	<p><b>Fiber Channel Error.</b> NOT SUPPORTED ON THIS DRIVE.</p>
<p><b>P</b></p>	<p><b>Write operation to a write protected cartridge has been attempted (this includes any attempt to overwrite a WORM protected tape).</b> Ensure the tape cartridge is the correct media type. Writes to Ultrium 2 tape cartridges are not supported in LTO 4 Half-High tape drives. If the tape cartridge is the correct media type, check the write-protect switch on the cartridge. The drive will not write to a write-protected cartridge. The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p>

## Using sense data

When a drive encounters an error, it makes sense data available. You can use IBM device drivers to examine the sense data and determine errors. Instructions for downloading, installing, and properly configuring the IBM device drivers are available in the *IBM Ultrium Device Drivers Installation and User's Guide*. The IBM device drivers may conflict with some commercial software applications unless properly configured. To avoid conflicts on Windows operating systems, refer to your device driver's procedures for setting the driver to manual startup mode. For applications that use Open Systems device drivers that are provided by IBM (for example, AIX, Linux, Sun Solaris, HP-UX, Windows 2003, and Windows 2000), the *IBM Ultrium Device Drivers Installation and User's Guide* contains information about how to obtain sense data after an error has occurred.

If your application uses other device drivers, see the appropriate documentation for those drivers to obtain the sense data.

Raw sense data (as returned from the drive) is documented in the *IBM TotalStorage LTO Ultrium Tape Drive SCSI Reference*.

In addition to device drivers, other methods exist for obtaining sense data and error information. The sections that follow describe alternatives for gathering such information from the IBM AS/400®, System i, RS/6000®, and System p servers.

## Obtaining error information from the AS/400 or System i with RISC processor

For OS/400, sense data is provided by the System Service Tools application. To obtain error information from the AS/400 or System i by using the tool:

1. On the command entry line of the AS/400 Main Menu, type **STRSST** (Start System Service Tools) and press Enter.
2. Select Start a service tool.
3. Select Product activity log.
4. Select Analyze log.
5. On the Select System Data menu, select the Magnetic media option then specify the time period for searching the error log.
6. On the Select Analysis Report Options menu, specify a Device selection of 3580 and press Enter. Leave all other options at their default values.
7. On the Log Analysis Report menu, select the Display report option to display the desired error log. Figure 5-1 shows a sample error log.

```

Display Detail Report for Resource

Name          Type      Model      Serial      Resource
TAP07         3580     002        00-00000    TAP07

Log ID . . . . . : 00452B54   Sequence . . . . . : 4732468
Date . . . . . : 08/14/02   Time . . . . . : 09:50:21
Reference code . . . . . : 9210   Secondary code . . . . . : 00000000
Table ID . . . . . : 63A00001   IPL source/state . . . . . : B/3

Class . . . . . : Permanent
System Ref Code . . . . . : 63A09210
Illegal or unsupported tape unit response

Press Enter to continue.

F3=Exit          F4=Additional Information  F6=Hexadecimal report
F9=Address Information  F10=Previous detail report  F12=Cancel

```

Figure 5-1. Example of an error log from the AS/400 or IBM System i servers

8. Press F4 to view the sense data (see the example in Figure 5-2 on page 5-10).

```

Display Additional Information for Resource

Name          Type      Model      Serial      Resource
TAP07         3580     002        00-00000    TAP07

SENSE DATA FOLLOWS. . . . . :
DATA OFFSET   0 1 2 3   4 5 6 7   8 9 A B   C D E F
00000000     70000500 0000001C 00000000 240000C0
00000010     00020000 00000000 00000000 00000000
00000020     058B0000

```

Figure 5-2. Example of sense data from the AS/400 or IBM System i servers

### Obtaining error information from the RS/6000 or System p™

The AIX® Tape and Media Changer Device Driver for the IBM RS/6000 or IBMSystem p servers provides logging to the system error log for a variety of errors. You can view the error log by issuing the AIX **errpt** command. Figure 5-3 on page 5-11 displays a sample drive error log; Figure 5-4 on page 5-12 displays a sample SCSI bus error log.

To view the error log:

1. At the AIX command line, type **errpt -a |pg** to display a detailed report.
2. Press Enter to scroll through the error log.
3. Type **q** to quit the error log at any time.

**Example of a Drive Error Log:**

In the SENSE DATA area of Figure 5-3 on page 5-11, entries in bold are defined as follows:

Hexadecimal code	Description
01	SCSI command
0000, 0200, 0000	Command parameters
70	Byte 0 of SCSI sense data
03	Sense key
5200	ASC/ASCQ (Additional Sense Code/Additional Sense Code Qualifier)
20B0	FSC (Fault Symptom Code)
058A	Relative LPOS
02	SCSI ID

```

LABEL:          TAPE_ERR1
IDENTIFIER:     4865FA9B

Date/Time:     Wed Oct 11 11:39:43
Sequence Number: 25264
Machine ID:    000D090D4C00
Node ID:       tsm
Class:         H
Type:          PERM
Resource Name: rmt2
Resource Class: tape
Resource Type: LTO
Location:      40-60-00-2,0
VPD:
  Manufacturer.....IBM
  Machine Type and Model.....ULT3580-TD2
  Serial Number.....1300015078
  Device Specific.(FW).....0B70 (Firmware Level)
Description
TAPE OPERATION ERROR

Probable Causes
TAPE

User Causes
MEDIA DEFECTIVE
DIRTY READ/WRITE HEAD

Recommended Actions
FOR REMOVABLE MEDIA, CHANGE MEDIA AND RETRY
PERFORM PROBLEM DETERMINATION PROCEDURES

Detail Data
SENSE DATA
0602 0000 0100 0000 0200 0000 0000 0000 0000 0000 0000 7000 0300 0000 001C 0000 0000
5200 0700 20B0 0000 0000 0000 0000 0000 0000 0000 0000 058A 0200 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

```

Figure 5-3. Example of an AIX ERRPT Drive Error Log

### Example of a SCSI bus error:

```

LABEL:          SCSI_ERR10
IDENTIFIER:     0BA49C99

Date/Time:     Wed Oct 18 09:55:32
Sequence Number: 16140
Machine Id:    00003ABF4C00
Node Id:      ofgtsm
Class:        H
Type:         TEMP
Resource Name: scsi3
Resource Class: adapter
Resource Type: sym896
Location:     40-59
VPD:
    Product Specific.( ).....DUAL CHANNEL PCI TO ULTRA2 SCSI
                                ADAPTER
    Part Number.....03N3606
    EC Level.....F71335
    Manufacture ID.....A16592
    Serial Number.....0749

Description
SCSI BUS ERROR

Probable Causes
CABLE
CABLE TERMINATOR
DEVICE
ADAPTER

Failure Causes
CABLE LOOSE OR DEFECTIVE
DEVICE
ADAPTER

Recommended Actions
PERFORM PROBLEM DETERMINATION PROCEDURES
CHECK CABLE AND ITS CONNECTIONS

Detail Data
SENSE DATA
0001 0017 0000 0000 0000 0091 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 4304 0000 0000 0000 0000 2000 0003 0203 6760 9808 0000 F7FB E1B8
0000 0015 000B 0210 0678 C800 0000 8200 8277 1B20 00A2 ED00 0000 0002 FFFF FFFF
00FF 0000 111F F000 F3DF F110

```

Figure 5-4. Example of an error that suggests a SCSI bus problem

## Obtaining a drive dump

You can obtain a drive dump by selecting a function code on the drive or by using a device driver utility (or a system tool) on the server. The sections that follow describe each method.

### Using ITDT

For information on obtaining a drive dump using the ITDT tool, refer to “ITDT Firmware Update, Dump Retrieval and Library/Drive Test Tool” on page 3-23.

### Using the drive

To obtain a drive dump directly from the drive, see “Function Code 5: Copy Drive Dump” on page 3-12



## Using a device driver utility

To obtain a drive dump by using a device driver utility, determine whether your server is installed with a utility that can read files from the server's memory. If it is, use that utility to obtain the drive dump.

For information about using IBM's utility programs to obtain drive dumps, see the *IBM Ultrium Device Drivers Installation and User's Guide*.

To determine where to send a file that contains a drive dump to be analyzed, contact your OEM Product Application Engineer (PAE).

---

## Viewing the Drive Error Log

The drive keeps an error log that you can use to identify and correct errors. The log contains the 10 most recent error codes, which appear (one at a time) on the Single-character Display (SCD).

To view the drive error log, refer to "Function Code 9: Display Error Code Log" on page 3-15

---

## 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. The sections that follow describe how to fix an error.

### Fixing SAS Bus Errors

1. Check that the tape drive power is on.
2. Verify the SAS cable is connected properly to the server and to the tape drive.
3. Replace SAS cable if it shows any signs of damage.

---

## Resolving media-related problems

To resolve problems that are related to media, the drive's firmware includes Statistical Analysis and Reporting System (SARS) to assist in isolating failures between media and hardware. To determine the cause of failure, SARS uses the cartridge performance history that is saved in the cartridge memory (CM) and the 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 the IBM LTO Ultrium Tape Drive SCSI Reference for more information on TapeAlert flags).

### Attention

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

If you encounter a media-related problem with the drive, run the tape cartridge in a different drive, if possible.

1. If the operation in the other drive fails, replace the media.
2. If the operation succeeds, see "Function Code 1: Run Drive Diagnostics" on page 3-9.



---

## Chapter 6. Ordering Optional Features, Replacement Parts, and Media

For ordering information, please refer to the following sections:

- “Optional Features”
- “Replacement Parts”
- “Media Supplies”
- “Bar Code Labels” on page 6-2

### Optional Features

Table 6-1. *Optional Features*

Feature Code	Description
5400	SAS/Mini-SAS 4x Interposer
5402	2.0 M SAS/Mini-SAS 1x Cable
5406	5.5 M SAS/Mini-SAS 1x Cable
5500	Mini-SAS/550x 4x Interposer
5502	2.0 M Mini-SAS/Mini-SAS 1x Cable
5506	5.5 M Mini-SAS/Mini-SAS 1x Cable

### Replacement Parts

Table 6-2. *Replacement Parts*

Part Number	Description
95P4587	2 M SAS/Mini-SAS 1x Cable
95P4588	5.5 M SAS/Mini-SAS 1x Cable
95P4488	2 M Mini-SAS/Mini-SAS 1x Cable
95P4494	5.5 M Mini-SAS/Mini-SAS 1x Cable
95P4994	SAS/Mini-SAS 4x Interposer
95P4996	Mini-SAS/Mini-SAS 4x Interposer

### Media Supplies

To find the closest IBM-authorized distributor, visit the web at <http://www.ibm.com/storage/media> or call 1-888-IBM-MEDIA.

Table 6-3. Media supplies

Item Type	Description	Quantity	Order by Machine Type / Model from IBM Sales Representative or authorized IBM Business Partner	Order by Part Number (P/N) from an IBM Authorized Distributor
Data Cartridges (with labels)  (Specify the VOLSER characters that you want.)	Ultrium 4	20-PK	Machine Type 3589 Model 010	95P4443 (color) 95P4445 (black and white)
	Ultrium 3	1	Machine Type 3589 Model 008	96P1470 (color) 96P1471 (black and white)
	Ultrium 2	1	Machine Type 3589 Model 006	
Data Cartridges (without labels)  Order VOLSER labels separately (see "Bar Code Labels").	Ultrium 4	20-PK	Machine Type 3589 Model 011	95P4447
	Ultrium 3	1	Machine Type 3589 Model 009	24R1922
	Ultrium 2	1	Machine Type 3589 Model 007	
	Ultrium 1	20-PK	Machine Type 3589 Model 003	08L9120
WORM Cartridges (with labels)  (Specify the VOLSER characters that you want.)	Ultrium 4	20-PK	Machine Type 3589 Model 032	95P4457 (color) 95P4459 (black and white)
	Ultrium 3	20-PK	Machine Type 3589 Model 028  WORM cartridges labeled with starting volume serial information and, optionally, packed in individual jewel cases.	
WORM Cartridges (without labels)  Order VOLSER labels separately (see "Bar Code Labels").	Ultrium 4	20-PK	Machine Type 3589 Model 033	95P4461
	Ultrium 3	20-PK	Machine Type 3589 Model 029 Feature Code 2920  WORM cartridges packed in individual jewel cases with unattached blank labels.	
Cleaning Cartridge (with label)	Universal Cleaning Cartridge	5-PK	Machine Type 3589 Model 004 Feature Code 4005	35L2086
Repair Tools	Leader Pin Reattachment Kit	1	not available in this sales channel	08L9129
	Manual Rewind Tool	1	not available in this sales channel	08L9130

### Bar Code Labels

The LTO Ultrium 4 Tape Drives do not require cartridge bar code labels. However, if you use your data cartridges or cleaning cartridges in an IBM tape library

product, you may need cartridge bar code labels if your tape library product requires them. You can order these labels separately from the IBM Data Cartridges and Cleaning Cartridges.

You can order bar code labels directly from the authorized label suppliers listed in the table below.

*Table 6-4. Authorized suppliers of custom bar code labels*

In America	In Europe and Asia
Tri-Optic Broomfield, CO U. S. A. Telephone: 888-438-8362 <a href="http://www.tri-optic.com">http://www.tri-optic.com</a>	EDP Europe, Ltd. U. K. Telephone: 44 (0) 1245-322380 <a href="http://www.edpeurope.com">http://www.edpeurope.com</a>
Dataware Houston, TX U. S. A. Telephone: 800-426-4844 <a href="http://www.datawarelabels.com/">http://www.datawarelabels.com/</a>	Dataware Labels Europe Germany Telephone: 49 8062-9455 <a href="http://www.datawarelabels.com/">http://www.datawarelabels.com/</a>
NetC Fairfield, CT U. S. A. Telephone: 203-372-6382 <a href="http://www.netc11c.com/">http://www.netc11c.com/</a>	NetC Europe Ltd U. K. Telephone: 44 (0) 1823 49 1439 <a href="http://www.netclabels.co.uk">http://www.netclabels.co.uk</a>
	NetC Asia Pacific Pty Ltd Australia Telephone: 61 (0) 2 4573 6556 <a href="http://www.netclabels.com.uk">http://www.netclabels.com.uk</a>



## Appendix A. TapeAlert flags

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 SCSI or Library/Drive Interface (LDI or RS-422 interface). The server reads the flags from Log Sense Page 0x2E. This appendix lists the TapeAlert flags that are supported by the IBM LTO Ultrium 4-H Tape Drive.

Table A-1. Supported TapeAlert flags

Flag number	Flag parameter (in hex)	Flag	Description	Action required
3	03h	Hard error	Set for any unrecoverable read, write, or positioning error. (This flag is set in conjunction with flags 4, 5, or 6.)	See the Action Required column for Flag 4, 5, or 6 in this table.
4	04h	Media	Set for any unrecoverable read, write, or positioning error that is due to a faulty tape cartridge.	Replace the tape cartridge.
5	05h	Read failure	Set for any unrecoverable read error where isolation is uncertain and failure could be due to a faulty tape cartridge or to faulty drive hardware.	If Flag 4 is also set, the cartridge is defective. Replace the tape cartridge.
6	06h	Write failure	Set for any unrecoverable write or positioning error where isolation is uncertain and failure could be due to a faulty tape cartridge or to faulty drive hardware.	If Flag 9 is also set, make sure that the write-protect switch is set so that data can be written to the tape (see "Write-Protect Switch" on page 4-2). If Flag 4 is also set, the cartridge is defective. Replace the tape cartridge.
8	08h	Not data grade	Set when severe servo errors occur while loading a tape cartridge.	Replace the tape cartridge.
9	09h	Write protect	Set when the drive detects that the tape cartridge is write-protected.	Make sure that the cartridge's write-protect switch is set so that the drive can write data to the tape (see "Write-Protect Switch" on page 4-2).
10	0Ah	No removal	Set when the drive receives an UNLOAD command after the server prevented the tape cartridge from being removed.	Refer to the documentation for your server's operating system.
11	0Bh	Cleaning media	Set when you load a cleaning cartridge into the drive.	No action required.
12	0Ch	Unsupported format	Set when you load an unsupported cartridge type into the drive or when the cartridge format has been corrupted.	Use a supported tape cartridge.

Table A-1. Supported TapeAlert flags (continued)

Flag number	Flag parameter (in hex)	Flag	Description	Action required
15	0Fh	Cartridge memory chip failure	Set when a cartridge memory (CM) failure is detected on the loaded tape cartridge.	Replace the cartridge.
16	10h	Forced eject	Set when you manually unload the tape cartridge while the drive was reading or writing.	No action required.
18	12h	Tape directory corrupted in the cartridge memory	Set when the drive detects that the tape directory in the cartridge memory has been corrupted.	Re-read all data from the tape to rebuild the tape directory.
20	14h	Clean now	Set when the drive detects that it needs cleaning.	Clean the drive. See "Cleaning the Drive Head" on page 3-6.
21	15h	Clean periodic	Set when the drive detects that it needs routine cleaning.	Clean the tape drive as soon as possible. The drive can continue to operate, but you should clean the drive soon. See "Cleaning the Drive Head" on page 3-6.
22	16h	Expired clean	Set when the drive detects a cleaning cartridge that has expired.	Replace the cleaning cartridge.
23	17h	Invalid cleaning tape	Set when the drive expects a cleaning cartridge and the loaded cartridge is not a cleaning cartridge.	Use a valid cleaning cartridge.
30	1Eh	Hardware A	Set when a hardware failure occurs which requires that you reset the drive to recover.	If resetting the drive does not recover the error, use SCSI drive sense data. See "Using sense data" on page 5-8.
31	1Fh	Hardware B	Set when the drive fails its internal self tests.	Use the SCSI drive sense data. See "Using sense data" on page 5-8.
32	20h	Interface	Set when the drive detects a problem with the SCSI or LDI (RS-422) interface.	Use the SCSI drive sense data. See "Using sense data" on page 5-8..
33	21h	Eject media	Set when a failure occurs that requires you to unload the cartridge from the drive.	Unload and reload the tape cartridge.
34	22h	Download fail	Set when an FMR image is unsuccessfully downloaded to the drive via the SCSI interface.	Ensure that it is the correct image. Download the FMR image again.
36	24h	Drive temperature	Set when the drive's temperature sensor indicates that the drive's temperature is exceeding the recommended temperature of the enclosure (see "Physical specifications" on page 1-6).	Use the SCSI drive sense data. See "Using sense data" on page 5-8.



Table A-1. Supported TapeAlert flags (continued)

Flag number	Flag parameter (in hex)	Flag	Description	Action required
37	25h	Drive voltage	Set when the drive detects that the externally supplied voltages are either approaching the specified voltage limits or are outside the voltage limits (see "Physical specifications" on page 1-6).	Use the SCSI drive sense data. See "Using sense data" on page 5-8.
39	27h	Diagnostics required	Set when the drive detects a failure that requires diagnostics to isolate the problem.	Use the SCSI drive sense data. See "Using sense data" on page 5-8.
51	33h	Tape directory invalid at unload	Set when the tape directory on the tape cartridge that was previously unloaded is corrupted. The file-search performance is degraded.	Rebuild the tape directory by reading all the data
52	34h	Tape system area write failure	Set when the tape cartridge that was previously unloaded could not write its system area successfully.	Copy the data to another tape cartridge, then discard the old cartridge.
53	35h	Tape system area read failure	Set when the tape system area could not be read successfully at load time.	Copy the data to another tape cartridge, then discard the old cartridge.
55	37h	Loading failure	The drive is unable to load the media and thread the tape.	Remove the cartridge, inspect it as specified in the product manual, and retry the operation. If the problem persists, IBM Support.
56	38h	Unrecoverable unload failure	The drive is unable to unload the media.	Do not attempt to extract the tape cartridge. Contact IBM Support.



---

## Appendix B. Repairing a Cartridge

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

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

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

### Examples of Cartridge Problems

**Example: Split Cartridge Case (see [../commonfiles/ltomedia\\_handling.dita#ltomedia\\_handling.dita/megap](#))**

The cartridge's case is damaged. There is a high possibility of media damage and potential loss. Perform the following steps:

1. Look for cartridge mishandling.
2. Use the IBM Leader Pin Reattachment Kit (part number 08L9129) to correctly seat the pin.
3. Use data recovery procedures to minimize chances of data loss.
4. Review media-handling procedures.

**Example: Improper Placement of Leader Pin (see [Figure B-1 on page B-2](#))**

The leader pin is misaligned. Perform the following steps:

1. Look for cartridge damage.
2. Use the IBM Leader Pin Reattachment Kit (part number 08L9129) to correctly seat the pin.
3. Use data recovery procedures to minimize chances of data loss.

---

## Repositioning a Leader Pin

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

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

A leader pin that is improperly seated inside a cartridge can interfere with the operation of the drive. Figure B-1 on page B-2 shows a leader pin in the incorrect **1** and correct **2** positions.

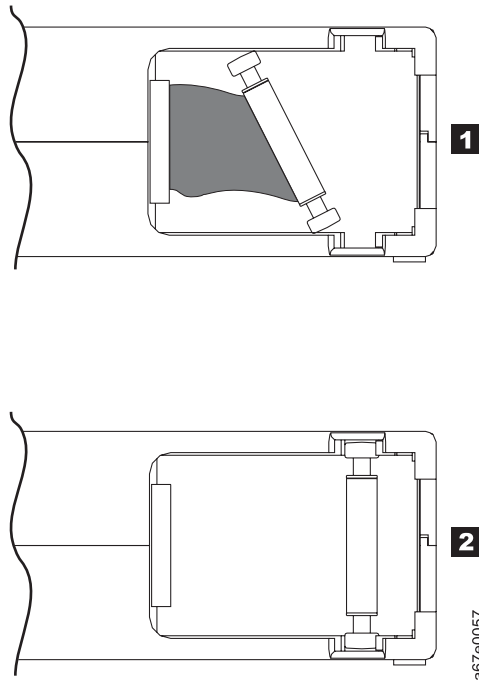


Figure B-1. Leader pin in the incorrect and correct positions. The cartridge door is open and the leader pin is visible inside the cartridge.

To reposition the leader pin, refer to Figure B-2 and perform the steps below.

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

The diagram shows a cross-section of the cartridge with the door open. A downward arrow labeled '1' points to the door. An upward arrow labeled '2' points to the leader pin. Two lines labeled '3' point to the spring clips. A line labeled '4' points to the top edge of the cartridge housing. A vertical label 'ac7e0058' is located to the right of the diagram.

Figure B-2. Placing the dislodged leader pin into the correct position

To rewind the tape, refer to Figure B-3 and perform the steps below.

1. Insert the cartridge manual rewind tool ( **1** ) into the cartridge's hub ( **2** ) and turn it clockwise until the tape becomes taut.
2. Remove the rewind tool by pulling it away from the cartridge.
3. If you suspect that the cartridge has been mishandled but it appears usable, copy any data onto a good cartridge immediately for possible data recovery. Discard the mishandled cartridge.

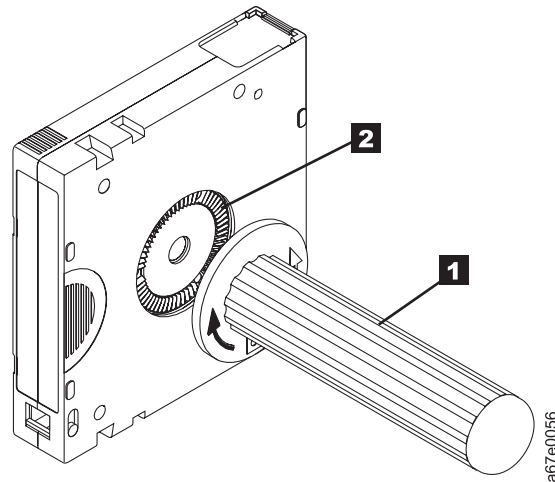


Figure B-3. Rewinding the tape into the cartridge

## Reattaching a Leader Pin

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

The Leader Pin Reattachment Kit contains three parts:

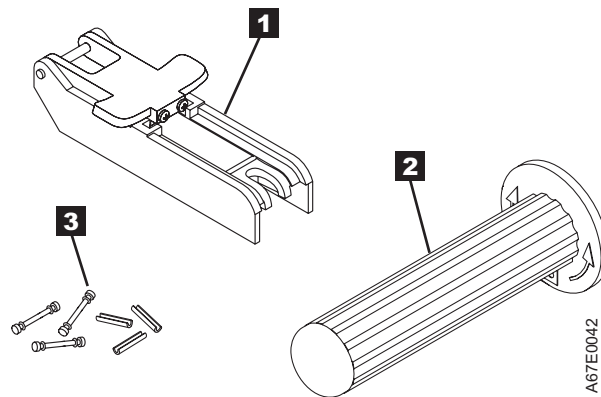


Figure B-4. Leader Pin Reattachment Kit

- **Leader pin attach tool ( 1 )**. A plastic brace that holds the cartridge door open.
- **Cartridge manual rewind tool ( 2 )**. A device that fits into the cartridge's hub and lets you wind the tape into and out of the cartridge.

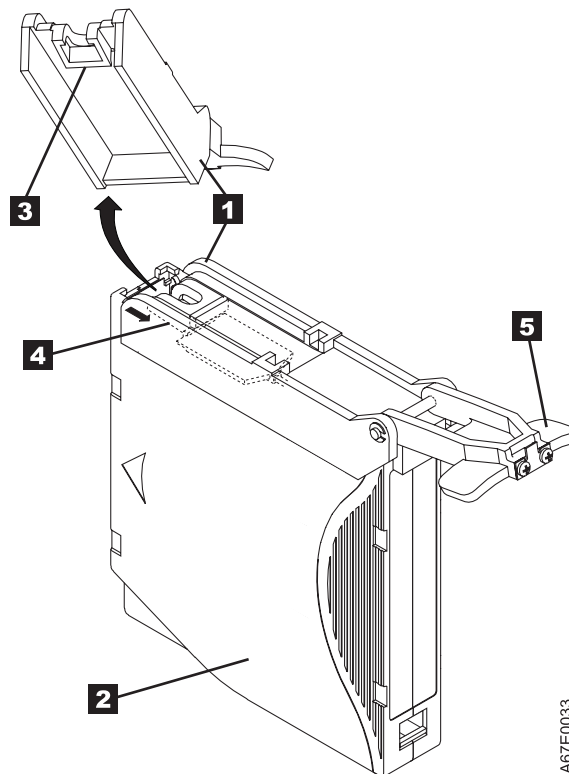
- Pin supplies ( **3** ). Leader pins and C-clips.

**Attention:**

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

To reattach a leader pin by using the IBM Leader Pin Reattachment Kit, refer to Figure B-5 and perform the steps below.

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. Open the tool's pivot arm ( **5** ).



A67E0033

Figure B-5. Attaching the leader pin attach tool to the cartridge

To find the end of the tape inside the cartridge, refer to Figure B-6 and perform the steps below.

1. 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. Turn the tool clockwise until you see the end of the tape inside the cartridge. Then, slowly turn the rewind tool counterclockwise to bring the tape edge toward the cartridge door ( **3** ).
2. Continue to turn the rewind tool counterclockwise until approximately 13 cm (5 in.) of tape hangs from the cartridge door. If necessary, grasp the tape and pull gently to unwind it from the cartridge.
3. Remove the rewind tool by pulling it away from the cartridge. Set the tool and the cartridge aside.

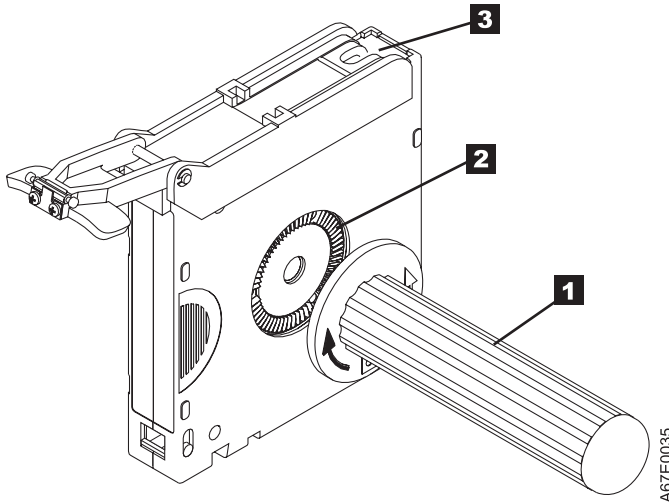


Figure B-6. Winding the tape out of the cartridge

To remove the C-clip from the leader pin, refer to Figure B-7 and perform the steps below.

1. On the leader pin ( **1** ), 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.
2. 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.

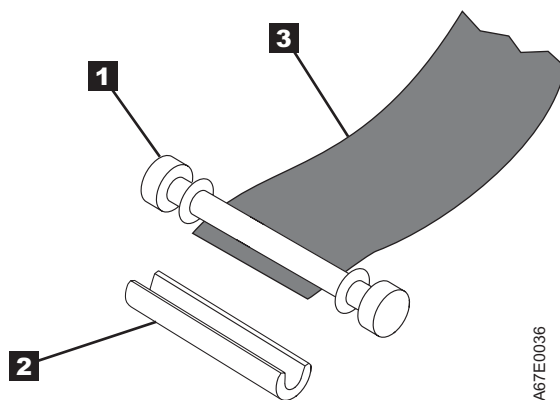


Figure B-7. Removing the C-clip from the leader pin

To attach the leader pin to the tape, refer to Figure B-8 and perform the steps below.

1. Position the tape in the alignment groove of the leader pin attach tool ( **1** ).
2. 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.
3. Place the leader pin that was removed earlier into the cavity ( **3** ) of the leader pin attach tool.  
**Attention:** To prevent the leader pin from rolling into the cartridge, in the following step use care when folding the tape over the pin.
4. Fold the tape over the leader pin and hold it with your fingers.  
**Note:** Use care to ensure that the tape is centered over the leader pin. Failure to properly center the tape on the pin will cause the repaired cartridge to fail. When the tape is properly centered, a 0.25 mm (0.01 in.) gap exists on both sides of the pin.
5. 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.
6. Swing the pivot arm open and trim the excess tape ( **5** ) so that it is flush with the reattached leader pin ( **6** ).
7. Use your fingers to remove the leader pin from the cavity ( **3** ) in the leader pin attach tool.
8. 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.
9. Remove the rewind tool.
10. Remove the leader pin attach tool by lifting its end up and away from the cartridge.

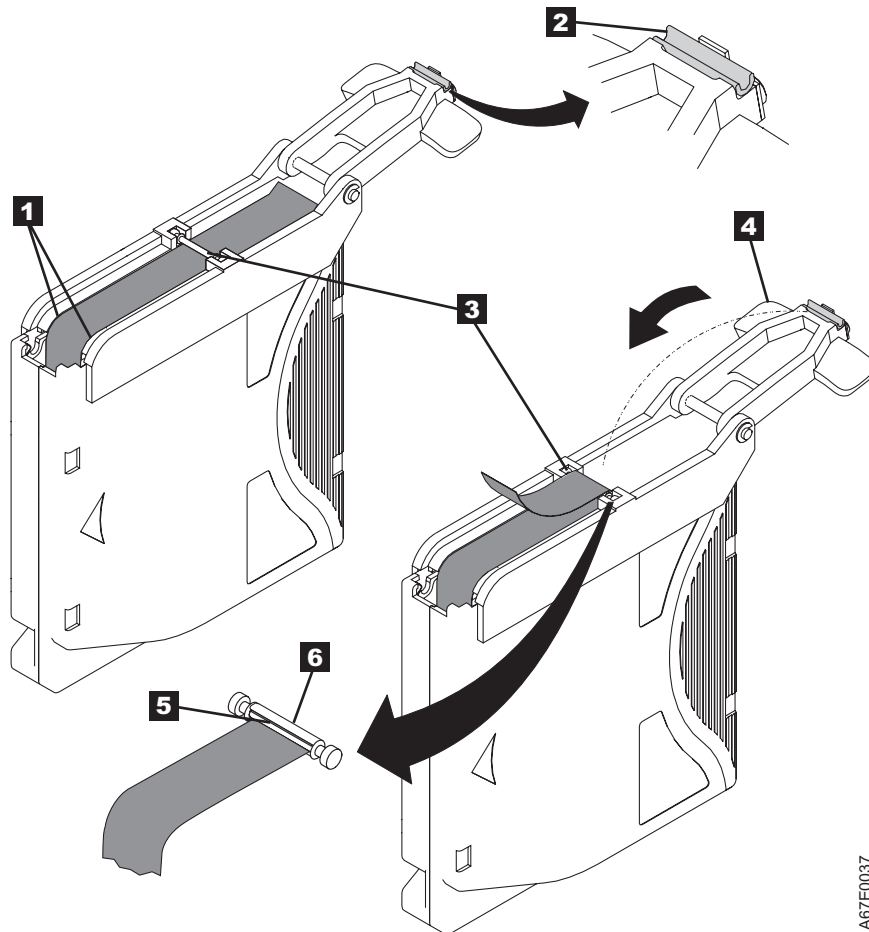


Figure B-8. Attaching the leader pin to the tape



---

## Appendix C. Information for Trained Service Personnel

### Attention

- It is strongly recommended that the drive and stuck tape be returned to IBM for removal and recovery.
- These procedures must be performed only by a trained IBM service provider. SSRs should claim their time against service code 33 ECA 013 when performing this procedure.
- Inform the customer the following procedure has high risk of damaging the drive and high risk of not being able to recover the data.

---

### Removing/Reinstalling/Replacing a drive

Information on removing a Half-high drive from an enclosure and removing/reinstalling/replacing a drive is contained in this chapter. For information on diagnostic and maintenance functions of the drive, see “Diagnostic and Maintenance Functions” on page 3-7.

#### Removing/reinstalling a SAS Drive from/in an enclosure

To remove a SAS drive from an enclosure, perform the following steps:

1. Ensure that the drive does not contain a tape cartridge.
2. Deconfigure the drive from the server (for instructions, see your server’s documentation).
3. Turn off the power to the enclosure.
4. Disconnect the power cable from the enclosure and the electrical outlet.
5. Remove the cover of the enclosure.
6. Disconnect the internal SAS cable (see **2** in Figure C-1).

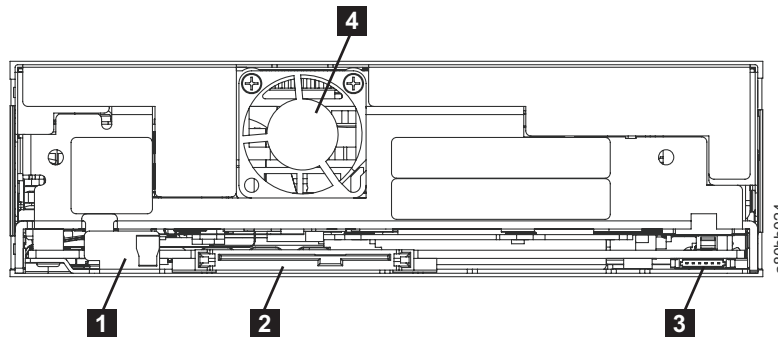


Figure C-1. Rear panel of the SAS Half-high drive

7. If connected, disconnect the internal LDI (RS-422) cable from the LDI (RS-422) connector (see **3** in Figure C-1).
8. Remove the mounting screws from the side brackets of the chassis (see **2** in Figure 2-2 on page 2-4).
9. Remove the drive from the enclosure.
10. To reinstall a drive, reverse the steps in this procedure.

---

## Manually Removing a Tape Cartridge

The purpose of this section is to assist you in determining the condition of the cartridge or the magnetic tape and to direct you to the procedure you must follow to remove the cartridge.

### Attention

- **The best solution for recovering data on a damaged cartridge is to send it to IBM for professional data recovery.**
- Before using this procedure, you must have exhausted all other means of removing the tape cartridge from the drive. Use this procedure **only** if you cannot remove the tape cartridge by using any other means.
- Determine from the customer if the cartridge contains **critical customer data**. If the cartridge contains sensitive data that cannot leave the site, inform the customer that certain failure conditions diagnostics will be performed to test the drive for continued use.
- The following removal procedures **can destroy** customer data! Use **extreme care** when handling or removing the customer's tape cartridges to minimize tape damage and lost data.
- **DO NOT TOUCH** the magnetic tape or tape path. Both are extremely sensitive to the oil and salt from your skin. Use clean, lint-free gloves when working around magnetic tape or the tape path components.
- Electrostatic-sensitive components: Consider using an ESD Kit.
- After you remove the tape cartridge, advise the customer to copy the data to another cartridge and to remove this tape cartridge from service.
- Do not use power tools or magnetic tools to perform this procedure.
- To avoid contamination and electrostatic-discharge damage to the drive, never touch the head or electronic components inside the drive.
- If you cannot remove the cartridge from the drive using the following procedures, contact your next level of support.
- The cartridge will not eject automatically at the end of a mid-tape recovery. Instead, the tape will be reloaded into the drive and may result in the loss of data.
- **INTERNAL COMPONENTS OF THE DRIVE ARE DELICATE AND CAN EASILY BE DAMAGED. EXERCISE EXTREME CAUTION WHEN MANUALLY REMOVING A CARTRIDGE THAT WILL NOT EJECT AFTER PRESSING THE UNLOAD BUTTON.**

### Before You Begin

1. If you have not already done so, attempt to remove the cartridge with the device power ON and using library manager, a host application, or the unload button. When using the Unload button, press and hold the button for 12 seconds. This will cause the drive to eject the cartridge when it has completed the mid-tape recovery.
2. If you have not already done so, ensure the operator has issued the appropriate application commands to perform a rewind and unload of the cartridge. This is to ensure that the stuck cartridge is not due to a hang condition in the application.
3. If you have not already done so, attempt to remove the cartridge by power cycling the drive. Look for the drive to attempt a midtape recovery.

**Note:** It can take as long as five minutes for the cartridge to rewind and unload.

4. If the cartridge unloads, inform the operator that the cartridge is unloaded. If the cartridge does not unload, repeat steps 2 and 3 once before continuing with this procedure.

## Recommended Tools

- #1 Phillips screwdriver
- ESD Kit
- Flashlight (optional)
- #1 Flathead screwdriver (optional)

## Beginning Procedure

1. Refer to the enclosure documentation for instructions on removing the drive.
2. Place the drive on a non-slip, sturdy work surface.
3. Ground yourself to the drive by using the ESD Kit.
4. Remove the cover of the drive by performing the following steps:
  - a. To remove the drive bezel, pull the right side of the bezel from the front of the drive, then pull the left side of the bezel out of the frame of the drive.
  - b. Remove the cover of the internal drive by performing the following steps:
    - 1) Remove the four cover-mounting screws ( **1** in Figure C-2). Two screws are located on each side of the drive.
    - 2) Remove the cover by lifting it up.

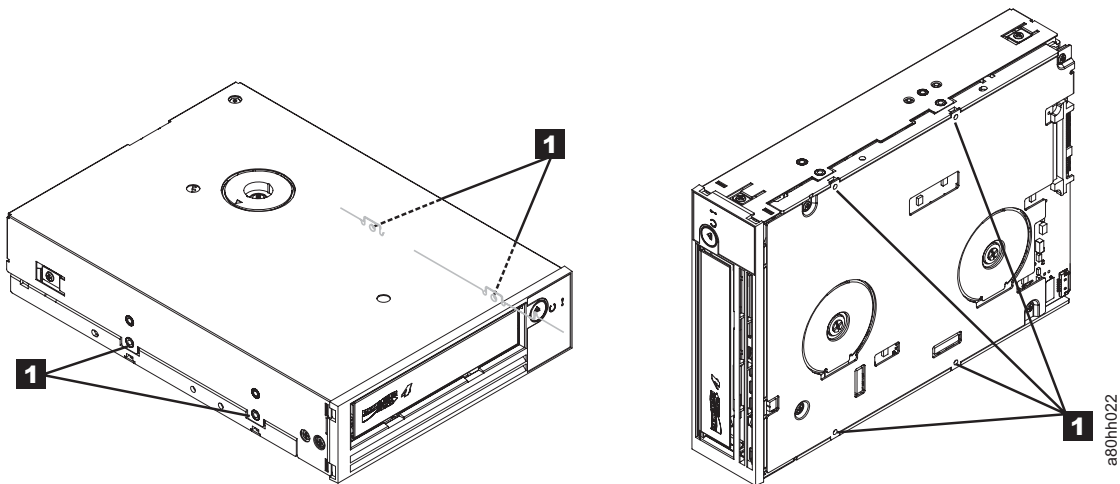


Figure C-2. Removing the bezel and the cover from the internal drive

5. Inspect the drive to decide which of the following conditions most closely matches the symptom on the drive:
  - **Tape spooled off the supply reel** - All the tape appears to be on the takeup reel and no tape is on the supply reel (inside the cartridge). Test the drive after the procedure is completed.
  - **Tape pulled from leader pin (or broken at the front end)** - All the tape appears to be on the supply reel (inside the cartridge) and very little or no tape appears to be on the takeup reel. The leader block is positioned in the takeup reel. Return the drive after the procedure is completed.

- **Tape broken in mid-tape** - Tape appears to be on both the supply reel (inside the cartridge) and takeup reel. Test the drive after the procedure is completed.
- **Tape tangled along tape path** - Tape appears to be tangled and damaged but intact. Return the drive after the procedure is completed.

-- OR --

**No damage to tape (or no apparent failure)** - There appears to be no damage or slack to the tape. Return the drive after the procedure is completed.

## Tape Spooled off Supply Reel

**Attention:** DO NOT TOUCH THE OUTER GUIDE RAIL ( **2** in Figure C-3). THIS RAIL IS VERY DELICATE AND EASILY DAMAGED.

1. From the takeup reel, pull an arm's length of tape around the rear of the tape path and over the head and rollers on the left side of the drive.
2. Set the drive on its left side with the head and tape path facing up.
3. Make sure the tape is not twisted. Untwist tape if required.
4. Moisten a cotton swab with water and wet approximately 13 mm (0.5 in.) of the tape end and feed it onto the supply reel (inside the cartridge).
5. Turn the supply reel ( **4** in Figure C-3) clockwise, allowing the moistened tape to adhere to the hub as it winds around the supply reel (inside the cartridge).

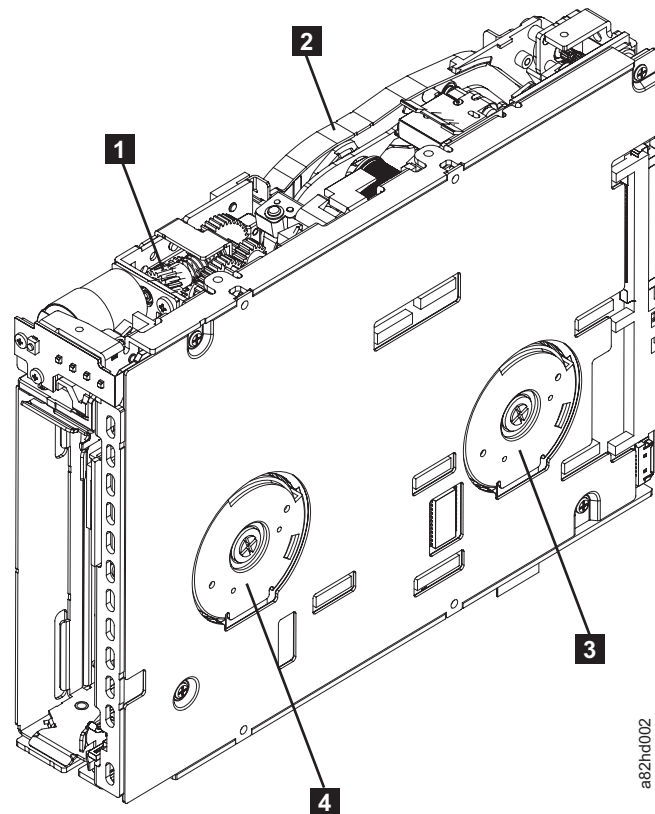


Figure C-3. Rewinding tape into cartridge

**1** Loader motor worm gear      **3** Takeup reel motor

- 2** Outer guide rail  
**WARNING: DO NOT TOUCH**
- 4** Supply reel motor

6. Continue spooling into the cartridge until the tape is taut and remains within the flanges of the tape guiding rollers. Turn the supply reel (**4** in Figure C-3 on page C-4) 10 additional turns. Ensure that you do not stretch the tape.
7. Reassemble the drive, reversing the steps in "Beginning Procedure" on page C-3.
8. Reassemble the drive chassis, reversing the steps in "Removing/Reinstalling/Replacing a drive" on page C-1.
9. Reinstall the drive canister into the cradle assembly. Ensure that the connector on the drive is seated properly into the connector on the cradle.
10. Allow the drive to perform mid-tape recovery. This takes several minutes. When this activity completes, push the Unload button to eject the cartridge.
11. Test the drive (see "Function Code 1: Run Drive Diagnostics" on page 3-9) to determine if it should be replaced.

## Tape Pulled from or Broken near Leader Pin

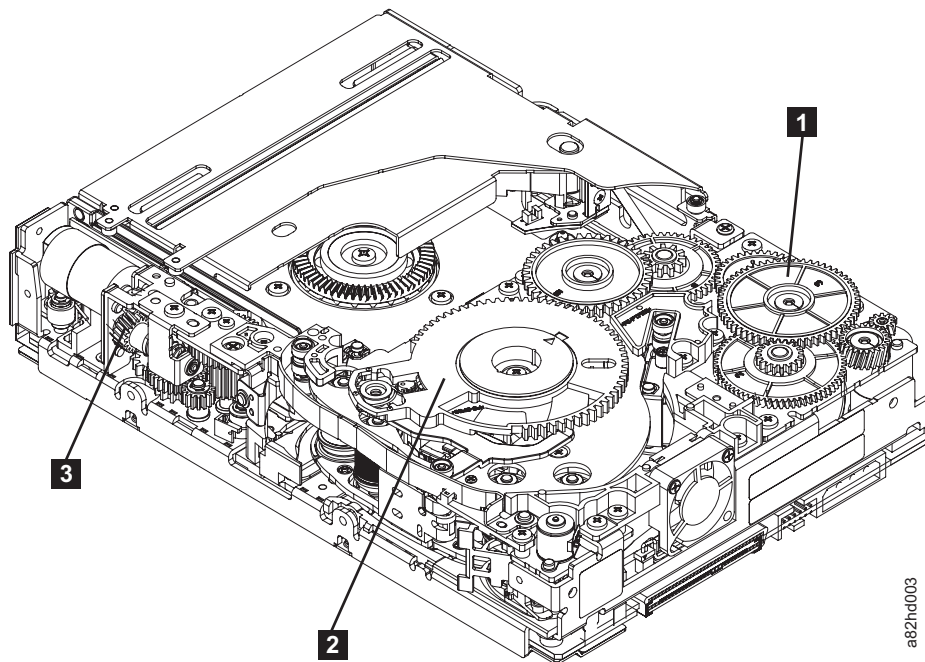


Figure C-4. Drive with cover removed to reveal gear train.

- 1** Threader intermediate gear
- 2** Threader mechanism gear
- 3** Loader motor worm gear

1. Pull out tape from the takeup reel.

**Note:** If there is more than approximately 0.6 m (2 ft.) of tape on the takeup reel, go to "Tape Broken in Mid-tape" on page C-6.

2. If there is less than approximately 0.6 m (2 ft.) of tape on the takeup reel, cut off the excess tape as close to the leader pin, as possible.

3. Reattach the leader pin to the remaining tape. For instructions, see Appendix B, "Repairing a Cartridge," on page B-1.
4. Locate the threader intermediate gear ( **1** in Figure C-4 on page C-5) near the rear of the drive. You can use your finger to rotate the threader intermediate gear ( **1** in Figure C-4 on page C-5) and slowly rotate the threader mechanism gear ( **2** in Figure C-4 on page C-5) clockwise.

This draws the tape leader block assembly (LBA) into the cartridge.

5. As the leader pin is secured in the cartridge, you should hear the leader pin retention spring clips click into place. If you do not hear the click, continue rolling until the threader intermediate gear ( **1** in Figure C-4 on page C-5) stops. The LBA is in the correct position.

**Note:** Be sure to keep tension on the tape as the LBA is drawn into the cartridge.

6. Rotate the loader motor worm gear ( **3** in Figure C-4 on page C-5) clockwise as viewed from the front of the drive until it stops. This releases the LBA leader pin.
7. Rotate the threader intermediate gear ( **1** in Figure C-4 on page C-5) counterclockwise until the leader block is in front of the Read/Write head. This moves the LBA out of the cartridge.

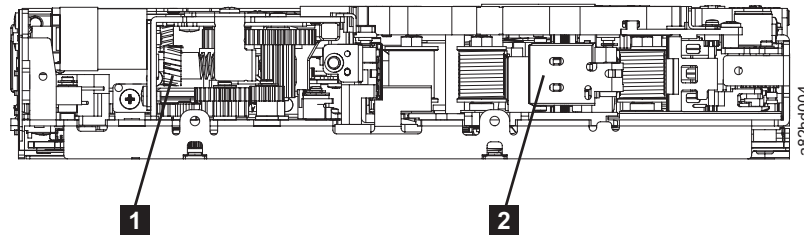


Figure C-5. Leader Block Assembly (LBA)

- |          |                        |          |                             |
|----------|------------------------|----------|-----------------------------|
| <b>1</b> | Loader motor worm gear | <b>2</b> | Leader block assembly (LBA) |
|----------|------------------------|----------|-----------------------------|

8. Rotate the loader motor worm gear ( **3** in Figure C-4 on page C-5) counterclockwise as viewed from the front of the drive until it stops.
9. Remove the cartridge from the cartridge loader tray.
10. Reassemble the drive by reversing the procedure in Step 4 in "Beginning Procedure" on page C-3.
11. Reassemble the drive chassis.
12. Refer to the appropriate procedure to install the new drive and return the failed drive.

## Tape Broken in Mid-tape

1. With the front of the drive facing you, pull an arm's length of tape out of the takeup reel. From the takeup reel, thread tape around the rear of the tape path and over the head rollers on the left side of the drive.

**Note:** If there is less than approximately 5 cm (2 in.) of tape on the takeup reel, go to "Tape Pulled from or Broken near Leader Pin" on page C-5.

2. From the supply reel inside the cartridge, pull approximately 0.3 m (1 ft.) of tape.
3. Make sure the tape is not twisted. Untwist tape if required.

4. Moisten a cotton swab with water, and wet approximately 13 mm (0.5 in.) of the tape end. Overlap the tape ends, loosely mending them together.
5. Set the drive on its left side with the head and tape path facing up.
6. Turn the supply reel ( **4** in Figure C-6) clockwise, carefully guiding the mended portion of the tape to wind around the hub of the supply reel located inside the cartridge. Continue spooling into the cartridge until the tape is taut. The tape must remain within the flanges of the tape guiding rollers. Turn the supply reel ( **4** in Figure C-6) 10 additional turns. Ensure that you do not stretch the tape.

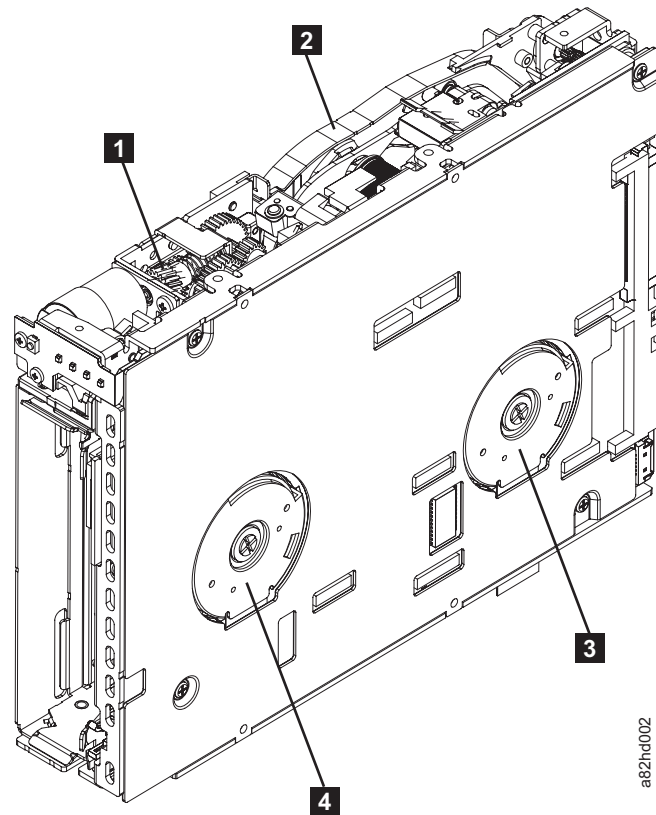


Figure C-6. Rewinding tape into cartridge

- |          |                        |          |                   |
|----------|------------------------|----------|-------------------|
| <b>1</b> | Loader motor worm gear | <b>3</b> | Takeup reel motor |
| <b>2</b> | Outer guide rail       | <b>4</b> | Supply reel motor |
- WARNING: DO NOT TOUCH

7. Reassemble the drive by reversing the procedure in Step 4 in “Beginning Procedure” on page C-3.
8. Reassemble the chassis by following the steps in “Removing/Reinstalling/Replacing a drive” on page C-1.
9. Allow the drive to perform mid-tape recovery. This takes several minutes. When this activity completes, push the Unload button to eject the cartridge.
10. Test the drive (see “Function Code 1: Run Drive Diagnostics” on page 3-9) to determine if it should be replaced.

## Tape Tangled along Tape Path

1. Carefully pull out excess tape and untangle.

**Note:** If you find the tape to be broken, go to one of the following appropriate procedures:

- “Tape Spooled off Supply Reel” on page C-4
- “Tape Pulled from or Broken near Leader Pin” on page C-5

--OR--

“Tape Broken in Mid-tape” on page C-6

2. Set the drive on its left side with the head and tape path facing up.

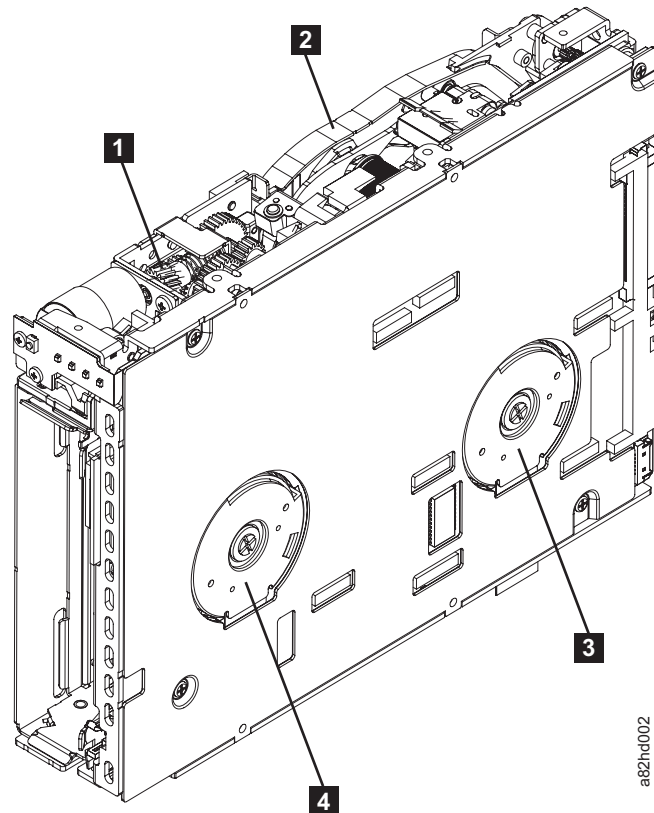


Figure C-7. Rewinding tape into cartridge

<b>1</b>	Loader motor worm gear	<b>3</b>	Takeup reel motor
<b>2</b>	Outer guide rail	<b>4</b>	Supply reel motor

WARNING: DO NOT TOUCH

3. Turn the supply reel ( **4** in Figure C-7) clockwise.
4. Continue spooling into the cartridge until the tape is taut and remains within the flanges of the tape guiding rollers. turn the supply reel ( **4** in Figure C-7) 10 turns. Ensure that you do not stretch the tape.
5. Reassemble the chassis by following the steps in “Removing/Reinstalling/Replacing a drive” on page C-1.
6. Allow the drive to perform mid-tape recovery. This takes several minutes. When this activity completes, push the Unload button to eject the cartridge.



7. Test the drive (see “Function Code 1: Run Drive Diagnostics” on page 3-9) to determine if it should be replaced.

## No Apparent Failure or Damage to Tape

1. Set the drive on its left side with the head and tape path facing up.

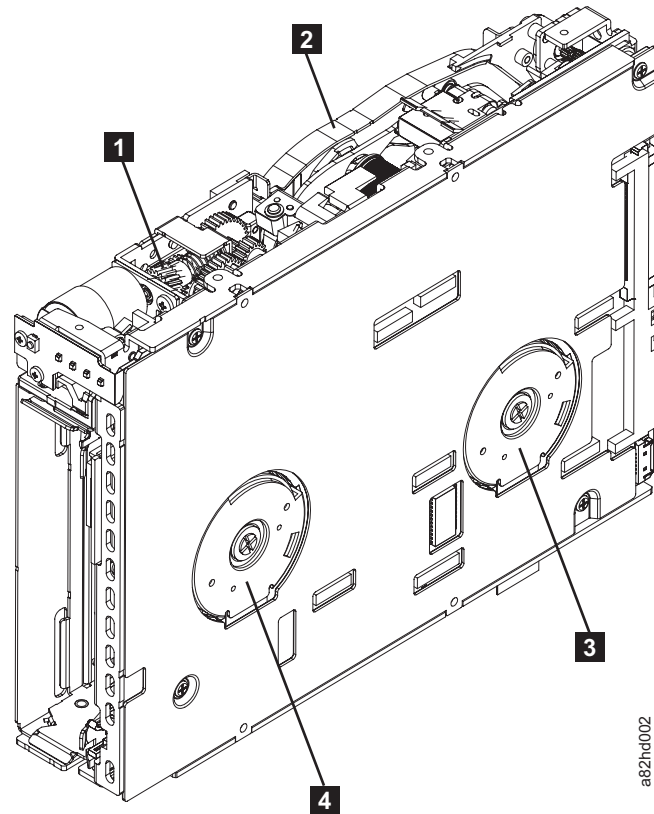
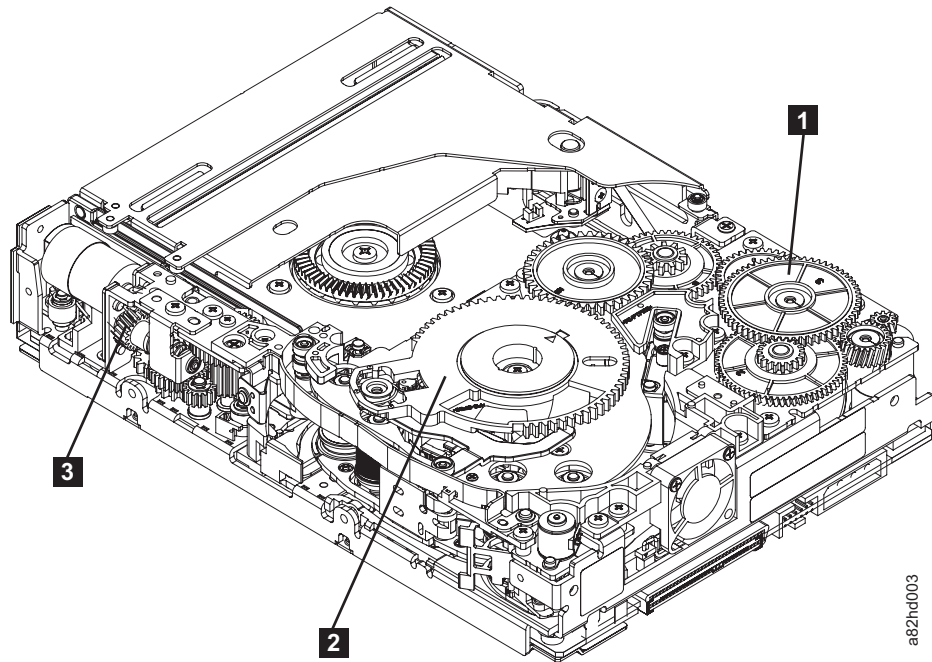


Figure C-8. Rewinding tape into cartridge

<b>1</b>	Loader motor worm gear	<b>3</b>	Takeup reel motor
<b>2</b>	Outer guide rail	<b>4</b>	Supply reel motor

WARNING: DO NOT TOUCH

2. Begin spooling the tape back into the cartridge by turning the supply reel motor (**4** in Figure C-8) clockwise.
3. Continue spooling into the cartridge until the tape is taut and remains within the flanges of the tape guiding rollers. Ensure that you do not stretch the tape. Continue spooling until all tape is removed from the takeup reel (**3** in Figure C-8).
4. Locate the threader intermediate gear (**1** in Figure C-9 on page C-10) near the rear of the drive. You can use your finger to rotate the threader intermediate gear (**1** in Figure C-9 on page C-10) and slowly rotate the threader mechanism gear (**2** in Figure C-9 on page C-10) clockwise. This draws the tape leader block assembly (LBA) into the cartridge.



a82hd003

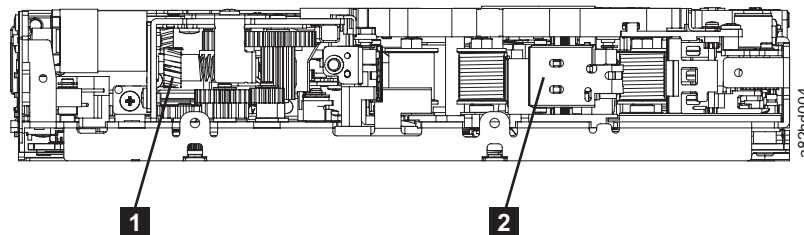
Figure C-9. Drive with cover removed to reveal gear train.

- |          |                                  |          |                               |          |                           |
|----------|----------------------------------|----------|-------------------------------|----------|---------------------------|
| <b>1</b> | Threader<br>intermediate<br>gear | <b>2</b> | Threader<br>mechanism<br>gear | <b>3</b> | Loader motor<br>worm gear |
|----------|----------------------------------|----------|-------------------------------|----------|---------------------------|

5. As the leader pin is secured in the cartridge, you should hear the leader pin retention spring clips click into place. If you do not hear the click, continue rolling until the threader intermediate gear (**1** in Figure C-9) stops. The LBA is in the correct position.

**Note:** Be sure to keep tension on the tape as the LBA is drawn into the cartridge.

6. Rotate the loader intermediate gear (**1** in Figure C-10) clockwise as viewed from the front of the drive until it stops. This releases the LBA leader pin.
7. Rotate the threader motor worm gear (**3** in Figure C-10) counterclockwise until the leader block is in front of the Read/Write head. This moves the LBA out of the cartridge.



a82hd004

Figure C-10. Leader Block Assembly (LBA)

- |          |                        |          |                             |
|----------|------------------------|----------|-----------------------------|
| <b>1</b> | Loader motor worm gear | <b>2</b> | Leader block assembly (LBA) |
|----------|------------------------|----------|-----------------------------|

8. Rotate the loader motor worm gear (**3** in Figure C-10) counterclockwise as viewed from the front of the drive until it stops.

9. Remove the cartridge from the cartridge loader tray.
10. Reassemble the drive by reversing the procedure in Step 4 in "Beginning Procedure" on page C-3.
11. Reassemble the drive chassis by following the steps in "Removing/Reinstalling/Replacing a drive" on page C-1.
12. Refer to the appropriate procedure to install the new drive and return the failed drive.



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## Glossary

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

### Numbers

#### 2:1 compression

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

### A

**A** Ampere.

**ac** Alternating current.

#### access method

A technique for moving data between main storage and input or output devices.

#### adapter card

A circuit board that adds function to a computer.

**ADI** Automation Drive Interface.

**adj** Adjustment.

**AIX** Advanced Interactive Executive. IBM's implementation of the UNIX<sup>®</sup> operating system. The RS/6000 system, among others, uses AIX as its operating system.

#### alphanumeric

Pertaining to a character set that contains letters, numerals, and usually other characters, such as punctuation marks.

**alter** To change.

#### ambient temperature

The temperature of air or other media in a designated area, particularly the area surrounding equipment.

#### ampere (A)

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

**ANSI** American National Standards Institute.

#### archive

To collect and store files in a designated place.

**ASCII** American National Standard Code for Information Interchange. A 7 bit coded character set (8 bits including parity check) that consists of control characters and graphic characters.

**assigning a device**

The establishing of the relationship of a device to a running task, process, job, or program.

**assignment**

The naming of a specific device to perform a function.

**asynchronous**

Pertaining to two or more processes that do not depend upon the occurrence of specific events such as common timing signals.

**attention (notice)**

A word for calling attention to the possibility of danger to a program, device, or system, or to data. Contrast with *caution* and *danger*.

**ATTN** Attention.

**B****backup**

To make additional copies of documents or software for safekeeping.

**bar code**

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

**bar code label**

Paper bearing a bar code and having an adhesive backing. The bar code label must be affixed to a tape cartridge to enable the library to identify the cartridge and its volume serial number.

**bar code reader**

A laser device specialized for scanning and reading bar codes and converting them into either the ASCII or EBCDIC digital character code.

**bezel** Decorative and safety cover.

**bicolored**

Having two colors.

**bit** Either of the digits 0 or 1 when used in the binary numbering system.

**BM or bill of materials**

A list of specific types and amounts of direct materials expected to be used to produce a given job or quantity of output.

**BRMS** Backup Recovery and Media Services.

**browser**

A client program that initiates requests to a Web server and displays the information that the server returns.

**buffer**

A routine or storage used to compensate for a difference in rate of flow of data or time of occurrence of events, when transferring data from one device to another.

**bus** A facility for transferring data between several devices located between two end points, only one device being able to transmit at a given moment.

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

## C

### **capacity**

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

### **cartridge manual rewind tool**

A device that can be fitted into the reel of a cartridge and used to rewind tape into or out of the cartridge.

**CM** Cartridge Memory.

### **cartridge storage slot**

Individual slot located within a magazine that is used to house tape cartridges.

### **caution (notice)**

A word to call attention to possible personal harm to people. Contrast with *attention* and *danger*.

**CE** Customer engineer; field engineer; service representative.

### **centimeter (cm)**

One one-hundredth of a meter (0.01 m). Approximately 0.39 inch.

### **channel command**

An instruction that directs a data channel, control unit, or device to perform an operation or set of operations.

**char** Character.

**CHK** Check.

### **cleaning cartridge**

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

### **command**

A control signal that initiates an action or the start of a sequence of actions.

### **compact disc (CD)**

A disc, usually 4.75 inches in diameter, from which data is read optically by means of a laser.

### **compression**

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

### **concurrent**

Refers to diagnostic procedures that can be run on one control unit while the rest of the subsystem remains available for customer applications.

### **contingent connection**

A connection between a channel path and a drive caused when a unit check occurs during an I/O operation.

### **controller**

A device that provides the interface between a system and one or more tape drives.

**CP** Circuit protector.

**CRU** Customer Replaceable Unit.

**CSA** Canadian Standards Association.

**ctrl** Control.

**CU** Control unit.

## **D**

### **danger (notice)**

A word to call attention to possible lethal harm to people. Contrast with *attention* and *caution*.

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

### **data buffer**

The storage buffer in the control unit. This buffer is used to increase the data transfer rate between the control unit and the channel.

### **data cartridge**

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

### **data check**

A synchronous or asynchronous indication of a condition caused by invalid data or incorrect positioning of data.

**dc** Direct current.

### **degauss**

To make a magnetic tape nonmagnetic by means of electrical coils carrying currents that neutralize the magnetism of the tape.

### **degausser**

A device that makes magnetic tape nonmagnetic.

### **degradation**

A decrease in quality of output or throughput or an increase in machine error rate.

### **degraded**

Decreased in quality of output or throughput or increased machine error rate.

### **deserialize**

To change from serial-by-bit to parallel-by-byte.

### **detented**

A part being held in position with a catch or lever.

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

### **device driver**

A file that contains the code needed to use an attached device.

### **DIAG**

Diagnostic section of maintenance information manual.

### **differential**

See *High Voltage Differential (HVD)*.

### **direct access storage**

A storage device in which the access time is independent of the location of the data.

**DNS** Directory Name System. This allows the library to recognize text-based addresses instead of numeric IP addresses.

**download**

To transfer programs or data from a computer to a connected device, typically a personal computer.

To transfer data from a computer to a connected device, such as a workstation or microcomputer.

**DRAM**

Dynamic random-access memory.

**drive, magnetic tape**

A mechanism for moving magnetic tape and controlling its movement.

**DRV** Drive.

**DSE** Data security erase.

**DSP** Digital signal processor.

**E****EBCDIC**

Extended binary-coded decimal interchange code.

**EC** Edge connector. Engineering change.

**ECC** Error correction code.

**EEPROM**

Electrically erasable programmable read-only memory.

**EIA** Electronics Industries Association.

**EIA unit**

A unit of measure, established by the Electronic Industries Association, equal to 44.45 millimeters (1.75 inches).

**eject** To remove or force out from within.

**electronic mail**

Correspondence in the form of messages transmitted between user terminals over a computer network.

**e-mail** See *electronic mail*.

**EPO** Emergency power off.

**EPROM**

Erasable programmable read only memory.

**EQC** Equipment check.

**equipment check**

An asynchronous indication of a malfunction.

**Error log**

A dataset or file in a product or system where error information is stored for later access.

**ESD** Electrostatic discharge.

**F****fault symptom code (FSC)**

A hexadecimal code generated by the drive or the control unit microcode in response to a detected subsystem error.

- FC** Feature code.
- FCC** Federal communications commission.
- FE** Field engineer, customer engineer, or service representative.
- fiducial**  
A target used for teaching a physical location to a robot.
- field replaceable unit (FRU)**  
An assembly that is replaced in its entirety when any one of its components fails.
- file** A named set of records stored or processed as a unit. Also referred to as a dataset.
- file protection**  
The processes and procedures established in an information system that are designed to inhibit unauthorized access to, contamination of, or deletion of a file.
- file transfer protocol (FTP)**  
In the Internet suite of protocols, an application layer protocol that uses TCP and Telnet services to transfer bulk-data files between machines or hosts.
- firmware**  
Proprietary code that is usually delivered as microcode as part of an operating system. Firmware is more efficient than software loaded from an alterable medium and more adaptable to change than pure hardware circuitry. An example of firmware is the Basic Input/Output System (BIOS) in read-only memory (ROM) on a PC motherboard.
- FLASH EEPROM**  
An electrically erasable programmable read-only memory (EEPROM) that can be updated.
- FMR** Field microcode replacement.
- format**  
The arrangement or layout of data on a data medium.
- formatter**  
Part of a magnetic tape subsystem that performs data conversion, speed matching, encoding, first level error recovery, and interfaces to one or more tape drives.
- FP** File protect.
- frayed** Damaged as if by an abrasive substance.
- FRU** Field replaceable unit.
- FSC** Fault symptom code.
- FSI** Fault symptom index.
- functional microcode**  
Microcode that is resident in the machine during normal customer operation.
- G**
- g** Gram.
- GB** gigabyte.



**GBIC** Gigabit Interface Converter.

**Gbi** gigabit

**gigabit (Gbit)**  
1 000 000 000 bits.

**gigabyte (GB)**  
1 000 000 000 bytes.

**Gigabit Interface Converter (GBIC)**  
Converts copper interface to optic interface.

**gnd** Ground.

## **H**

**HBA** Host Bus Adapter.

**hertz (Hz)**  
Unit of frequency. One hertz equals one cycle per second.

**hex** Hexadecimal.

**High Voltage Differential (HVD)**  
A logic signaling system that enables data communication between a supported host and the library. HVD signaling uses a paired plus and minus signal level to reduce the effects of noise on the SCSI bus. Any noise injected into the signal is present in both a plus and minus state, and is thereby canceled. Synonymous with *differential*.

**HVD** SCSI Bus High Voltage Differential

**Hz** Hertz (cycles per second).

## **I**

### **IBM Ultrium Tape Drive**

Located within the library, a data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape.

**ID** Identifier.

**identifier (ID)**  
(1) In programming languages, a lexical unit that names a language object; for example, the names of variables, arrays, records, labels, or procedures. An identifier usually consists of a letter optionally followed by letters, digits, or other characters. (2) One or more characters used to identify or name data element and possibly to indicate certain properties of that data element. (3) A sequence of bits or characters that identifies a program, device, or system to another program, device, or system.

**IEC** International Electrotechnical Commission.

**IML** Initial microprogram load.

**initial microprogram load (IML)**  
The action of loading a microprogram from an external storage to writable control storage.

**initiator**  
The component that executes a command. The initiator can be the host system or the tape control unit.

**INST** Installation.

**interface**

A shared boundary. An interface might be a hardware component to link two devices or it might be a portion of storage or registers accessed by two or more computer programs.

**interposer**

The part used to convert a 68-pin connector to a 50-pin D-shell connector.

**intervention required**

Manual action is needed.

**INTRO**

Introduction.

**I/O** Input/output.

**IOP** Input/output processor.

**IPL** Initial program load.

**ISV** Independent Software Vendor.

**ITST** Idle-time self-test.

**K**

**kilogram (kg)**

One thousand grams (approximately 2.2 pounds).

**km** kilometer. 1000 Meters, Approximately 5/8 mile.

**L**

**LAN** Local area network. A computer network within a limited area.

**LCD** See *liquid crystal display*.

**LDAP** Lightweight Directory Access Protocol. This allows the library to use login and password information stored on a server to grant access to the library functionality.

**LDI** Library Drive Interface.

**LED** Light-emitting diode.

**Linear Tape-Open (LTO)**

A type of tape storage technology developed by the IBM Corporation, Hewlett-Packard, and Certance. LTO technology is an “open format” technology, which means that its users will have multiple sources of product and media. The “open” nature of LTO technology enables compatibility between different vendors’ offerings by ensuring that vendors comply with verification standards. The LTO technology is implemented in two formats: the Accelis format focuses on fast access; the Ultrium format focuses on high capacity. The Ultrium format is the preferred format when capacity (rather than fast access) is the key storage consideration. An Ultrium cartridge has a compressed data capacity of up to 800 GB (2:1 compression) and a native data capacity of up to 400 GB.

**liquid crystal display (LCD)**

A low-power display technology used in computers and other I/O devices.

**loadable**

Having the ability to be loaded.

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

Within each LTO Ultrium data cartridge, an embedded electronics and interface module that can store and retrieve a cartridge's historical usage and other information.

**LUN** Logical Unit Number.

**LVD** SCSI Bus Low Voltage Differential

**M****magnetic tape**

A tape with a magnetical surface layer on which data can be stored by magnetic recording.

**MAP** Maintenance analysis procedure.

**mask** A pattern of characters that controls the retention or elimination of portions of another pattern of characters. To use a pattern of characters to control the retention or elimination of portions of another pattern of characters.

**master file**

A file used as an authority in a given job and that is relatively permanent, even though its contents may change. Synonymous with main file.

**MB** Mega Byte (usually expressed as data rate in MB/s or MB/second).

**media capacity**

The amount of data that can be contained on a storage medium, expressed in bytes of data.

**media-type identifier**

Pertaining to the bar code on the bar code label of the IBM Ultrium Tape Cartridge, a 2-character code, L1, that represents information about the cartridge. L identifies the cartridge as one that can be read by devices which incorporate LTO technology; 1 indicates that it is the first generation of its type.

**mega** One million of.

**meter** In the Metric System, the basic unit of length; equal to approximately 39.37 inches.

**micro** One millionth of.

**microcode**

(1) One or more micro instructions. (2) A code, representing the instructions of an instruction set, implemented in a part of storage that is not program-addressable. (3) To design, write, and test one or more micro instructions. (4) See also *microprogram*.

**microdiagnostic routine**

A program that runs under the control of a supervisor, usually to identify field replaceable units.

**microdiagnostic utility**

A program that is run by the customer engineer to test the machine.

**microinstruction**

A basic or elementary machine instruction.

**microprogram**

A group of microinstructions that when executed performs a preplanned function.

The term microprogram represents a dynamic arrangement or selection of one or more groups of microinstructions for execution to perform a particular function. The term microcode represents microinstructions used in a product as an alternative to hard-wired circuitry to implement certain functions of a processor or other system component.

**MIM** Media information message.

**mm** Millimeter.

**modifier**

That which changes the meaning.

**mount a device**

To assign an I/O device with a request to the operator.

**MP** Microprocessor.

**ms** Millisecond.

**MSG** Message.

**multipath**

Pertaining to using more than one path.

**N**

**N/A** Not applicable.

**NEMA**

National Electrical Manufacturers Association.

**node** In a network, a point at which one or more functional units connect channels or data circuits.

**NTP** Network Time Protocol. This allows the library to set its internal date and time based on the date and time of a sever.

**NVS** Nonvolatile storage. A storage device whose contents are not lost when power is cut off.

**O**

**oersted**

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

**offline**

Pertaining to the operation of a functional unit without the continual control of a computer. Contrast with *online*.

**online** Pertaining to the operation of a functional unit that is under the continual control of a computer. Contrast with *offline*.

**OPER** Operation.

**ov** Over voltage.

**overrun**

Loss of data because a receiving device is unable to accept data at the rate it is transmitted.

**overtightening**

To tighten too much.

**P****parameter**

A variable that is given a constant value for a specified application and that may denote the application.

**p bit** Parity bit.

**PC** Parity check.

**PCC** Power control compartment.

**PDF** Portable Document Format.

**PE** Parity error. Product engineer.

**pick** Pertaining to the library, to remove, by means of a robotic device, a tape cartridge from a storage slot or drive.

**picker** A robotic mechanism located inside the library that moves cartridges between the cartridge storage slots and the drive.

**PM** Preventive maintenance.

**POR** Power-on reset.

**port** A physical connection for communication between the 3590 and the host processor. The 3590 has two SCSI ports.

**Portable Document Format (PDF)**

A standard specified by Adobe Systems, Incorporated, for the electronic distribution of documents. PDF files are compact, can be distributed globally (via e-mail, the Web, intranets, or CD-ROM), and can be viewed with the Acrobat Reader, which is software from Adobe Systems that can be downloaded at no cost from the Adobe Systems home page.

**PROM**

Programmable read only memory.

**PS** Power supply.

**PWR** Power.

**R**

**rack** A unit that houses the components of a storage subsystem, such as the library.

**rackmount kit**

A packaged collection of articles used to install the rack mounted version of the library.

**RAM** Random access memory.

**Random access memory**

A storage device into which data is entered and from which data is retrieved in a nonsequential manner.

**RAS** Reliability, availability, and serviceability.

**record** A collection of related data or words, treated as a unit.

- recording density**  
The number of bits in a single linear track measured per unit of length of the recording medium.
- recoverable error**  
An error condition that allows continued execution of a program.
- ref** Reference.
- reg** Register.
- reinventory**  
To inventory again.
- retension**  
The process or function of tightening the tape onto the cartridge, if it is sensed that the tape has a loose wrap on the cartridge.
- RID tag**  
Repair identification tag.
- robot** Picker.
- robotics**  
Picker assembly.
- RPQ** Request for price quotation.
- R/W** Read/write.
- S**
- s** Seconds of time.
- SAC** Service Action Code. Code developed to indicate possible FRU or FRU's to replace to repair the hardware.
- SAN** Storage Area Network.
- SAS** Serial Attached SCSI. A computer bus technology and serial communication protocol for direct attached storage devices. SAS is a replacement for parallel SCSI with higher speeds, but still using SCSI commands.
- scratch cartridge**  
A data cartridge that contains no useful data, but can be written to with new data.
- SCD** Single Character Display.
- SCSI** Small computer system interface.
- segment**  
A part.
- sel** Select.
- serialize**  
To change from parallel-by-byte to serial-by-bit.
- serializer**  
A device that converts a space distribution of simultaneous states representing data into a corresponding time sequence of states.
- servo, servos**  
An adjective for use in qualifying some part or aspect of a servomechanism.

**servomechanism**

A feedback control system in which at least one of the system signals represents mechanical motion.

**Small Computer Systems Interface (SCSI)**

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

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

**SMTP** Simple Mail Transfer Protocol. SMTP is a standard for e-mail transmissions across the internet.

**SNMP**

Simple Network Management Protocol. SNMP is used by network management systems to monitor network-attached devices for conditions that warrant administrative attention.

**SMW** Servo Manufacturer’s Word.

**SNS** Sense.

**special feature**

A feature that can be ordered to enhance the capability, storage capacity, or performance of a product, but is not essential for its basic work.

**SR** Service representative, see also *CE*.

**SRAM**

Static random access memory.

**SS** Status store.

**SSP** Serial SCSI Protocol.

**ST** Store.

**standard feature**

The significant design elements of a product that are included as part of the fundamental product.

**START**

Start maintenance.

**subsystem**

A secondary or subordinate system, usually capable of operating independently of, or asynchronously with, a controlling system.

**SUPP** Support.

**sync** Synchronous, synchronize. Occurring with a regular or predictable time relationship.

**T****tachometer, tach**

A device that emits pulses that are used to measure/check speed or distance.

**tape cartridge**

A container holding magnetic tape that can be processed without separating it from the container.

**tape void**

An area in the tape in which no signal can be detected.

**TCP/IP**

Transmission Control Protocol/Internet Protocol.

**TCU** Tape control unit.

**TH** Thermal.

**thread/load operation**

A procedure that places tape along the tape path.

**TM** Tapemark.

**U**

**UART** Universal asynchronous receiver/transmitter.

**UL** Underwriter's Laboratories.

**unload**

Prepare the tape cartridge for removal from the drive.

**utilities**

Utility programs.

**utility programs**

A computer program in general support of the processes of a computer; for instance, a diagnostic program.

**uv** Under voltage.

**V****VOLSER**

Volume serial number.

**volume**

A certain portion of data, together with its data carrier, that can be handled conveniently as a unit.

**VPD** Vital product data. The information contained within the tape drive that requires nonvolatile storage used by functional areas of the drive, and information required for manufacturing, RAS, and engineering.



## **W**

**word** A character string that is convenient for some purpose to consider as an entity.

### **WORM**

Write Once Read Many.

**Write** Write command.

**WT** world trade.

### **WWCID**

World Wide Cartridge Identifier.

**WWN** World Wide Name.

### **WWNN**

World Wide Node Name.

### **WWPN**

World Wide Port Name.

## **X**

**XR** External register.

**XRA** External register address register.



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## Readers' Comments — We'd Like to Hear from You

IBM LTO Ultrium 4 Half-High Tape Drive  
Setup, Operator, and Service Guide  
Model T1600V

Publication No. GC27-2150-00

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Please do not staple

Fold and Tape



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IBM LTO Ultrium 4 Half-High  
Tape Drive

LTO Ultrium 4 Half-High Tape Drive

Model T1600V