IBM TotalStorage Ultrium Tape Drive
Models T800 and T800F

Setup, Operator, and Service Guide

GC26-7697-01

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Note

Before using this guide and the product it supports, read the information in "Safety and Environmental Notices" on page ix and "Notices" on page 115.

Second Edition (March 2005)

This edition applies to the *IBM TotalStorage Ultrium Tape Drive Models T800 and T800F Setup, Operator, and Service Guide* and to all subsequent releases and modifications until otherwise indicated in new editions.

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Safety and Environmental Notices

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

Danger notices contain a Dxxxx reference number. Caution notices contain a Cxxxx reference number. Rack safety notices contain a Rxxxx reference number. Use the reference number to locate the translation in *IBM® Translated Safety Notices*, 96P0851.

The sections that follow define each type of safety notice.

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.

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 due to 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, and so forth).
	A hazardous condition due to mechanical movement in or around the product.

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If the symbol is...	It means....
	A hazardous condition due to the weight of the unit. Weight symbols are accompanied by an approximation of the product's weight.

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.

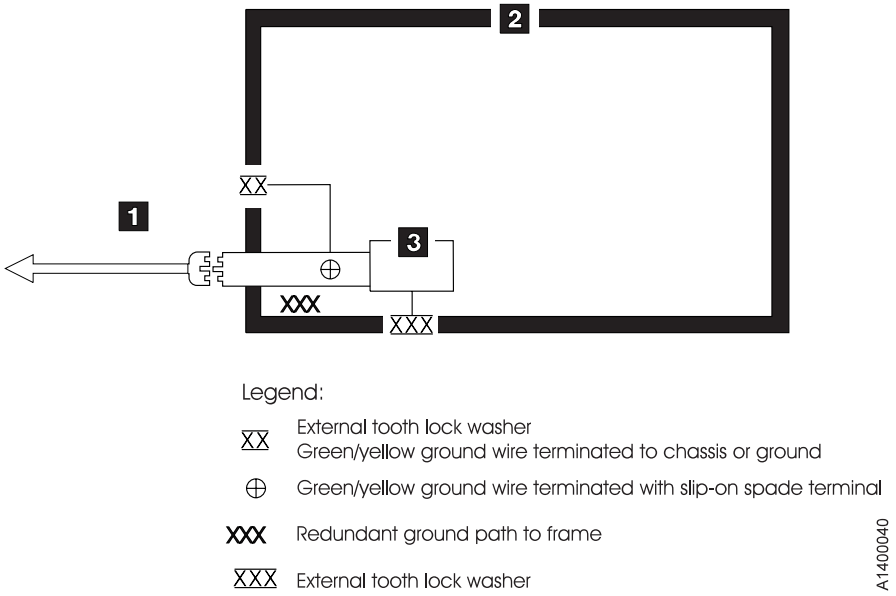

Figure 1. AC Grounding Diagram (50 Hz and 60 Hz)

End of Life (EOL) Plan

This box is a purchased unit. Therefore, it is the sole responsibility of the purchaser to dispose of it in accordance with local laws and regulations at the time of disposal. This unit contains recyclable materials. The materials should be recycled where facilities are available and according to local regulations. In some areas IBM may provide a product take-back program that ensures proper handling of the product. Contact your IBM representative for more information.

Summary of Changes

The following changes have been applied to the information in this publication.

Second Edition

- Information about the Fibre Channel drive was added.
- Diagnostic Functions F, J and L were modified/added.
- The procedure for aborting a diagnostic function was modified.
- The information for error code A was modified.

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About This Guide

This guide includes information on setting up, operating and servicing the tape drive in the following chapters:

- "Product Description" on page 1 describes the drive, discusses supported servers, operating systems, and device drivers, and lists hardware specifications.
- "Installing the Drive" on page 13 tells how to unpack and set up the drive.
- "Operating the Drive" on page 27 describes the unload button, and status light on the drive. It explains the function of the message display and the single-character display. It tells how to insert and remove a tape cartridge, describes methods of updating drive firmware, and explains how to clean the drive. It also lists the diagnostic and maintenance functions that the drive can perform.
- "Using Ultrium Media" on page 51 describes the types of tape cartridges to use in the drive and defines the conditions for storing and shipping them. It also tells how to handle the cartridges, how to set a cartridge's write-protect switch, and how to order additional cartridges.
- "Resolving Problems" on page 73 gives tips for solving problems with the drive and includes a flowchart that analyzes when the drive requires maintenance.
- "Servicing the Drive" on page 93 gives instructions on servicing the drive.
- "Parts List" on page 109 lists all tools and supplies available for ordering for the drive.
- "TapeAlert Flags," on page 111 lists TapeAlert messages that are supported by the drive and that may aid during problem determination.

Related Publications

- *IBM TotalStorage® Ultrium Tape Drive Quick Reference*, GC26-7710, illustrates how to configure and operate the IBM TotalStorage Ultrium Tape Drive.
- *IBM TotalStorage 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 the IBM 3580 Tape Drive Model L33/L3H and the IBM TotalStorage Ultrium Tape Drive Models T800 and T800F.
- *IBM Ultrium Device Drivers Installation and User's Guide*, GA32-0430, 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.
- *IBM Ultrium Device Drivers Programming Reference*, GC35-0483, 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/devdrvr**.
- *IBM Translated Safety Notices*, 96P0851, provides translation of danger and caution notices.

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Product Description

The IBM TotalStorage Ultrium 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. The drive is the third-generation in the Ultrium series of products. It is available as Model T800 with a Small Computer Systems Interface (SCSI) or as Model T800F with a Fibre Channel interface.

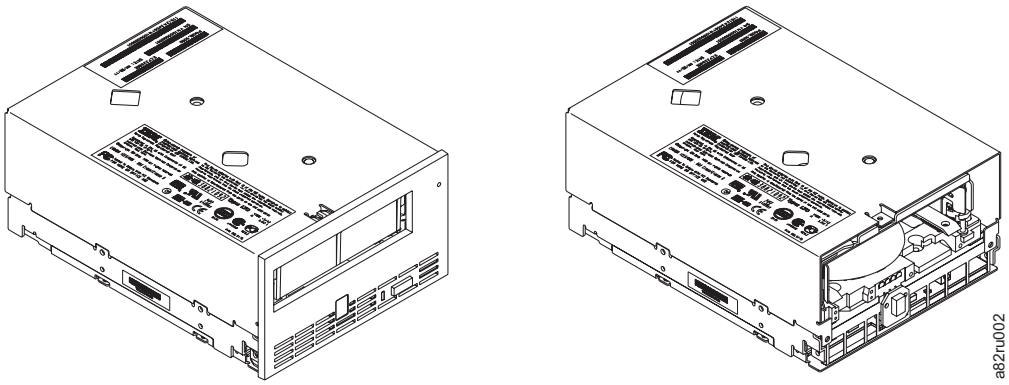

Figure 2. View of the drive with and without the bezel

Drive Features

The drive offers the following features:

- Ultra160 Low Voltage Differential (LVD) Small Computer Systems Interface or FC-2 Fibre Channel interface
- 68-pin, D-shell connector (for SCSI signals, SCSI ID selection, and power connection) or connector for direct conection to a n F-port
- Native storage capacity of 400 GB per cartridge (800 GB at 2:1 compression)
- Native data transfer rate of up to 80 MB per second
- Burst data transfer rate of 160 MB per second
- New dual stage 16 channel head activator for precision head alignment to help support higher track density with improved data integrity and backwards compatibility with previous LTO generations
- Graceful dynamic braking designed to maintain tension until the tape comes to a complete stop, to help prevent stretching or breaking the tape, and loose tape wraps
- Larger internal buffer (the size has been doubled over the Ultrium 2 to 128 MB)
- New independent tape loader and threader motors designed to help with cartridge insertion in the tape drive.
- Highly integrated electronics using IBM engineered copper technology designed to reduced the total number of components in the drive, lower chip temperatures, and reduce power requirements, helping to provide for a more reliable drive. The Generation 3 drive electronics also incorporate on-the-fly error correction of soft errors in the memory arrays in data and control paths.

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Front Panel of the Drive

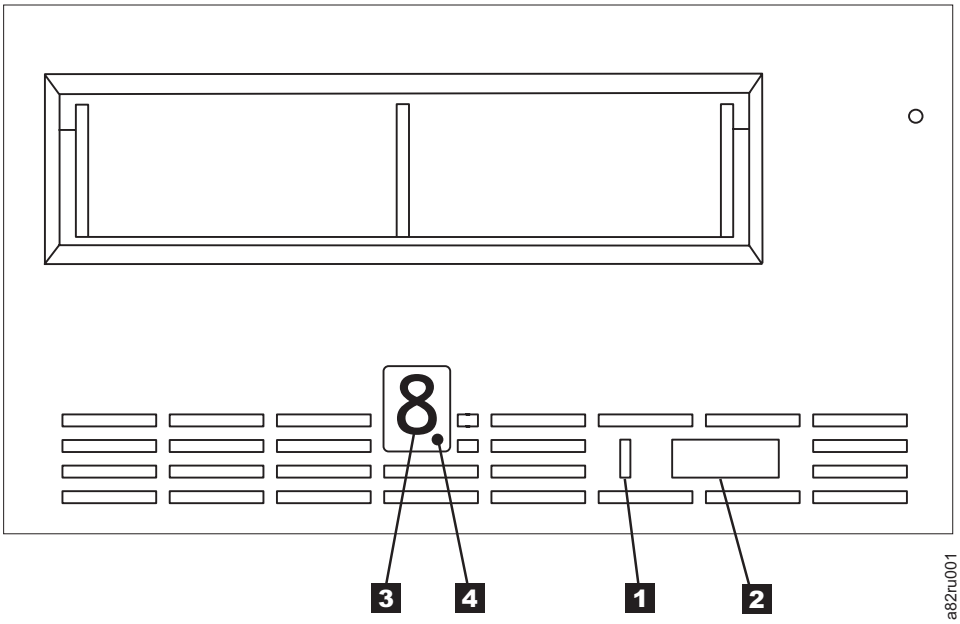

Figure 3. Front panel of the drive

1	Status Light	3	Single-character Display (SCD)
2	Unload Button	4	SCD Dot

Rear Panel of the SCSI Drive

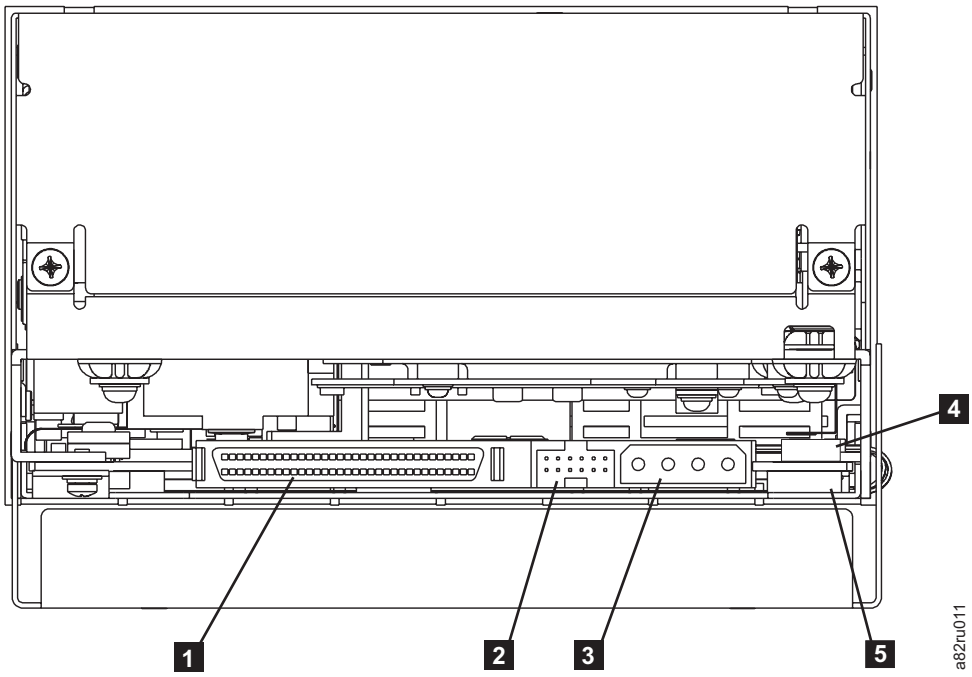

Figure 4. Rear panel of the SCSI drive

1	SCSI connector	4	Library/Drive Interface (LDI or RS-422 interface) connector
2	SCSI ID connector	5	Serial port
3	Power connector		

Rear View of the Fibre Channel Drive

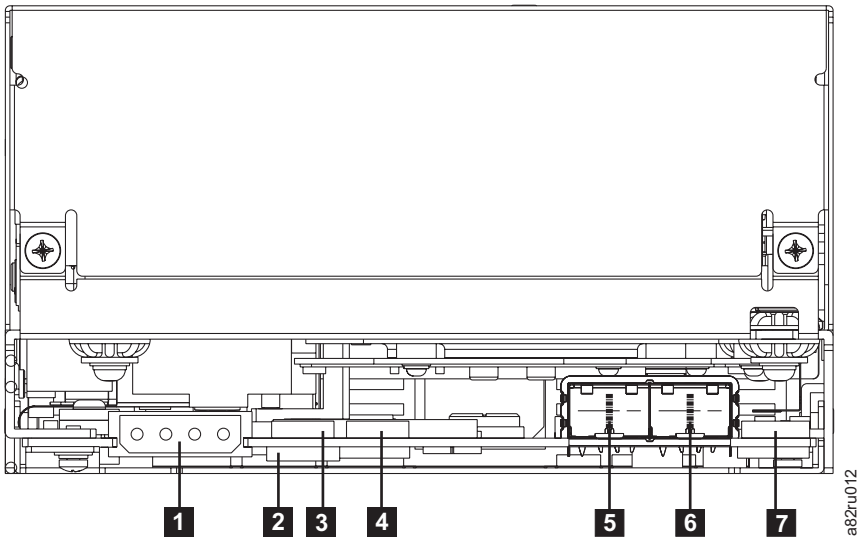

Figure 5. Rear view of the Fibre Channel drive

1	Power connector	4	Fibre Channel configuration/status connector
2	Feature switches	5&6	Fibre Channel connectors: 5) Port 0 6) Port 1, for future use
3	Loop identifier (LID) / status connector	7	Library/Drive Interface (LDI or RS-422 interface) connector

Cartridge Compatibility

The drive (Generation 3) uses the IBM TotalStorage LTO Ultrium 400 GB Data Cartridge and is compatible with the cartridges of its predecessor, the IBM Ultrium Internal Tape Drive (Generation 2). The drive performs the following functions:

- Reads and writes Generation 3 cartridges to Generation 3 format
- Reads and writes Generation 2 cartridges to Generation 2 format
- Reads Generation 1 cartridges
- Does not write Generation 3 cartridges to Generation 2 format
- Does not write Generation 2 cartridges to Generation 3 format
- Does not write Generation 1 cartridges

The drive reads tapes that have been written by other licensed Ultrium 3 drives. It also writes to tapes that can be read by other licensed Ultrium 3 drives.

In addition to using the IBM TotalStorage LTO Ultrium Data Cartridge with up to 400 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 five speeds when reading or writing the Generation 3 cartridge format to achieve a native data rate of 40, 50, 60, 70, or 80 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.

Sleep Mode

To conserve energy when circuit functions are not needed for drive operation, the drive features a power-management function that causes the drive's electronics to enter a low-power mode known as *sleep mode*. To enter sleep mode, the drive must be inactive for a minimum of 30 seconds (default value; this is programmable via the mode pages); to exit, the drive must receive a command across the SCSI or Fibre Channel interface, a command across the Library/Drive Interface (LDI or RS-422 interface), or a load or unload request. When in sleep mode, the drive's response time to commands that do not require media motion increases by up to ten microseconds. Commands that require media motion may be delayed an additional 100 milliseconds because the tape must be retensioned.

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.

Supported Servers and Operating Systems

The drive attaches to the servers and operating systems shown in Table 1. Any attachment can include (but is not limited to) these servers and operating systems. To determine the latest supported attachments, visit the web at **http://www.ibm.com/storage/lto**. For specific instructions about attaching the drive, see "Installing the Drive" on page 13.

Table 1. Supported servers and operating systems for SCSI and Fibre Channel attachment

Supported Servers	Supported Operating Systems
IBM AS/400® or @server iSeries™	OS/400®
IBM RS/6000®, RS/6000 SP, or @server pSeries®	AIX®
IBM @server zSeries® 800 or 900	Linux™
Hewlett-Packard	HP-UX
Sun Microsystems	Solaris
32-bit, Intel™-compatible servers	Microsoft Windows 2000 or Windows® 2003
	Red Hat Linux
64-bit, Intel Itanium servers	Red Hat Linux

SCSI Interface

To communicate with a server, the SCSI drive uses the Ultra160 LVD SCSI interface.

Physical Characteristics

The drive contains a high-density, 68-pin, D-shell receptacle connector (HD68) for attachment to the server. The HD68 connector includes the connectors for the SCSI signal, the SCSI ID, and the drive's power. The drive supports LVD SCSI cables with HD68 connectors.

For a list of available cables, see "Parts List" on page 109.

Speed

The Ultra160 LVD SCSI interface is compatible with older SCSI technology and is capable of data transmission at 160 MB/s. Ultra160 SCSI uses the three management features of the Ultra3 SCSI standard that specifically affect data transfer rate:

- **Double transition clocking** - a data-transfer technique that enables data rates to double without increasing clock speed
- **Domain validation** - a procedure that detects and adjusts SCSI configuration issues that might prevent interoperation between SCSI devices
- **Cyclic redundancy check (CRC)** - an error-checking technique

Because the cables, connectors, and terminators are the same for the Ultra160 and Ultra2 SCSI interfaces, devices with those interfaces can be mixed on the same bus and each device can operate at its fully rated speed.

Address Assignments

Each device on a SCSI bus must have a SCSI identifier (ID) that allows the server to recognize it. For more information, see "Set the SCSI ID or Arbitrated Loop Physical Address" on page 15.

Installing, Removing, or Resetting a Drive on an Active SCSI Bus

You can attach a drive to an active SCSI bus. However, the preferred and safest method of adding, removing, or resetting a drive is to power-off the system.

To add, remove, or reset a drive on an active SCSI bus:

1. Quiesce all drives on the SCSI bus. The drive to be added, removed, or reset must not be involved in any bus activity.
2. Disconnect power to the drive.
3. Connect (to install) or disconnect (to remove or reset) the SCSI bus cables to or from the drive's SCSI connector. Ensure that the SCSI bus remains intact from the server (initiator) to the terminator throughout the connection or disconnection process.

   Note: Changing or moving the terminator disrupts the continuity of the SCSI bus and interrupts any process on the bus.

Fibre Channel Interface

Attention: A Class I laser assembly, in the optical transceiver, is mounted on the Ultrium Fibre Channel electronics card. This laser assembly is registered with the Department of Health and Human Services and is in compliance with IEC825.

To communicate with a server, the drive has one Fibre Channel interface (also called a *port*). In accordance with the standards of the American National Standards Institute (ANSI), the port runs Fibre Channel Protocol (which includes SCSI commands on the Fibre Channel) with ANSI-defined Fibre Channel Tape Support. The method by which the drive and server communicate is determined by the type of topology in which they reside and the type of connection that you choose.

Supported Topologies

The drive can be attached in a two-node configuration, either directly to a switch as a public device (switched fabric) or directly to a host bus adapter (HBA) as a private device. It can do so in a Point-to-Point topology (through an F_port) or Arbitrated Loop topology (through an L_port or FL_port).

Unless you set the drive to force an explicit configuration (by using the FC configuration/status connector; see "Change the Link Services of the Drive (optional)" on page 21), the drive automatically configures to an L_port or an

N_port when it boots. The type of port to which it configures depends on whether the drive recognizes the connection as a loop or a point-to-point connection:

- An L_port supports a Fibre Channel Arbitrated Loop connection to an NL_port or FL_port.
- An N_port supports direct connection to another N_port or to an F_port (for example, a director-class switch) in a point-to-point topology.

Regardless of the port to which you connect the drive, it automatically configures to a public device (through an F_port or FL_port to a switch) or to a private device (through an L_port by using direct attachment to a server).

Table 2 lists the topologies in which the drive can operate, the Fibre Channel server connections that are available, and the port through which communication must occur.

Table 2. Choosing the port for your topology and Fibre Channel connection

Type of Topology	Type of Fibre Channel Connection to Server	
	Direct Connection (Private)	**Switched Fabric (Public)**
Fibre Channel-Arbitrated Loop (can be Two-Node Arbitrated Loop or Two-Node Switched Fabric Loop; is limited to two nodes)	L_Port	FL_Port
Switched fabric (two nodes)	N/A	F_Port

Physical Characteristics

The drive attaches to Open Systems servers by using short-wave, multimode fiber optic cables. All cables feature LC-duplex connectors and are designated as 50/125 (50 refers to the diameter of the optical fiber and 125 refers to the diameter of the cable; both are measured in micrometers).

For a list of available cables, see "Parts List" on page 109.

Speed

The drive's Fibre Channel interface facilitates data at 2 Gb/s (200 MB/s). It automatically negotiates to a rate of 1 Gb/s (100 MB/s) if the system or switch to which it connects does not support the 2-Gb rate (if this is the case, you may experience performance degradation). You can force the drive to an explicit speed by placing jumpers on the Fibre Channel (FC) configuration/status connector. For more information, see "Change the Link Services of the Drive (optional)" on page 21.

Address Assignments

Each device on a Fibre Channel loop must have a Loop Identifier (LID) and a corresponding Arbitrated Loop Physical Address (AL_PA) to communicate with other devices in the topology. The AL_PA identifies the device on the loop. (LIDs and their corresponding AL_PAs are listed in Table 3 on page 18 and Table 4 on page 20.) You can set an AL_PA by using one of two methods known as *soft addressing* or *hard addressing*.

Soft addressing allows the drive to dynamically arbitrate the AL_PA with other Fibre Channel devices on the loop. Hard addressing allows you to choose the LID, which determines the corresponding AL_PA. The higher the AL_PA, the lower the priority of the device.

Generally, servers (initiators) require that devices use hard addressing; they do not support soft addressing. When setting addresses, assign the lowest AL_PA (and thus the highest priority) to the server; assign the highest AL_PA (and thus the lowest priority) to the drive.

To set soft or hard addressing, you must place jumpers on designated pins in the drive's LID/status connector (see (**2** in Figure 5 on page 4). The pin configuration for soft and hard addressing is defined in "Setting the Arbitrated Loop Physical Address (Fibre Channel Drive Only)" on page 16.

World Wide Names

Each drive has an 8-byte World Wide Node Name and an 8-byte World Wide Port Name that is assigned by IBM Manufacturing. The World Wide Node Name identifies the drive's SCSI logical unit; the World Wide Port Name identifies the physical port on the drive. An enclosure queries the World Wide Names through the LDI or RS-422 interface; a server queries the Names through the Fibre Channel interface. The drive reports the World Wide Names to switches. You can use the World Wide Node Name or Wide Node Port Name to uniquely identify the drive on a SAN.

When your drive is installed in a tape library, you can change the World Wide Node Name and World Wide Port Name through the LDI or RS-422 interface. For instructions, refer to the documentation for your tape library.

Installing, Removing, or Resetting a Drive on an Active Fibre Channel

A Fibre Channel network supports dynamic drive attachment. When adding, removing, or resetting a drive on an active server or SAN, perform the following steps:

1. Quiesce the drive. The drive to be added, removed, or reset must not be involved in activity.
2. Connect or disconnect the Fibre Channel cables to or from the drive.

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/devdrvr**
  - **ftp://207.25.253.26/storage/devdrvr**

- 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/devdrvr`

IBM provides PostScript- and PDF-formatted versions of its documentation in the /storage/devdrvr/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*

Device drivers and utilities for each supported server are beneath /storage/devdrvr/ in the following directories (the device driver for the iSeries or AS/400 server is included in the OS/400 operating system):

- AIX
- HPUX
- Linux
- Solaris
- Tru64
- Win2003
- Win2000

Specifications

The sections below give the physical, power, and environmental specifications for the drive. Specifications for tape cartridges are given in "Environmental and Shipping Specifications for Tape Cartridges" on page 68.

Physical Specifications

Specification	Measurement
Width	146.0 mm (5.75 in.) without bezel
	148.3 mm (5.84 in.) with bezel
Length	205.5 mm (8.09 in.) without bezel
	210.5 mm (8.29 in.) with bezel
Height	82.5 mm (3.25 in.) without bezel
	84.8 mm (3.34 in.) with bezel
Weight (without a cartridge)	3 kg (6 lb 10 oz)

Power Specifications

Power Supply	5 V dc	12 V dc
Tolerance	10%	10%
Voltage Ripple/Noise (50 Hz - 20 MHz)	60 mV pp	125 mV pp
Minimum Supply Current (steady state)	1.3 A	0.2 A
Maximum Supply Current (steady state)	3.0 A	1.1 A
Peak Supply Current (instantaneous power by power supply)	3.3 A for 100 ms (15 W)	4.50 A for 2 ms (49.20 W)

Power Measurements	Ultra-160 SCSI drive	FC-2 Fibre Channel drive
Idle Mode (no cartridge)	10W	13W
Idle Mode (Cartridge loaded)	12W	15W
Reading and Writing (@5.46 m/s)	28W	30W

Environmental Specifications

Environmental Factor	Operating (see Note 3)	Storage	Shipping
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	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 6 on page 14).			

Other Specifications

Maximum altitude	3048 m (10,000 ft) for operating and storage
	12192 m (40,000 ft) for shipping
Extraction force	250 to 750 gms-force

Installing the Drive

Depending on the type of enclosure, installation procedures may vary. 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 the Drive" on page 14
__ 2. "Power Off the Enclosure" on page 14
__ 3. "Set the SCSI ID or Arbitrated Loop Physical Address" on page 15
__ 4. "Mount the Drive into an Enclosure" on page 23
__ 5. "Connect and Test Power to the Drive" on page 24
__ 6. "Connect the Internal SCSI or Fibre Channel Cable" on page 24
__ 7. "Connect the Internal LDI Cable (optional)" on page 24
__ 8. "Run Drive Diagnostics" on page 25
__ 9. "Install Device Drivers" on page 25
__ 10. "Connect the Enclosure's External SCSI or Fibre Channel Interface to the Server" on page 25
__ 11. "Connect the External LDI Interface to the Server (optional)" on page 26
__ 12. "Configure the Drive to the Server, Switch, or Hub" on page 26

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Unpack the Drive

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

Acclimate the Drive

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 as shown in Figure 6). 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.

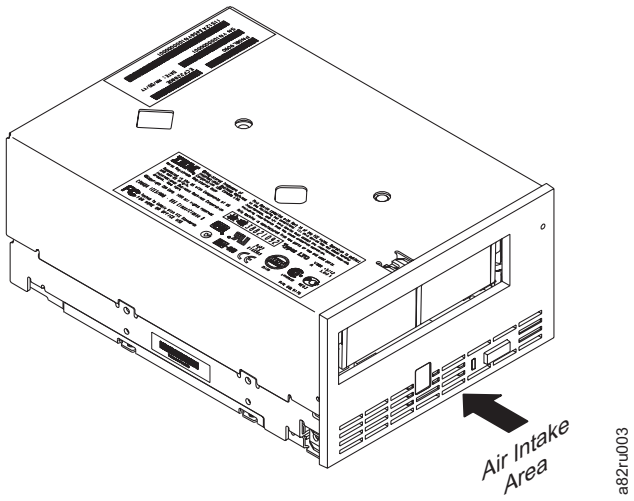


Figure 6. Temperature of the drive is taken near the air intake area

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 SCSI ID or Arbitrated Loop Physical Address

See instructions in the sections that follow to set a SCSI ID for a SCSI drive or an Arbitrated Loop Physical Address for a Fibre Channel drive.

Setting the SCSI ID (SCSI Drive Only)

You can set the SCSI ID in one of three ways:

- By placing jumpers on the SCSI ID connector
- By using a SCSI ID switch that is connected to the SCSI ID connector
- By issuing a command from the library to set the SCSI ID through the drive's LDI interface

Setting the SCSI ID with Jumpers

The SCSI ID can be set on the drive by installing 2 mm jumpers on the drive's SCSI ID connector (see **2** in Figure 4 on page 3). Your drive may come set to a default SCSI configuration, with jumpers already installed. To change the default SCSI configuration, contact your sales or technical support representative. You can change the SCSI ID by rearranging, adding, or removing jumpers.

To set the SCSI ID:

__ 1. Locate the SCSI ID connector (see **2** in Figure 4 on page 3).

__ 2. Before attaching the SCSI bus cable to the server, determine the SCSI ID. Make sure that the ID is not being used by another device.

__ 3. Referring to Figure 7, find the ID number that you chose then place jumpers on the connector pins as shown (use a pair of needle-nose pliers to connect the jumpers to the pins that are shaded).

Note: If you set the SCSI ID to 15, the drive will not necessarily be set to that ID; instead, the drive will expect to receive the SCSI ID through a command over its LDI interface.

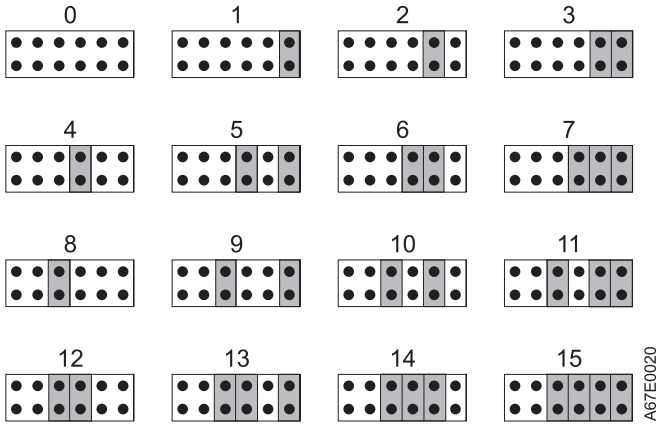


Figure 7. SCSI ID settings on the SCSI ID connector

Setting the SCSI ID with a SCSI ID Switch

If your enclosure uses a SCSI ID switch (rather than jumpers), connect the switch to the drive's SCSI ID connector (see **2** in Figure 4 on page 3). If any jumpers are preinstalled, be sure to remove them before connecting the switch. The SCSI ID

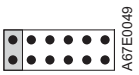
switch must be compatible with the drive's SCSI ID connector and must make an electrical connection between the same pins as the jumpers to achieve the same corresponding SCSI ID.

Setting the SCSI ID through the LDI Interface

If the drive is being installed into a tape library, a command can be issued from the library to set the drive's SCSI ID through the LDI interface. Make sure that the SCSI ID is set to 15 (see Figure 7 on page 15). When configured to accept its SCSI ID through the LDI interface, the drive does not respond to SCSI commands until it receives a SET™ CONFIGURATION command through the interface.

Supplying TERMPOWER (SCSI Drive Only)

To supply TERMPOWER to the bus, locate one of the five jumpers shipped with the drive and place it on the SCSI ID connector as shown in the following figure. Place the jumper on the pins that are shaded.



Attention
SCSI termination must be provided externally to the drive.

Setting the Arbitrated Loop Physical Address (Fibre Channel Drive Only)

Each device on a Fibre Channel loop must have an Arbitrated Loop Physical Address (AL_PA) to communicate. The AL_PA identifies the device on the loop. To set the drive's AL_PA, you must place jumpers on specific pins in the drive's loop identifier (LID)/status connector. The placement of the jumpers indicates whether you want to choose the LID yourself (each LID corresponds to a specific AL_PA) or whether you want the drive to choose the AL_PA by arbitrating it with other devices on the loop. Valid LIDs and their corresponding AL_PAs are provided in this section.

Note: A Loop ID is part of a contiguous range of values; valid AL_PA values are not in a contiguous range.

In addition to establishing the AL_PA, by moving Feature Switch 3 on the drive to ON or off you can set the drive so that it provides one of the following functions:

- Status about the Fibre Channel loop (through the use of external indicators in an enclosure)
- Additional LIDs

The sections that follow describe how to select the AL_PA. They also describe how to set Feature Switch 3 so that the drive gives status about the loop or provides additional LIDs.

Setting the Loop ID to Provide Status About the Loop

If Feature Switch 3 on the drive is set to OFF (see **1** in Figure 8 on page 17), the LID/status connector **2** has the following definition:

- Pins 1, 2, 3, 4, 7, and 8 are inputs and are used to set the LID.
- Pins 5 and 6 are used as outputs:

– Pin 5 has three states: *off* (ground), *on* (3.3 V), and *alternating* (between off and on). Pin 5 will be off if the drive does not detect light on the Fibre Channel connector, if (while communicating as an L_port) the drive does not complete the Loop Initialization Protocol (LIP), or if (while communicating as an N_port) the drive does not complete logging in to the host or switch. Pin 5 will be on if the drive detects light, successfully completes the LIP process, or logs in to another port. After the drive has completed the LIP process, the pin will be alternating when the drive is receiving SCSI commands, and the pin will be on when the drive is not receiving SCSI commands.
– Pin 6 indicates that the drive detects light. If pin 6 is on but pin 5 is off, this could indicate communication problems across the fiber cable.
– If the drive is installed in an enclosure, pins 5 and 6 may be used to support external indicators, such as light-emitting diodes (LEDs), on the enclosure.

Note: If indicators are used on an enclosure, the drive does not report error codes 8 and F (Fibre Channel problems) to the single-character display. Instead, pins 5 and 6 signal to the indicators that there is a problem.

- Pin 9 is ground.

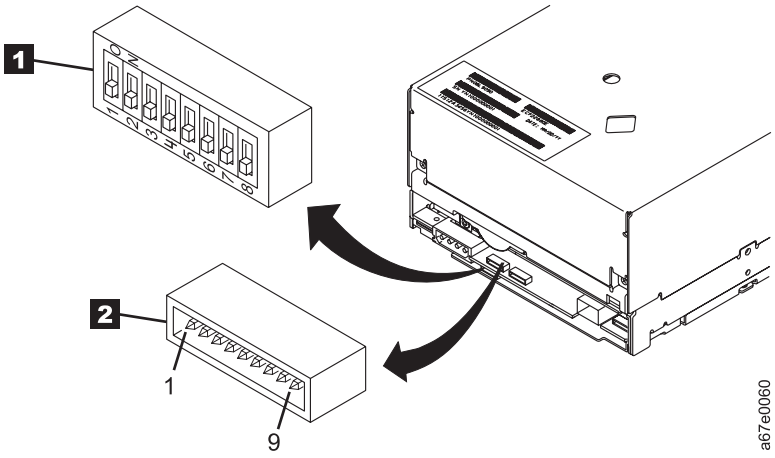


Figure 8. Setting the Loop ID and the AL_PA. The feature switches are located on the bottom of the drive.

To set the AL_PA:

__ 1. Determine an unused AL_PA for the drive and refer to Table 3 on page 18 for its corresponding LID.
__ 2. Locate the LID/status connector on the drive (see **2** in Figure 8).
__ 3. Place jumpers on pins 1, 2, 3, 4, 7, and 8 as shown in Table 3 on page 18.

By using hard addressing, you can specify one of 62 valid AL_PAs for the drive. If you place jumpers on the four top and bottom pins on the right (a total of eight pins), the drive gets the AL_PA from a field in its vital product data (VPD). (A tape library can set the AL_PA in the VPD through the LDI interface.) If you do not place jumpers on any pins, the drive uses soft addressing to determine the AL_PA.

Table 3. ID Settings that provide status about the loop. The table lists the AL_PAs, corresponding LIDs, and definitions of the jumpers on the connector pins. Feature Switch 3 must be set to OFF.

AL_PA	LID	Pin (see Notes)						AL_PA	LID	Pin (see Notes)					
		1	2	3	4	7	8			1	2	3	4	7	8
use soft addressing	0	-	-	-	-	-	-	B2	20	G	-	-	-	-	-
E8	1	-	-	-	-	-	G	B1	21	G	-	-	-	-	G
E4	2	-	-	-	-	G	-	AE	22	G	-	-	-	G	-
E2	3	-	-	-	-	G	G	AD	23	G	-	-	-	G	G
E1	4	-	-	-	G	-	-	AC	24	G	-	-	G	-	-
E0	5	-	-	-	G	-	G	AB	25	G	-	-	G	-	G
DC	6	-	-	-	G	G	-	AA	26	G	-	-	G	G	-
DA	7	-	-	-	G	G	G	A9	27	G	-	-	G	G	G
D9	8	-	-	G	-	-	-	A7	28	G	-	G	-	-	-
D6	9	-	-	G	-	-	G	A6	29	G	-	G	-	-	G
D5	A	-	-	G	-	G	-	A5	2A	G	-	G	-	G	-
D4	B	-	-	G	-	G	G	A3	2B	G	-	G	-	G	G
D3	C	-	-	G	G	-	-	9F	2C	G	-	G	G	-	-
D2	D	-	-	G	G	-	G	9E	2D	G	-	G	G	-	G
D1	E	-	-	G	G	G	-	9D	2E	G	-	G	G	G	-
CE	F	-	-	G	G	G	G	9B	2F	G	-	G	G	G	G
CD	10	-	G	-	-	-	-	98	30	G	G	-	-	-	-
CC	11	-	G	-	-	-	G	97	31	G	G	-	-	-	G
CB	12	-	G	-	-	G	-	90	32	G	G	-	-	G	-
CA	13	-	G	-	-	G	G	8F	33	G	G	-	-	G	G
C9	14	-	G	-	G	-	-	88	34	G	G	-	G	-	-
C7	15	-	G	-	G	-	G	84	35	G	G	-	G	-	G
C6	16	-	G	-	G	G	-	82	36	G	G	-	G	G	-
C5	17	-	G	-	G	G	G	81	37	G	G	-	G	G	G
C3	18	-	G	G	-	-	-	80	38	G	G	G	-	-	-
BC	19	-	G	G	-	-	G	7C	39	G	G	G	-	-	G
BA	1A	-	G	G	-	G	-	7A	3A	G	G	G	-	G	-
B9	1B	-	G	G	-	G	G	79	3B	G	G	G	-	G	G
B6	1C	-	G	G	G	-	-	76	3C	G	G	G	G	-	-
B5	1D	-	G	G	G	-	G	75	3D	G	G	G	G	-	G
B4	1E	-	G	G	G	G	-	74	3E	G	G	G	G	G	-
B3	1F	-	G	G	G	G	G	use AL_PA from VPD	3F	G	G	G	G	G	G

Notes:

1. G means that the pin is jumpered to ground.
2. - means that the pin is not jumpered.

Setting the Loop ID to Provide Additional Loop IDs

If Feature Switch 3 on the drive is set to ON (see **1** in Figure 8 on page 17), the LID/status connector **2** has the following definition:

- Pins 1 through 7 are used to set the LID.
- Pin 8 overrides pins 1 through 7. If you place a jumper on pin 8, the drive uses its vital product data (VPD) to set the AL_PA. A tape library can set the AL_PA in VPD through the LDI interface.
- Pin 9 is ground.

Note: Feature Switch 3 does not support LEDs on an enclosure. Therefore, when Feature Switch 3 is set to ON, the drive can report Fibre Channel problems (error codes 8 and F) on the single-character display, but not by using the enclosure's external indicators.

To set the AL_PA:

__ 1. Determine an unused AL_PA address for the drive and refer to Table 4 on page 20 for its corresponding LID.
__ 2. Locate the LID/status connector on the drive (see **2** in Figure 8 on page 17).
__ 3. Place jumpers on pins 1 through 7 as shown in Table 4 on page 20 or on pin 8.

Table 4. ID settings that provide additional Loop IDs. The table lists the AL_PAs, corresponding LIDs, and definitions of the jumpers on the connector pins. Feature Switch 3 must be set to ON.

AL_PA	LID	Pin (see Notes)							AL_PA	LID	Pin (see Notes)						
		1	2	3	4	5	6	7			1	2	3	4	5	6	7
EF	0	-	-	-	-	-	-	-	B1	21	-	G	-	-	-	-	G
E8	1	-	-	-	-	-	-	G	AE	22	-	G	-	-	-	G	-
E4	2	-	-	-	-	-	G	-	AD	23	-	G	-	-	-	G	G
E2	3	-	-	-	-	-	G	G	AC	24	-	G	-	-	G	-	-
E1	4	-	-	-	-	G	-	-	AB	25	-	G	-	-	G	-	G
E0	5	-	-	-	-	G	-	G	AA	26	-	G	-	-	G	G	-
DC	6	-	-	-	-	G	G	-	A9	27	-	G	-	-	G	G	G
DA	7	-	-	-	-	G	G	G	A7	28	-	G	-	G	-	-	-
D9	8	-	-	-	G	-	-	-	A6	29	-	G	-	G	-	-	G
D6	9	-	-	-	G	-	-	G	A5	2A	-	G	-	G	-	G	-
D5	A	-	-	-	G	-	G	-	A3	2B	-	G	-	G	-	G	G
D4	B	-	-	-	G	-	G	G	9F	2C	-	G	-	G	G	-	-
D3	C	-	-	-	G	G	-	-	9E	2D	-	G	-	G	G	-	G
D2	D	-	-	-	G	G	-	G	9D	2E	-	G	-	G	G	G	-
D1	E	-	-	-	G	G	G	-	9B	2F	-	G	-	G	G	G	G
CE	F	-	-	-	G	G	G	G	98	30	-	G	G	-	-	-	-
CD	10	-	-	G	-	-	-	-	97	31	-	G	G	-	-	-	G
CC	11	-	-	G	-	-	-	G	90	32	-	G	G	-	-	G	-
CB	12	-	-	G	-	-	G	-	8F	33	-	G	G	-	-	G	G
CA	13	-	-	G	-	-	G	G	88	34	-	G	G	-	G	-	-
C9	14	-	-	G	-	G	-	-	84	35	-	G	G	-	G	-	G
C7	15	-	-	G	-	G	-	G	82	36	-	G	G	-	G	G	-
C6	16	-	-	G	-	G	G	-	81	37	-	G	G	-	G	G	G
C5	17	-	-	G	-	G	G	G	80	38	-	G	G	G	-	-	-
C3	18	-	-	G	G	-	-	-	7C	39	-	G	G	G	-	-	G
BC	19	-	-	G	G	-	-	G	7A	3A	-	G	G	G	-	G	-
BA	1A	-	-	G	G	-	G	-	79	3B	-	G	G	G	-	G	G
B9	1B	-	-	G	G	-	G	G	76	3C	-	G	G	G	G	-	-
B6	1C	-	-	G	G	G	-	-	75	3D	-	G	G	G	G	-	G
B5	1D	-	-	G	G	G	-	G	74	3E	-	G	G	G	G	G	-
B4	1E	-	-	G	G	G	G	-	73	3F	-	G	G	G	G	G	G
B3	1F	-	-	G	G	G	G	G	72	40	G	-	-	-	-	-	-
B2	20	-	G	-	-	-	-	-	71	41	G	-	-	-	-	-	G
6E	42	G	-	-	-	-	G	-	39	61	G	G	-	-	-	-	G
6D	43	G	-	-	-	-	G	G	36	62	G	G	-	-	-	G	-
6C	44	G	-	-	-	-	G	-	35	63	G	G	-	-	-	G	G
6B	45	G	-	-	-	G	-	G	34	64	G	G	-	-	G	-	-
6A	46	G	-	-	-	G	G	-	33	65	G	G	-	-	G	-	G
69	47	G	-	-	-	G	G	G	32	66	G	G	-	-	G	G	-
67	48	G	-	-	G	-	-	-	31	67	G	G	-	-	G	G	G
66	49	G	-	-	G	-	-	G	2E	68	G	G	-	G	-	-	-
65	4A	G	-	-	G	-	G	-	2D	69	G	G	-	G	-	-	G

Table 4. ID settings that provide additional Loop IDs (continued). The table lists the AL_PAs, corresponding LIDs, and definitions of the jumpers on the connector pins. Feature Switch 3 must be set to ON.

AL_PA	LID	Pin (see Notes)						
		1	2	3	4	5	6	7
63	4B	G	-	-	G	-	G	G
5C	4C	G	-	-	G	G	-	-
5A	4D	G	-	-	G	G	-	G
59	4E	G	-	-	G	G	G	-
56	4F	G	-	-	G	G	G	G
55	50	G	-	G	-	-	-	-
54	51	G	-	G	-	-	-	G
53	52	G	-	G	-	-	G	-
52	53	G	-	G	-	-	G	G
51	54	G	-	G	-	G	-	-
4E	55	G	-	G	-	G	-	G
4D	56	G	-	G	-	G	G	-
4C	57	G	-	G	-	G	G	G
4B	58	G	-	G	G	-	-	-
4A	59	G	-	G	G	-	-	G
49	5A	G	-	G	G	-	G	-
47	5B	G	-	G	G	-	G	G
46	5C	G	-	G	G	G	-	-
45	5D	G	-	G	G	G	-	G
43	5E	G	-	G	G	G	G	-
3C	5F	G	-	G	G	G	G	G
3A	60	G	G	-	-	-	-	-

AL_PA	LID	Pin (see Notes)						
		1	2	3	4	5	6	7
2C	6A	G	G	-	G	-	G	-
2B	6B	G	G	-	G	-	G	G
2A	6C	G	G	-	G	G	-	-
29	6D	G	G	-	G	G	-	G
27	6E	G	G	-	G	G	G	-
26	6F	G	G	-	G	G	G	G
25	70	G	G	G	-	-	-	-
23	71	G	G	G	-	-	-	G
1F	72	G	G	G	-	-	G	-
1E	73	G	G	G	-	-	G	G
1D	74	G	G	G	-	G	-	-
1B	75	G	G	G	-	G	-	G
18	76	G	G	G	-	G	G	-
17	77	G	G	G	-	G	G	G
10	78	G	G	G	G	-	-	-
0F	79	G	G	G	G	-	-	G
08	7A	G	G	G	G	-	G	-
04	7B	G	G	G	G	-	G	G
02	7C	G	G	G	G	G	-	-
01	7D	G	G	G	G	G	-	G
SA	7E	G	G	G	G	G	G	-
SA	7F	G	G	G	G	G	G	G

Notes:

1. G means that the pin is jumpered to ground.
2. - means that the pin is not jumpered.
3. SA means soft addressing.

Change the Link Services of the Drive (optional)

You can optionally change the link services (for example, the speed and type of topology) of your Fibre Channel drive. If you choose not to alter the link services, the drive defaults to a negotiated speed and operation in an FC-AL topology with a direct connection to the server.

In the following procedure, note that:

- Pin 5 is disconnected and is not represented in Table 5 on page 22.
- Pin 9 is ground.

To change the type of topology and the speed of the Fibre Channel drive:

__ 1. Determine the type of topology in which you want to operate the drive and refer to Table 5 on page 22 for its corresponding pin configuration.
__ 2. Determine the speed at which you want the drive to operate and refer to Table 5 on page 22 for its corresponding pin configuration.
__ 3. Locate the Fibre Channel (FC) configuration/status connector on the drive (see **1** in Figure 9 on page 22).

__ 4. Place jumpers on the pins that you identified in steps 1 on page 21 and 2 on page 21.

Table 5. Topology and speed settings for the drive

Fibre Channel Characteristic	Pin				
	1	**2**	**3**	**4**	**5 through 8**
Speed Selection					
Drive uses VPD values that can be updated by the LDI or RS-422 (the default value is Negotiated)	-	-	X	X	X
2 Gb (200 MB/s)	-	G	X	X	X
1 Gb (100 MB/s)	G	-	X	X	X
Negotiated (the drive automatically negotiates to the highest common speed)	G	G	X	X	X
Topology Selection					
Drive uses VPD values that can be updated by the LDI or RS-422 (the default value is the NL_port)	X	X	-	-	X
L_Port	X	X	-	G	X
N_Port	X	X	G	-	X
NL_Port (the drive automatically selects and configures the topology)	X	X	G	G	X

Notes:

1. G means that the pin is jumpered to ground.
2. - means that the pin is not jumpered.
3. X means that the setting of the pin does not matter.

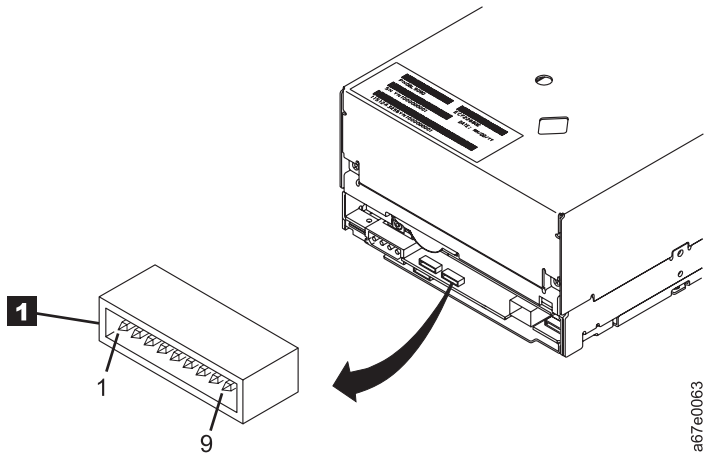


Figure 9. Location of the Fibre Channel (FC) configuration/status connector. The view is from the rear of the drive.

Mount the Drive into an Enclosure

The drive may be shipped with or without a front bezel (see **1** in Figure 10).

When mounting the drive:

- 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 M3 screws into the mounting holes **2** of the two 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 3.5 mm (0.14 in.) inside the chassis. If the length exceeds this measurement, the drive may become damaged.

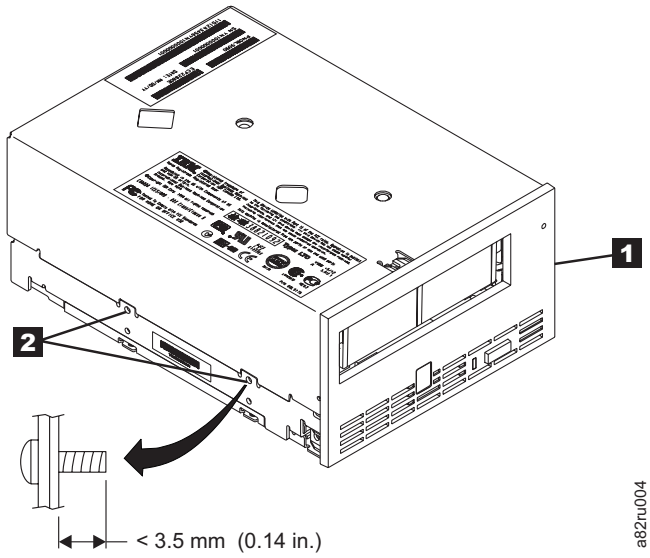


Figure 10. Mounting holes on drive. The holes are located on both sides of the drive. The drive is shown with a front bezel.

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 **3** in Figure 4 on page 3).

__ 4. Connect the power cord to the enclosure and to the electrical outlet.

__ 5. Review the location of the Single-character Display (SCD) and the Status Light in Figure 3 on page 2 (if your drive does not have a bezel, note that the bulb of the Status Light is recessed and the light is not visible until lit). To ensure that the drive is receiving power, watch for the following while turning on the power to the enclosure:

- The SCD presents a series of random characters, then becomes blank (not lit).

> **Attention**
> If the SCD does not come on, the drive may not be getting power.

- The Status Light briefly becomes solid amber, then becomes solid green.

__ 6. Power-off the enclosure.

__ 7. Disconnect the power cord from both the enclosure and the electrical outlet.

Connect the Internal SCSI or Fibre Channel Cable

Connect the enclosure's internal SCSI cable to the SCSI connector on the drive (see **1** in Figure 4 on page 3).

If you are using a Fibre Channel drive, connect the enclosure's internal Fibre Channel cable to the Fibre Channel connector on the drive (see **5** in Figure 5 on page 4).

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 **4** in "Rear Panel of the SCSI Drive" on page 3 or **6** in Figure 5 on page 4).

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 one or more of the following drive diagnostics:
- "Function Code 1: Run Drive Diagnostics" on page 33
- "Function Code 6: Run SCSI Wrap Test" on page 37).
- "Function Code 7: Run RS-422 Wrap Test" on page 38

If an error code appears on the single-character display (SCD), go to Table 15 on page 75. If no error appears, continue to the next step.

__ 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 SCSI or Fibre Channel Interface to the Server

Follow the instructions in the sections that follow to connect the drive to a server.

Connect the External SCSI Interface to the Server

To connect the enclosure to the SCSI bus:

__ 1. Connect an external SCSI bus 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 SCSI attachment verification procedure from your server (for instructions, refer to the *IBM Ultrium Device Drivers Installation and User's Guide*). If a SCSI error occurs, refer to "Using Sense Data" on page 79.

If you want to power a device on or off while it is connected to the same SCSI 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 Fibre Channel Interface to the Server

To connect the enclosure to the Fibre Channel interface:

__ 1. Connect an external fiber cable to both the enclosure and the appropriate attachment (server, switch, or hub). For the location of the connectors and for information about attaching the fiber cable, refer to the documentation for your enclosure and for your server, switch, or hub.

Note: A drive with a Fibre Channel interface can be ordered with several lengths of fiber cabling, up to 61 m (200 ft). For ordering information, see Table 16 on page 109.

__ 2. Run the appropriate Fibre Channel attachment verification procedure from your server (for instructions, refer to the *IBM Ultrium Device Drivers Installation and User's Guide*). If a SCSI error occurs, refer to "Using Sense Data" on page 79.

Connect the External LDI Interface to the Server (optional)

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

To perform a checkout of 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, Switch, or Hub

To configure the SCSI drive to the server, or to configure the Fibre Channel drive to a server, switch, or hub, refer to the documentation for that server, switch, or hub.

The drive is now ready for use.

Operating the Drive

Operating the drive involves using the following front panel items:

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

Single-character Display (SCD)

The SCD (**3** in "Front Panel of the Drive" on page 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 75 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 32 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 36.

The SCD Dot turns off when you obtain the dump (by using an FMR tape, a SCSI command, or a library command).

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Status Light

The Status Light (**1** in Figure 3 on page 2) is a light-emitting diode (LED) that provides information about the state of the drive. The light can be green or amber, and (when lit) solid or flashing. Table 6 lists the conditions of the Status Light and Single-character Display (SCD) and provides an explanation of what each condition means.

Table 6. Meaning of Status Light and Single-character Display (SCD)

If the Status Light is...	and the SCD is...	Meaning
Off	Off	The drive has no power or is powered off.
Green	Off	The drive is powered on and in an idle state.
Flashing Green	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	Off	The drive contains a cartridge during the power-on cycle. In this case, the drive completes POST and slowly rewinds the tape (the process may take up to ten minutes). The light stops blinking and becomes solid when the drive completes the recovery and is ready for a read or write operation. To eject the cartridge, press the unload button.
Amber	Displaying Error Code	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 39 and "Error Codes and Messages" on page 75.
Amber	Red numbers, letters, or segments	The drive is powering on, resetting, or in maintenance mode.
Amber	Flashing 	The drive is exiting from maintenance mode. For more information, see "Function Code 0: Exit Maintenance Mode" on page 32.
Amber	Flashing selected function	The drive is executing the selected function while in maintenance mode.
Flashing Amber once per second	Displaying error code	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 Table 15 on page 75 to determine the action that is required.
Flashing Amber once per second	Displaying 	The drive needs cleaning.
Flashing Amber twice per second	Displaying Function Code  or Off	The drive is updating firmware.[1] 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 46.
Flashing Amber twice per second	Off	The drive detected an error and is performing a firmware recovery. It will reset automatically.
Flashing Amber twice per second	Flashing 	The drive is requesting a cartridge to be loaded.

Table 6. Meaning of Status Light and Single-character Display (SCD) (continued)

If the Status Light is...	and the SCD is...	Meaning
Flashing Amber twice per second	Off	There is a drive dump in flash memory.
[1] 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 (**2** in Figure 3 on page 2) performs the following functions:

Table 7. 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 Status Light flashes green while the drive is rewinding and unloading. **Note:** 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 Status Light becomes solid amber and appears in the SCD. **Note:** While in maintenance mode, the drive does not accept SCSI interface commands.
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 32), 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 Status Light becomes solid green and the SCD becomes blank.
Force a drive dump (part of the maintenance mode)	**Attention:** 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: • If the drive is in maintenance mode (Status Light is solid amber), refer to "Function Code 4: Force a Drive Dump" on page 35. • If the drive is in operating mode (Status Light is solid or flashing green), press and hold the Unload Button for ten seconds. If captured dump data exists, the drive places it into a dump area (for information about retrieving the data, see "Obtaining a Drive Dump" on page 84).
Reset the drive	Press and hold the Unload Button on the drive for ten seconds. 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 is properly set (see "Write-Protect Switch" on page 55).
3. Grasp the cartridge so that the write-protect switch faces you (see **1** in Figure 11).
4. Slide the cartridge into the tape load compartment.

   Notes:

   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.

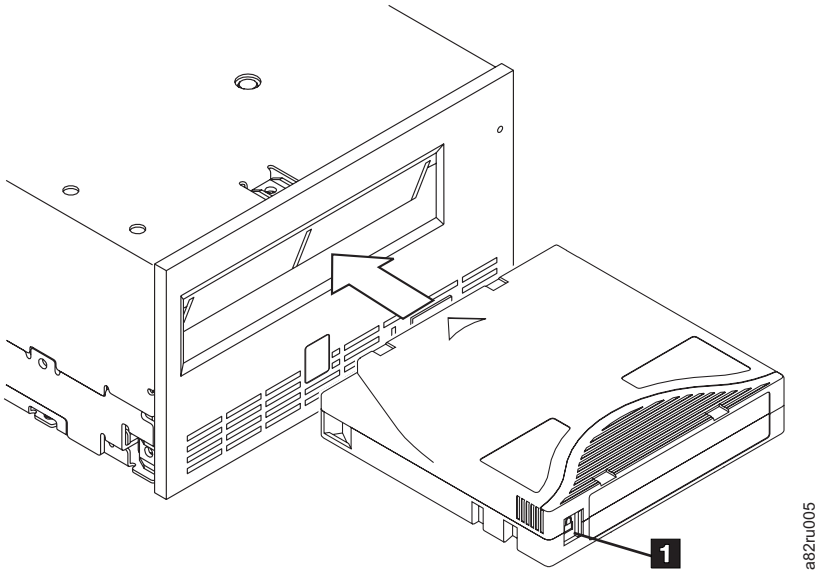

Figure 11. Inserting a cartridge into the drive

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 Status 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.

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

Mid-tape Recovery

If a power cycle or reset occurs while a cartridge is loaded, the drive will slowly rewind the tape and eject the cartridge.

Cleaning the Drive Head

Attention
When cleaning the drive head, use the IBM TotalStorage LTO Ultrium Cleaning Cartridge (part number 35L2087). 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 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.

To clean the head, insert the cleaning cartridge into the tape load compartment (see "Front Panel of the Drive" on page 2). The drive performs the cleaning automatically in less than two minutes then ejects the cartridge.

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

The IBM TotalStorage 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 its own 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. The tape drive does accept LDI or RS-422 commands.

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 Status 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.

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.

Function Code 0: Exit Maintenance Mode

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

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode."
2. Press and hold the Unload Button for 3 or more seconds to take the drive out of maintenance mode. The Status Light turns off.

   - If no error is detected,  temporarily appears in the SCD, then goes blank. The drive then exits maintenance mode.
   - If an error is detected, the SCD shows an error code but still exits maintenance mode. To determine the error, locate the code in Table 15 on page 75. To clear the error, turn the power off, then on again.

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

Function Code 1: Run Drive Diagnostics

Approximate Run Time = 20 minutes per loop

Total Number of Loops = 10

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

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

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.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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  . The SCD changes to a flashing  .
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  and the test begins.

   Note: If you inserted an invalid or write-protected tape cartridge, error code  appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.

   - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends,  temporarily appears in the SCD. The drive rewinds and unloads the cartridge, and then exits maintenance mode. The solid amber Status Light turns off.
   - If an error is detected, the Status Light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in Table 15 on page 75. The tape drive unloads the tape cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

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.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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 (or the tape drive exits maintenance mode). The SCD changes to a flashing  . 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 Table 15 on page 75. The drive then unloads the FMR tape and exits maintenance mode. Contact IBM Technical Support for problem determination or machine replacement.

Function Code 3: Create FMR Tape

Function Code  copies the drive's field microcode replacement (FMR) data to a scratch 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.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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 that is not write protected (or the tape drive exits maintenance mode). The SCD changes to a flashing  . The tape drive copies the FMR data to the scratch data cartridge.

   Note: If you inserted an invalid or write-protected tape cartridge, error code  appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.

   - 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 Table 15 on page 75. The tape drive then unloads the FMR tape, exits maintenance mode.

Function Code 4: Force a Drive Dump

Function Code  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 32.
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 drive performs the dump. The SCD shows  , then goes blank. To access the contents of the dump, see "Function Code 5: Copy Drive Dump" on page 36.

   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.

Function Code 5: Copy Drive Dump

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

Attention

For the  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.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
2. Press the Unload Button once per second to cycle through the following functions:
   -  : no function
   -  : copy dump to tape
   -  : copy dump to flash memory
   -  : erase flash memory

   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. The SCD changes to a flashing  .
4. Insert a scratch (blank) data cartridge that is not write protected (or the tape drive exits maintenance mode). The SCD flashes the selection number while performing the function.

   Note: If you inserted an invalid or write-protected tape cartridge, error code  appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.
   - If the copy operation completes successfully, the tape drive rewinds and unloads the tape, and exits maintenance mode.
   - If the copy operation fails, an error code appears in the SCD. To determine the error, locate the code in Table 15 on page 75. The tape drive unloads the tape cartridge and exits maintenance mode.

Function Code 6: Run SCSI Wrap Test

Approximate Run Time = 10 seconds per loop

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

Function Code  performs a check of the SCSI circuitry from and to the SCSI connector.

Note: This test requires that the drive be terminated by either the terminator on the connector or at the end of the bus. Before you select this function, disconnect the SCSI cable of the drive that is closest to the server. Then, attach the SCSI wrap plug to that SCSI connector.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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. Make sure that the SCSI wrap plug is connected to one of the SCSI connectors at the rear of the drive.
4. Make sure that the drive is terminated at one of its SCSI connectors or at the SCSI bus.
5. Press and hold the Unload Button for three or more seconds, then release it to select the function. The drive automatically starts the test (one loop of which lasts for less than one second).
   - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, function code  temporarily appears in the Single-character Display. The drive then exits maintenance mode. Disconnect the SCSI wrap plug.
   - If an error is detected, the test stops, error code  appears in the SCD. To determine the error, locate  in Table 15 on page 75. To clear the error, turn the power off, then on again.

Function Code 7: Run RS-422 Wrap Test

This test causes the drive to perform a check of the circuitry from and to the LDI or RS-422 connector.

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.
2. Within a 1.5-second interval, press the Unload Button three times. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per 1.5 seconds until  appears in the Single-character Display (SCD). If you cycle past  , 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,  flashes and the drive automatically starts the test.

   - If the test is successful, it loops and begins again. To half the test, press the Unload Button. The test continues to the end of its loop and then stops. The drive then displays  and exits maintenance mode.
   - If the test fails,  displays, the test stops, and the drive exits maintenance mode. To resolve the error, locate  in Table 15 on page 75

Function Code 8: Unmake FMR Tape

Function Code  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 32.
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  . The SCD changes to a flashing  .
4. Insert the FMR data cartridge (or the tape drive exits maintenance mode). The SCD changes to a flashing  . 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:

   - If the operation is successful, the tape drive displays function code  , rewinds and unloads the newly converted scratch data cartridge, and exits maintenance mode.
   - If the operation is not successful, an error code displays. To determine the error, locate the code in Table 15 on page 75. To clear the error, turn the power off, then on again.

Function Code 9: Display Error Code Log

Function Code 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 displays in the Single-character Display (SCD).

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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 view the most recent error codes.
4. Press the Unload Button again to view successive error codes. Let two to three seconds pass between each depression.
5. After viewing all error codes, exit this function and maintenance mode by pressing the Unload Button again.

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 32.
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. The tape drive 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.

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

Attention

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

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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. Ensure that the write-protect switch on the suspect cartridge is off, then insert the cartridge (or the tape drive exits maintenance mode). The SCD changes to  . The tape drive runs the tests.
   - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends,  temporarily appears in the SCD. The drive rewinds the tape, unloads the cartridge, and exits maintenance mode.
   - If an error is detected the test stops,  or  appears in the SCD (another code could appear). To determine the error, locate  or  in Table 15 on page 75. The drive unloads the tape cartridge, exits maintenance mode. To clear the error, turn the power off, then on again.

Function Code F: Write Performance Test

Approximate Run Time = 5 minutes

Total Number of Loops = 10

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

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

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.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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 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 F. The tape drive runs the tests.

   Note: If you inserted an invalid or write-protected tape cartridge, 7 appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.

   - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, 0 temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.
   - If the write performance is degraded less than 94%, the Status Light flashes amber, the tape drive posts an error code to the SCD. To determine the error, locate the code in Table 15 on page 75. The tape drive unloads the cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

Function Code H: Test Head

Approximate Run Time = 10 minutes

Total Number of Loops = 10

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

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

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.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
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 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 H. The tape drive runs the tests.
   - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, 0 temporarily appears in the SCD. The drive rewinds the tape and unloads the cartridge. The drive then exits maintenance mode.
   - If an error is detected the test stops, error code S appears in the SCD. To determine the error, locate S in Table 15 on page 75. The drive unloads the tape cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

Function Code J: Fast Read/Write Test

Approximate Run Time = 5 minutes

Total Number of Loops = 10

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

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

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.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
2. Press the Unload Button once per second until J 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 J. The tape drive runs the tests.

   Note: If you inserted an invalid or write-protected tape cartridge, 7 appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.

   - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, 0 temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.
   - If an error is detected, the Status Light flashes amber, the tape drive posts an error code to the SCD. To determine the error, locate the code in Table 15 on page 75. The tape drive unloads the cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

Function Code L: Load/Unload Test

Approximate Run Time = 15 seconds per loop

Total Number of Loops = 10

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

The diagnostic loops ten times. To stop the diagnostic and exit maintenance mode, press the Unload Button once to abort the test.

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 32.
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 that is not write-protected (or the tape drive exits maintenance mode). The SCD changes to a flashing  . The tape drive runs the tests.
   - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends,  temporarily appears in the SCD. The drive rewinds the tape and unloads the cartridge. The drive then exits maintenance mode.
   - If an error is detected the test stops,  appears in the SCD. To determine the error, locate  in Table 15 on page 75. The drive unloads the tape cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

Function Code P: Enable Post Error Reporting

When selected, deferred-check conditions are reported to the host. Therefore, temporary errors are reported in the sense data. This selection is normally used as a request from support personnel. Default is  (disabled).

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
2. Press and hold the Unload Button for three seconds while  appears in the SCD. The SCD changes to  then exits maintenance mode.

Function Code U: Disable Post Error Reporting

When selected, turns Post Error reporting off. Deferred-check conditions (temporary errors) are NOT reported to Host (normal mode of drive operation).

Default is  (disabled).

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 32.
2. Press and hold the Unload Button for three seconds while  appears in the SCD. The SCD changes to  then exits maintenance mode.

Updating Firmware

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

Periodically check for updated levels of drive firmware by visiting the web at **http://www.ibm.com/storage/lto**. Update drive firmware using:

- The SCSI interface
- The LDI or RS-422 interface
- The ITDT tool
- The LTO-TDX 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 SCSI or Fibre Channel Interface

Attention
SCSI drives and Fibre Channel drives require different firmware images.

When updating drive firmware by using the SCSI or Fibre Channel 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 Ultrium 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.

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 update typically takes 63 seconds and a maximum of 140 seconds. The command may be received by the SCSI interface or the LDI (RS-422) interface.

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 SCSI Firmware Update, Dump Retrieval and Library/Drive Test Tool

Attention

At the time of publication, the ITDT tool was not available. Register with MySupport (**http://www.ibm.com/support/mySupport**) to be notified by email when the tool becomes available, or periodically check the IBM support site (**http://www.ibm.com/storage/lto**) .

A newly designed tool, ITDT, is a tool with multiple functional capability and is a very quick, convenient and efficient method for both drive and library firmware updates. As a note, both drive and library dump retrievals can be performed by the tool as well. Currently, the tool is very similar to the LTO-TDX drive only firmware update and drive dump retrieval tool (explained in detail later on in the Tape Drive Update firmware paragraph in this section).

Below are some of the capabilities of this tool:

- Firmware update capability via SCSI to all IBM LTO Tape Drive and Tape Library products.
- The tool does not require any special device drivers.
- The tool is available for most major platforms (Windows, AIX, SUN, Linux, NetWare).
- The tool is capable of uploading drive and library 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 SCSI 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.
- 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.

In the following firmware update sections which explain each method in detail, only a brief mention of ITDT will be made since the Readme text file will more fully explain tool usage.

LTO-TDX: LTO SCSI and Fibre Drive Firmware Download & LTO Drive Dump Upload Tool

The tool, LTO-TDX, is an alternative method for downloading LTO drive firmware across the SCSI bus or fibre channel. In addition, this tool can be used to upload LTO drive error dumps. The following information describes how to obtain the tool and lists its capabilities.

- The tool supports all IBM LTO Generation 1, Generation 2, and Generation 3 SCSI and FC drives. The tool will not support any other manufacturer's LTO drive. The tool is available for three different operating systems:

  - **LTO-TDX_WinTool** (for Windows operating systems)
  - **LTO-TDX_NWTool** (for Netware operating systems)
  - **LTO-TDX_LxTool** (for Linux operating systems)
- The tool can perform two functions:
  1. Download firmware to the drive
  2. Upload a dump of the drive firmware logs from the drive to a computer system
- The tool is distributed from the IBM web site. Download the tool by visiting **http://www.ibm.com/storage/support/lto/**. The install package or an executable file will be placed on the host system in a location chosen by the user.
- When the user opens the install package, he will be presented with a license agreement that he must accept to proceed with the install. The user will also be presented with a license anytime the executable file is copied to another location where the firmware or dump folders do not exist. The tool will detect the missing folders at launch and present the user license, assuming that this is the first launch of a new copy of the tool. There will also be a function that allows the user to view the license at will when he starts the tool.
- The Windows install package will create a directory for the tool on the user's hard disk and place the executable file (the tool) in that directory. The install package will also load the file into the Programs Menu accessed via the ″Start″ button and put an icon on the desktop of the Windows operating system. The install package will perform a similar function on any other operating system that has a similar structure.
- Selection of the icon on the desktop or selection of the tool from the Program Menu will start the tool and create the ″LTO Firmware″ and ″LTO Dumps″ files in the directory with the executable tool file.
- The user must first put the firmware to be downloaded in the firmware folder.
- Any dumps created will be put in the dump folder.
- The tool will present a list of the supported devices on the bus. The tool will allow selection of a target device and then perform the download or the dump on the target device.
- The tool itself is a command line tool but it is menu driven and very simple to use.
- The program displays are in English.
- The user is responsible to make sure the drive is not in use when firmware is downloaded or a dump is taken. He also must remove any cartridge from the drive or the firmware download function will not work.
- If the user does make a mistake, the program will respond with instructive error messages.
- If no IBM LTO tape drives are on the bus, the tool will inform the user that there are none before closing the tool window.

Firmware Download Function

- The tool is capable of displaying the current firmware level for any drive on the bus.
- The tool does a check to see if a cartridge is in the drive (cartridge present sensor activated). If a cartridge is present, an error will be posted and the user will be asked to remove the cartridge.
- The tool downloads code to IBM LTO drives ONLY. The tool will recognize ULT3580-TDX inquiry string devices as well as ULTRIUM-TDX devices. The letter ″X″ could be 1, 2, or 3.

- The tool is capable of loading back level (older) code.
- The program presents the user with a numbered list of firmware files available for selection from the LTO Firmware folder. The user can then select the number of the firmware file for the program to load.
- After the firmware has been loaded into drive memory the drive automatically reboots. The tool discourages the user from power cycling the drive before the reboot is complete. A message is displayed saying *"Updating.....Please Wait"* until the reboot is complete. A gauge displays progress.
- A *"Wait"* message is displayed on the user screen during firmware load.
- If the program tries to load code and it fails with a sense Key 5 and an ASC/ASCQ of 82/83, the following wording is displayed: "Bad Firmware Detected. The firmware is the wrong type for your tape drive or the file is corrupted." Verify that you are downloading the correct level of firmware then repeat the procedure.

Drive Log Dump Function

- When the dump function is executed on a drive, the tool will read the existing dump on the drive, force a dump, then read the forced dump. This will create two dump files.
- The two dump files created by the dump function will be time stamped with year, month, day, and seconds and contain the drive serial number. The first dump file read has an "A" suffix. The second file produced has a "B" suffix.
- The Tool will place the files that are created in the "LTO Dumps" folder in the directory with the tool.
- The tool creates the dump files with a file type of .dmp.

Updating the Firmware with an FMR Tape Cartridge

Attention: SCSI drives and Fibre Channel drives require different firmware images.

> **Tip**
> After creating an FMR tape (see "Function Code 3: Create FMR Tape" on page 35), the firmware of multiple drives can be updated with the same FMR tape. After updating the drive firmware, unmake the FMR tape (see "Function Code 8: Unmake FMR Tape" on page 38) and use it as a data cartridge.

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

1. Ensure that a cartridge is not loaded in the drive.
2. Place the drive in maintenance mode by pressing the Unload Button three times within a two seconds. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per second until  displays, then press and hold the button for three seconds. When  flashes, the drive is waiting for a cartridge.
4. Insert the FMR tape cartridge.  flashes, the drive loads the updated firmware from the cartridge, and the Status Light flashes amber. When the update completes successfully,  displays and the cartridge automatically ejects.

The drive resets itself and automatically activates the new firmware.

If the update fails, an error code displays. To resolve the error, locate the code in Table 15 on page 75.

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 TotalStorage LTO Ultrium 400 GB Data Cartridge cannot be interchanged with the media used in other IBM non-LTO Ultrium tape products.

Figure 12 shows the IBM TotalStorage LTO Ultrium 400 GB Data Cartridge and its components.

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

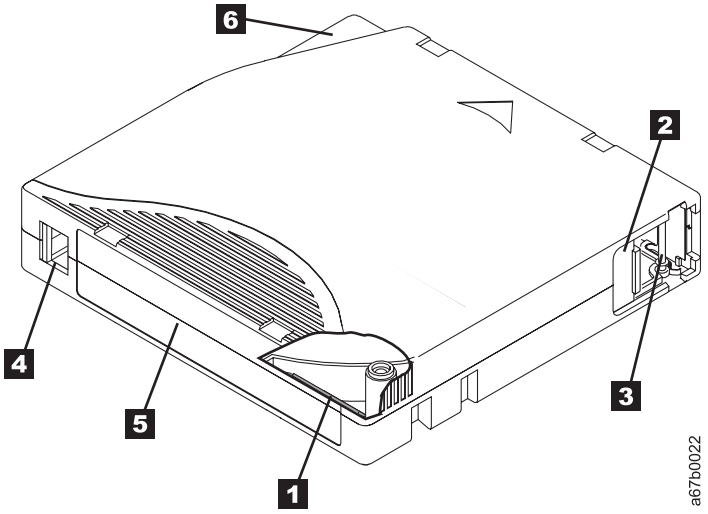

Figure 12. The IBM TotalStorage LTO Ultrium 400 GB Data Cartridge

Cartridge Compatibility

Table 8. Ultrium data and cleaning cartridge compatibility with Ultrium tape drive

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

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Data Cartridge

The different generations of IBM TotalStorageUltrium data cartridges can be identified by color:

- the Ultrium 3 Data Cartridge is slate blue
- the Ultrium 2 Data Cartridge is purple
- the Ultrium 1 Data Cartridge is black

All three generations contain 1/2-inch, dual-coat, metal-particle tape.

You can order tape cartridges with the bar code labels included, or you can order custom labels. To obtain tape cartridges and bar code labels, see "Ordering Media Supplies" on page 69.

The native data capacity of Ultrium data cartridges is as follows:

- The Ultrium 3 cartridge has a native data capacity of 400 GB (800 GB at 2:1 compression).
- The Ultrium 2 cartridge has a native data capacity of 200 GB (400 GB at 2:1 compression).
- The Ultrium 1 cartridge has a native data capacity of 100 GB (200 GB at 2:1 compression).

When processing tape in the cartridges, Ultrium Tape Drives use a linear, serpentine recording format. The Ultrium 3 drive reads and writes data on 704 tracks, sixteen tracks at a time. The Ultrium 2 drive reads and writes data on 512 tracks, eight tracks at a time. The Ultrium 1 drive reads and writes data on 384 tracks, eight tracks at a time. The first set of tracks (sixteen for Ultrium 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.

The cartridge door **2** protects the tape from contamination when the cartridge is out of the drive. Behind the door, the tape is attached to a leader pin **3**. When the cartridge is inserted into the drive, a threading mechanism pulls the pin (and tape) out of the cartridge, across the drive head, and onto a non-removable take-up reel. The head can then read or write data from or to the tape.

The write-protect switch **4** prevents data from being written to the tape cartridge. For more information, see "Write-Protect Switch" on page 55.

The label area **5** provides a location to place a label. For more information, see "Bar Code Label" on page 53.

The insertion guide **6** is a large, notched area that prevents the cartridge from being inserted incorrectly.

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

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*.

Cleaning Cartridge

With each drive, 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. It alerts you by displaying C on the Single-character Display. To clean the head, insert the cleaning cartridge into the tape load compartment (see Figure 11 on page 30). The drive performs the cleaning automatically. When the cleaning is finished, the drive ejects the cartridge.

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

To remove a cleaning cartridge, see "Unload Button" on page 29.

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

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 12 on page 51), 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-CM is 4096 bytes.

Bar Code Label

A bar code label contains:

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

Table 9. Bar code label requirements for Ultrium tape drives and libraries

Ultrium Tape Drive/Library	Bar Code Label Requirements
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 or cleaning cartridge. In addition, the bar code includes the two-character media-type identifier Lx, where x equals 1, 2, or 3. L identifies the cartridge as an LTO cartridge. 1 indicates that the cartridge is the first generation of its type; 2 indicates that the cartridge is the second generation of its type; 3

indicates that the cartridge is the third generation of its type. Figure 13 shows a sample bar code label for the LTO Ultrium Tape 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” on page 69. 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 L3, L2, or L1
- 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 12 on page 51). 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.

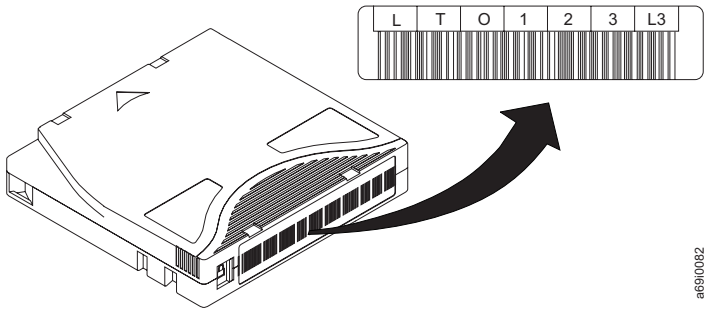

Figure 13. Sample bar code label on the LTO Ultrium 3 Tape Cartridge. The volume serial number (LTO123) and bar code are printed on the label.

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 12 on page 51).
- 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.

Write-Protect Switch

The position of the write-protect switch on the tape cartridge (see **1** in Figure 14) determines whether you can write to the tape. If the switch is set to the:

- 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.

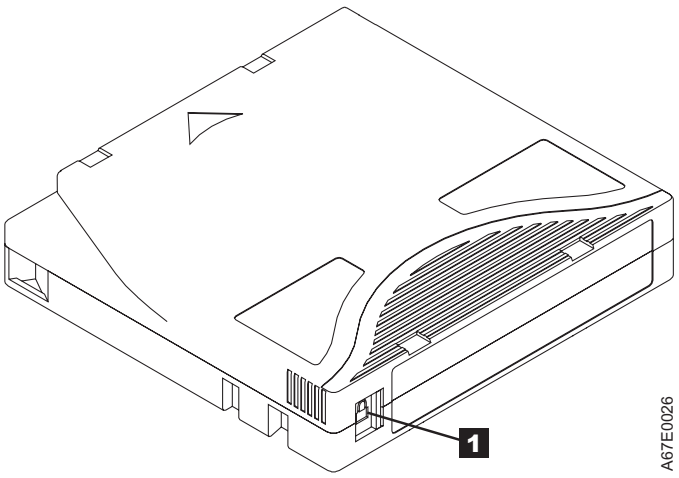

Figure 14. Setting the write-protect switch

Handling the 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.

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 (see Figure 15 on page 57). They are available at **http://www.turtlecase.com**.

Figure 15. 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 (see Figure 16).

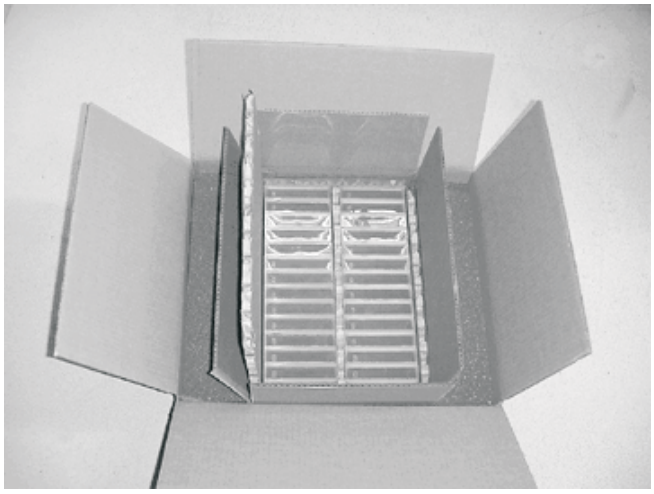

Figure 16. Double-boxing tape cartridges for shipping

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 "Environmental and Shipping Specifications for Tape Cartridges" on page 68.

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 17 and **4** in Figure 19 on page 62). If there are gaps in the seam (see Figure 17), the leader pin may be dislodged. Go to "Repositioning or Reattaching a Leader Pin" on page 61.

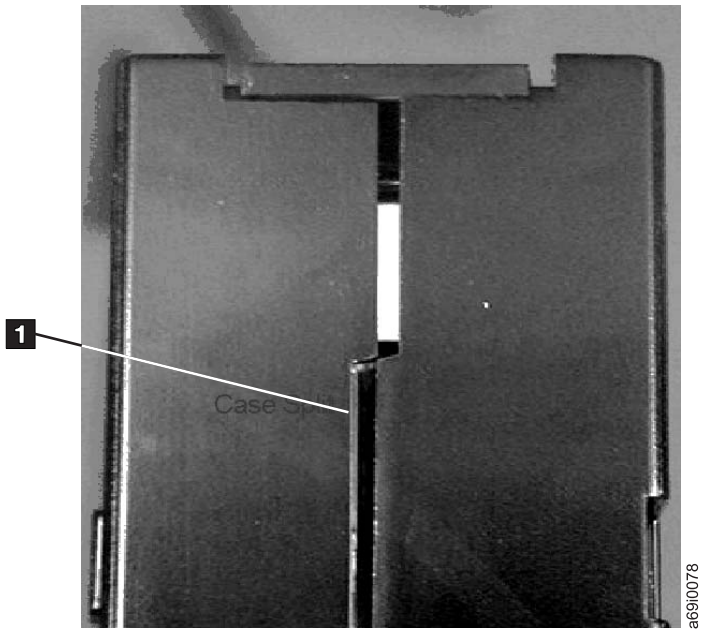

Figure 17. Checking for gaps in the seams of a cartridge

- Check that the leader pin is properly seated (see **2** in Figure 18 on page 61).
- 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 18 on page 61). If the leader pin has become dislodged, go to "Repositioning or Reattaching a Leader Pin" on page 61.
- 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.

Examples of Cartridge Problems

Example: Split Cartridge Case (see Figure 17 on page 58)

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 (see "Repositioning a Leader Pin" on page 61). Then, immediately use data recovery procedures to minimize chances of data loss.
3. Review media-handling procedures.

Example: Improper Placement of Leader Pin (see Figure 18 on page 61)

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 (see "Repositioning a Leader Pin" on page 61). Then, immediately use data recovery procedures to minimize chances of data loss.

Repositioning or Reattaching a Leader Pin

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.

Repositioning a Leader Pin

A leader pin that is improperly seated inside a cartridge can interfere with the operation of the drive. Figure 18 shows a leader pin in the incorrect **1** and correct **2** positions.

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)

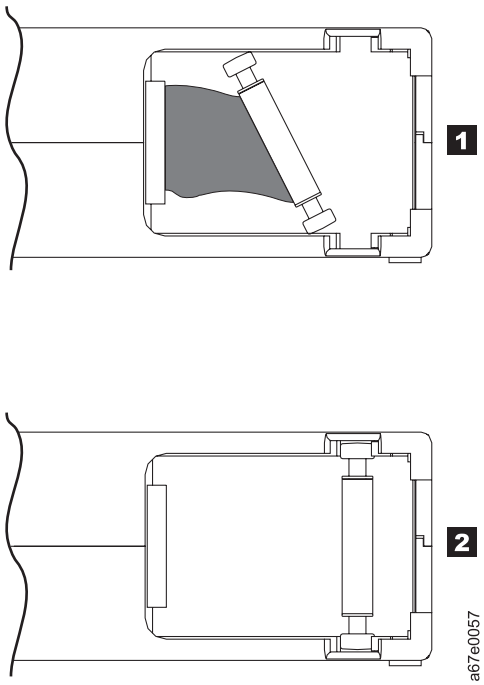

Figure 18. Leader pin in the incorrect and correct positions. The cartridge door is open and the leader pin is visible inside the cartridge.

To reposition the leader pin, perform the following steps.

1. Slide open the cartridge door (1 in Figure 19) and locate the leader pin 2 (you may need to shake the cartridge gently to roll the pin toward the door).
2. With plastic or blunt-end tweezers, grasp the leader pin and position it in the pin-retaining spring clips 3 .
3. Press the leader pin gently into the clips until it snaps into place and is firmly seated.
4. Close the cartridge door.

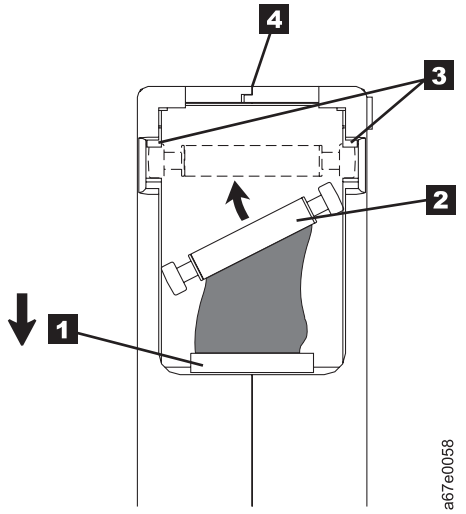

Figure 19. Placing the dislodged leader pin into the correct position. The cartridge door is open to show the leader pin.

5. To rewind the tape, insert the cartridge manual rewind tool (1 in Figure 20) into the cartridge's hub 2 and turn it clockwise until the tape becomes taut.

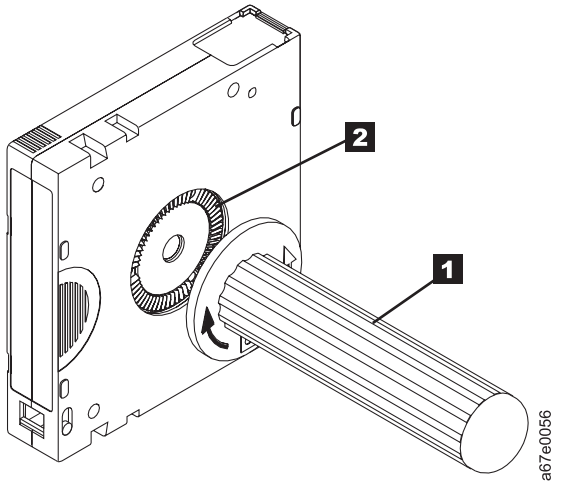

Figure 20. Rewinding the tape into the cartridge

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

Reattaching a Leader Pin

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

The Leader Pin Reattachment Kit contains three parts:

- **Leader pin attach tool** (see 1 in Figure 21). A plastic brace that holds the cartridge door open.
- **Cartridge manual rewind tool** (see 2 in Figure 21). A device that fits into the cartridge's hub and lets you wind the tape into and out of the cartridge.
- **Pin supplies** (see 3 in Figure 21). 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.

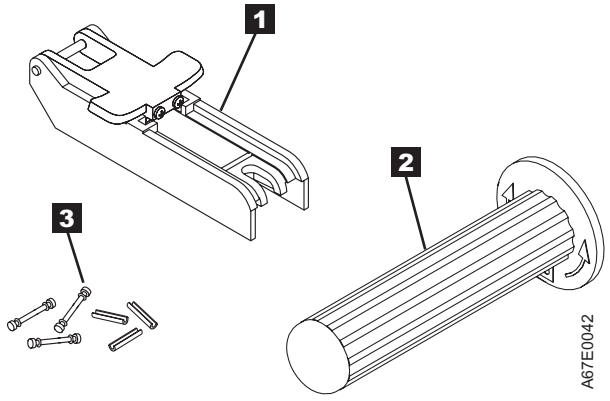

Figure 21. Leader Pin Reattachment Kit

The following procedure describes how to reattach a leader pin.

To reattach a leader pin by using the IBM Leader Pin Reattachment Kit:

1. Attach the leader pin attach tool (**1** in Figure 22) to the cartridge **2** so that the tool's hook **3** latches into the cartridge's door **4** . Pull the tool back to hold the door open, then slide the tool onto the cartridge. Open the tool's pivot arm **5** .

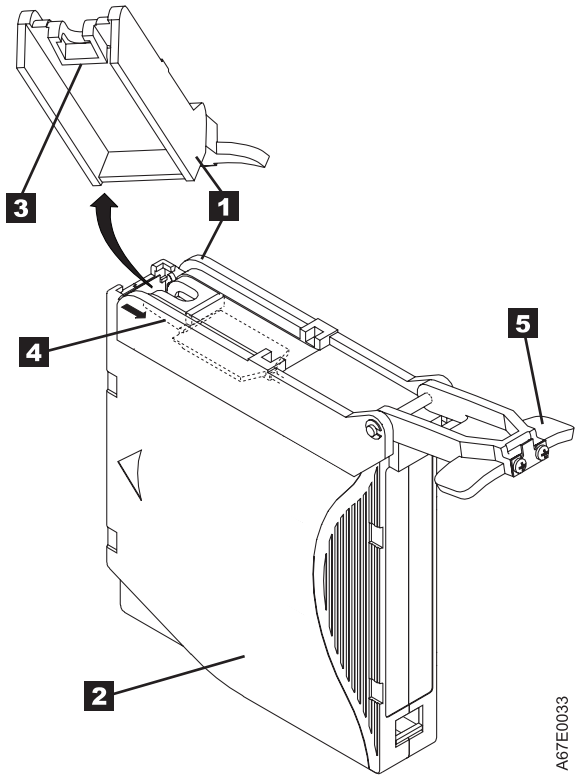

Figure 22. Attaching the leader pin attach tool to the cartridge. To hold the cartridge door open, hook the tool into the door and pull the tool back.

2. To find the end of the tape inside the cartridge, attach the cartridge manual rewind tool (1 in Figure 23) 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 .
3. 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.
4. Remove the rewind tool by pulling it away from the cartridge. Set the tool and the cartridge aside.

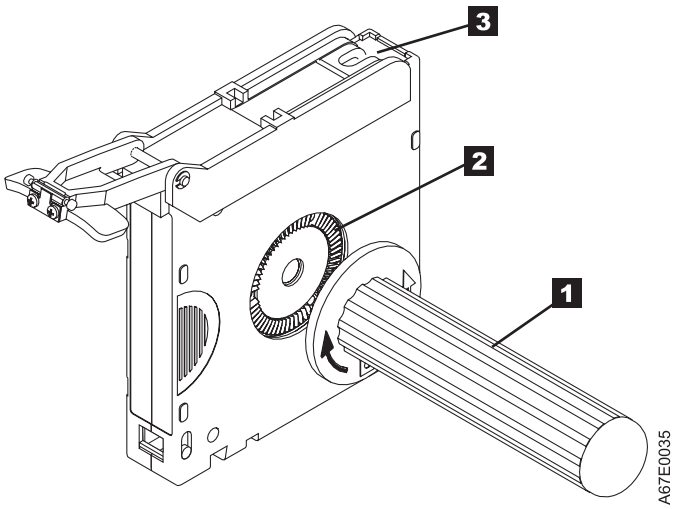

Figure 23. Winding the tape out of the cartridge. Turn the cartridge manual rewind tool clockwise to see the end of the tape, then turn it counterclockwise to bring the tape to the cartridge door.

5. On the leader pin (1 in Figure 24), 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.
6. Remove the C-clip from the leader pin by using your fingers to push the clip away from the pin. Set the pin aside and discard the clip.

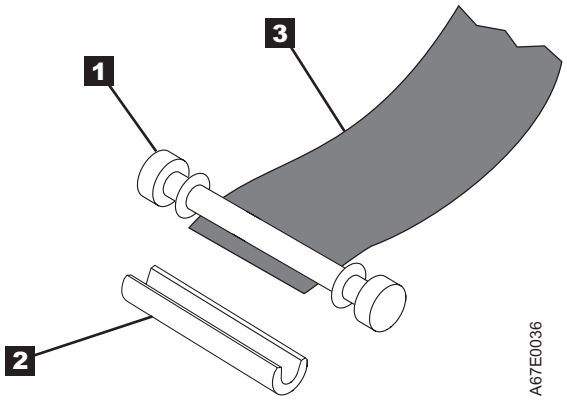

Figure 24. Removing the C-clip from the leader pin. Use your fingers to push the C-clip from the leader pin.

7. Position the tape in the alignment groove of the leader pin attach tool (see 1 in Figure 25).
8. Place a new C-clip into the retention groove 2 (Figure 25) on the leader pin attachment tool and make sure that the clip's open side faces up.
9. Place the leader pin (from step 6 on page 65) into the cavity 3 (Figure 25) 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.

10. Fold the tape over the leader pin and hold it with your fingers (see Figure 25).

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

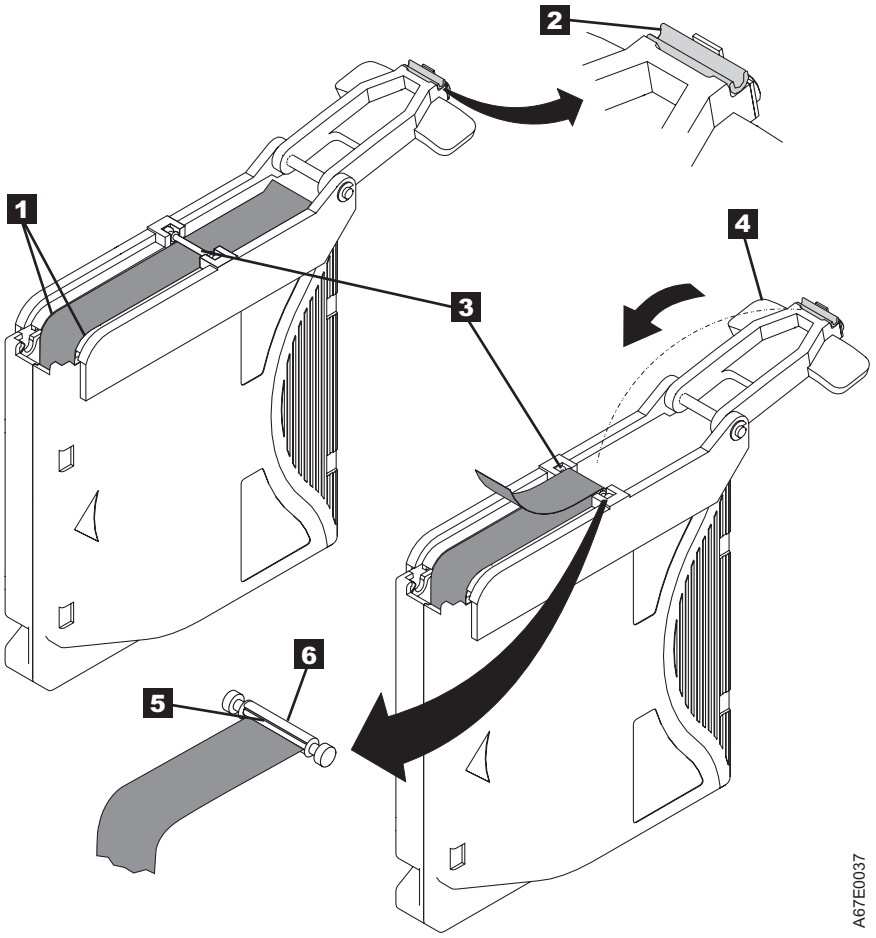

Figure 25. Attaching the leader pin to the tape

11. 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.
12. Swing the pivot arm open and trim the excess tape 5 so that it is flush with the reattached leader pin 6.

13. Use your fingers to remove the leader pin from the cavity **3** in the leader pin attach tool.
14. Use the cartridge manual rewind tool to wind the tape back into the cartridge (wind the tape clockwise). Ensure that the leader pin is latched by the pin-retaining spring clips on each end of the leader pin.
15. Remove the rewind tool.
16. Remove the leader pin attach tool by lifting its end up and away from the cartridge.

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.

Environmental and Shipping Specifications for Tape Cartridges

Before you use a tape cartridge, acclimate it to the operating environment for 24 hours or the time necessary to prevent condensation in the drive (the time 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 10 gives the environment for operating, storing, and shipping LTO Ultrium Tape Cartridges.

Table 10. Environment for operating, storing, and shipping the LTO Ultrium Tape Cartridge

	Environmental Specifications			
Environmental Factor	**Operating**	**Operational Storage**[1]	**Archival Storage**[2]	**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)

Notes:

1. Operational storage equals less than one year.
2. Archival storage equals one 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 1200 oersted peak field over the entire space that the cartridge occupies). Degaussing makes the cartridge unusable.

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

Ordering Media Supplies

Table 11 lists the cartridges and media supplies that you can order for the drive.

Table 11. Media supplies

Supply Item	Methods of Ordering
IBM TotalStorage LTO Ultrium 400 GB Data Cartridge Bar code labels are pre-applied to cartridges.	• Order the cartridge from your IBM Sales Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 009. Specify the VOLSER characters that you want. • Order as part number 96P1470 (color label) or 96P1471 (black and white label) through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`). Or, call 1-888-IBM-MEDIA. Specify the VOLSER characters that you want.
IBM TotalStorage LTO Ultrium 400 GB Data Cartridge Order VOLSER labels separately.	• Order the cartridge from your IBM Sales Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 008. • Order as part number 24R1922 through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`). Or, call 1-888-IBM-MEDIA. Specify the VOLSER characters that you want.
IBM TotalStorage LTO Ultrium 200 GB Data Cartridge Bar code labels are pre-applied to cartridges.	• Order the cartridge from your IBM Sales Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 006. Specify VOLSER characters you want. • call 1-888-IBM-MEDIA.
IBM TotalStorage LTO Ultrium 200 GB Data Cartridge Order VOLSER labels separately (see "Ordering Bar Code Labels" on page 71).	• Order the cartridge from your IBM Sales Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 007. • call 1-888-IBM-MEDIA.

Table 11. Media supplies (continued)

Supply Item	Methods of Ordering
IBM LTO Ultrium 100 GB Data Cartridge Order VOLSER labels separately (see "Ordering Bar Code Labels" on page 71).	• Order as part number 08L9120 through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`), or • if you do not have Internet access, order the cartridge from any authorized IBM Business Partner or your IBM Sales Representative, or • call 1-888-IBM-MEDIA.
IBM TotalStorage LTO Ultrium Cleaning Cartridge (universal cleaning cartridge for use with Ultrium 1, Ultrium 2, and Ultrium 3 drives) VOLSER labels are included.	• Order as part number 35L2086 through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`), or • if you do not have Internet access, order the cartridge from any authorized IBM Business Partner or your IBM Sales Representative, or • call 1-888-IBM-MEDIA.
Leader Pin Reattachment Kit	Order as part number 08L9129 through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`).
Manual Rewind Tool	Order as part number 08L9130 through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`).

Ordering Bar Code Labels

The IBM TotalStorage 3580 Tape Drive does 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 in Table 12.

Table 12. Authorized suppliers of custom bar code labels

In America	In Europe and Asia
EDP/Colorflex 2550 W. Midway Blvd. Broomfield, CO 80020 U. S. A. Telephone: 800-522-3528 http://www.colorflex.com/	EDP Europe, Ltd. 43 Redhills Road South Woodham Ferrers Chelmsford, Essex CM3 5UL U. K. Telephone: 44 (0) 1245-322380 http://www.edpeurope.com/media_labelling.htm
Dataware P.O. Box 740947 Houston, TX 77274 U. S. A. Telephone: 800-426-4844 http://www.datawarelabels.com/	Dataware Labels Europe Heubergstrasse 9 D-83052 Bruckmuhl-Gotting Germany Telephone: 49 8062-9455 http://www.datawarelabels.com/
NetC P. O. Box 1067 Fairfield, CT 06825 U. S. A. Telephone: 203-372-6382 http://www.netcllc.com/	NetC Europe Ltd Town Farm Bungalow The Pavement North Curry TA3 6LX Somerset U. K. Telephone: 44 (0) 1823 49 1439 http://www.netclabels.co.uk
	NetC Asia Pacific Pty Ltd Locked Bag 1 Kenthurst NSW 2156 Australia Telephone: 61 (0) 2 4573 6556 http://www.netclabels.com.uk

Resolving Problems

If you encounter problems when running the drive, refer to Table 13. If the problem is not identified in Table 13, refer to "Methods of Receiving Errors and Messages" on page 74. The color and condition of the Status Light may also indicate a problem. For more information, see "Status Light" on page 28.

Table 13. Troubleshooting tips

If the problem is this....	Do this....
A code displays on the Single-character Display (SCD) and the Status Light flashes amber.	The drive detected an error or is directing you to an informational message. See Table 15 on page 75.
The Status Light or SCD 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 24). If the problem persists, replace the drive.
The drive will not load a tape cartridge.	One of the following has occurred: • 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 Status Light becomes solid green, press the Unload Button to eject the cartridge. • The tape cartridge was inserted incorrectly. To properly insert a cartridge, see "Inserting a Tape Cartridge" on page 30. • The tape cartridge may be defective. Insert another tape cartridge. If the problem exists for multiple cartridges, the drive is defective. Replace the drive (see "Removing a SCSI Drive from an Enclosure" on page 93). • The drive has no power. Connect power to the drive (see "Connect and Test Power to the Drive" on page 24).
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.
The server received TapeAlert flags.	See "TapeAlert Flags," on page 111.
The server reported SCSI problems (such as selection or command time-outs, or parity errors).	See "Fixing SCSI Bus Errors" on page 86.
The library reported an LDI or RS-422 communication problem with the drive.	The LDI or RS-422 circuitry may be defective. Run the LDI or RS-422 wrap test ("Function Code 7: Run RS-422 Wrap Test" on page 38). If the test runs successfully but the problem persists, refer to your library's service documentation.
Codes display on the SCD, but the Status Light does not turn on.	The drive is defective. Replace the drive (see "Removing a SCSI Drive from an Enclosure" on page 93).
The drive does not respond to server commands.	Press and hold the Unload Button on the drive for ten 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.

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Methods of Receiving Errors and Messages

Use Table 14 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 Table 15 on page 75. Codes that occur while in maintenance mode are defined in "Diagnostic and Maintenance Functions" on page 32.

Table 14. 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 Status Light flashes amber	See Table 15 on page 75. To determine the meaning of Status Light activity, see "Status Light" on page 28.
The drive's SCD and the Status Light is solid amber	See "Diagnostic and Maintenance Functions" on page 32. To determine the meaning of Status Light activity, see "Status Light" on page 28.
SCSI log sense data (such as TapeAlert flags) and SCSI drive sense data at the server console	See "TapeAlert Flags," on page 111, Table 15 on page 75, or "Using Sense Data" on page 79.
Drive sense data sent to a library (if the drive is enclosed in a library)	Refer to your library's documentation, then see Table 15 on page 75.
The drive's error log	See Table 15 on page 75 and "Viewing the Drive Error Log" on page 85.

Error Codes and Messages

Table 15 gives descriptions of the errors and messages that pertain to the drive, and tells what to do when you receive them.

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 15. Error codes on the Single-character Display. To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.

Error Code	Cause and Action
	No error occurred and no action is required. This code displays: • When power is cycled (turned off, then on) to the tape drive. • When diagnostics have finished running and no error occurred. **Note:** The Single-character Display is blank during normal operation of the tape drive.
	Cooling problem. The tape drive detected that the recommended operating temperature was exceeded. Perform one or more of the following actions: • Ensure that the cooling fan is rotating and is quiet. If not, refer to your enclosure documentation. • Remove any blockage that prevents air from flowing freely through the tape drive. • Ensure that the operating temperature and airflow is within the specified range (see "Physical Specifications" on page 10). • If the operating temperature is within the specified range and the problem persists, replace the drive. The error code clears when you power-off the tape drive or place it in maintenance mode.
	Power problem. The tape drive detected that the externally supplied power is approaching the specified voltage limits (the tape drive is still operating) or is outside the specified voltage limits (the tape drive is not operating). Perform the following action: 1. Ensure that the power connector is properly seated. 2. Ensure that the proper dc voltages are being applied within the tolerances allowed (see "Physical Specifications" on page 10). 3. If the proper voltages are being applied but the problem persists, replace the unit. The error code clears when you power-off the tape drive or place it in maintenance mode.
	Firmware problem. The tape drive determined that a firmware error occurred. Perform the following action: 1. Collect a drive dump from one of the following: **Note:** Do not force a new dump; the tape drive has already created one. • Server's SCSI interface by using a device driver utility or system tool (for instructions about reading a drive dump from tape, visit the Web at **http://www.ibm.com/storage/lto**) • Ultrium Tape Drive (to copy and read a drive dump, use "Function Code 5: Copy Drive Dump" on page 36) 2. Power the tape drive off and on, then retry the operation that produced the error. 3. If the problem persists, download new firmware and retry the operation. 4. If the problem persists, send the drive dump that you collected in step 1 to your IBM Support Center. The error code clears when you power-off the tape drive or place it in maintenance mode.

Table 15. Error codes on the Single-character Display (continued). To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.

Error Code	Cause and Action
4	Firmware or tape drive problem. The tape drive determined that a firmware or tape drive hardware failure occurred. Perform the following action: 1. Collect a drive dump from one of the following: **Note:** Do not force a new dump; one already exists. • Server's SCSI interface by using a device driver utility or system tool (for instructions about reading a drive dump from tape, visit the Web at **http://www.ibm.com/storage/lto**) • Ultrium Tape Drive (to copy and read a drive dump, use "Function Code 5: Copy Drive Dump" on page 36) 2. Power the tape drive off and on, then retry the operation that produced the error. The error code clears when you power-off the tape drive or place it in maintenance mode. 3. If the problem persists, download new firmware and retry the operation; if new firmware is not available, replace the drive.
5	Tape drive hardware problem. The drive determined that a tape path or read/write error occurred. To prevent damage to the drive or tape, the 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. **Note:** Copy the drive dump to flash memory before returning the drive. For instructions, refer to "Function Code 5: Copy Drive Dump" on page 36.

Table 15. Error codes on the Single-character Display (continued). To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.

Error Code	Cause and Action
6	Tape drive or media error. The tape drive determined that an error occurred, but it cannot isolate the error to faulty hardware or to the tape cartridge. Perform the following action: **For Problems with Writing Data:** If the problem occurred while the tape drive was writing data to the tape, and if you know the volume serial number (located on the cartridge label) of the tape cartridge that was loaded in the drive when the problem occurred, retry the operation with a different cartridge: • If the operation succeeds, the original cartridge was defective. Copy data from the defective cartridge and discard it. • If the operation fails and another tape drive is available, insert the cartridge into the other unit and retry the operation. – If the operation fails, discard the defective cartridge. – If the operation succeeds, insert a scratch data cartridge into the first unit and run "Function Code 1: Run Drive Diagnostics" on page 33. - If the diagnostics fail, replace the tape drive. - If the diagnostics succeed, the error was temporary. • If the operation fails and another tape drive is not available, insert a scratch data cartridge into the unit and run "Function Code 1: Run Drive Diagnostics" on page 33. – If the diagnostics fail, replace the tape drive. – If the diagnostics succeed, discard the cartridge. If the problem occurs with multiple tape cartridges or if you do not know the tape cartridge's volume serial number, run "Function Code 1: Run Drive Diagnostics" on page 33: • If the diagnostics fail, replace the tape drive. • If the diagnostics succeed, run "Function Code H: Test Head" on page 42. – If the diagnostic fails, replace the tape drive. – If the diagnostic succeeds, replace the cartridges that caused the problem. The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode. **For Problems with Reading Data:** If the problem occurred while the tape drive was reading data from the tape, and if you know the volume serial number of the tape cartridge, perform one of the following procedures: • If another tape drive is available, insert the cartridge into the other unit and retry the operation: – If the operation fails, discard the defective cartridge. – If the operation succeeds, insert a scratch data cartridge into the first unit and run "Function Code 1: Run Drive Diagnostics" on page 33: - If the diagnostic fails, replace the tape drive. - If the diagnostic succeeds, the error was temporary. • 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 33: – If the diagnostic fails, replace the tape drive. – If the diagnostic succeeds, discard the cartridge. If the problem occurs with multiple tape cartridges or if you do not know the tape cartridge's volume serial number, run "Function Code 1: Run Drive Diagnostics" on page 33: • If the diagnostic fails, replace the tape drive. • If the diagnostic succeeds, run "Function Code H: Test Head" on page 42. – If the diagnostic fails, replace the tape drive. – If the diagnostic succeeds, replace the cartridges that caused the problem. The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.

Table 15. Error codes on the Single-character Display (continued). To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.

Error Code	Cause and Action
7	A high probability of media error. The tape drive determined that an error occurred because of a faulty tape cartridge. Try another tape cartridge. If the problem occurs with multiple tape cartridges, use the following procedure: **Attention:** When you run the Test Cartridge & Media diagnostic, data on the suspect tape is overwritten. Use only a scratch data cartridge to run the test. 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 & Media" on page 40. • If the diagnostic fails, replace the media. • If the diagnostic succeeds, clean the drive head (see "Cleaning the Drive Head" on page 31) and run "Function Code 1: Run Drive Diagnostics" on page 33. – If the drive diagnostic fails, replace the drive. – If the drive diagnostic succeeds, perform the operation that produced the initial media error. The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.
8	Tape drive or SCSI bus failure. The tape drive determined that a failure occurred in the tape drive's hardware or in the SCSI bus. See "Fixing SCSI Bus Errors" on page 86. The error code clears 10 seconds after the drive detected the error or when you place the drive in maintenance mode.
9	Tape drive or RS-422 error. The tape drive determined that a failure occurred in the tape drive's hardware or in the RS-422 connection. Replace the tape drive. The error code clears 10 seconds after the drive detected the error or when you place the tape drive in maintenance mode.

Table 15. Error codes on the Single-character Display (continued). To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.

Error Code	Cause and Action
	Tape drive hardware problem. The tape drive determined that a problem occurred which degraded the operation of the tape drive, but it did not restrict continued use. If the problem persists, determine whether the problem is with the drive or the media. **Note:** The drive is usable, though the Single-character Display continues to indicate an error and the Status Light flashes amber. The error code may clear when you cycle power to the tape drive or place it in maintenance mode. To determine if the problem is with the drive hardware, or the tape media, perform the following procedures: 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 & Media diagnostic (see "Function Code E: Test Cartridge & Media" on page 40). 2. If the Test Cartridge & Media diagnostic fails, replace the media. If it runs successfully, clean the failing drive and run the drive diagnostics (see "Cleaning the Drive Head" on page 31 and "Function Code 1: Run Drive Diagnostics" on page 33). If the drive diagnostics run successfully, perform the operation that produced the initial drive error. 3. If the problem persists replace the drive. If it is not possible to run the tape cartridge in a different drive, perform the following procedures: 1. Clean the failing drive and run the drive diagnostics (see "Cleaning the Drive Head" on page 31 and "Function Code 1: Run Drive Diagnostics" on page 33). If the drive diagnostics run successfully, run the Test Cartridge & media diagnostic (see "Function Code E: Test Cartridge & Media" on page 40). 2. If the Test Cartridge & Media diagnostic fails, replace the media. If it runs successfully, perform the operation that produced the initial drive error. 3. If the problem persists replace the drive.
	No error or message is assigned. See error code  in this table.
	The tape drive needs to be cleaned. Clean the tape drive. See "Cleaning the Drive Head" on page 31. The error code clears when you clean the tape drive or place it in maintenance mode.
	No error or message assigned. See error code  in this table.
	The Unload Button is depressed. Verify that the button pushes freely.

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, @server iSeries, RS/6000, and @server pSeries servers.

Obtaining Error Information from the AS/400 or iSeries 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 iSeries 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 26 shows a sample error log.

```
                        Display Detail Report for Resource

                                                 Serial            Resource
Name             Type      Model                 Number            Name
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 26. Example of an error log from the AS/400 or IBM @server iSeries

8. Press F4 to view the sense data (see the example in Figure 27 on page 81).

```
                Display Additional Information for Resource

                                          Serial            Resource
Name            Type      Model           Number            Name
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 27. Example of sense data from the AS/400 or IBM @server iSeries

Obtaining Error Information from the RS/6000 or pSeries

The AIX® Tape and Media Changer Device Driver for the IBM RS/6000 or IBM @server pSeries 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 28 on page 82 displays a sample drive error log; Figure 29 on page 83 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 28 on page 82, 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 7000 0300 0000 001C 0000 0000
5200 0700 20B0 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
```

Figure 28. 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 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 29. 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

> **Attention**
>
> At the time of publication, the ITDT tool was not available. Register with MySupport (**http://www.ibm.com/support/mySupport**) to be notified by email when the tool becomes available, or periodically check the IBM support site (**http://www.ibm.com/storage/lto**) .

For information on obtaining a drive dump using the ITDT tool, refer to "ITDT SCSI Firmware Update, Dump Retrieval and Library/Drive Test Tool" on page 47.

Using LTO-TDX

For information on obtaining a drive dump using the LTO-TDX tool, refer to "LTO-TDX: LTO SCSI and Fibre Drive Firmware Download & LTO Drive Dump Upload Tool" on page 47.

Using the Drive

To obtain a drive dump directly from the drive:

1. Make sure that no cartridge is in the drive.
2. Within two seconds, press the Unload Button three times. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per second until  appears in the Single-character Display.
4. To select the function, press and hold the Unload Button for three seconds. After you release the button,  flashes. Within 60 seconds, insert a scratch data cartridge that is not write-protected. After you insert the cartridge,  flashes and the drive writes the dump data to the scratch tape. When the function is complete, the drive rewinds and unloads the tape.
5. Insert the tape into a drive.
6. From the server, issue the SCSI READ command to read the dump from the tape to a file or electronic image (you may need to issue the command several times to read the complete dump).
7. To determine where to send the file for analysis, contact your OEM Product Application Engineer (PAE).

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:

1. Make sure that no cartridge is in the drive.
2. Within two seconds, press the Unload Button three times. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per second until  appears in the SCD.
4. Press and hold the Unload Button for three seconds to view the most recent error code.
5. Refer to Table 15 on page 75 to determine the meaning of the code and the action to take.
6. Press the Unload Button to view the next error code. (The codes are ordered; the most recent is presented first and the oldest (tenth) is presented last.)
7. Continue to press the Unload Button until the ten error codes have been displayed. After you display the tenth error code, the drive automatically exits maintenance mode.

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

Resolving Problems Reported by the Server

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

Fixing SCSI Bus Errors

Note: If you are using a Storage Area Network (SAN) Data Gateway to convert a drive with a SCSI interface to a Fibre Channel interface, ensure that the problem is occurring between the SAN Data Gateway and the drive by running the SCSI wrap test on the drive and running the SCSI loopback test on the SAN Data Gateway. (To run the SCSI wrap test, see "Function Code 6: Run SCSI Wrap Test" on page 37; to run the SCSI loopback test, refer to the section about that test in the *IBM Storage Area Network Gateway Module Setup, Operator, and Service Guide*.)

Fixing a Consistent Error with a Single Drive on a SCSI Bus

1. Ensure that the power is on to the drive.
2. Ensure that the drive's SCSI address is the same as the SCSI address assigned by the server.
3. Run the SCSI wrap test (see "Function Code 6: Run SCSI Wrap Test" on page 37).
   - If the test fails, replace the SCSI terminator first, then the SCSI cable and the interposer (if installed). Repeat the operation that caused the error. If you replaced the SCSI terminator or SCSI cable and the problem persists, the fault is with the server's hardware or software. To isolate the cause of the failure, refer to the server's service documentation.
   - If the test fails again, replace the drive (see "Removing a SCSI Drive from an Enclosure" on page 93).
   - If the test is successful, refer to your enclosure documentation for additional troubleshooting information.

Fixing a Consistent Error with Multiple Drives on a SCSI Bus

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

1. Ensure that the SCSI cable from the server to the first device is connected.
2. Disconnect all but the first drive on the SCSI bus. Move the terminator to the first SCSI device.
3. Run a device driver utility (such as IBM's *ntutil* or *tapeutil*) to determine whether the error will occur.
   - If the error occurs, run the SCSI wrap test on the first drive (see "Function Code 6: Run SCSI Wrap Test" on page 37).
     - If the test runs successfully, replace the SCSI terminator first, then the SCSI cable and the interposer (if installed) to the first drive. Repeat the operation that caused the error. If you replaced the SCSI terminator or SCSI cable and the problem persists, the fault is with the server's hardware or software. To isolate the cause of the failure, refer to the server's service documentation.

- If the test fails, replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 93).

- If the error does not occur, connect one drive at a time back to the bus and repeat step 3 for each drive until you can identify which drive is defective.

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

4. Determine if the problem is with only one drive or with two or more drives.
   - If the problem is with only one drive, run the SCSI wrap test on that drive (see “Function Code 6: Run SCSI Wrap Test” on page 37).
     - If the test runs successfully, replace the SCSI terminator first, then the SCSI cable to that drive and interposer (if installed).
     - If the test fails, replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 93).
   - If the problem is with two or more drives, locate the first drive that has the error and replace the SCSI cable that connects the drive and the interposer (if installed).

Fixing an Intermittent Error with a Single Drive on a SCSI Bus

1. Replace the SCSI terminator on the drive.
2. Run the operation that caused the error. If the problem persists, the problem may be with the cable.
3. Isolate which cable is causing the problem by replacing one cable at a time and running the operation that caused the error after each replacement. If the problem persists after all cables have been replaced, the problem may be with the drive.
4. Replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 93). If the problem persists, the problem is with your server. Consult your server’s documentation.

Fixing an Intermittent Error with Multiples Drives on a SCSI Bus

Refer to the server’s error logs to determine which drive is the source of the problem:

- If only one drive is reporting a SCSI failure, replace that drive (see “Removing a SCSI Drive from an Enclosure” on page 93).
- If multiple drives are reporting SCSI failures, the problem may be with the terminator or the SCSI cables:
  - Replace the terminator and run the operation that caused the error. If the problem persists, the problem may be with the cables.
  - Isolate which cable is causing the problem by replacing one cable at a time and run the operation that caused the error after each replacement.

Fixing Fibre Channel Errors

If you are connected to a Fibre Channel Storage Area Network (SAN) by using a SAN Data Gateway, use the *IBM Storage Area Network Gateway Module Setup, Operator, and Service Guide* to determine whether the problem is occurring between the drive and the SAN Data Gateway. If you are using a SCSI drive and are having SCSI problems, see "Fixing SCSI Bus Errors" on page 86.

Starting Problem Determination

Before starting the problem determination, perform the following steps:

1. Determine the type of Fibre Channel topology that you are using (see page 7). Ensure that the drive and the port to which it is attached are configured in compatible topologies.
2. Using this guide or the service guides of associated switch, hub, or fiber products, try to determine where the problem exists (whether in the drive, cable, or the device to which the drive and cable attach).
3. Ensure that the configuration and software levels are supported (see "Fibre Channel Interface" on page 7).
4. Ensure that the Fibre Channel cables are installed correctly. Refer to the appropriate steps in "Installing the Drive" on page 13.
5. Go to one of the following procedures:
   - "Fixing a Consistent Error with a Single Drive on a Fibre Channel Loop"
   - "Fixing a Consistent Error with Multiple Drives on a Fibre Channel Loop" on page 89
   - "Fixing a Consistent Error in a Point-to-Point Topology" on page 89
   - "Fixing Intermittent Fibre Channel Errors" on page 90

Fixing a Consistent Error with a Single Drive on a Fibre Channel Loop

1. Ensure that the tape drive is powered on.
2. Verify that the tape drive's serial number is the same as the drive serial number that the server program is using.
3. Ensure that the drive's Fibre Channel AL_PA is set correctly, that it is on the loop, and that it is not being used by another device (see "Setting the Arbitrated Loop Physical Address (Fibre Channel Drive Only)" on page 16). The tape drive must be able to detect light and communicate with the server.
4. Run the Fibre Channel wrap test at the drive's Fibre Channel connector (see Function Code 6 in "Function Code 6: Run SCSI Wrap Test" on page 37).
   - If the test fails, replace the tape drive.
   - If the test is successful, go to step 5.
5. Run the Fibre Channel wrap test at the end of the fiber cable (see Function Code 6 in "Function Code 6: Run SCSI Wrap Test" on page 37).
   - If the test fails, replace the fiber cable.
   - If the test is successful, go to step 6.
6. Check the Fibre Channel cable connection at the server.
7. Using a device driver utility such as *ntutil* or *tapeutil*, verify that the drive is properly configured and available at the server.
8. If the problem persists, the fault may be with the server's hardware or software. Refer to your server's service manual.
9. When the problem is corrected (or determined to be a server problem), restore all of the fiber cables to their correct position.

Fixing a Consistent Error with Multiple Drives on a Fibre Channel Loop

Use the following procedure to determine if all of the drives on the Fibre Channel have the problem:

1. Use a device driver utility (such as *ntutil* or *tapeutil*) to verify that the drive is available and properly configured at the server.
2. Determine the type of Fibre Channel topology that you are using (see page 7).
3. Using this guide or the service guides of associated switch, hub, or fiber products, try to isolate which part of the Fibre Channel Storage Area Network (SAN) is experiencing problems.
4. Perform one of the following:
   - If the problem exists on a small number of drives, go to "Fixing a Consistent Error with a Single Drive on a Fibre Channel Loop" on page 88.
   - If the problem exists with a large number of drives, perform the following steps:
     a. Disconnect all except one failing drive on the Fibre Channel.
     b. Run the Fibre Channel wrap test to determine if a failure occurs on that drive (see Function Code 6 in "Function Code 6: Run SCSI Wrap Test" on page 37). If it does, perform the procedure in "Fixing a Consistent Error with a Single Drive on a Fibre Channel Loop" on page 88.
     c. Continue to connect one drive at a time to the Fibre Channel loop.
5. When the problem is corrected, restore all of the Fibre Channel cables to their correct position.

Fixing a Consistent Error in a Point-to-Point Topology

1. Ensure that the tape drive is powered on.
2. Verify that the tape drive's serial number is the same as the drive serial number that the server program is using.
3. Ensure that the drive is connected to the host or switch. The drive must be able to detect light and communicate with the server.
4. Run the Fibre Channel wrap test at the drive's Fibre Channel connector (see Function Code 6 in "Function Code 6: Run SCSI Wrap Test" on page 37).
   - If the test fails, replace the tape drive.
   - If the test is successful, go to step 5.
5. Run the Fibre Channel wrap test at the end of the fiber cable (see Function Code 6 in "Function Code 6: Run SCSI Wrap Test" on page 37).
   - If the test fails, replace the fiber cable.
   - If the test is successful, go to step 6.
6. Check the Fibre Channel cable connection at the server.
7. Using a device driver utility such as *ntutil* or *tapeutil*, verify that the drive is properly configured and available at the server.
8. If the problem persists, the fault may be with the server's hardware or software. Refer to your server's service manual.
9. When the problem is corrected (or determined to be a server problem), restore all of the fiber cables to their correct position.

Fixing Intermittent Fibre Channel Errors

1. Determine the type of Fibre Channel topology that you are using (see page 7).
2. Ensure that the configuration and software levels are supported (see "Fibre Channel Interface" on page 7).
3. Check that each Fibre Channel cable does not exceed 500 m (1640 ft).
4. Ensure that all Fibre Channel cables are installed correctly. Refer to the appropriate steps in "Installing the Drive" on page 13.
5. Using this guide or the service guides of associated switch, hub, or fiber products, determine that a problem exists between the drive, drive cable, and the device to which they attach. Try to isolate which part of the Storage Area Network (SAN) is experiencing problems.
6. Using this guide or the service guides of associated switch, hub, or fiber products, verify that the SAN configurations are correct (such as switch zoning for drive sharing).
7. Obtain all errors reported by the drive to the server (see "Using Sense Data" on page 79), then contact your OEM Product Application Engineer (PAE) for error analysis.

Resolving Media-Related Problems

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

- Test Cartridge & Media diagnostic that verifies whether a suspect cartridge and its magnetic tape are acceptable for use.
- Statistical Analysis and Reporting System (SARS) to 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 "TapeAlert Flags," on page 111).

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, use the following procedure:

Attention
When you run the Test Cartridge & Media diagnostic, data on the suspect tape is overwritten. Use only a scratch data cartridge to run the test.

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 & Media diagnostic (see "Function Code E: Test Cartridge & Media" on page 40).
2. If the Test Cartridge & Media diagnostic fails, replace the media. If it runs successfully, clean the drive and run the drive diagnostics (see "Cleaning the Drive Head" on page 31 and "Function Code 1: Run Drive Diagnostics" on page 33. If the drive diagnostics run successfully, perform the operation that produced the initial media error.

If it is not possible to run the tape cartridge in a different drive, perform the following procedures:

1. Clean the failing drive and run the drive diagnostics (see "Cleaning the Drive Head" on page 31 and "Function Code 1: Run Drive Diagnostics" on page 33). If the drive diagnostics run successfully, run the Test Cartridge & Media diagnostic (see "Function Code E: Test Cartridge & Media" on page 40).
2. If the Test Cartridge & Media diagnostic fails, replace the media. If it runs successfully, perform the operation that produced the initial drive error.

Servicing the Drive

Removing a SCSI Drive from an Enclosure

To remove a SCSI 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. Disconnect the power cable from the enclosure and the electrical outlet.
4. Remove the cover of the enclosure.
5. Disconnect the internal power cable from the power connector (see **3** in Figure 4 on page 3).
6. If connected, disconnect the internal LDI (RS-422) cable from the LDI (RS-422) connector (see **4** in Figure 4 on page 3).
7. Disconnect the internal SCSI cable from the SCSI connector (see **1** in Figure 4 on page 3).
8. Perform one of the following procedures on the SCSI ID connector (see **2** in Figure 4 on page 3):
   - If your enclosure uses an internal SCSI ID switch, disconnect it from the SCSI ID connector.
   - If your enclosure uses jumpers to set the SCSI ID, do not remove them from the connector.
9. Remove the mounting screws from the side brackets of the chassis (see **2** in Figure 10 on page 23).
10. Remove the drive from the enclosure.
11. To reassemble, reverse these steps.

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Removing a Fibre Channel Tape Drive from an Enclosure

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

1. Ensure that the tape drive does not contain a tape cartridge.
2. Deconfigure the drive from the server, switch, or hub (for instructions, see the documentation for these devices).
3. Turn off the power to the enclosure. Disconnect the power cable from the enclosure and the electrical outlet.
4. Disconnect the internal power cable from the power connector (see **1** in "Rear View of the Fibre Channel Drive" on page 4).
5. If connected, disconnect the internal LDI (RS-422) cable from the LDI (RS-422) connector (see **7** in "Rear View of the Fibre Channel Drive" on page 4).
6. Disconnect the internal fiber cable from the Fibre Channel connector (see **5** in "Rear View of the Fibre Channel Drive" on page 4).
7. Disconnect the LID/status connector (see **3** in "Rear View of the Fibre Channel Drive" on page 4).
8. Disconnect the FC configuration/status connector (see **4** in "Rear View of the Fibre Channel Drive" on page 4).
9. Remove the mounting screws from the side brackets of the chassis (see **2** in Figure 10 on page 23).
10. Remove the tape drive from the enclosure.
11. To reassemble, reverse these steps.

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

- 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.

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.
2. If you have not already done so, attempt to remove the cartridge by power cycling the drive. Look for the drive to attempt a mid-tape recovery.

   Note: It can take as long as five minutes for the cartridge to rewind and unload.
3. If the cartridge unloads, inform the operator that the cartridge is unloaded. If the cartridge does not unload, continue with this procedure.

Recommended Tools

- 2.5 mm offset hex wrench (do not use magnetized wrench)
- #1 Phillips screwdriver
- ESD Kit
- Flashlight (optional)
- #1 Flathead screwdriver (optional)

Beginning Procedure

__ Step 1. Refer to the enclosure documentation for instructions on removing the drive.

__ Step 2. Place the drive on a non-slip, sturdy work surface.

__ Step 3. Ground yourself to the drive by using an ESD Kit.

__ Step 4. Remove the cover of the drive by performing the following steps:

a. Using a Phillips screwdriver, remove the three screws and washers (see **1** in Figure 30) that secure the bezel **2** to the internal drive, then remove the bezel.

b. Remove the cover of the internal drive by performing the following steps:

1) Remove the four cover-mounting screws and washers **3** .

2) Remove the cover by lifting it up.

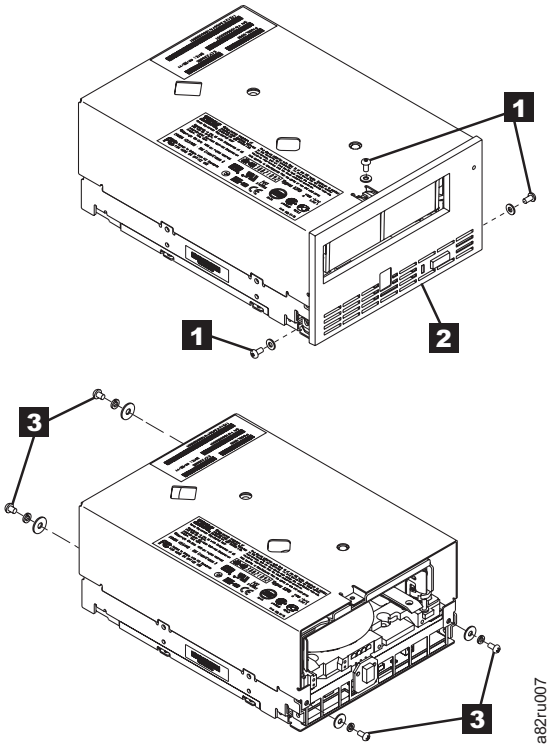

Figure 30. Removing the cover from the internal drive

__ Step 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 take up 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 take up reel. The leader block is positioned in the take up 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 take up reel. Test the drive after the procedure is completed.
- **Tape tangled along tape path** - Tape appears to be tangled and damaged but in tact. 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

__ Step 1. With the front of the drive facing you, pull an arm's length of tape out of the take up reel from the left side of the drive.

__ Step 2. From the take up reel, thread tape around the rear of the tape path and over the head rollers on the left side of the drive.

__ Step 3. Set the drive on its left side with the head and tape path facing up.

__ Step 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).

__ Step 5. From the bottom of the drive, insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle.

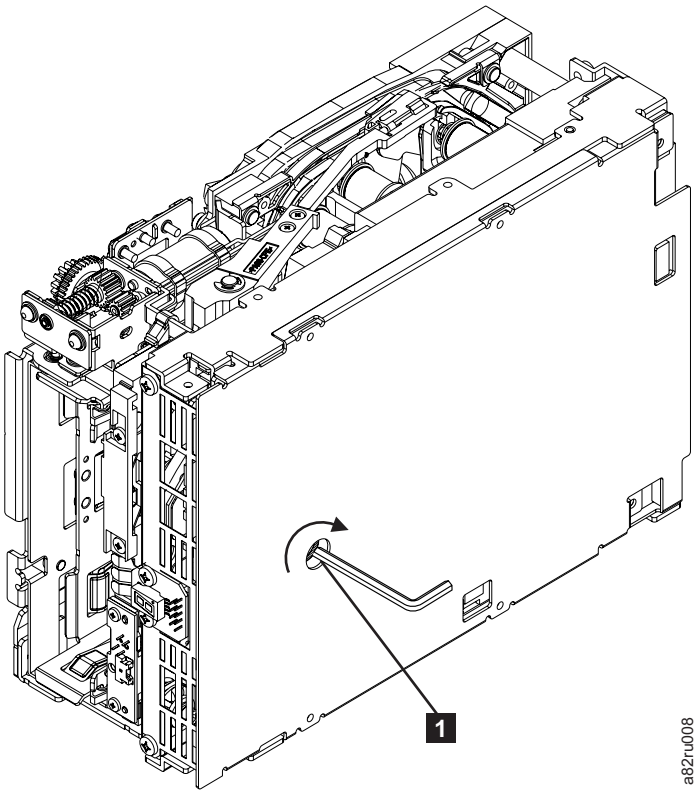

Figure 31. Using hex wrench to rewind tape into cartridge

__ Step 6. Turn the supply reel clockwise, allowing the moistened tape to adhere to the hub as it winds around the supply reel (inside the cartridge).

__ Step 7. 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.

__ Step 8. Reassemble the drive, reversing the steps in "Beginning Procedure" on page 96.

__ Step 9. Allow the drive to perform mid-tape recovery. This takes several minutes. When this activity completes, the cartridge ejects automatically.

__ Step 10. Test the drive (see "Function Code 1: Run Drive Diagnostics" on page 33) to determine if it should be replaced.

Tape Pulled from or Broken near Leader Pin

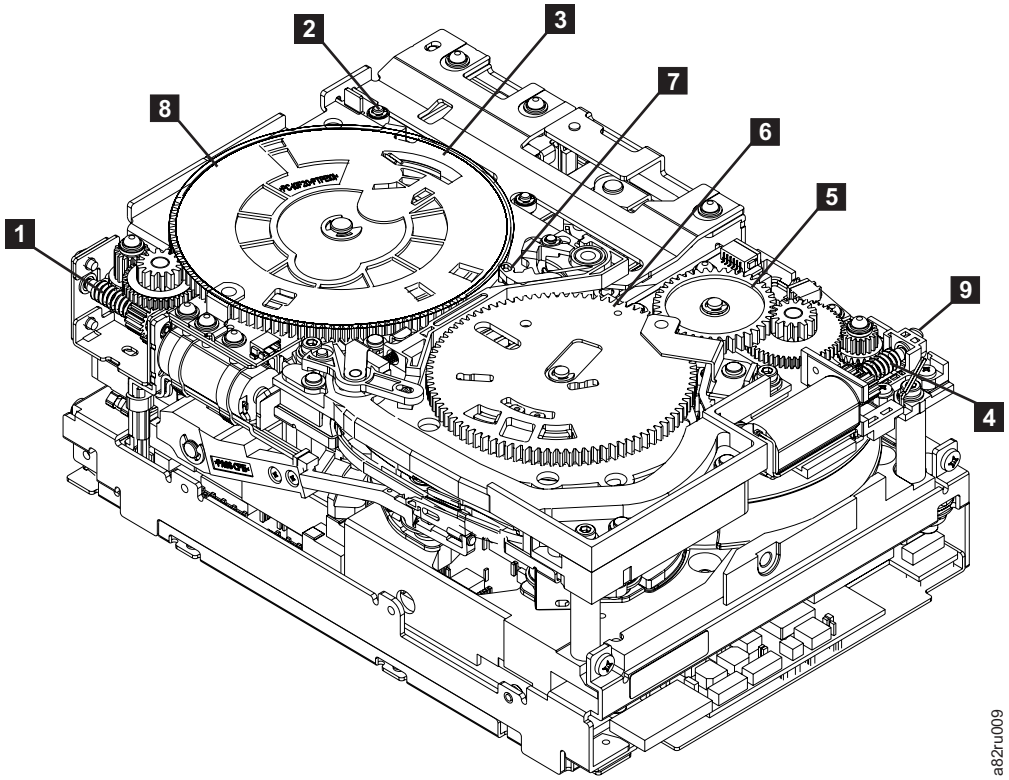

Figure 32. Drive with cover removed to reveal gear train.

1	Loader motor worm gear	6	Threader mechanism gear
2	Cartridge loader tray guide bearing	7	Lever
3	Rotator stub	8	Loader mechanism gear
4	Threader motor worm gear	9	Threader worm gear
5	Threader intermediate gear		

__ Step 1. From the left side of the drive, pull out tape from the take up reel.

Note: If there is more than approximately 0.6 m (2 ft.) of tape on the take up reel, go to "Tape Broken in Mid-tape" on page 101.

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

__ Step 3. Locate the threader motor worm gear (4 in Figure 32) the rear of the drive. You can either:

a. Use your finger to rotate the threader motor worm gear and slowly rotate the threader mechanism gear (6 in Figure 32) clockwise; or

b. Use a #1 flathead screwdriver to turn the threader worm gear (9 in Figure 32) clockwise.

This rotates the threader motor worm gear (4 in Figure 32) clockwise, drawing the tape leader block assembly (LBA) into the cartridge.

__ Step 4. As the LBA is secured in the cartridge, you should hear the LBA retention spring clips click into place. If you do not hear the click, continue rolling until the threader motor worm gear (4 in Figure 32 on page 99) 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 by using a hex wrench as shown in Figure 31 on page 98.

__ Step 5. Notice the following:

a. Loader mechanism gear (8 in Figure 32 on page 99) nearest the front of the drive that actuates the cartridge loader mechanism

b. Position of the rotator stub (3 in Figure 32 on page 99).

c. Front loader motor worm gear (1 in Figure 32 on page 99). Rotating this gear allows the loader mechanism gear (8 in Figure 32 on page 99) to turn.

__ Step 6. Rotate the loader motor worm gear (1 in Figure 32 on page 99) to turn the loader mechanism gear (6 in Figure 32 on page 99) counterclockwise. Continue turning until the rotator stub (3 in Figure 32 on page 99) loses contact with the lever (7 in Figure 32 on page 99). This releases the LBA leader pin.

__ Step 7. Rotate the threader motor worm gear (4 in Figure 32 on page 99) to turn the threader mechanism gear (6 in Figure 32 on page 99) counterclockwise. This moves the LBA out of the cartridge and past the read/write head. Stop this rotation when the LBA is near the tape guide roller nearest the rear of the drive (1 in Figure 33).

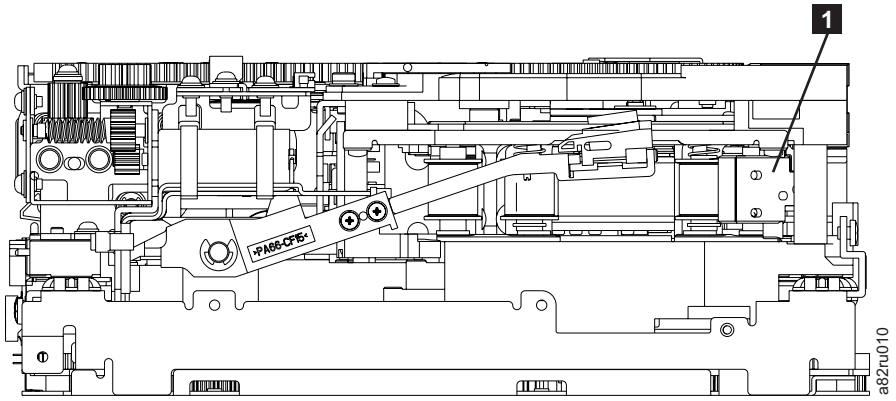

Figure 33. Leader Block Assembly (LBA)

__ Step 8. Continue rotating the loader motor worm gear (1 in Figure 32 on page 99) until the rotate stub (3 in Figure 32 on page 99) is positioned as shown. Notice that the rotator stub (3 in Figure 32 on page 99) is nearly aligned with the cartridge loader tray guide bearing (2 in Figure 32 on page 99).

__ Step 9. Remove the cartridge from the cartridge loader tray.

__ Step 10. Reassemble the drive by reversing the procedure in Step 4 on page 96 in Beginning Procedure.

__ Step 11. Refer to the appropriate procedure to install the new drive and return the failed drive.

Tape Broken in Mid-tape

__ Step 1. With the front of the drive facing you, pull an arm's length of tape out of the take up reel from the left side of the drive.

Note: If there is less than approximately 5 cm (2 in.) of tape on the take up reel, go to "Tape Pulled from or Broken near Leader Pin" on page 99.

__ Step 2. From the supply reel inside the cartridge, pull approximately 0.3 m (1 ft.) of tape.

__ Step 3. From the take up reel, thread tape around the rear of the tape path and over the head rollers on the left side of the drive.

__ Step 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.

__ Step 5. Set the drive on its left side with the head and tape path facing up.

__ Step 6. From the bottom of the drive, locate the access hole (**1** in Figure 34) in the bottom cover. Insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle. begin spooling tape back into the cartridge by turning the hex wrench clockwise.

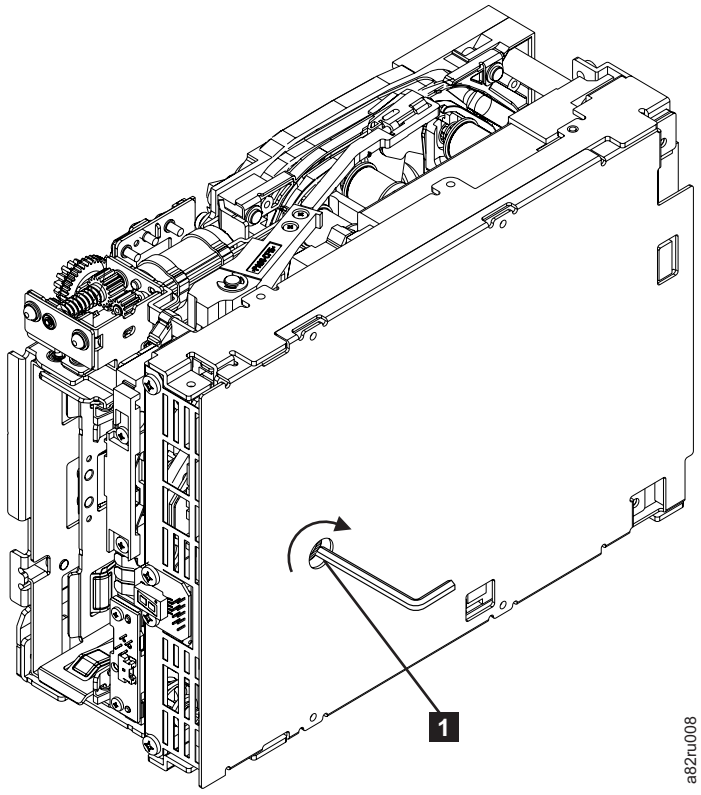

Figure 34. Using hex wrench to rewind tape into cartridge

__ Step 7. Turn the supply reel 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. Ensure that you do not stretch the tape.

__ Step 8. Reassemble the drive by reversing the procedure in Step 4 on page 96 in Beginning Procedure.

__ Step 9. Allow the drive to perform mid-tape recovery. This takes several minutes. When this activity completes, the cartridge ejects automatically.

__ Step 10. Test the drive (see "Function Code 1: Run Drive Diagnostics" on page 33) to determine if it should be replaced.

Tape Tangled along Tape Path

__ Step 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 98
- "Tape Pulled from or Broken near Leader Pin" on page 99

--OR--

"Tape Broken in Mid-tape" on page 101

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

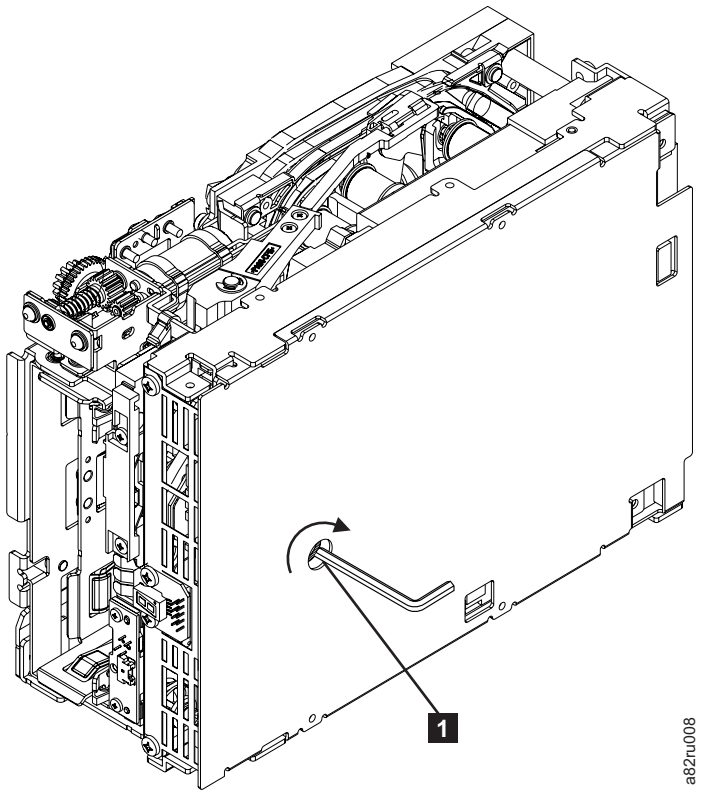

Figure 35. Using hex wrench to rewind tape into cartridge

__ Step 3. From the bottom of the drive, locate the access hole (**1** in Figure 35).

__ Step 4. Insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle. Begin spooling the tape back into the cartridge by turning the hex wrench clockwise.

__ Step 5. 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.

__ Step 6. Locate the threader motor worm gear (4 in Figure 36) on the rear of the drive. You can either:

a. Use your finger to rotate the treader motor worm gear and slowly rotate the threader mechanism gear (6 in Figure 36) clockwise; OR

b. Use a #1 flathead screwdriver to turn the worm gear (9 in Figure 36) clockwise.

This rotates the threader motor worm gear (4 in Figure 36) clockwise, drawing the LBA into the cartridge.

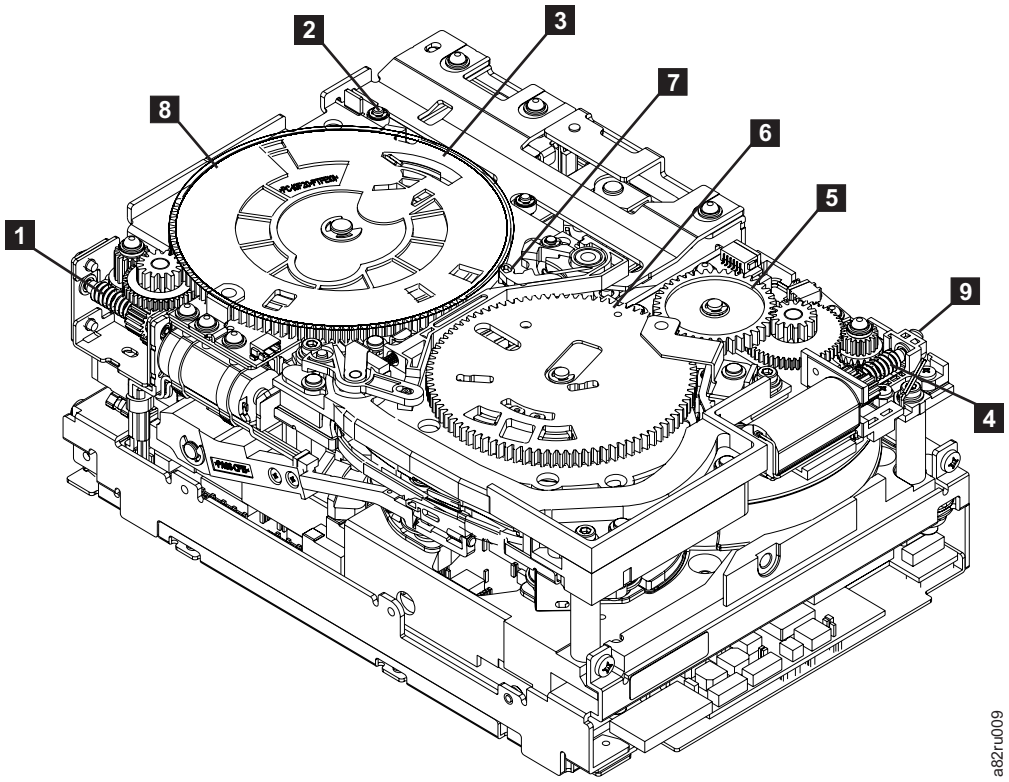

Figure 36. Drive with cover removed to reveal gear train.

1	Loader motor worm gear	6	Threader mechanism gear
2	Cartridge loader tray guide bearing	7	Lever
3	Rotator stub	8	Loader mechanism gear
4	Threader motor worm gear	9	Threader worm gear
5	Threader intermediate gear		

__ Step 7. As the tape leader block assembly (LBA) is secured in the cartridge, you should hear the LBA retention spring clips click into place. If you do not hear the click, continue rolling until the threader motor worm gear (4 in Figure 36) 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 by using a hex wrench as shown in Figure 35 on page 102.

__ Step 8. Notice the:

a. Loader mechanism gear (**6** in Figure 36 on page 103) nearest the front of the drive that actuates the cartridge loader mechanism.

b. Position of the rotate stub (**3** in Figure 36 on page 103).

c. Front loader motor worm gear (**1** in Figure 36 on page 103). Rotating this gear allows the loader mechanism gear (**8** in Figure 36 on page 103) to turn.

__ Step 9. Rotate the loader motor worm gear (**1** in Figure 36 on page 103) to turn the threader mechanism gear (**6** in Figure 36 on page 103) counterclockwise. Continue turning until the rotator stub (**3** in Figure 36 on page 103) loses contact with the lever (**7** in Figure 36 on page 103). This releases the LBA leader pin.

__ Step 10. Rotate the threader motor worm gear (**4** in Figure 36 on page 103) to turn the threader mechanism gear (**6** in Figure 36 on page 103) counterclockwise. This moves the LBA out of the cartridge and past the read/write head. Stop this rotation when the LBA is near the tape guide roller nearest the rear of the drive shown as **1** Figure 37.

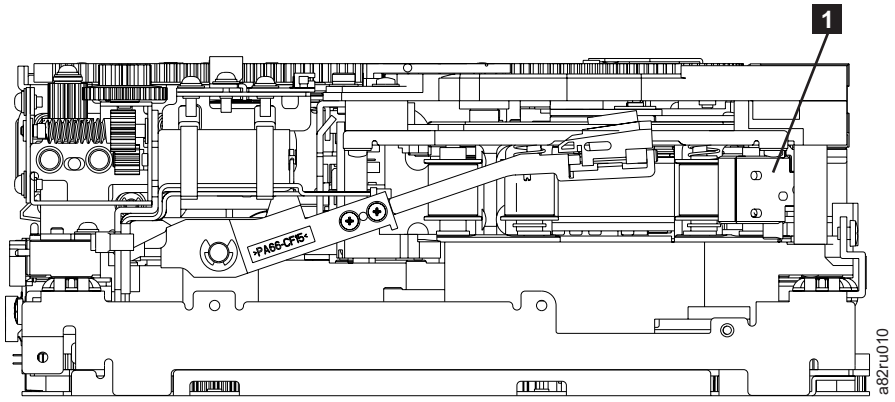

Figure 37. Leader Block Assembly (LBA)

__ Step 11. Continue rotating the loader motor worm gear (**1** in Figure 36 on page 103) until the rotator stub (**3** in Figure 36 on page 103) is positioned as shown. Notice that the rotator stub (**3** in Figure 36 on page 103) is nearly aligned with the cartridge loader tray guide bearing (**2** in Figure 36 on page 103).

__ Step 12. Remove the cartridge from the cartridge loader tray.

__ Step 13. Reassemble the drive by reversing the procedure in Step 4 on page 96 in Beginning Procedure.

__ Step 14. Refer to the appropriate procedure to install the new drive and return the failed drive.

No Apparent Failure or Damage to Tape

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

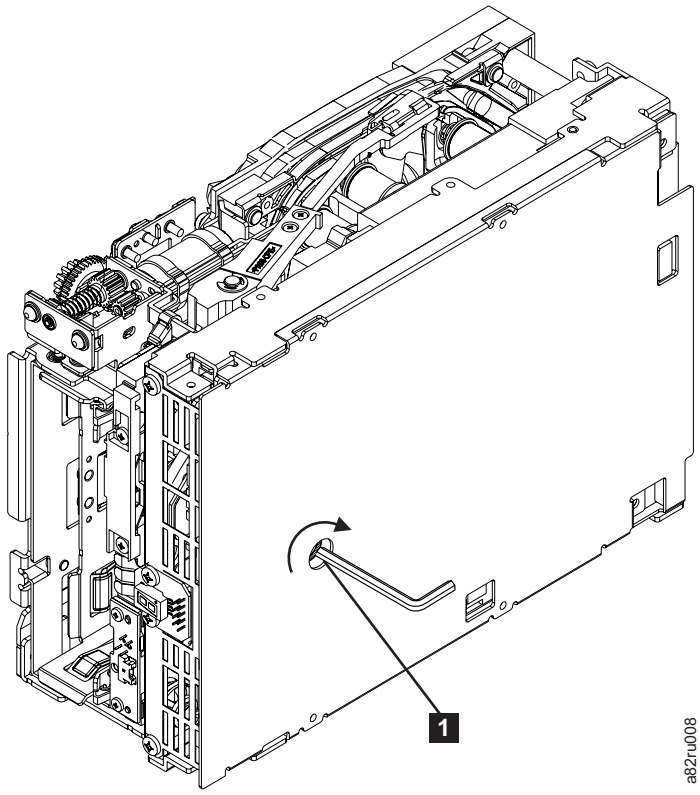

Figure 38. Using hex wrench to rewind tape into cartridge

__ Step 2. From the bottom of the drive, locate the access hole (**1** in Figure 38).

__ Step 3. Insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle. Begin spooling the tape back into the cartridge by turning the hex wrench clockwise.

__ Step 4. 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.

__ Step 5. Locate the threader motor worm gear (**4** in Figure 39 on page 106) on the rear of the drive. You can either:

a. Use your finger to rotate the threader motor worm gear and slowly rotate the threader mechanism gear (**6** in Figure 39 on page 106) clockwise;

--OR--

b. Use a #1 flathead screwdriver to turn the threader worm gear (**9** in Figure 39 on page 106) clockwise.

This rotates the threader motor worm gear (**4** in Figure 39 on page 106) clockwise, drawing the LBA into the cartridge.

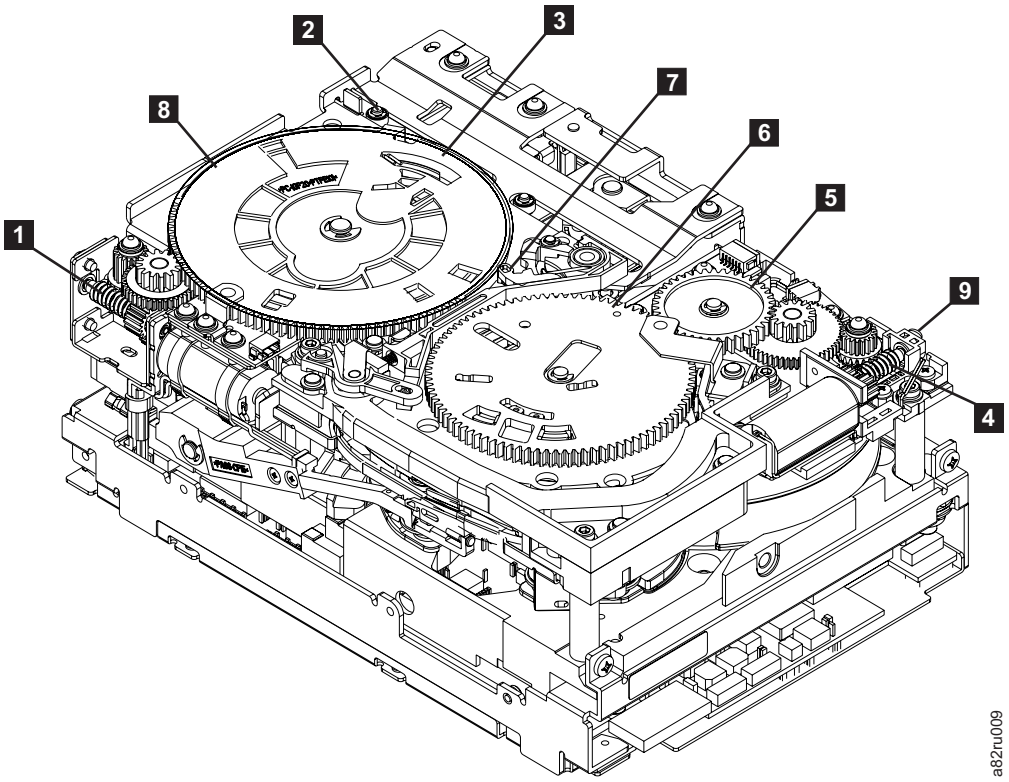

Figure 39. Drive with cover removed to reveal gear train.

1	Loader motor worm gear	6	Threader mechanism gear
2	Cartridge loader tray guide bearing	7	Lever
3	Rotator stub	8	Loader mechanism gear
4	Threader motor worm gear	9	Threader worm gear
5	Threader intermediate gear		

__ Step 6. As the tape leader block assembly (LBA) is secured in the cartridge, you should hear the LBA retention spring clips click into place. If you do not hear the click, continue rolling until the threader motor worm gear (4 in Figure 39) 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 by using a hex wrench as shown in Figure 38 on page 105.

__ Step 7. Notice the:

a. Loader mechanism gear (6 in Figure 39) nearest the front of the drive that actuates the cartridge loader mechanism.

b. Position of the rotate stub (3 in Figure 39).

c. Front loader motor worm gear (1 in Figure 39). Rotating this gear allows the loader mechanism gear (8 in Figure 39) to turn.

__ Step 8. Rotate the loader motor worm gear (1 in Figure 39) to turn the threader mechanism gear (6 in Figure 39) counterclockwise. Continue turning until the rotator stub (3 in Figure 39) loses contact with the lever (7 in Figure 39). This releases the LBA leader pin.

__ Step 9. Rotate the threader motor worm gear (**4** in Figure 39 on page 106) to turn the threader mechanism gear (**6** in Figure 39 on page 106) counterclockwise. This moves the LBA out of the cartridge and past the read/write head. Stop this rotation when the LBA is near the tape guide roller nearest the rear of the drive shown as **1** Figure 40.

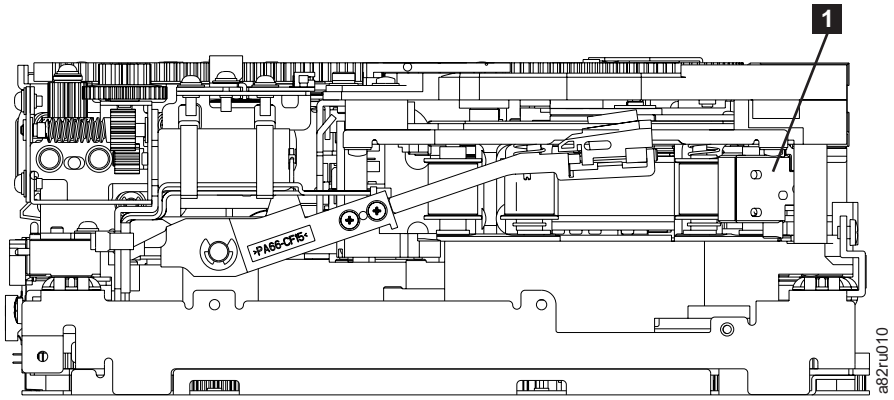

Figure 40. Leader Block Assembly (LBA)

__ Step 10. Continue rotating the loader motor worm gear (**1** in Figure 39 on page 106) until the rotator stub (**3** in Figure 39 on page 106) is positioned as shown. Notice that the rotator stub (**3** in Figure 39 on page 106) is nearly aligned with the cartridge loader tray guide bearing (**2** in Figure 39 on page 106).

__ Step 11. Remove the cartridge from the cartridge loader tray.

__ Step 12. Reassemble the drive by reversing the procedure in Step 4 on page 96 in Beginning Procedure.

__ Step 13. Refer to the appropriate procedure to install the new drive and return the failed drive.

Parts List

Table 16 lists the tools and supplies that you can use with the IBM TotalStorage Ultrium Tape Drive. To order tools and supplies, contact your OEM Product Application Engineer (PAE) or visit the web at `http://www.ibm.com/storage/lto`.

Table 16. Tools and supplies for the IBM TotalStorage Ultrium Tape Drive

IBM Part Number	Product Description
08L9129	Leader pin reattachment kit
- -	2.5-mm allen wrench (procure locally)
- -	Plastic or blunt-end tweezers (procure locally)
24R1922	IBM TotalStorage LTO Ultrium 400 GB Data Cartridge
35L2087	IBM TotalStorage Ultrium Cleaning Cartridge (Universal)
35L1782	SCSI Y-cable
19P0051	0.5-m (1.6-ft) SCSI cable
19P0052	5.0-m (16-ft) SCSI cable
19P0053	10-m (32-ft) SCSI cable
19P0054	25-m (82-ft) SCSI cable
19K1252	5-m (16-ft) fiber cable
11P3880	13-m (43-ft) fiber cable
19K1253	25-m (82-ft) fiber cable
11P3884	61-m (200-ft) fiber cable
11P3885	Custom-length fiber cable
11P3847	Single port Fibre Channel wrap plug
19P5424	Fibre Channel duplex adapter

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Appendix. 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 TotalStorage Ultrium Tape Drive.

Table 17. 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. If Flag 4 is not set, see error code 6 in Table 15 on page 75.
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 55). If Flag 4 is also set, the cartridge is defective. Replace the tape cartridge. If Flag 4 is not set, see error code 6 in Table 15 on page 75.
8	08h	Not data grade	Set when severe servo errors occur while loading a tape cartridge.	Replace the tape cartridge. If this error occurs with multiple tapes, see error code 6 in Table 15 on page 75.
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 55).
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.

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Table 17. Supported TapeAlert Flags (continued)

Flag Number	Flag Parameter (in hex)	Flag	Description	Action Required
12	0Ch	Unsupported format	Set when you load an unsupported cartridge type into the drive or when the cartridge format has been corrupted.	Use a supported tape cartridge.
15	0Fh	Cartridge memory chip failure	Set when a cartridge memory (CM) failure is detected on the loaded tape cartridge.	Replace the cartridge. If this error occurs on multiple tapes, see error code 6 in Table 15 on page 75.
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 31.
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 31.
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 the error code from the single-character display, library user interface, or SCSI drive sense data. See Table 15 on page 75.
31	1Fh	Hardware B	Set when the drive fails its internal self tests.	Use the error code on the single-character display, library user interface, or SCSI drive sense data. See Table 15 on page 75.
32	20h	Interface	Set when the drive detects a problem with the SCSI or LDI (RS-422) interface.	Locate error code 8 or 9 in Table 15 on page 75.
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.

Table 17. Supported TapeAlert Flags (continued)

Flag Number	Flag Parameter (in hex)	Flag	Description	Action Required
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 10).	See error code 1 in Table 15 on page 75.
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 10).	See error code 2 in Table 15 on page 75.
39	27h	Diagnostics required	Set when the drive detects a failure that requires diagnostics to isolate the problem.	See error code 6 in Table 15 on page 75.
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.

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Getting Help

If you need assistance while installing or operating your IBM TotalStorage Ultrium Tape Drive, contact your OEM Product Application Engineer (PAE).

Warranty

The warranty for this product is negotiated on a per-customer basis.

Glossary

This glossary defines the special terms, abbreviations, and acronyms that are used in this publication.

Numbers and Symbols

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.

µs. Abbreviation for microsecond or one millionth of a second (.000001 s).

A

A. See *ampere.*

acclimation time. Pertaining to the drive, the amount of time that is needed for the drive to adjust to change in temperature, altitude, climate, or environment.

active. The condition that the SCSI bus is in when a server is trying to use one or more devices on the bus.

adapter. See *adapter card.*

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

AL_PA. See *Arbitrated Loop Physical Address.*

amp. See *ampere.*

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

American National Standards Institute. A private, non-profit organization that gathers and disseminates information about standards and conformity issues that affect the business, government, and people of the United States.

ANSI. See *American National Standards Institute.*

autosense data. Sent by the drive to the server, sense data that automatically accompanies a Check Condition in response to an error. The server does not need to send a REQUEST SENSE command to get the sense data. Autosense data is available only in the Fibre Channel version of the drive (Model T400F).

B

backhitch. During tape movement (reading or writing), the condition that occurs when the tape drive must stop the tape, reverse it, and restart tape motion due to certain events. A backhitch usually occurs when the server's net (compressed) data rate is less than the drive's data rate.

backreflection. Pertaining to instances where light is launched into an optical fiber in a forward direction, the light that is returned to the launch point in the reverse direction.

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

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

bar code. A code that represents characters by sets of parallel bars of varying thickness and separation. The bars are read optically by transverse scanning.

bar code label. A slip of 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.

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

bit. The smallest unit of data in a computer. A bit (short for binary digit) has a single binary value (either 0 or 1). Computers store data and execute instructions in bit multiples called bytes. In most computer systems, there are eight bits in a byte.

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

bus. See *SCSI bus.*

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

C

C. See *Celsius.*

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

cartridge. See *tape cartridge*.

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

cartridge 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.

cartridge memory. See *LTO cartridge memory*.

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

channel calibration. A feature of the drive by which it 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. Channel calibration optimizes system performance.

circuit board. A thin sheet on which chips and other electronic components are placed. Computers consist of one or more boards, often called cards or adapters.

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

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

command time-out. Following the issuance of a command, a period of time during which it is determined that there is a bad connection between the server and the drive.

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

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

contiguous. Touching along a boundary or at a point.

core. The light-conducting central portion of an optical fiber. The core is composed of material that has a higher index of refraction than the cladding (the material that surrounds the core).

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

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

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

D

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

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

data compression. See *compression*.

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

dc. Direct current.

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

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

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

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

diagnostic cartridge. A tape cartridge that enables the detection and isolation of errors in programs and faults in equipment.

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

director-class switch. A high-end switch that includes such qualities as fault tolerance, high throughput, high reliability, port density, and so forth.

drive. See *IBM TotalStorage Ultrium Tape Drive*.

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

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

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

dump. See *drive dump*.

duplex. See *duplex transmission*.

duplex adapter. A mechanism that allows a device to send and receive communication at the same time.

duplex transmission. Transmission in both directions, either one direction at a time (half-duplex) or both directions simultaneously (full-duplex).

E

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*.

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

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

F

feature switch. Located under the drive, a bank of eight micro switches that can be manually toggled on or off to activate or deactivate different characteristics of the drive.

fiber optic cable. The medium by which light is transmitted through fibers or thin rods of glass or some other transparent material of high refractive index.

fiber optics. A branch of optics dealing with the transmission of light through fibers or thin rods of glass or some other transparent material of high refractive index.

field microcode replacement tape. A tape cartridge that contains new or revised firmware (microcode) for the drive.

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

filemark. Located on the magnetic tape within a tape cartridge, a recorded element that typically marks the organizational boundaries in a serial file structure (such as directory boundaries) and that is requested to be written or read by the server.

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

FMR tape. See *field microcode replacement tape*.

foot. A unit of length comprising 12 inches.

G

Gb. See *gigabit*.

GB. See *gigabyte*.

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

Generation2. The informal name for the drive, which is the second-generation version of the IBM Ultrium Internal Tape Drive (Generation 1). The Generation 2 drive has a native storage capacity of up to 200 GB per cartridge and a native sustained data transfer rate of 35 MB per second.

Generation 3. The informal name for the drive, which is the third-generation version of the IBM Ultrium Internal Tape Drive (Generation 1). The Generation 3 drive has a native storage capacity of up to 400 GB per cartridge and a native sustained data transfer rate of 135 MB per second.

gigabit (Gb). 1 000 000 000 bits. 1 Gb equals 100 MB.

gigabyte (GB). 1 000 000 000 bytes.

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

H

hard addressing. Pertaining to the Fibre Channel drive (Model T400F), a method that identifies the drive's LID and, consequently, its AL_PA (the AL_PA enables the drive to communicate with other devices).

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

head. See *drive head*.

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

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

hot-pluggable. Pertaining to the drive, the ability to remove the drive from an enclosure while the enclosure is powered-on.

hub. A communications device to which nodes on a multi-point bus or loop are physically connected. Hubs are commonly used in Fibre Channel networks to improve the manageability of physical cables. They maintain the logical loop topology of the network of which they are a part, while creating a "hub and spoke" physical star layout. Unlike switches, hubs do not aggregate bandwidth. They typically support the addition or removal of nodes from the bus while it is operating.

I

ID. Identifier.

in. See *inch*.

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

initiator. In SCSI terms, a SCSI device that requests an I/O process to be performed by another SCSI device (a target). In many cases, an initiator can also be a target.

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

insertion guide. On the surface of the IBM LTO Ultrium Tape Cartridge, a large, notched area that prevents you from inserting the cartridge incorrectly.

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

Internet. The worldwide collection of interconnected networks that use the Internet suite of protocols and permit public access.

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

I/O. See *input/output*.

J

J2 connector. Located at the rear of the drive, the connector for the LDI (or RS-422) interface.

J33 connector. Located at the rear of the drive, a single connector that contains the connections for the SCSI signals and grounds, SCSI ID, SCSI bus termination, and drive power.

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

L

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

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

LAN. See *local area network*.

LDI. See *Library/Drive Interface*.

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

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

LED. See *light-emitting diode*.

Library/Drive Interface. An electrical interface standard that is approved by the Electronic Industries Association (EIA) for connecting serial devices.

Library/Drive Interface (LDI) connector. Located at the rear of the drive, the connector to which the internal LDI cable of an enclosure connects. The connection enables serial devices to communicate with the drive.

LID. See *loop identifier*.

LID/status connector. See *loop identifier (LID)/status connector*.

link services. The speed and topology of your Fibre Channel drive. If you choose not to alter the link services, the drive defaults to a negotiated speed and operation in an FC-AL topology with a direct connection to the server.

LIP. See *loop initialization protocol*.

light-emitting diode (LED). A semiconductor diode that emits light when subjected to an applied voltage and that is used in an electronic display.

Linear Tape-Open (LTO). A type of tape storage technology developed by the IBM Corporation,

Hewlett-Packard, and Seagate. LTO technology is an "open format" technology, which means that its users have multiple sources of product and media. The "open" nature of LTO technology enables compatibility between different vendors' offerings by ensuring that vendors comply with verification standards.

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

load and unload cycle. The act of inserting a cartridge into a tape drive, loading the tape to load point, rewinding the tape into the cartridge, and ejecting the cartridge from the drive.

local area network (LAN). A computer network that is located on a user's premises within a limited geographical area. The network consists of a set of devices that are connected to one another for communication and that can be connected to a larger network. Communications are limited to a moderate-sized geographic area (1 to 10 km) such as a single office building, warehouse, or campus.

log sense data. See *SCSI log sense data*.

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

loss. In fiber optics technology, the amount of a signal's power (expressed in dB) that is lost in connectors, splices, or fiber defects.

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

LTO. See *Linear Tape-Open*.

LTO 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.

LTO-CM. See *LTO cartridge memory*.

LTO-DC. See *LTO Data Compression*.

LTO Data Compression (LTO-DC). A method that compresses a server's data before the drive writes it to tape. LTO-DC detects but does not recompress or test record boundaries and file markers (which are encoded as control symbols). It also allows switching between compression and no compression within the data stream, which prevents data from expanding when the drive compresses random or encrypted data.

LVD. See *Low Voltage Differential*.

M

m. See *meter*.

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

maintenance mode. The state of operation in which the drive must be before it can run diagnostics, verify write and read operations, verify a suspect tape cartridge, update its own firmware, and perform other diagnostic and maintenance functions.

MB. See *megabyte*.

media. The plural of *medium*.

media capacity. See *capacity*.

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

megabyte (MB). 1 000 000 bytes.

metal particle tape. In the LTO Ultrium Tape Cartridge, tape that uses very small, pure metal particles (rather than oxide coatings) in the magnetic layer.

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

micrometer. One millionth of a meter (.000001 m). Synonymous with *micron*. Abbreviated as µm.

micron. One millionth of a meter (.000001 m). Synonymous with *micrometer*. Abbreviated as µm.

microsecond. One millionth of a second (.000001 s). Abbreviated as µs.

millimeter (mm). One thousandth of a meter (.001 m).

millisecond (ms). One thousandth of a second (.001 s).

mm. See *millimeter*.

Model T800. The version of the IBM TotalStorage Ultrium Tape Drive that uses the SCSI interface.

ms. See *millisecond*.

multimode fiber. An optical fiber that has a core that is large enough to propagate more than one electromagnetic wave of light. The typical diameter is 62.5 micrometers.

N

N/A. Not applicable.

native storage capacity. The amount of data that can be stored without compression on a tape cartridge.

native sustained data transfer rate. See *data transfer rate*.

negotiated speed. Defined by Fibre Channel Standards, the algorithm that ensures the highest speed that is supported by both the drive and the port to which it attaches. This negotiation occurs at power up and whenever a catastrophic link event occurs, such as a cable pull that exceeds the timeouts that are specified in the Standards. The speed is negotiated when the first possibility of a new connection (for example, a fiber cable) is established, and is maintained until the Fibre Channel connection is terminated. The speed is not renegotiated when a new device is attached to a loop.

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

network server. In a local area network, a personal computer that provides access to files for all of the workstations in the network.

ntutil. Created by IBM, a utility program for LTO devices that connect to Windows NT® and Windows 2000. *ntutil* provides problem determination for hardware or connections, assists with device and medium changer recognition, forces dumps, loads new firmware, sends and receives SCSI commands to and from the hardware, and obtains SCSI sense data to use in resolving errors.

NVRAM. Non Volatile Random Access Memory.

O

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

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

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

Open Systems. Computer systems whose standards are not proprietary.

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

operating system. The master computer control program that translates the user's commands and allows software application programs to interact with the computer's hardware.

optical transceiver. A device that both transmits and receives analog or digital signals over a light source.

P

panic reset. The act of pressing and holding the Unload Button for 10 seconds to force a reset of a nonresponsive drive.

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

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

point-to-point connection. Pertaining to data transmission between two locations without the use of any intermediate display station or computer.

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

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

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

power-off. To remove electrical power from a device.

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

private device. A device that is attached directly to a server and is not connected to a fabric or switch. A private device can be part of an arbitrated loop topology or point-to-point topology.

protocol. The meanings of, and the sequencing rules for, requests and responses that are used to manage a network, transfer data, and synchronize the states of network components.

public device. A device that is attached to a fabric or switch, and can communicate to that fabric or switch. A public device can be part of an arbitrated loop topology or point-to-point topology.

Q

quiesce. To put a device into a temporarily inactive or inhibited state, but not remove it from the server.

R

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

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

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

record boundaries. The fixed limits of a record.

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

repeater. A device that regenerates signals to extend the range of transmission between data stations or to interconnect two branches. A repeater is a node of a local area network.

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

LDI wrap plug. A connector mechanism that connects to an LDI port for the purpose of testing the drive's circuitry for the LDI interface.

LDI wrap test. A diagnostic that can be run on the drive to determine whether the circuitry functions properly to and from the LDI connector.

S

s. See *second*.

SAN. See *Storage Area Network*.

SAN Data Gateway. A device that provides Fibre Channel attachment between Open Systems servers and SCSI disk and tape storage systems.

SC. See *subscription channel connector*.

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

SCSI. See *Small Computer Systems Interface*.

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

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

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

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

SCSI ID. The unique address (from 1 to 15) that you assign to an drive that uses a SCSI interface (Model T400).

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

SCSI interface. See *Small Computer Systems Interface*.

SCSI protocol. A set of rules that control the communication and transfer of data between two or more SCSI devices or systems in a communications network.

SCSI ID switch. Located on an enclosure that contains a drive, a mechanism that connects to the drive and allows you to change the drive's SCSI ID without using jumpers.

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

SCSI wrap plug. A connector mechanism that connects to a SCSI port for the purpose of testing the drive's circuitry for the SCSI interface.

SCSI wrap test. A diagnostic that can be run on the drive to determine whether the circuitry functions properly to and from the SCSI connector.

second. One sixtieth of a minute.

selection time-out. Following the selection of an option (for example, a data transfer), the period of time during which it is determined that there is a bad connection between the server and the drive.

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

serial interface. An interface that sequentially or consecutively executes two or more operations in a single device, such as an arithmetic and logic operation.

server. A functional unit that provides services to one or more clients over a network. Examples include a file server, a print server, or a mail server. The IBM @server pSeries, IBM @server iSeries, HP, and Sun are servers. Synonymous with *host*.

ship group. The group of supplies, cords, or documentation that is shipped with the drive.

shipping environment. The temperature, relative humidity rate, and wet bulb temperature of the environment to which the drive is exposed when it is transferred from one location to another.

short-wave cable. In Fibre Channel technology, a laser cable that uses a wavelength of 780 nanometers and is only compatible with multimode fiber.

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

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

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

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

soft addressing. Pertaining to the Fibre Channel drive (Model T400F), a method that enables the drive to dynamically arbitrate its AL_PA with other Fibre Channel devices on the loop. The AL_PA enables the drive to communicate with other devices.

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

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

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

Storage Area Network (SAN). A high-speed subnetwork of shared storage devices. A SAN's architecture makes all storage devices available to all servers on a LAN or WAN. As more storage devices are added to a SAN, they too will be accessible from any server in the larger network. Because stored data does not reside directly on any of a network's servers, server power is used for business applications, and network capacity is released to the end user.

storage environment. The temperature, relative humidity rate, and wet bulb temperature of the environment in which the drive is nonoperational and is being kept for future use.

subscription channel connector (SC). A push-pull type of optical connector that features high density, low loss, low backreflection, and low cost.

switch. A network infrastructure component to which multiple nodes attach. Unlike hubs, switches typically have the ability to switch node connections from one to another. A typical switch can facilitate several simultaneous bandwidth transmissions between different pairs of nodes.

T

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

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

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

tape drive. See *IBM TotalStorage Ultrium Tape Drive*.

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

tapeutil. Created by IBM, a utility program for LTO devices that connect to all supported servers except Windows NT and Windows 2000. *tapeutil* provides service aids for tape subsystems, offers a menu-driven tool for exercising or testing IBM tape and medium changer devices, and includes a command-line interface that is convenient for use in shell scripts.

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

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

TERMPOWER. Electrical power that is provided by a device (such as the drive) to a SCSI terminator so that the SCSI bus can function. To supply TERMPOWER, a jumper must be placed on pin 1 of the SCSI ID connector on the drive.

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

throughput. A measure of the amount of information that is transmitted over a network in a given period of time.

topology. In communications, the physical or logical arrangement of nodes in a network, especially the relationships among nodes and the links between them.

track. A linear or angled pattern of data that is written on a tape surface.

transfer rate. See *data transfer rate*.

U

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

uniform resource locator (URL). The address of an item on the World Wide Web. It includes the protocol followed by the fully qualified domain name (sometimes called the host name) and the request. The web server typically maps the request portion of the URL to a path and file name. For example, if the URL is `http://www.networking.ibm.com/nsg/nsgmain.htm`, the protocol is `http`; the fully qualified domain name is `www.networking.ibm.com`; and the request is `/nsg/nsgmain.htm`.

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

Unload Button. Located at the front of the drive, a push button that, when depressed, rewinds the tape in a cartridge and ejects the cartridge from the drive. The Unload Button can also be used to place the tape drive in maintenance mode, scroll through maintenance functions, exit maintenance mode, force a drive dump, and reset the drive.

URL. See *uniform resource locator*.

utility. See *utility program*.

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

V

Vdc. Volts dc (direct current).

vital product data (VPD). Information about a product. Among other details, the VPD may include a model number, serial number, part number, or level of firmware.

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

VPD. Vital product data.

W

W. Watts.

WAN. See *wide area network*.

watt. The metric unit of power that is required to do work at the rate of one joule per second.

web. See *World Wide Web*.

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

wide area network (WAN). A data communications network that is designed to serve an area of hundreds or thousands of miles (for example, national telephone networks).

World Wide Web. A network of servers that contain programs and files. Many of the files contain hypertext links to other documents that are available through the network.

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

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

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

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

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