

IBM Half High LTO Gen 5 SAS Tape Drive



# Installation and User's Guide

*Machine Type 3628 Model L5X and N5X*

**Important:**

Review the maintenance information in Chapter 3, "Operating the drive" and in the *Warranty information* document that comes with the tape drive, because periodic maintenance is not covered by the IBM warranty. Repairs or exchanges that result from improper maintenance might result in billable service charges.



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# Installation and User's Guide

*Machine Type 3628 Model L5X and N5X*

**Note:** Before using this information and the product it supports, read the general information in Appendix F, "Notices," on page 77, the *Safety Information* and *Environmental Notices and User Guide* documents on the IBM Documentation CD, and the *Warranty information* and *Important notices* documents that come with the product.

**First Edition (May 2011)**

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## Safety

Before installing this product, read the Safety Information.

قبل تركيب هذا المنتج، يجب قراءة الملاحظات الأمنية

Antes de instalar este produto, leia as Informações de Segurança.

在安装本产品之前，请仔细阅读 **Safety Information**  
(安全信息)。

安裝本產品之前，請先閱讀「安全資訊」。

Prije instalacije ovog produkta obavezno pročitajte Sigurnosne Upute.

Před instalací tohoto produktu si přečtěte příručku bezpečnostních instrukcí.

Læs sikkerhedsforskrifterne, før du installerer dette produkt.

Lees voordat u dit product installeert eerst de veiligheidsvoorschriften.

Ennen kuin asennat tämän tuotteen, lue turvaohjeet kohdasta Safety Information.

Avant d'installer ce produit, lisez les consignes de sécurité.

Vor der Installation dieses Produkts die Sicherheitshinweise lesen.

Πριν εγκαταστήσετε το προϊόν αυτό, διαβάστε τις πληροφορίες ασφάλειας  
(safety information).

לפני שתתקינו מוצר זה, קראו את הוראות הבטיחות.

A termék telepítése előtt olvassa el a Biztonsági előírásokat!

Prima di installare questo prodotto, leggere le Informazioni sulla Sicurezza.

製品の設置の前に、安全情報をお読みください。

본 제품을 설치하기 전에 안전 정보를 읽으십시오.

Пред да се инсталира овој продукт, прочитајте информацијата за безбедност.

Les sikkerhetsinformasjonen (Safety Information) før du installerer dette produktet.

Przed zainstalowaniem tego produktu, należy zapoznać się z książką "Informacje dotyczące bezpieczeństwa" (Safety Information).

Antes de instalar este produto, leia as Informações sobre Segurança.

Перед установкой продукта прочтите инструкции по технике безопасности.

Pred inštaláciou tohto zariadenia si pečítajte Bezpečnostné predpisy.

Pred namestitvijo tega proizvoda preberite Varnostne informacije.

Antes de instalar este producto, lea la información de seguridad.

Läs säkerhetsinformationen innan du installerar den här produkten.

---

## Statement 1



### DANGER

Electrical current from power, telephone, and communication cables is hazardous.

To avoid a shock hazard:

- Do not connect or disconnect any cables or perform installation, maintenance, or reconfiguration of this product during an electrical storm.
- Connect all power cords to a properly wired and grounded electrical outlet.
- Connect to properly wired outlets any equipment that will be attached to this product.
- When possible, use one hand only to connect or disconnect signal cables.
- Never turn on any equipment when there is evidence of fire, water, or structural damage.
- Disconnect the attached power cords, telecommunications systems, networks, and modems before you open the device covers, unless instructed otherwise in the installation and configuration procedures.
- Connect and disconnect cables as described in the following table when installing, moving, or opening covers on this product or attached devices.

**To Connect:**

1. Turn everything OFF.
2. First, attach all cables to devices.
3. Attach signal cables to connectors.
4. Attach power cords to outlet.
5. Turn device ON.

**To Disconnect:**

1. Turn everything OFF.
2. First, remove power cords from outlet.
3. Remove signal cables from connectors.
4. Remove all cables from devices.

---

## Statement 3



### CAUTION:

When laser products (such as CD-ROMs, DVD drives, fiber optic devices, or transmitters) are installed, note the following:

- Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.
- Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.



### DANGER

Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.

Laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam.

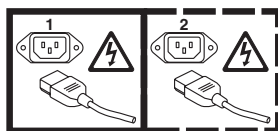
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## Statement 5



### CAUTION:

The power control button on the device and the power switch on the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.





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## Statement 8



**CAUTION:**

Never remove the cover on a power supply or any part that has the following label attached.



Hazardous voltage, current, and energy levels are present inside any component that has this label attached. There are no serviceable parts inside these components. If you suspect a problem with one of these parts, contact a service technician.



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## Preface

This guide describes how to install and use both the internal and external IBM LTO Ultrium 5 Half-High Tape Drive in the following chapters:

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

Chapter 2, “Installing the drive,” on page 9 contains information about unpacking, setup, and configuration for the internal and external tape drives.

Chapter 3, “Operating the drive,” on page 17 describes the Power button, Unload button, and status light, and explains the function of the single-character display. It gives instructions for inserting and removing a tape cartridge, describes methods of updating drive firmware, and explains how to clean the tape drive. It also lists diagnostic and maintenance functions.

Chapter 4, “Using Ultrium media,” on page 41 describes the types of tape cartridges to use with the tape drive and defines the conditions for storing and shipping them. It also describes how to handle the cartridges, how to set a cartridge write-protect switch, and how to order additional cartridges.

Chapter 5, “Resolving problems,” on page 49 gives tips for solving tape drive problems.

Appendix A, Getting help and technical assistance, describes what to do if you experience a problem with your tape drive, and might help you determine whom to call for service, if it is necessary.

Appendix B, “TapeAlert flags,” on page 57 lists TapeAlert messages that are supported and that might help you determine the cause of tape drive problems.

Appendix C, “Error codes and messages,” on page 59 describes the error and informational codes that appear on the single-character display.

Appendix D, “Repairing a cartridge,” on page 65 describes how to repair a tape cartridge.

Appendix E, “Information for trained service personnel,” on page 73 gives the procedure for removing a tape cartridge that will not eject from the drive and other servicing procedures.

### Notices and statements in this document

The caution and danger statements in this document are also in the multilingual *Safety Information* document, which is on the IBM Documentation CD. Each statement is numbered for reference to the corresponding statement in your language in the *Safety Information* document.

The following notices and statements are used in this document:

- **Note:** These notices provide important tips, guidance, or advice.

- **Important:** These notices provide information or advice that might help you avoid inconvenient or problem situations.
- **Attention:** These notices indicate potential damage to programs, devices, or data. An attention notice is placed just before the instruction or situation in which damage might occur.
- **Caution:** These statements indicate situations that can be potentially hazardous to you. A caution statement is placed just before the description of a potentially hazardous procedure step or situation.
- **Danger:** These statements indicate situations that can be potentially lethal or extremely hazardous to you. A danger statement is placed just before the description of a potentially lethal or extremely hazardous procedure step or situation.

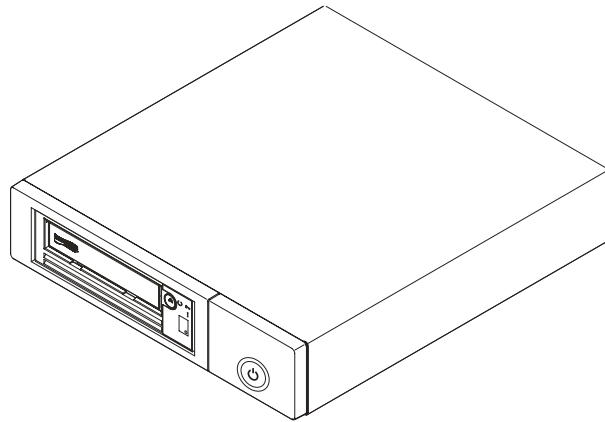
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## Chapter 1. Introduction

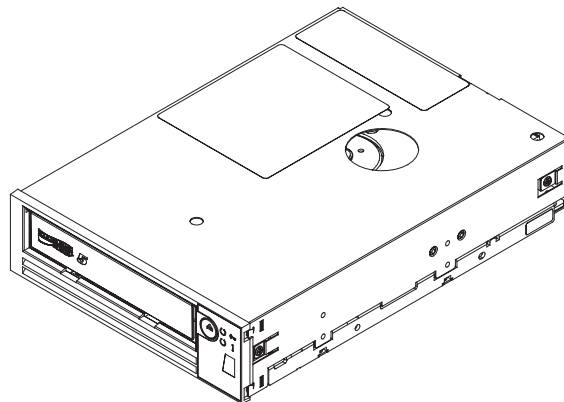
The IBM LTO Ultrium 5 Half High Tape Drive is a high-performance, high-capacity data-storage device that is designed to backup and restore open-systems applications. The tape drive is available as an internal or external device (L5X and N5X models). The L5X model of the tape drive includes a power cord for use in the United States; the N5X model does not include a power cord.

The IBM LTO Ultrium 5 Half High Tape Drive is the fifth generation in the Ultrium series of products, and is available with a Serial Attached SCSI interface (SAS). This model incorporates the Linear Tape-Open (LTO) IBM Ultrium 5 Half High Tape Drive.

Read this entire document and the IBM Safety, Warranty, Environmental, and Electronic Emission Notices document that comes with the drive before you install or use the drive.



*Figure 1. View of an external tape drive*



*Figure 2. View of an internal tape drive*

The Customer Replaceable Unit (CRU) part numbers and the Option part numbers for the IBM LTO 5 Half High Tape Drive are shown in the following list:

Table 1. CRU and Option part numbers

Description	CRU part number	Option part number
IBM Internal Half High LTO Gen 5 SAS Tape Drive	46X5683	49Y9898
IBM External Half High LTO Gen 5 SAS Drive, with US line cord	49Y9907	3628L5X
IBM External Half High LTO Gen 5 SAS Drive, with no line cord	49Y9907	3628N5X
SAS cable, internal	44E8878	
Mini-SAS cable, external, 3 m x 4 plug	39R6532	
US line cord, 3 ft, 10 A / 125 V	39M5081	

## Drive features

The internal and external tape drives offer the following features:

- 6 Gbps Serial Attached Small Computer Systems interface (SAS)

**Note:** Although the tape drive has two SAS ports, the drive supports only one host connection. The Ethernet port is only used by service personnel.

- Half-height form factor
- Native storage capacity of 1,500 GB (1.5 TB) per cartridge (3,000 GB at 2:1 compression)
- Maximum native data transfer rate of up to 140 MB per second
- Burst data transfer rate of 600 MB per second
- 256 MB read-and-write cache
- Support for encryption on Ultrium 5 tape cartridges
- Single-character display (SCD) operator panel
- Ready and Fault status lights
- Maintenance mode functions

## Front panel of the drive

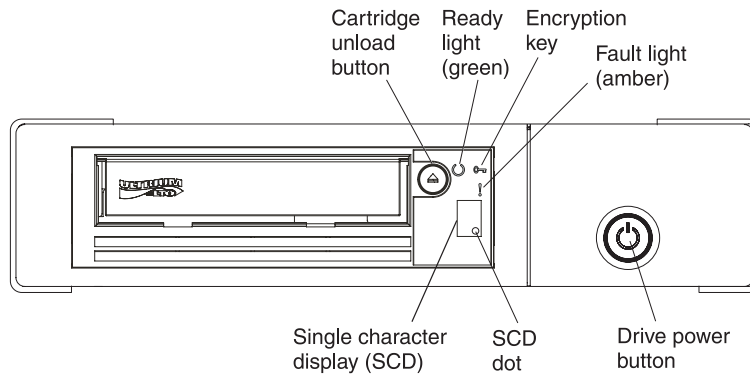


Figure 3. External tape drive front panel element descriptions

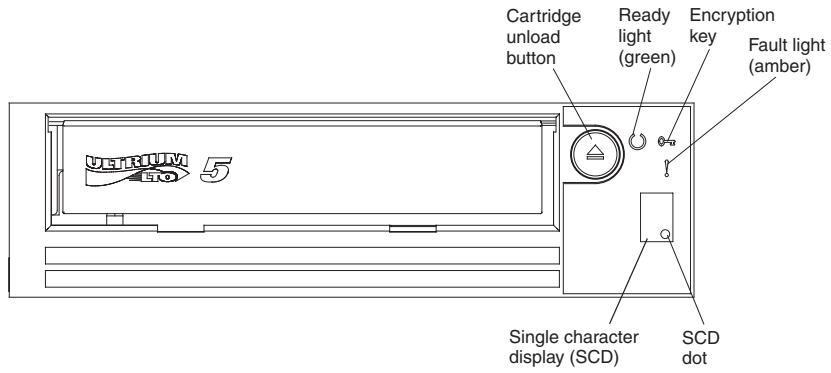
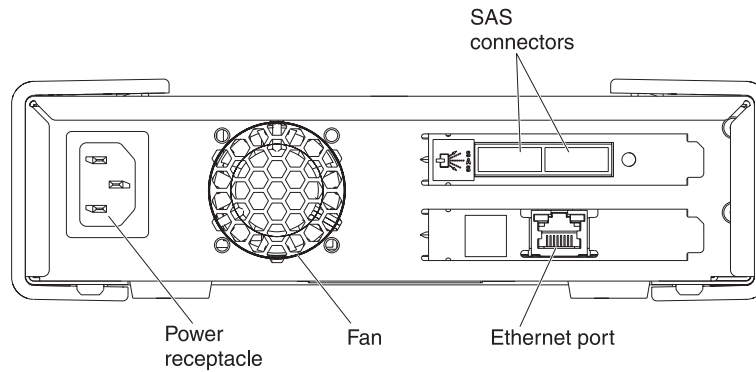


Figure 4. Internal tape drive front panel element descriptions

## Rear panel of the drive



**Important:**

1. The tape drive supports only one host connection.
2. The Ethernet port is only used by service personnel.

Figure 5. External tape drive rear panel element descriptions

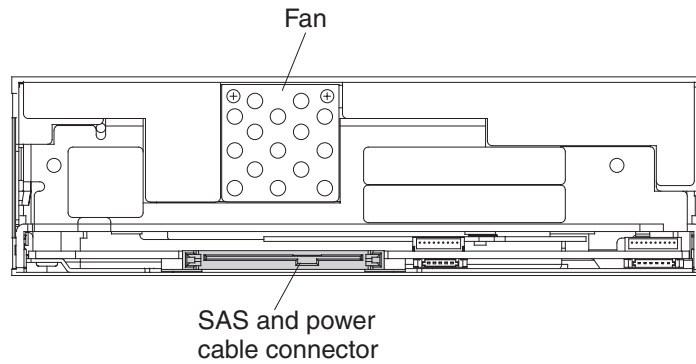


Figure 6. Internal tape drive rear panel element descriptions

## Drive performance

Details about the drive tape-processing speed are shown in the following table.

Table 2. Performance rates and times

Native data rate	140 MB/second (with Ultrium 5 media)
Maximum sustained data rate (at maximum compression)	550 MB/second
Burst data rate	600 MB/second
Nominal load-to-ready time	12 seconds
Nominal unload time	17 seconds
Average rewind time	75 seconds
<b>Note:</b> All sustained data rates are dependent on the capabilities of the interconnect, and application software performance might be slower than the published performance ratings.	

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

## Cartridge compatibility

The tape drive uses the IBM® LTO Ultrium 1,500 GB Data Cartridge and is compatible with the cartridges of its predecessor, the IBM Half-High LTO Ultrium 4 Tape Drive. The drive has the following capabilities and limitations:

**Note:** To improve system performance, the drive uses a feature called *speed matching* to dynamically adjust its native (uncompressed) data rate to the slower data rate of a server. For more information about speed matching, see “Speed matching” on page 5.

Table 3. Ultrium cartridge compatibility with Ultrium tape drives

IBM Ultrium Tape Drive	IBM LTO Ultrium Data Cartridges				
	1500 GB (Ultrium 5)	800 GB (Ultrium 4)	400 GB (Ultrium 3)	200 GB (Ultrium 2)	100 GB (Ultrium 1)
Ultrium 5	Read/Write	Read/Write	Read only		
Ultrium 4		Read/Write	Read/Write	Read only	
Ultrium 3			Read/Write	Read/Write	Read only
Ultrium 2				Read/Write	Read/Write
Ultrium 1					Read/Write

The drive reads tapes that have been written by other licensed Ultrium 5 drives. It also writes to tapes that can be read by other licensed Ultrium 5 drives.

In addition to using the IBM LTO Ultrium Data Cartridge with up to 1500 GB capacity, the drive also has read and write capabilities with certified LTO Ultrium tape cartridges.

---

## Speed matching

To improve system performance, the drive uses a feature called *speed matching* to dynamically adjust its native (uncompressed) data rate to the slower data rate of a server. With speed matching, the drive operates at different speeds when reading or writing the Ultrium 4 or Ultrium 5 cartridge formats. Native data rates are shown in the following table.

Table 4. Performance parameters

	Ultrium generation media		
	Generation 5 media	Generation 4 media	Generation 3 media
Speed matching data rates (MB/second)	140.0	120.0	80.0
	130.0	113.1	76.1
	120.0	106.0	72.3
	112.7	99.2	68.4
	105.5	92.3	64.6
	98.2	85.3	60.7
	90.9	78.5	56.8
	83.6	71.4	53.0
	76.4	64.6	59.2
	69.1	57.6	45.3
	61.8	50.7	41.5
	53.5	43.8	37.6
	46.3	36.9	33.8
	40.0	30.5	30.0

If the server net (compressed) data rate is between two of the preceding native data rates, the drive calculates the data rate at which to operate. Speed matching 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.

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## Channel calibration

System performance is further optimized by a *channel calibration* feature. With this feature, the drive automatically customizes each read or write data channel to compensate for variations in the recording channel transfer function, the media, and the characteristics of the drive head.

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## Encryption

This drive supports host Application Managed Encryption (AME), using T10 encryption methods. However, encryption must be enabled through the software application that you use to manage the tape drive. For more information about enabling encryption, see the independent software vendor documentation that came with your software.

Data encryption is supported only with LTO Ultrium 5 and LTO Ultrium 4 data cartridges. The encryption-enabled drive contains the necessary hardware and firmware to encrypt and decrypt host tape application data. Encryption policy and

encryption keys are provided by the host application; there is no encryption setup required for this drive. A drive digital certificate is installed at manufacturing time. Each drive has a unique serial number and certificate. The T10 application might validate each drive instance by checking the drive digital certificate.

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

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

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## SAS interface

The drive has a dual-port 6 Gbps SAS (Serial Attached SCSI) host interface, but only one of the SAS ports is used for a host connection.

**Important:** The tape drive supports only one host connection.

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

SAS drives will auto-negotiate speed. There are no configurable topologies, and therefore no feature switches associated with SAS.

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## Supported servers and operating systems

To determine the latest supported attachments, visit the IBM ServerProven website for System x Tape Backup Units: <http://www-03.ibm.com/servers/eserver/serverproven/compat/us/xseries/storage/tmatrix.html>.

For specific instructions about installing the drive, see Chapter 2, “Installing the drive,” on page 9.

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## Supported device drivers

To download the latest device drivers, go to <http://www-947.ibm.com/systems/support/supportsite.wss/docdisplay?lnocid=TAPE-FILES&brandind=5000019>, or complete the following steps.

**Note:** Changes are made periodically to the IBM website. The actual procedure might vary slightly from what is described in this document.

1. Go to <http://www-947.ibm.com/support/entry/portal/>.
2. In the **Search within all of support & downloads** text field at the bottom of the screen, type `tape files` and press Enter.
3. In the list of search results, click the link **Tape Files (index) - Software for tape drives and libraries**.
- 4.



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## External tape drive specifications

The following sections show the physical, power, and environmental specifications for the external tape drive. For specifications for the internal tape drive, see “Internal tape drive specifications.” Specifications for tape cartridges are shown in “Environmental specifications.”

### Physical specifications

Width	213 mm (8.4 in.)
Length	332 mm (13.1 in.)
Height	58 mm (2.3 in.)
Weight (without a cartridge)	4.3 kg (9.4 lbs.)

### Power specifications

AC line current	100 to 240 Vac
Line frequency	50 to 60 Hz, auto-ranging
Line current at 100 Vac	0.48 A
Line current at 240 Vac	0.20 A

### Other specifications

Maximum altitude for operating and storage	3,048 m (10,000 ft)
Maximum altitude for shipping	12,192 m (40,000 ft)

### Environmental specifications

Environmental factor	Operating	Storage or Shipping
Drive temperature	10 to 40°C (50 to 104°F)	-40 to 60°C (-40 to 140°F)
Relative humidity (noncondensing)	20 to 80%	10 to 90%
Wet bulb temperature (maximum)	26°C (78.8°F)	26°C (78.8°F)

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## Internal tape drive specifications

The following sections show the physical, power, and environmental specifications for the internal tape drive. For specifications for the external tape drive, see “External tape drive specifications.” Specifications for tape cartridges are shown in “Environmental specifications” on page 8.

### Physical specifications

	Without bezel	With bezel
Width	146 mm (5.7 in.)	148 mm (5.8 in.)
Length	205 mm (8.1 in.)	210 mm (8.3 in.)
Height	41 (1.6 in.)	42.7 mm (1.7 in.)
Weight (without a cartridge)	1.61 kg (3.5 lbs.)	

## Power specifications

The internal tape drive receives power from the host system in which it is installed.

## Other specifications

Maximum altitude for operating and storage	3,048 m (10,000 ft)
Maximum altitude for shipping	12,192 m (40,000 ft)

## Environmental specifications

Environmental factor	Operating	Storage or Shipping
Drive temperature	10 to 40°C (50 to 104°F)	-40 to 60°C (-40 to 140°F)
Relative humidity (noncondensing)	20 to 80%	10 to 90%
Wet bulb temperature (maximum)	26°C (78.8°F)	26°C (78.8°F)

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## Chapter 2. Installing the drive

This chapter describes the installation procedures for both the internal and external tape drives. It is the customer's responsibility to install this product.

Depending on the type of enclosure, installation procedures might vary. Refer to the enclosure documentation for drive installation. The following generic procedures can be used if the enclosure documentation is not available:

- "Installing an internal tape drive" on page 10
- "Installing an external tape drive" on page 15

**Note:** Before you install the internal or external tape drive, read the information in the following sections:

- "Installation guidelines"
- "Avoiding drive damage"
- "Inventory checklist" on page 10

---

### Installation guidelines

Before you remove or replace a device, read the following safety information:

- Read the safety information in "Safety" on page iii. This information will help you work safely. Take standard electrostatic discharge precautions when you work inside the server.
- Observe good housekeeping in the area where you are working. Place removed covers and other parts in a safe place.
- Do not attempt to lift an object that you think is too heavy for you. If you have to lift a heavy object, observe the following precautions:
  - Make sure that you can stand safely without slipping.
  - Distribute the weight of the object equally between your feet.
  - Use a slow lifting force. Never move suddenly or twist when you lift a heavy object.
  - To avoid straining the muscles in your back, lift by standing or by pushing up with your leg muscles.
- Make sure that you have an adequate number of properly grounded electrical outlets for the server and all attached devices.
- Back up all important data before you make changes to disk drives.

---

### 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 in 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.

---

## Inventory checklist

Make sure that the following items are included in the shipment:

- Internal or external tape drive
- Power cord:
  - The L5X model of the external drive comes with a power cord for the United States.
  - The N5X model of the external drive does not include a power cord.You must order the applicable cord for your country or region separately.
- IBM LTO Ultrium Cleaning Cartridge
- The *IBM Safety, Warranty, Environmental, and Electronic Emission Notices* document.
- Documentation CD, that includes the *IBM Half High LTO Gen 5 SAS Tape Drive Installation and User's Guide* (this document), the multilingual *Safety Information* document and the *Environmental Notices and User's Guide*
- SAS cable:
  - An internal (split) SAS cable for the internal drive
  - An external SAS cable for the external drive
- Mounting screws (internal drive only, and are not used for installations in servers that come with mounting rails)

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## Installing an internal tape drive

Use the information in this section to install an internal tape drive. The following list of steps provides a brief overview of the installation process.

1. "Unpack the drive" on page 11
2. "Acclimate the drive and media" on page 11
3. "Turn off the enclosure" on page 11
4. "Set the feature switches" on page 11
5. "Mount the drive in an enclosure or server" on page 12
6. "Connect and test power to the drive" on page 13
7. "Connect the internal cable" on page 14
8. "Run drive diagnostics" on page 14
9. "Install device drivers" on page 14
10. "Connect the external interface cable (tape enclosure installations only)" on page 14
11. "Configure the drive to the server, switch, or hub" on page 15

## Unpack the drive

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

**Attention:** If you return the unit for service, ship it in its original or equivalent packing material, or the warranty might be invalidated.

## Acclimate the drive and media

Acclimation time is required if the temperature of the drive and media when unpacked is different than the temperature of its operating environment (measured at the front of the bezel near the air intake area). 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 might 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.

## Turn off the enclosure

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

## Set the feature switches

The tape drive has eight factory-set feature switches by which the drive is configured for various functions. The feature switches are preset to the off position at the factory but are described here in case you must change the feature-switch settings for your application.

The feature switches are on the rear panel of the tape drive. The switches are labeled 1 through 8 and the on and off positions are marked. The feature switches are defined in the following table.

*Table 5. Feature switch definitions*

Switch	On function	Off function
1	Library interface at 9,600 baud / polled	Library interface at 38,400 baud / non-polled
2	Library interface uses two stop bits	Library interface uses one stop bit
3	Reserved	Reserved
4	Library interface at 115,000 baud rate	Switch 1 active

Table 5. Feature switch definitions (continued)

Switch	On function	Off function
5	Enable ADI	Enable LDI
6	Reserved	Reserved
7	Disable head brush ERP <sup>1</sup>	Enable head brush ERP <sup>1</sup>
8	Reserved	Reserved
<p><b>Note:</b> The default settings for the feature switches are all switches placed in the off position.</p> <p>*The head brush error recovery procedure (ERP) is intended to prevent a permanent read or write error by removing debris that might have accumulated on the read or write head. In order to brush the head, the tape must be unthreaded to expose the head. This forces the loader to be cycled to enable re-thread. During the loader cycling, the back of the cartridge will temporarily extend beyond the front of the bezel. Extension of the cartridge is problematic in some automation environments, so you have the ability to disable this function. If the head brush ERP is disabled, the drive will immediately report the permanent error instead of activating the head brush ERP.</p>		

## Mount the drive in an enclosure or server

### When mounting the drive:

- Use an appropriate screw length.
- Make sure 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 your 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 of the two side brackets located on the left and right sides of the chassis.

**Attention:** When the mounting screws or drive rail prongs are inserted into the drive, they must not extend farther than 2.5 mm (0.098 in.) inside the chassis. Otherwise, they might damage the drive.

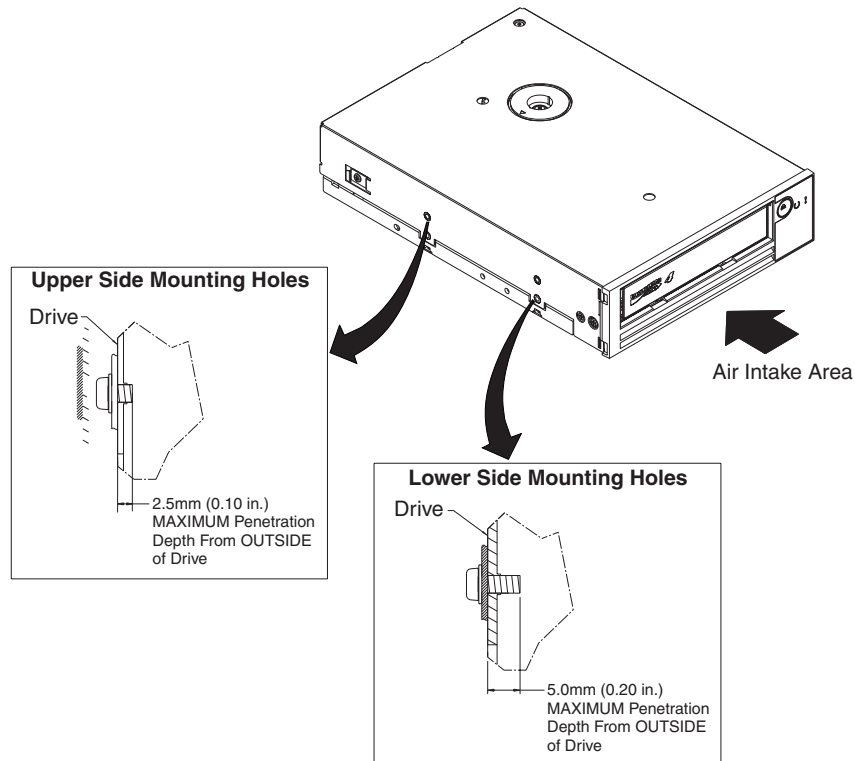



Figure 7. Mounting holes on the drive. The holes are located on both sides of the drive. The drive is shown with a front bezel.

## Connect and test power to the drive

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

To connect and test power to the drive, complete the following steps:

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 internal power cable to the power connector on the drive.
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 LED in "Front panel of the drive" on page 2. To make sure that the drive is receiving power, watch for the following while turning on the power to the enclosure:
  - During the power-on/initialization and POST (Power-On Self Test), the SCD briefly displays , then becomes blank (not lit) when POST is complete and there are no POST errors. If a POST error has been detected, an error code will be displayed in the SCD and the status LED will flash amber.
 

**Attention:** If the SCD does not come on, the drive might not be getting power.
  - The status LED will be off during the initial power-on and initialization. The status LED briefly becomes green and then becomes amber during the

- remainder of the power-on and initialization phase. The status LED becomes solid green after the power-on/initialization and POST are complete.
6. Turn off the enclosure.
  7. Disconnect the power cord from both the enclosure and the electrical outlet.

## Connect the internal cable

Connect the enclosure internal SAS cable to the SAS connector on the drive. Attach the host side (data and power) of the SAS cable included with your tape drive to the SAS and power connectors on your server. Then, attach the drive side to the drive connector (for the drive connector location, see “Rear panel of the drive” on page 3).

## Run drive diagnostics

1. Replace the cover on the enclosure.
2. If you are not already connected to a power source, connect the power cord to both the enclosure and the electrical outlet.
3. Turn on the enclosure.
4. Run one or more of the following drive diagnostics:
  - “Function code 1: Run drive diagnostics” on page 26
  - “Function code 6: Run host interface wrap test” on page 30
  - “Function code 7: Run RS-422 wrap test” on page 31If an error code appears on the single-character display (SCD), go to Appendix C, “Error codes and messages,” on page 59. If no error appears, continue to the next step.
5. Turn off the enclosure.
6. Disconnect the power cord from both the enclosure and the electrical outlet.

## Install device drivers

If you intend to use the tape drive with a commercial software application, see the documentation for that application to install the device driver and configure the tape drive.

## Connect the external interface cable (tape enclosure installations only)

For information about connecting the enclosure, see the documentation for your enclosure.

### Connect the external SAS interface to the server

To connect the enclosure to the SAS interface, complete the following steps:

1. Connect the external SAS cable that ships with the drive 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 applicable SAS attachment verification procedure for your server.

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



## Configure the drive to the server, switch, or hub

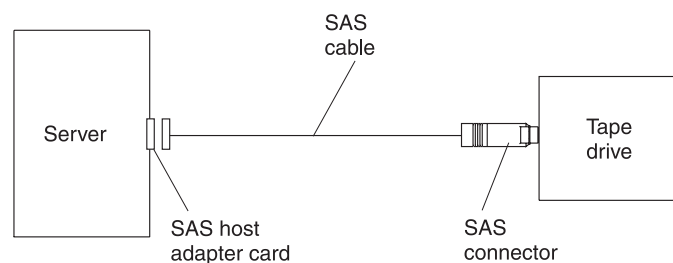
To configure the drive to work with the server, see the documentation for that server, switch, or hub.

The drive is now ready for use.

---

### Installing an external tape drive

1. Unpack the drive and store the packaging for future moves or shipping.  
**Important:** If you return the unit for service, ship it in its original or equivalent packing material, or the warranty might be invalidated.
2. Inspect the unit for shipping damage. If there is damage, do not install the unit. Report the damage immediately by contacting your place of purchase.
3. Locate the label on the rear panel of the unit with the machine type, model number, and serial number of the unit. Make a note of these numbers and store them in an easily accessible place. Should you need to contact Technical Support, you will be asked for these numbers.
4. Inspect the power cord plug to make sure that it matches the power receptacle.
5. Make sure that all of the associated electrical outlets are grounded and that the circuit breaker is turned on.
6. Position the drive so that it is convenient to the server. The only restrictions are the length of the power cord and the length of the cable to the server. Do not place anything on top of the tape drive.
7. If there are no other devices attached to your server, a SAS host adapter card might need to be installed in the server. To install an adapter, see the instructions that accompany it, as well as the documentation that came with your server.
8. Locate the SAS cable and make sure the tape drive is turned off.
9. Connect the SAS cable to SAS host adapter and to the tape drive. Although the tape drive has two SAS ports, it can be connected only to one server. The following image shows a connection to one server.



10. Make sure that the host adapter and the server are configured correctly for a SAS bus operation. See the documentation that came with the host adapter and your server for instructions.
11. Plug the power cord into the rear panel (see Figure 5 on page 3), then plug the other end into a grounded electrical outlet.
12. Turn on the unit by pressing the Power button. The POST runs, which checks all hardware except the drive head. During the POST, the single-character display (SCD) flashes several segmented characters. Each segmented character represents a test performed during the POST. When the POST finishes, the SCD momentarily lights all of the segmented characters and then goes blank.

---

## Updating firmware

**Attention:** When updating firmware, do not turn off power to the drive until the update is complete, or the firmware update might not take effect.

It is your responsibility to make sure that the drive has the latest firmware. Periodically check for updated levels of drive firmware by visiting the IBM website.

To download the latest firmware, go to <http://www-947.ibm.com/systems/support/supportsite.wss/docdisplay?Indocid=TAPE-FILES&brandind=5000019>, or complete the following steps.

**Note:** Changes are made periodically to the IBM website. The actual procedure might vary slightly from what is described in this document.

1. Go to <http://www-947.ibm.com/support/entry/portal/>.
2. In the **Search within all of support & downloads** text field at the bottom of the screen, type tape files and press Enter.
3. In the list of search results, click the link **Tape Files (index) - Software for tape drives and libraries**.
- 4.

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## Chapter 3. Operating the drive

The following indicators on the front panel are used to operate the drive:

- Single-character display (SCD)
- SCD dot
- Ready and Fault status lights
- Unload button
- Encryption status light

---

### Operating modes

The drive functions in the following modes:

#### Operation mode

Operation mode functions include reading and writing data, cartridge manipulation, error reporting, and firmware updating using an FMR cartridge. For more information, see “Status lights” on page 18.

#### Maintenance mode

Maintenance mode functions include drive diagnostic, create FMR cartridge, and drive dump manipulation (force to RAM, copy to tape, copy to flash memory, and erase flash). For more information, see “Diagnostic and maintenance functions” on page 23.

The Unload button is used to switch between modes. For more information, see “Unload button” on page 20.

---

### Single-character display (SCD)

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


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

Appendix C, “Error codes and messages,” on page 59 lists the codes for error conditions and informational messages. If multiple errors occur, the code with the highest priority (represented by the lowest number) is displayed first. When the error is corrected, the code with the next highest priority is displayed, and so on until no errors remain.

“Diagnostic and maintenance functions” on page 23 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 dot illuminates in the lower right corner of the SCD (). For information about how to copy the dump, see “Function code 5: Copy drive dump” on page 29.

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

The SCD dot turns off when you obtain a dump with IBM TotalStorage Tape Diagnostic Tool (ITDT) or a SCSI command) or update the drive firmware.

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

## Status lights

The status lights (see “Front panel of the drive” on page 2) are LEDs that provide information about the state of the drive. The Ready status light is green and the Fault status light is amber, and solid or flashing when lit. The Encryption status light is white.

Mode	SCD	Ready LED (green)	Fault LED (amber)
Operational	Blank	On	Off
Activity (tape movement) in Operational mode	Blank	Flashing	Off
Maintenance	Solid character	Off	On
Executing maintenance selection	Flashing character	Off	On
Error condition	Solid character	Off	Flashing
Power is turned on or a reset is initiated	Random segments	Off	On

**Note:** The white Encryption status light will be on when the tape drive has a cartridge loaded and all data on this cartridge is encrypted. This applies only to LTO Ultrium 5 cartridges.

Table 6 lists the conditions of the status lights and single-character display (SCD) and provides an explanation of what each condition means.

Table 6. Meaning of status lights and single-character display (SCD)

Ready status light	Fault status light	Encryption status light	SCD	SCD dot	Meaning
Off	Off	Off	Off	Off	The drive has no power or is powered off.
Green and solid	Off	On or off	Off	Off	The drive is powered on and in an idle state. <b>Note:</b> If a cartridge is loaded, the Encryption status light will be on when all the data on the cartridge is encrypted. This applies only to LTO Ultrium 5 cartridges.

Table 6. Meaning of status lights and single-character display (SCD) (continued)







Ready status light	Fault status light	Encryption status light	SCD	SCD dot	Meaning
Flashing green (once per second)	Off	On or off	Off	Off	The drive is reading from the tape, writing to the tape, rewinding the tape, locating data on the tape, loading the tape, or unloading the tape. <b>Note:</b> The Encryption status light will be on when the tape drive has a cartridge loaded and all data on this cartridge is encrypted. This applies only to LTO Ultrium 5 cartridges.
Flashing green (once per second)	Off	Off	Off	Off	If the drive contains a cartridge when the drive is turned on, the drive completes POST and slowly rewinds the tape (the process might take up to 10 minutes). The light stops blinking and becomes solid when the drive completes the recovery and ejects the cartridge.
Off	Amber and solid	Off	Displaying an error code or Maintenance mode function	On or off	The drive is displaying error codes from the error code log on the SCD. For more information, see "Function code 9: Display error code log" on page 32 and Appendix C, "Error codes and messages," on page 59.
On or off	On or off	Off	Displaying random segments, then blank, then displaying random segments, then displaying  , then blank	Off	During power on, or a drive reset, the drive front panel will display drive progress as follows: <ol style="list-style-type: none"> <li>1. SCD will display random segments (no LEDs on).</li> <li>2. SCD will go blank (LEDs - green on, amber off)</li> <li>3. SCD will display random segments (LEDs - green off, amber on)</li> <li>4. SCD will display [8] (LEDs - green off, amber on)</li> <li>5. SCD will go blank (LEDs - green on, amber off) after the power is turned on or after the drive is reset.</li> </ol> <p>If an error is detected when the drive power is turned on or during a reset, the tape drive posts an error code to the SCD. To determine the error, locate the code in Appendix C, "Error codes and messages," on page 59.</p>
Off	Amber and solid	Off		On or off	The drive is entering or exiting from Maintenance mode. For more information, see "Function code 0: Maintenance mode" on page 26.
Off	Amber and solid	Off	Flashing selected function	On or off	The drive is executing the selected function while in Maintenance mode.

Table 6. Meaning of status lights and single-character display (SCD) (continued)

Ready status light	Fault status light	Encryption status light	SCD	SCD dot	Meaning
Off	Flashing amber (once per second)	Off	Displaying error code	Off	An error occurred and the drive or media might require service, or it might require cleaning. Note the code on the SCD, then go to Appendix C, “Error codes and messages,” on page 59 to determine the action that is required.
Off	Flashing amber	Off	Displaying 	Off	The drive needs to be cleaned.
Off	Flashing amber	Off	Displaying Function code  or flashing	Off	The drive is updating firmware. <sup>1</sup> The SCD will display a  if an FMR cartridge is in use. The SCD will be off if the SAS interface is in use. For more information, see “Updating firmware” on page 16.
Off	Flashing amber (twice per second)	Off	Off	Off	The drive detected an error and is performing a firmware recovery. It will reset automatically.
Off	Amber and solid	Off	Flashing 	Off	The drive is ready for a cartridge to be loaded.
Off	Flashing amber (twice per second)	Off	Off	On	There is a drive dump in flash memory.

<sup>1</sup> Power should not be disconnected 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 (see “Front panel of the drive” 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. <b>Note:</b> During a rewind and eject operation, the drive does not accept SCSI commands from the server.
Place the drive in Maintenance mode	Ensure that the drive is unloaded. Then, within 2 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. <b>Note:</b> While in Maintenance mode, the drive does not accept SCSI interface commands. <b>Note:</b> If you attempt to enter Maintenance mode with a cartridge in the drive, the drive will rewind and eject the cartridge. Remove the cartridge and repeat the steps for entering Maintenance mode.

Table 7. Functions that the Unload button performs (continued)

Unload button function	How to initiate the function
Scroll through the maintenance functions	While in Maintenance mode, press the Unload button once per second to increase the display character by one. When you reach the character of the diagnostic or maintenance function that you want (see “Diagnostic and maintenance functions” on page 23), press and hold the Unload button for 3 seconds.
Exit Maintenance mode	Press the Unload button once per second until  displays. Then press and hold the Unload button for 3 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)	<p><b>Attention:</b> If the drive detects a permanent error and displays an error code, it automatically forces a drive dump (also known as a save of the firmware trace). If you force a drive dump, the existing dump will be overwritten and data will be lost. After you force a drive dump, do not turn off the power to the drive or you might lose the dump data.</p> <p>Choose one of the following procedures:</p> <ul style="list-style-type: none"> <li>• If the drive is in Maintenance mode (status light is flashing and fault light is solid), see “Function code 4: Force a drive dump” on page 28.</li> <li>• If the drive is in Operating mode (status light is solid or flashing green), press and hold the Unload button for ten seconds.</li> </ul> <p>If a captured dump data exists, the drive places it into a dump area.</p>
Reset the drive	<p>Press and hold the Unload button until the drive begins the reset procedure (status light will be amber).</p> <p><b>Note:</b> If a tape cartridge is loaded in the drive the drive will unload the tape. Repeat the procedure to reset the drive after the tape is unloaded. The drive saves a dump of the current drive state, then reboots to allow communication. Do not reset the drive power; this will erase the contents of the dump.</p>

## Inserting a tape cartridge

To insert a tape cartridge, complete the following steps:

1. Make sure that the drive power is turned on.
2. Make sure that the write-protect switch on the tape cartridge is properly set (see “Write-protect switch” on page 42).
3. Grasp the cartridge so that the write-protect switch faces you (see Figure 8 on page 22).
4. Slide the cartridge into the tape load compartment.

**Note:**

- a. If the cartridge is already in an ejected position and you want to reinsert it, remove the cartridge then insert it again.
- b. If the cartridge is already loaded and you reset the drive power, the tape will reload.

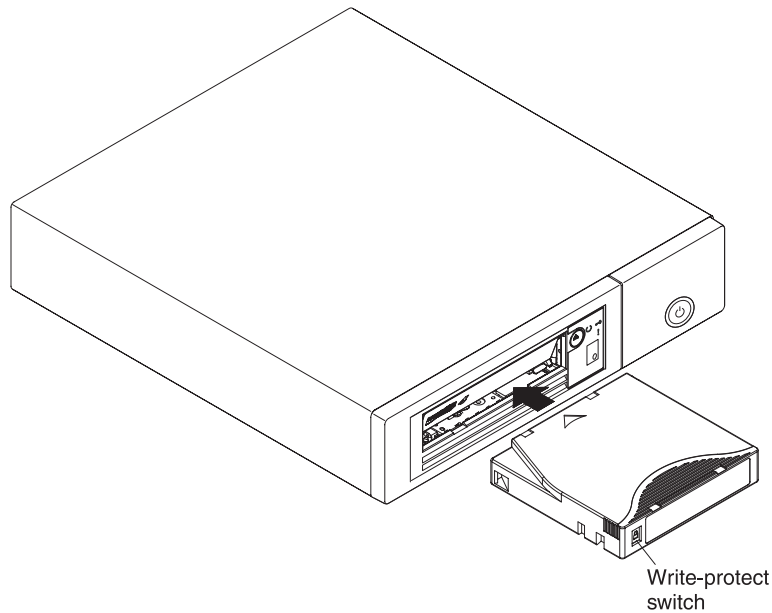


Figure 8. Inserting a cartridge into the drive

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## Removing a tape cartridge

**Attention:** To clean the tape drive, use only an IBM LTO Ultrium Cleaning Cartridge. The use of cleaning methods other than an LTO cleaning cartridge might cause damage to the drive.

To remove a tape cartridge, complete the following steps:

1. Make sure that the drive power is turned on.
2. Press the Unload button. The drive rewinds the tape and partially ejects the cartridge. The Ready light flashes green while the tape rewinds, then becomes blank before the cartridge partially ejects.
3. After the cartridge partially ejects, grasp the cartridge and remove it.

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

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

---

## Mid-tape recovery

If the tape drive is reset while a cartridge is loaded, the drive will slowly rewind the tape and eject the cartridge. If the drive power is turned off and then on again while a cartridge is loaded, the drive will slowly rewind the tape. The drive will not automatically eject the cartridge.


The Ready light flashes during tape movement. Push the Unload button to eject the cartridge.




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## Cleaning the drive head

**Attention:** When cleaning the drive head, use the IBM LTO Ultrium Cleaning Cartridge. You can use another LTO cleaning cartridge, but it might not meet the standards of reliability established by IBM.

Clean the drive head whenever  is displayed on the single-character display and the status light is flashing amber once per second. You do not need to clean the drive head on a periodic basis.

**Note:** In Maintenance mode, a flashing  with the **solid** amber status light, means to insert a cartridge, not clean the drive head.

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

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

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

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## Cleaning the tape drive

Clean the exterior surface of the tape drive with a damp towel. If you use a liquid all-purpose cleaner, apply it to the towel. Do not spray cleaner directly on the tape drive.

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## Diagnostic and maintenance functions

The drive is capable of the following:

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

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

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




Table 8 on page 24 describes each diagnostic and maintenance function that the drive can perform, gives the function code which appears on the Single-character display (SCD), and directs you to the instructions for performing the function. Use a customer-supplied scratch (blank) data cartridge for diagnostic testing.

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

Table 8. Diagnostic and maintenance functions


Function code	Diagnostic or maintenance function	Instructions location
0	<b>Exit Maintenance Mode:</b> Causes the drive to become available for reading and writing data.	"Function code 0: Maintenance mode" on page 26
1	<b>Run Drive Diagnostics:</b> Runs tests to determine whether the drive can properly load and unload cartridges, and read and write data.	"Function code 1: Run drive diagnostics" on page 26
2	<b>Update Tape Drive Firmware from FMR Tape:</b> Loads updated firmware from a field microcode replacement (FMR) tape.	"Function code 2: Update drive firmware from FMR tape" on page 27
3	<b>Create FMR Tape:</b> Copies its field microcode replacement (FMR) data to a customer-supplied scratch (blank) data cartridge.	"Function code 3: Create FMR tape" on page 28
4	<b>Force a Drive Dump:</b> Performs a dump of data (also known as saving a microcode trace).	"Function code 4: Force a drive dump" on page 28
5	<b>Copy Drive Dump:</b> Copies data from a drive dump (captured by using Function code 4) to the beginning of a customer-supplied scratch (blank) data cartridge, copies a drive dump to flash memory, or erases a dump from flash memory.	"Function code 5: Copy drive dump" on page 29
6	<b>Run Host Interface Wrap Test:</b> Performs a check of the circuitry from and to the connector.	"Function code 6: Run host interface wrap test" on page 30
7	<b>Run RS-422 Wrap Test:</b> This test causes the drive to perform a check of the circuitry and connector for the RS-422 interface.	"Function code 7: Run RS-422 wrap test" on page 31
8	<b>Unmake FMR Tape:</b> Erases the FMR data on a customer-supplied scratch (blank) data cartridge and rewrite the cartridge memory on the tape. This turns the cartridge into a valid customer-supplied scratch data cartridge.	"Function code 8: Unmake FMR tape" on page 32
9	<b>Display Error Code Log:</b> Displays the last 10 error codes, one at a time. The codes are ordered; the most recent is presented first and the oldest is presented last.	"Function code 9: Display error code log" on page 32
A	<b>Clear Error Code Log:</b> Erases the contents of the error code log.	"Function code A: Clear error code log" on page 33
C	<b>Insert Cartridge into Tape Drive:</b> This function cannot be selected by itself, but is a part of other maintenance functions (such as Run Tape Drive Diagnostics and Create FMR Tape) that require a tape cartridge to be loaded.	"Function code C: Insert cartridge into tape drive" on page 33
E	<b>Test Cartridge &amp; Media:</b> Performs tests to make sure that a suspect cartridge and its magnetic tape are acceptable.	"Function code E: Test cartridge & media" on page 33
F	<b>Write Performance Test:</b> Performs tests to make sure that the drive can read from and write to tape.	"Function code F: Write performance test" on page 34
H	<b>Test Head:</b> Performs tests to make sure that the tape drive head and tape-carriage mechanics are working correctly.	"Function code H: Test head" on page 35
J	<b>Fast Read/Write Test:</b> Performs tests to make sure that the drive can read from and write to tape.	"Function code J: Fast read/write test" on page 36


Table 8. Diagnostic and maintenance functions (continued)

Function code	Diagnostic or maintenance function	Instructions location
	<b>Load/Unload Test:</b> Tests the ability of the drive to load and unload a tape cartridge.	“Function code L: Load/unload test” on page 37
	<b>Enable Post Error Reporting:</b> When selected, deferred-check conditions are reported to the host.	“Function code P: Enable post error reporting” on page 38
	<b>Disable Post Error Reporting:</b> When selected, deferred-check conditions are NOT reported to the host.	“Function code U: Disable post error reporting” on page 38

## Entering Maintenance mode

The drive must be in Maintenance mode to run drive diagnostics or maintenance functions. To put the unit in Maintenance mode, complete the following steps:



1. Make sure that no cartridge is in the drive.
2. Press the Unload button three times within 2 seconds.  appears in the SCD, and the Fault light turns amber.

**Note:** If a cartridge is in the tape drive, it will eject the first time that you press the Unload button and the drive will not be placed in Maintenance mode. To continue placing the drive in Maintenance mode, perform the preceding step. While in Maintenance mode, the drive will not accept a cartridge unless the drive requests it. The SCD will display a flashing  to indicate a cartridge needs to be inserted.

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

## Exiting Maintenance mode

The drive must be in Maintenance mode to run drive diagnostics or maintenance functions. To exit Maintenance mode, complete the following steps:

1. Press the Unload Button once per second until  is displayed. Press and hold the Unload Button for 3 or more seconds then release the button to take the drive out of Maintenance mode. If no error is detected,  temporarily appears in the SCD, and it goes blank. The drive then exits Maintenance mode and the status light turns on.
2. If an error is detected, the SCD shows an error code but still exits Maintenance mode. To determine the error, locate the code in Appendix C, “Error codes and messages,” on page 59. To clear the error, turn the power off, then on again.
3. Press and hold the Unload button until the drive resets.

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

## Function code 0: Maintenance mode

Function code  makes the drive available for running drive diagnostics or maintenance functions.


1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. To exit Maintenance mode, see “Exiting Maintenance mode” on page 25.

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

## Function code 1: Run drive diagnostics

Approximate Run Time = 5 minutes per loop




Total Number of Loops = 1

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




Once you begin this test, the diagnostic begins the loop sequence. Time the first loop by pressing the Unload button once to stop the diagnostic after the completion of the first loop, then record the time it takes for the test to complete. Compare the recorded time with the "Approximate Run Time" above. If the test runs successfully but the execution time is significantly longer than the "Approximate Run Time", run “Function code F: Write performance test” on page 34. If the Write performance test fails, replace the media and exit Maintenance mode.



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

**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM

media), error code  or  appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for example, Gen 3 media), error code  appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.


To execute Function code 1: Run drive diagnostics, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
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 3 or more seconds, then release it to select function . Wait for the SCD to change to a flashing .




4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing  and the test begins. During the test, the drive will unload and load the cartridge. Do not remove the cartridge during the test.
  - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends,  temporarily appears in the SCD.
  - 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 Appendix C, “Error codes and messages,” on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## Function code 2: Update drive firmware from FMR tape

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

Function code  loads drive firmware from a field microcode replacement (FMR) tape. The FMR tape must have been created by a LTO 5 tape drive with the same host interface (e.g. SAS).

To execute Function code 2: Update drive firmware from FMR tape, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload button once per second until the code reappears.)
3. Press and hold the Unload button for three or more seconds, then release it to select the function. The SCD changes to a flashing .
4. Insert the FMR tape cartridge. The SCD changes to a flashing . The amber Fault light will be solid during tape movement and flashing while code is being loaded. The green Ready light will be off. The tape drive loads the updated firmware from the FMR tape into its erasable programmable read-only memory (EPROM) area.
  - If the update completes successfully, the tape drive rewinds and unloads the FMR tape, resets itself, and is ready to use the new firmware. The drive automatically reboots.
  - If the update fails, the tape drive posts an error code to the SCD. To determine the error, locate the code in Appendix C, “Error codes and messages,” on page 59. Push the Unload button to eject the cartridge. The drive exits Maintenance mode after the cartridge is removed. Contact IBM Technical Support for problem determination or machine replacement.

## Function code 3: Create FMR tape

Function code **3** copies the drive field microcode replacement (FMR) data to a scratch data cartridge. The resulting FMR tape can only be used to update the firmware on other LTO Gen 5 tape drives with the same host interface (SAS).

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

**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM

media), error code **U** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for example, Gen 3 media), error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

To execute Function code 3: Create FMR tape, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until **3** appears in the SCD. (If you cycle past the desired code, press the Unload button once per second until the code reappears.)
3. Press and hold the Unload button for 3 or more seconds, then release it to select the function. The SCD changes to a flashing **C**.
4. Insert a scratch (blank) data cartridge that is not write protected (or the tape drive exits maintenance mode). The SCD changes to a flashing **3**. The tape drive copies the FMR data to the scratch data cartridge.
  - If the tape drive creates the FMR tape successfully, it rewinds and unloads the new tape, exits Maintenance mode, and the tape is ready to use.
  - If the tape drive fails to create the FMR tape, it displays an error code. To determine the error, see Appendix C, “Error codes and messages,” on page 59. The tape drive then unloads the FMR tape and exits Maintenance mode after the cartridge is removed.

## Function code 4: Force a drive dump

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

To execute Function code 4: Force a drive dump, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until **4** appears in the SCD. (If you cycle past the desired code, press the Unload button once per second until the code reappears.)

3. Press and hold the Unload button for 3 or more seconds, then release it to select the function. The drive performs the dump. The SCD shows  $\boxed{5}$ , then goes blank, and the drive exits Maintenance mode. To access the contents of the dump, see “Function code 5: Copy drive dump.”

**Note:** You can also force a drive dump when the tape drive is in normal operating mode. Simply press and hold the Unload button for ten seconds. This causes the drive to reboot.

## Function code 5: Copy drive dump

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

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

**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM media), error code  $\boxed{U}$  or  $\boxed{7}$  appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for example, Gen 3 media), error code  $\boxed{P}$  appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

To execute Function code 5: Copy drive dump, complete the following steps:

1. Put the drive in Maintenance mode. (For instructions, see “Entering Maintenance mode” on page 25.) Index through the Maintenance mode options until  $\boxed{5}$  is displayed on the SCD.
2. Press and hold the Unload button for 3 seconds to select Function code 5. After selecting Function code 5, the SCD will display option  $\boxed{5} - \boxed{1}$ . Press the Unload button within 5 seconds to make a different selection. If no other selection is made, the drive will perform option  $\boxed{5} - \boxed{1}$ .
3. Press the Unload button once per second to cycle through the following functions:
  - $\boxed{5} - \boxed{1}$ : copy dump to tape; clears RAM dump
  - $\boxed{5} - \boxed{2}$ : copy dump to flash memory; clears RAM dump
  - $\boxed{5} - \boxed{3}$ : erase flash memory
  - $\boxed{5} - \boxed{0}$ : no function

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

4. Press and hold the Unload button for 3 or more seconds, then release it to select one of the above functions.

5. If you selected **5 - 0** the drive will exit Maintenance mode. If you selected **5 - 2** or **5 - 3** the SCD will change to a flashing **5** while the procedure is being performed. After the procedure is completed the drive will exit Maintenance mode. If you selected **5 - 1** the SCD will change to a flashing **6** indicating that a data cartridge is to be inserted.
6. Insert a scratch (blank) data cartridge within 60 seconds, or the drive will exit Maintenance mode. Make sure that the scratch cartridge is not write protected (or the tape drive exits Maintenance mode). The SCD flashes the selection number while performing the function.
  - If the copy operation completes successfully, the tape drive rewinds and unloads the tape, and exits Maintenance mode after the cartridge is removed.
  - If the copy operation fails, an error code appears in the SCD. To determine the error, locate the code in Appendix C, "Error codes and messages," on page 59. The tape drive unloads the tape cartridge and exits Maintenance mode after the cartridge is removed.

## Function code 6: Run host interface wrap test

Approximate Run Time = 10 seconds per loop





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

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

To execute Function code 6: Run host interface wrap test:

1. Make sure that the host interface wrap plug is connected to the host interface connector at the rear of the drive.
2. Place the drive in Maintenance mode. For instructions, see "Entering Maintenance mode" on page 25.
3. Press the Unload button once per second until **6** appears in the SCD. Index through the Maintenance mode options until **6** is displayed on the SCD.
4. Press and hold the Unload button for 3 seconds to select Function code 6. After selecting Function code 6 the SCD will display option **6 - 1**. Press the Unload button within 5 seconds to make a different selection. If no other selection is made, the drive will perform option **6 - 1**.
5. Press the Unload button once per second to cycle through the following functions:
  - **6 - 1** : test the primary SAS port
  - **6 - 2** : test the secondary SAS port
  - **6 - 3** : test both primary and secondary SAS ports at the same time (requires a wrap plug in both ports)



-  -  : exit
6. Press and hold the Unload button for 3 or more seconds, then release it to select one of the above functions. The drive automatically starts the test. If you cycle past the desired code, press the Unload button once per second until the code reappears.
  7. The SCD will display a flashing  during the test.
    - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends,  temporarily appears in the SCD.
    - 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 Appendix C, "Error codes and messages," on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## Function code 7: Run RS-422 wrap test





Approximate Run Time = 10 seconds per loop

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


**Note:** This function is described here only for informational purposes. It is not supported on the tape drive.

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





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




1. Make sure that no cartridge is in the drive, and the correct wrap plug is attached to the RS-422 connector.
2. Put the drive in Maintenance mode. For instructions, see "Entering Maintenance mode" on page 25.
3. Press the Unload button once per second until  appears in the 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 3 seconds. After you select the function,  flashes and the drive automatically starts the test.
  - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends,  temporarily appears in the SCD.
  - 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 Appendix C, "Error codes and messages," on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## 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.

To execute Function code 8: Unmake FMR tape, complete the following steps:



1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
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 3 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. The drive then ejects the cartridge and exits Maintenance mode.


**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM media), error code  or  appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for example, Gen 3 media), error code  appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

## Function code 9: Display error code log


Function code  displays the last 10 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 SCD and exits Maintenance mode.

To execute Function code 9: Display error code log, complete the following steps:




1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
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 the Unload button, then release it to view the most recent error code.
4. Press and release the Unload button again to view successive error codes. Let 2 to 3 seconds pass between each depression. The green Ready light and amber Fault light will flash on and off once for each successive error code. The SCD will display  when all the error codes have been displayed.

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

## Function code A: Clear error code log

Function code  erases the contents of the error code log.

To execute Function code A: Clear error code log, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
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 3 or more seconds, then release it to select the function.  flashes in the SCD, followed by . The tape drive erases all errors from the error code log and exits Maintenance mode.


## Function code C: Insert cartridge into tape drive

You cannot select this function; it is part of other maintenance functions (such as Run tape drive diagnostics and Create FMR tape) that require a tape cartridge to be inserted.

## Function code E: Test cartridge & media

Approximate Run Time = 15 minutes per loop



Total Number of Loops = 10


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

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

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

**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM

media), error code  or  appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for

example, Gen 3 media), error code  appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

To execute Function code E: Test cartridge & media, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until **E** appears in the SCD. (If you cycle past the desired code, press the Unload button once per second until the code reappears.)
3. Press and hold the Unload button for 3 or more seconds, then release it to select the function. The SCD changes to a flashing **C** requesting a cartridge.
4. Make sure that the write-protect switch on the cartridge is off, then insert the cartridge (or the tape drive exits Maintenance mode). The SCD changes to flashing **E**. The tape drive runs the tests.
  - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends, **C** temporarily appears in the SCD.
  - 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 Appendix C, “Error codes and messages,” on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## Function code F: Write performance test

Approximate Run Time = 5 minutes per loop

Total Number of Loops = 10

Function code **F** performs tests to make sure that the drive can read from and write to tape.

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

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

**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM media), error code **L** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for example, Gen 3 media), error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

To execute Function code F: Write performance test, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.

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 3 or more seconds, then release it to select the function. The SCD changes to a flashing **F**.
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing **F** and the tape drive runs the tests.
  - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends, **F** temporarily appears in the SCD.
  - 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 Appendix C, "Error codes and messages," on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## Function code H: Test head

Approximate Run Time = 10 minutes per loop

Total Number of Loops = 10

Function code **H** performs tests to make sure that the tape drive head and tape-carriage mechanics work correctly.

Once you begin this test, the diagnostic begins the loop sequence. Time the first loop by pressing the Unload button once to stop the diagnostic after the completion of the first loop, then record the time it takes for the test to complete. Compare the recorded time with the "Approximate Run Time" above. If the test runs successfully but the execution time is significantly longer than the "Approximate Run Time", run "Function code F: Write performance test" on page 34. If the Write performance test fails, replace the media and exit Maintenance mode.

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

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

**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM

media), error code **U** or **7** appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for

example, Gen 3 media), error code **P** appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

To execute Function code H: Test head, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until  $\boxed{H}$  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 3 or more seconds, then release it to select the function. The SCD changes to a flashing  $\boxed{L}$ .
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing  $\boxed{H}$ . The tape drive runs the tests.
  - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends,  $\boxed{L}$  temporarily appears in the SCD.
  - 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 Appendix C, “Error codes and messages,” on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## Function code J: Fast read/write test

Approximate Run Time = 5 minutes per loop

Total Number of Loops = 10

Function code  $\boxed{J}$  performs tests to make sure that the drive can read from and write to tape.

Once you begin this test, the diagnostic begins the loop sequence. Time the first loop by pressing the Unload button once to stop the diagnostic after the completion of the first loop, then record the time it takes for the test to complete. Compare the recorded time with the "Approximate Run Time" above. If the test runs successfully but the execution time is significantly longer than the "Approximate Run Time", run “Function code F: Write performance test” on page 34. If the Write performance test fails, replace the media and exit Maintenance mode.

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

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

**Note:** If you inserted an invalid tape cartridge (for example, Gen 2 or WORM media), error code  $\boxed{J}$  or  $\boxed{7}$  appears in the SCD. If you inserted a write-protected cartridge, or the media has read-only compatibility (for

example, Gen 3 media), error code  $\square P$  appears in the SCD. In either case, the tape drive unloads the cartridge and exits Maintenance mode after the cartridge is removed.

To execute Function code J: Fast read/write test, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until  $\square J$  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 3 or more seconds, then release it to select the function. The SCD changes to a flashing  $\square J$ .
4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing  $\square J$  and the tape drive runs the tests.
  - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends,  $\square J$  temporarily appears in the SCD.
  - 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 Appendix C, “Error codes and messages,” on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## Function code L: Load/unload test

Approximate Run Time = 15 seconds per loop

Total Number of Loops = 10

Function code  $\square L$  tests the ability of the drive to load and unload a tape cartridge.

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

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

To execute Function code L: Load/unload test, complete the following steps:

1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until  $\square L$  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 3 or more seconds, then release it to select the function. The SCD changes to a flashing  $\square L$ .

4. Insert a scratch (blank) data cartridge. The SCD changes to a flashing **L** and the tape drive runs the tests.
  - If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload button for 1 second and release. When the loop ends, **L** temporarily appears in the SCD.
  - 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 Appendix C, “Error codes and messages,” on page 59. To clear the error, either turn the power off and then on again, or restart the drive by pressing and holding the Unload button for 10 seconds.

## Function code P: Enable post error reporting

When post error reporting is enabled, deferred-check conditions are reported to the host and temporary errors are reported in the sense data. Function code **P** will be displayed in Maintenance mode when the drive has post error reporting enabled.

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

To execute Function code P: Enable post error reporting, complete the following steps:







1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until either **P** or **U** appears in the SCD. **P** or **U** will appear in the SCD to indicate the current setting for post error reporting. If you cycle past the desired code, press the Unload button once per second until the code reappears.
3. Exit Maintenance mode if you do not want to change the current setting for post error reporting. For instructions, see “Exiting Maintenance mode” on page 25.
4. To disable post error reporting, press and hold the Unload button for 3 seconds while **P** appears in the SCD. The SCD changes to **U** after you release the Unload button.
5. Press the Unload button once per second to select another Maintenance mode function. To exit Maintenance mode, see “Exiting Maintenance mode” on page 25.

## Function code U: Disable post error reporting

When post error reporting is disabled, deferred-check conditions are not reported to the host and temporary errors are not reported in the sense data. This is the normal (default) setting for the drive. When the drive has post error reporting disabled, Function code **U** will be displayed in Maintenance mode. The drive will default to post error reporting disabled after a reboot or power off/on cycle.

To execute Function code U: Disable post error reporting, complete the following steps:



1. Put the drive in Maintenance mode. For instructions, see “Entering Maintenance mode” on page 25.
2. Press the Unload button once per second until either  or  appears in the SCD.  or  will appear in the SCD to indicate the current setting for post error reporting. If you cycle past the desired code, press the Unload button once per second until the code reappears.
3. Exit Maintenance mode if you do not want to change the current setting for post error reporting. For instructions, see “Exiting Maintenance mode” on page 25.
4. To disable post error reporting, press and hold the Unload button for 3 seconds while  appears in the SCD. The SCD changes to  after you release the Unload button.
5. Press the Unload button once per second to select another Maintenance mode function. To exit Maintenance mode, see “Exiting Maintenance mode” on page 25.



---

## Chapter 4. Using Ultrium media

To make sure that your IBM Ultrium tape drive conforms to IBM's specifications for reliability, use only IBM LTO Ultrium tape cartridges. Other LTO-certified data cartridges might not meet the standards of reliability that are established by IBM. The IBM LTO Ultrium data cartridge cannot be used in other IBM non-LTO Ultrium tape products.

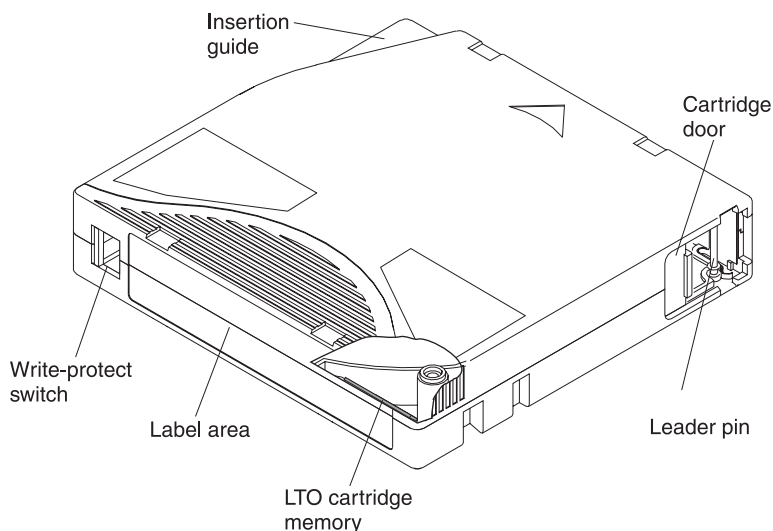


Figure 9. The IBM LTO Ultrium data cartridge

LTO Cartridge Memory	This is a chip that contains information about the cartridge and the tape, as well as statistical information about the use of the cartridge. For more information, see "Cartridge Memory chip (LTO-CM)" on page 42.
Cartridge door	The cartridge door protects the tape from contamination when the cartridge is out of the drive.
Leader pin	The tape is attached to a leader pin, behind the cartridge door. When the cartridge is inserted into the drive, a threading mechanism pulls the pin (and tape) out of the cartridge, across the drive head, and onto a take-up reel. The head can then read or write data from or to the tape.
Write-protect switch	This switch prevents data from being written to the tape cartridge. For more information, see "Write-protect switch" on page 42.
Label area	This provides a location to place a label.
Insertion guide	This is a large, notched area that prevents the cartridge from being inserted incorrectly.

---

### Types of cartridges

IBM Ultrium media is available in the following types:

- "Data cartridge" on page 42
- "WORM (Write Once, Read Many) cartridge" on page 43
- "Cleaning cartridge" on page 44

## Data cartridge

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

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

Data cartridge	Case color	Native data capacity	Recording format <sup>1</sup>	Nominal cartridge life (load/unload cycles)
Ultrium 5	Burgundy	1,500 GB (3,000 GB at 2:1 compression)	Reads and writes data on 1280 tracks, 16 tracks at a time	20,000
Ultrium 4	Green	800 GB (1,600 GB at 2:1 compression)	Reads and writes data on 896 tracks, 16 tracks at a time	20,000
Ultrium 3	Slate blue	400 GB (800 GB at 2:1 compression)	Reads and writes data on 704 tracks, 16 tracks at a time	20,000
Ultrium 2	Purple	200 GB (400 GB at 2:1 compression)	Reads and writes data on 512 tracks, 8 tracks at a time	10,000
Ultrium 1	Black	100 GB (200 GB at 2:1 compression)	Reads and writes data on 384 tracks, 8 tracks at a time	5,000

<sup>1</sup> The first set of tracks (16 for Ultrium 5, 4 and 3; 8 for Ultrium 2 and 1) is written from near the beginning of the tape to near the end of the tape. The head then repositions to the next set of tracks for the return pass. This process continues until all tracks are written and the cartridge is full, or until all data is written.

## Cartridge Memory chip (LTO-CM)

All generations of IBM LTO Ultrium data cartridges include a Linear Tape-Open Cartridge Memory (LTO-CM) chip (see Figure 9 on page 41), 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 use. The LTO-CM enhances the efficiency of the cartridge. For example, the LTO-CM stores the end-of-data location which, when the next time this cartridge is inserted and the WRITE command is issued, enables the drive to quickly locate the recording area and begin recording.


The LTO-CM also aids in determining the reliability of the cartridge by storing data about its age, how many times it has been loaded, and how many errors it has accumulated. Whenever a tape cartridge is unloaded, the tape drive writes any pertinent information to the cartridge memory.

The storage capacity of the LTO Generation 4 and 5 LTO-CM is 8,160 bytes. LTO Generations 1, 2, and 3 have an LTO-CM capacity of 4,096 bytes.

## Write-protect switch

The position of the write-protect switch on the tape cartridge (see Figure 9 on page 41) determines whether you can write to the tape.

If possible, use your server application software to write-protect your cartridges (rather than manually setting the write-protect switch). This allows the server 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 the switch is in the locked position,  (solid red), data cannot be written to the tape. If the switch is in the unlocked position (black void), data can be written to the tape.

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

## WORM (Write Once, Read Many) cartridge

Certain records-retention and data-security applications require a Write Once, Read Many (WORM) method for storing data on tape. The LTO Ultrium generation 3, 4 and 5 drives enable WORM support when a WORM tape cartridge is loaded into the drive.

Because standard read/write media are incompatible with the WORM feature, a specially formatted WORM tape cartridge (see Figure 10) is required. Each WORM cartridge has a unique, worldwide cartridge identifier (WWCID), which is comprised of the unique CM chip serial number and the unique tape media serial number.

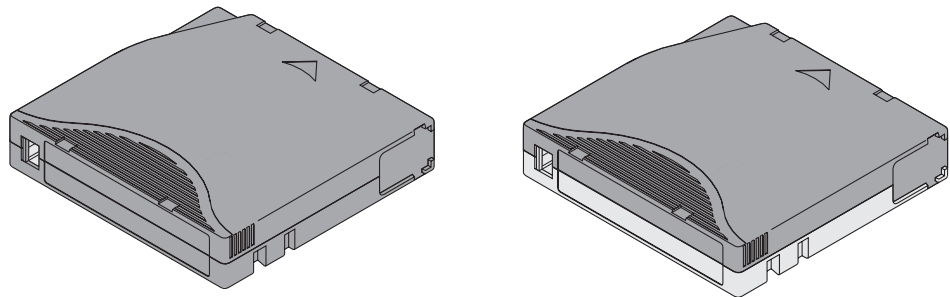


Figure 10. Ultrium data cartridge on the left; WORM cartridge on the right

Type of cartridge	Case color	Native data capacity	Recording format <sup>1</sup>
Ultrium 5 WORM	Burgundy and silvery gray	1,500 GB (3,000 GB at 2:1 compression)	Reads and writes data on 1,280 tracks, 16 tracks at a time
Ultrium 4 WORM	Green and silvery gray	800 GB (1,600 GB at 2:1 compression)	Reads and writes data on 896 tracks, 16 tracks at a time
Ultrium 3 WORM	Slate blue and silvery gray	400 GB (800 GB at 2:1 compression)	Reads and writes data on 704 tracks, 16 tracks at a time

<sup>1</sup> The first set of tracks, which is 16 for Ultrium 5, 4 and 3 cartridges, 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 of your data is written.

## Data security on WORM media

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

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

## WORM media errors

The following conditions cause WORM media errors to occur:

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

## Requirements for WORM capability

To add WORM capability to your LTO Ultrium generation 4 or generation 5 drive, firmware must be at the correct code level, and you must use either Ultrium 4,800 GB WORM tape cartridges or Ultrium 5 1,500 GB WORM tape cartridges.

## Cleaning cartridge

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

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

IBM cleaning cartridges are valid for 50 uses. The cartridge LTO-CM chip tracks the number of times that the cartridge is used.

---

## Cartridge compatibility

Table 9. Ultrium cartridge compatibility with Ultrium tape drives

IBM Ultrium tape drive	IBM LTO Ultrium data cartridges				
	1500 GB (Ultrium 5)	800 GB (Ultrium 4)	400 GB (Ultrium 3)	200 GB (Ultrium 2)	100 GB (Ultrium 1)
Ultrium 5	Read and write	Read and write	Read only		
Ultrium 4		Read and write	Read and write	Read only	
Ultrium 3			Read and write	Read and write	Read only
Ultrium 2				Read and write	Read and write
Ultrium 1					Read and write

---

## Handling cartridges

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

Incorrect handling or an incorrect environment can damage 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.
- Make sure that anyone who handles tape has been properly trained in handling and shipping procedures. This includes operators, users, programmers, archival services, and shipping personnel.
- Ensure that any service or contract personnel who perform archiving are properly trained in media-handling procedures.
- Include media-handling procedures as part of any services contract.
- Define and make personnel aware of data recovery procedures.

## **Provide proper acclimation and environmental conditions**

- Before using a cartridge, let it acclimate to the normal operating environment for 1 hour. If condensation is visible on the cartridge, wait an additional hour.
- Make sure 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 47.

## **Inspect the cartridge**

Before using the cartridge, perform the following steps:

- Inspect the cartridge 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 make sure that there are no gaps in the seam of the cartridge case. If there are gaps in the seam, the leader pin might be dislodged. Go to Appendix D, “Repairing a cartridge,” on page 65.
- Check that the leader pin is properly seated (see Figure 16 on page 66).
- 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 is dropped, slide the cartridge door back and make sure that the leader pin is properly seated in the pin-retaining

spring clips (see Figure 15 on page 66). If the leader pin has become dislodged, see Appendix D, "Repairing a cartridge," on page 65.

- Do not handle tape that is outside the cartridge. Handling the tape can damage the tape surface or edges, which might interfere with read or write reliability. Pulling on tape that is outside the cartridge can damage the tape and the brake mechanism in the cartridge.
- Do not stack more than six cartridges.
- Do not degauss a cartridge that you intend to reuse. Degaussing makes the tape unusable.

## Tape cartridge 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 holds the cartridge securely in its jewel case during transportation. Ultrium Turtlecases (by Perm-A-Store) have been tested and found to be satisfactory. They are available at <http://www.turtlecase.com>.



Figure 11. 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, make sure that the following conditions are met:
  - Place the cartridge in polyethylene plastic wrap or bags to protect it from dust, moisture, and other contaminants.
  - Pack the cartridge tightly; do not allow it to move around.
  - Double-box the cartridge (place it inside a box, then place that box inside the shipping box) and add padding between the two boxes.





Figure 12. Double-boxing tape cartridges for shipping

## Environmental and shipping specifications for tape cartridges

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

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

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

Table 10. Environment for operating, storing, and shipping LTO media

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

## Disposing of tape cartridges

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

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

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

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

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## Chapter 5. Resolving problems

If you encounter problems when operating the drive, see the flowchart in Figure 13. For explanations of codes on the single-character display (SCD), see “Single-character display (SCD)” on page 17. See Appendix A, Getting help and technical assistance before you call IBM Technical Support.

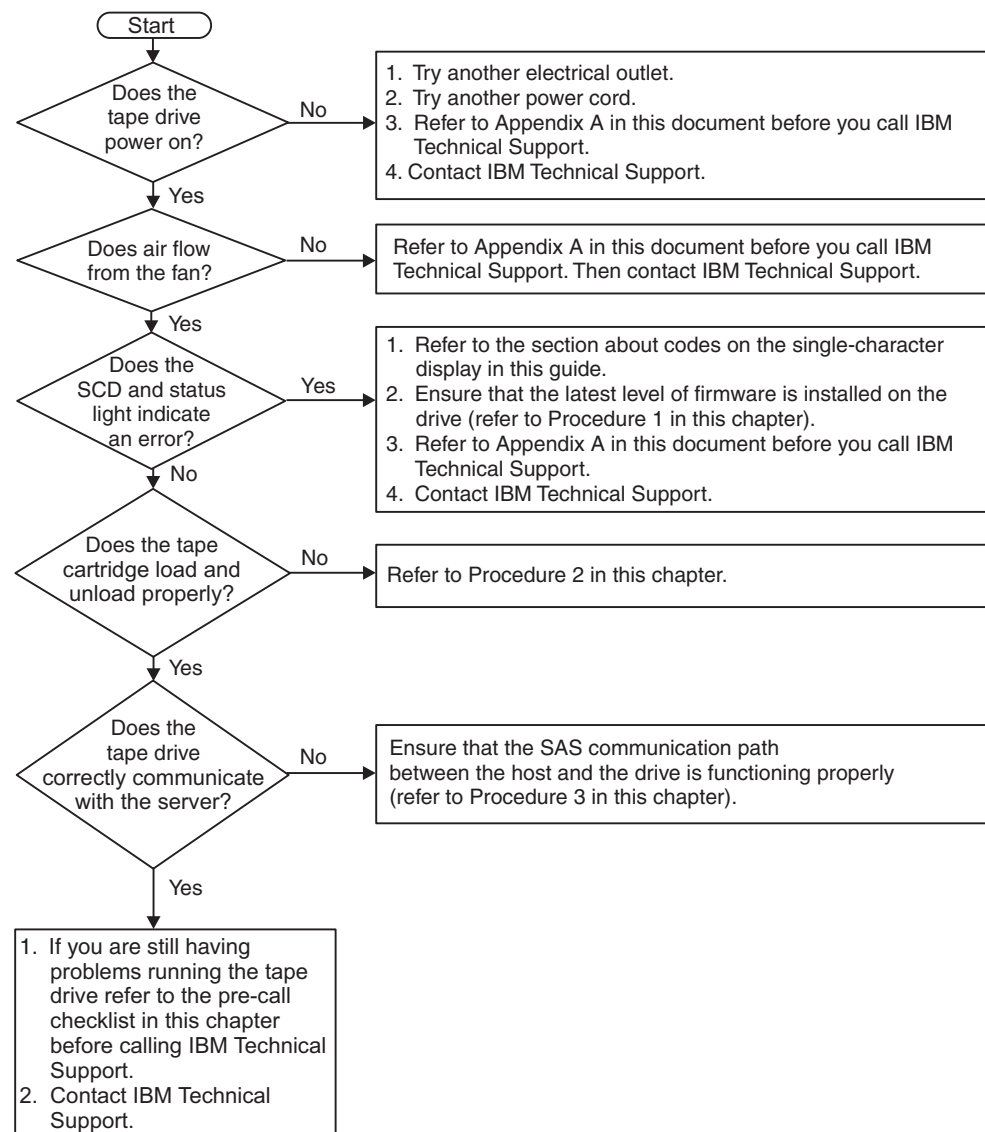


Figure 13. Flowchart for analyzing maintenance problems

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### Procedure 1: Inspecting a cartridge for damage

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

1. Check that the leader pin is attached and properly seated (see “Repositioning a leader pin” on page 65) by opening the cartridge door and observing the pin placement.

2. Inspect the cartridge case, the cartridge door, and the write-protect switch for damage.
3. Inspect the rear of the cartridge (the part that you load first into the tape load compartment) and make sure that there are no gaps in the seam of the cartridge case (see Figure 16 on page 66). If there are gaps, the leader pin might be dislodged. See Appendix D, “Repairing a cartridge,” on page 65.
4. Try loading or unloading another tape cartridge.
  - If the new cartridge loads or unloads properly, discard the cartridge that originally failed.
  - If the new cartridge does not load or unload properly, contact your IBM technical-support representative for additional problem determination.

**Note:**

1. If a damaged or mishandled cartridge is the problem, see “Handling cartridges” on page 44 for proper instructions about handling media. It is possible that your other cartridges might also be damaged.
2. If your cartridge does not eject properly, contact your service representative. (IBM service personnel should go to Appendix E, “Information for trained service personnel,” on page 73.)

---

## Procedure 2: Checking SAS host connections

If your server is not communicating with the SAS drive, the problem might be the SAS cable, the SAS host adapter, or the SAS host adapter setup.

To check the compatibility of your System x hardware and options, go to <http://www-03.ibm.com/systems/info/x86servers/serverproven/compat/us/indexsp.html>.

To check the host connections for your drive, complete the following steps:

1. Make sure that the tape drive power is on.
2. Make sure that the SAS cable is fully-seated in the server and in the tape drive.
3. Make sure that the parameters for the SAS host adapter installation are correct.
4. Make sure that the SAS host adapter is supported by the tape drive.
5. Make sure that there is a point-to-point connectivity between the server and the tape drive. SAS connectivity does not support multiple drive connections (a daisy-chain of devices).
6. Check the length of the SAS cable. It must not exceed 5.5 m (18 ft).

---

## Procedure 3: Verifying host interface communication

The Wrap diagnostic tests the communication function at the device interface. However, to thoroughly verify host-to-device communications, initiate activity over the SAS interface bus from the host to the drive and back. A utility to perform this test is the IBM TotalStorage Tape Diagnostic Tool (ITDT). ITDT is available on the IBM website at <http://www.ibm.com/storage/lto>.

The ITDT is effective for updating the drive firmware and for performing the Test Device function. For additional information about using the ITDT, see “Updating firmware” on page 16. To use the ITDT to execute the Test Device function, complete the following steps:

1. If the ITDT utility is not installed on your server, download the applicable version for your operating system from the IBM website into a directory on your server.
2. When installation is complete, run the SCAN (**s**) option to determine if your server can detect all of the Ultrium tape drive devices (including any libraries or autoloaders that might be on the bus).
3. Select the drive that is to be tested or to have firmware downloaded.
4. For testing, select the Test Device (**t**) option.

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

5. The test will run for at least 30 minutes. If you determine that the interface communication is operating correctly before test completes, enter the ABORT command (**a**).

---

## Resolving problems reported by the server

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

### Fixing SAS bus errors

1. Make sure that the tape drive power is on.
2. Make sure that the SAS cable is fully seated in the server and the tape drive.
3. Replace the SAS cable if it shows any signs of damage.

---

## Resolving problems with the tape media

To resolve problems that are related to media, the drive firmware includes the following capabilities:

- 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 VPD (Vital Product Data) area in NVRAM. Any failures that SARS detects are reported as TapeAlert flags on the server (see *IBM LTO Ultrium Tape Drive SCSI Reference* at <http://www-01.ibm.com/support/docview.wss?uid=ssg1S7001045&aid=1>).

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

If you encounter a media-related problem, see “Function code E: Test cartridge & media” on page 33.

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## Replacing the tape drive

The drive is a Tier 1 customer replaceable unit (CRU). Replacement of Tier 1 CRUs is your responsibility. If IBM installs a Tier 1 CRU at your request, you will be charged for the installation.

For more information about the terms of the warranty and getting service and assistance, see the *Warranty information* document that came with the tape drive.

If you are instructed to return a component, follow all packaging instructions, and use any packaging materials for shipping that are supplied to you.

The following table lists the replaceable components.

*Table 11. CRU and Option part numbers*

<b>Description</b>	<b>CRU part number</b>	<b>Option part number</b>
IBM Internal Half High LTO Gen 5 SAS Tape Drive	46X5683	49Y9898
IBM External Half High LTO Gen 5 SAS Drive, with US line cord	49Y9907	3628L5X
IBM External Half High LTO Gen 5 SAS Drive, with no line cord	49Y9907	3628N5X
SAS cable, internal	44E8878	
Mini-SAS cable, external, 3 m x 4 plug	39R6532	
US line cord, 3 ft, 10 A / 125 V	39M5081	

To replace your tape drive, complete the following steps:

1. Remove the replacement unit from its packaging.
2. Locate the repair identification (RID) tag that is included with the replacement unit. See Figure 14 on page 53.
3. Write down the serial number of the failed unit on the RID tag.
4. Affix the repair tag to the rear panel of the replacement unit (below the serial number label).
5. Place the failed unit into the packaging of the replacement unit.
6. Follow the instructions for returning the failed unit that are included with the replacement unit.

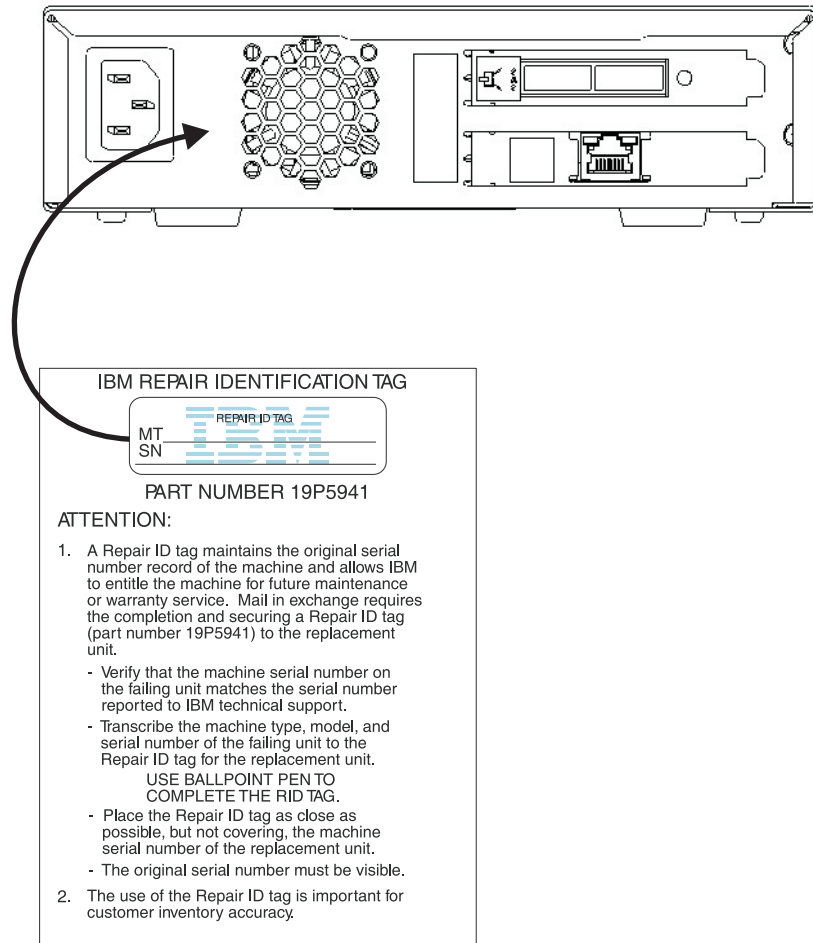


Figure 14. RID tag on rear panel





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## Appendix A. Getting help and technical assistance

If you need help, service, or technical assistance or just want more information about IBM products, you will find a wide variety of sources available from IBM to assist you. This section contains information about where to go for additional information about IBM and IBM products, what to do if you experience a problem with your system, and whom to call for service, if it is necessary.

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### Before you call

Before you call, make sure that you have taken these steps to try to solve the problem yourself:

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system and any optional devices are turned on.
- Use the troubleshooting information in your system documentation, and use the diagnostic tools that come with your system. Information about diagnostic tools is in the *Problem Determination and Service Guide* on the IBM Documentation CD that comes with your system.
- Go to the IBM support website at <http://www.ibm.com/supportportal/> to check for technical information, hints, tips, and new device drivers or to submit a request for information.

You can solve many problems without outside assistance by following the troubleshooting procedures that IBM provides in the online help or in the documentation that is provided with your IBM product. The documentation that comes with IBM systems also describes the diagnostic tests that you can perform. Most systems, operating systems, and programs come with documentation that contains troubleshooting procedures and explanations of error messages and error codes. If you suspect a software problem, see the documentation for the operating system or program.

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### Using the documentation

Information about your IBM system and preinstalled software, if any, or optional device is available in the documentation that comes with the product. That documentation can include printed documents, online documents, readme files, and help files. See the troubleshooting information in your system documentation for instructions for using the diagnostic programs. The troubleshooting information or the diagnostic programs might tell you that you need additional or updated device drivers or other software. IBM maintains pages on the World Wide Web where you can get the latest technical information and download device drivers and updates. To access these pages, go to <http://www.ibm.com/supportportal/> and follow the instructions. Also, some documents are available through the IBM Publications Center at <http://www.ibm.com/shop/publications/order/>.

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## Getting help and information from the World Wide Web

On the World Wide Web, the IBM website has up-to-date information about IBM systems, optional devices, services, and support. The address for IBM System x<sup>®</sup> and xSeries<sup>®</sup> information is <http://www.ibm.com/systems/x/>. The address for IBM BladeCenter<sup>®</sup> information is <http://www.ibm.com/systems/bladecenter/>. The address for IBM IntelliStation<sup>®</sup> information is <http://www.ibm.com/systems/intellistation/>.

You can find service information for IBM systems and optional devices at <http://www.ibm.com/supportportal/>.

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## Software service and support

Through IBM Support Line, you can get telephone assistance, for a fee, with usage, configuration, and software problems with System x and xSeries servers, BladeCenter products, IntelliStation workstations, and appliances. For information about which products are supported by Support Line in your country or region, see <http://www.ibm.com/services/supline/products/>.

For more information about Support Line and other IBM services, see <http://www.ibm.com/services/>, or see <http://www.ibm.com/planetwide/> for support telephone numbers. In the U.S. and Canada, call 1-800-IBM-SERV (1-800-426-7378).

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## Hardware service and support

You can receive hardware service through your IBM reseller or IBM Services. To locate a reseller authorized by IBM to provide warranty service, go to <http://www.ibm.com/partnerworld/> and click **Find Business Partners** on the right side of the page. For IBM support telephone numbers, see <http://www.ibm.com/planetwide/>. In the U.S. and Canada, call 1-800-IBM-SERV (1-800-426-7378).

In the U.S. and Canada, hardware service and support is available 24 hours a day, 7 days a week. In the U.K., these services are available Monday through Friday, from 9 a.m. to 6 p.m.

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## IBM Taiwan product service

台灣 IBM 產品服務聯絡方式：  
台灣國際商業機器股份有限公司  
台北市松仁路 7 號 3 樓  
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IBM Taiwan product service contact information:  
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3F, No 7, Song Ren Rd.  
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Telephone: 0800-016-888

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## Appendix B. 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 host interface. The server reads the flags from Log Sense Page 0x2E. See the *IBM LTO Ultrium Tape Drive SCSI Reference* document for the list of TapeAlert flags that are supported by this tape drive. To download the *IBM LTO Ultrium Tape Drive SCSI Reference* document (PDF), go to <http://www-01.ibm.com/support/docview.wss?uid=ssg1S7001045&aid=1>.



## Appendix C. Error codes and messages

If the drive detects a permanent error, it will display the error code on the SCD and flash the amber fault light (green status light will be off).

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


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

Table 12. Error codes on the SCD




Error code	Cause and action
	No error occurred and no action is required. This code displays when diagnostics have finished running and no error occurred. <b>Note:</b> The SCD is blank during normal operation of the tape drive.
	Temperature problem. The tape drive detected that the recommended operating temperature was exceeded. Perform one or more of the following actions: <ul style="list-style-type: none"> <li>• Make sure that the cooling fan is rotating and is quiet. If it is not, see the documentation that came with your enclosure.</li> <li>• Remove any blockage that prevents air from flowing freely through the tape drive.</li> <li>• Make sure that the operating temperature and airflow is within the specified range (see “External tape drive specifications” on page 7).</li> </ul> Clear the error code by turning off and turning on the tape drive power or placing the drive in Maintenance mode. If the operating temperature and airflow are within the specified range, and the problem persists, replace the drive.
	Power problem. The tape drive detected that the externally supplied power is outside the specified voltage limits (the tape drive is not operating). Complete the following steps: <ol style="list-style-type: none"> <li>1. Make sure that the power connector is properly seated.</li> <li>2. Make sure that the proper dc voltages are being applied within the tolerances allowed (see “External tape drive specifications” on page 7).</li> <li>3. If the proper voltages are not being applied, service the power supply.</li> <li>4. If the proper voltages are being applied, turn off and turn on the tape drive power to see if the problem repeats.</li> <li>5. Replace the tape drive if the problem persists.</li> </ol> The error code clears when you place the tape drive in Maintenance mode.

Table 12. Error codes on the SCD (continued)

Error code	Cause and action
3	<p>Firmware problem. The tape drive determined that a firmware error occurred. Complete the following steps:</p> <ol style="list-style-type: none"> <li>1. Collect a drive dump from one of the following:           <p><b>Note:</b> Do not force a new dump; the tape drive has already created one.</p> <ul style="list-style-type: none"> <li>• Server host interface by using a device driver utility or system tool (for instructions about reading a drive dump from tape, visit the IBM Web site for the IBM Tape Diagnostic Tool (ITDT) at <a href="http://www-01.ibm.com/support/docview.wss?uid=ssg1S4000662">http://www-01.ibm.com/support/docview.wss?uid=ssg1S4000662</a>)</li> <li>• Ultrium Tape Drive (to copy and read a drive dump, use “Function code 5: Copy drive dump” on page 29)</li> </ul> </li> <li>2. Power the tape drive off and on, then retry the operation that produced the error.</li> <li>3. If the problem persists, download new firmware and retry the operation.</li> <li>4. If the problem persists, send the drive dump that you collected in step 1 to IBM Support.</li> </ol> <p>The error code clears when you place the tape drive in Maintenance mode.</p>
4	<p>Firmware or hardware problem. The tape drive determined that a firmware or tape drive hardware failure occurred. Complete the following steps:</p> <ol style="list-style-type: none"> <li>1. Collect a drive dump from one of the following:           <p><b>Note:</b> Do not force a new dump; one already exists.</p> <ul style="list-style-type: none"> <li>• Server host interface by using a device driver utility or system tool (for instructions about reading a drive dump from tape, visit the IBM Web site for the IBM Tape Diagnostic Tool (ITDT) at <a href="http://www-01.ibm.com/support/docview.wss?uid=ssg1S4000662">http://www-01.ibm.com/support/docview.wss?uid=ssg1S4000662</a>)</li> <li>• Ultrium tape drive (to copy and read a drive dump, use “Function code 5: Copy drive dump” on page 29)</li> </ul> </li> <li>2. Turn the tape drive power off and on, then retry the operation that produced the error. The error code clears when you place the tape drive in Maintenance mode.</li> <li>3. If the problem persists, download new firmware and retry the operation; if new firmware is not available, replace the drive.</li> </ol>
5	<p>Tape drive hardware problem. The drive determined that a tape path or read or 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 might clear when you cycle power to the tape drive or place it in Maintenance mode. If the problem persists, replace the drive.</p> <p><b>Note:</b> Copy the drive dump to flash memory before returning the drive. For instructions, see “Function code 5: Copy drive dump” on page 29.</p>
6	<p>Tape drive or media error. The tape drive determined that an error occurred, but it cannot isolate the error to faulty hardware or to the tape cartridge. Make sure that the tape cartridge is the correct media type:</p> <ul style="list-style-type: none"> <li>• Ultrium 1 and Ultrium 2 tape cartridges are not supported in Ultrium 5 tape drives.</li> <li>• Drive will not accept an expired cleaning cartridge.</li> <li>• Drive will not accept a WORM cartridge when running diagnostic tests in Maintenance mode.</li> <li>• Drive will not write over existing datasets on a WORM cartridge. Make sure that you are appending datasets on WORM media rather than attempting to write over existing datasets.</li> </ul> <p>If the tape cartridge is the correct media type, perform one of the following actions:</p>

Table 12. Error codes on the SCD (continued)

Error code	Cause and action
	<p><b><u>For Problems with Writing Data:</u></b></p> <p>If the problem occurred while the tape drive was writing data to the tape, retry the operation with a different cartridge:</p> <ul style="list-style-type: none"> <li>• If the operation succeeds, the original cartridge was defective. Copy the data from the defective cartridge and discard it according to the security policy for your organization.</li> <li>• If the operation fails and another tape drive is available, insert the cartridge into the other unit and retry the operation. <ul style="list-style-type: none"> <li>– If the operation fails, discard the defective cartridge according to the security policy for your organization.</li> <li>– If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function code 1: Run drive diagnostics” on page 26. <ul style="list-style-type: none"> <li>- If the diagnostics fail, replace the tape drive.</li> <li>- If the diagnostics succeed, the error was temporary.</li> </ul> </li> </ul> </li> <li>• If the operation fails and another tape drive is not available, insert a scratch (blank) data cartridge into the unit and run “Function code 1: Run drive diagnostics” on page 26. <ul style="list-style-type: none"> <li>– If the diagnostics fail, replace the tape drive.</li> <li>– If the diagnostics succeed, discard the cartridge according to the security policy for your organization.</li> </ul> </li> </ul> <p>If the problem occurs with multiple tape cartridges, run “Function code 1: Run drive diagnostics” on page 26:</p> <ul style="list-style-type: none"> <li>• If the diagnostics fail, replace the tape drive.</li> <li>• If the diagnostics succeed, run “Function code H: Test head” on page 35. <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, replace the cartridges that caused the problem.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.</p> <p><b><u>For Problems with Reading Data:</u></b></p> <p>If the problem occurred while the tape drive was reading data from the tape, perform one of the following procedures:</p> <ul style="list-style-type: none"> <li>• If another tape drive is available, insert the cartridge into the other unit and retry the operation: <ul style="list-style-type: none"> <li>– If the operation fails, discard the defective cartridge according to the security policy for your organization.</li> <li>– If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function code 1: Run drive diagnostics” on page 26: <ul style="list-style-type: none"> <li>- If the diagnostic fails, replace the tape drive.</li> <li>- If the diagnostic succeeds, the error was temporary.</li> </ul> </li> </ul> </li> <li>• If another tape drive is not available, insert a scratch data cartridge into the unit and run “Function code 1: Run drive diagnostics” on page 26: <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, discard the cartridge according to the security policy for your organization.</li> </ul> </li> </ul> <p>If the problem occurs with multiple tape cartridges, run “Function code 1: Run drive diagnostics” on page 26:</p> <ul style="list-style-type: none"> <li>• If the diagnostic fails, replace the tape drive.</li> <li>• If the diagnostic succeeds, run “Function code H: Test head” on page 35. <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, replace the cartridges that caused the problem.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.</p>

Table 12. Error codes on the SCD (continued)



Error code	Cause and action
<p style="text-align: center;">7</p>	<p>Media error. The tape drive determined an error occurred because of a faulty tape cartridge or an invalid tape cartridge. Make sure that the tape cartridge is the correct media type:</p> <ul style="list-style-type: none"> <li>• Ultrium 1 and Ultrium 2 tape cartridges are not supported in Ultrium 5 tape drives.</li> <li>• Drive will not accept an expired cleaning cartridge.</li> <li>• Drive will not accept a WORM cartridge when running diagnostic tests in Maintenance mode.</li> <li>• Drive will not accept an FMR tape unless the drive is performing “Function code 8: Unmake FMR tape” on page 32.</li> <li>• Drive will not write over existing datasets on a WORM cartridge. Make sure that you are appending datasets on WORM media rather than attempting to write over existing datasets.</li> </ul> <p>If the tape cartridge is the correct media type, try another tape cartridge. If the problem occurs with multiple tape cartridges, use the following procedure:</p> <ol style="list-style-type: none"> <li>1. If possible, run the tape cartridge in a different tape drive. If the operation in the other unit fails and 6 or 7 displays, replace the media. If the operation succeeds, run “Function code E: Test cartridge &amp; media” on page 33.</li> </ol> <p><b>Attention:</b> When you run the Test Cartridge &amp; Media diagnostic, data on the suspect tape is overwritten. Use only a scratch data cartridge to run the test.</p> <ul style="list-style-type: none"> <li>• If the diagnostic fails, replace the media.</li> <li>• If the diagnostic succeeds, clean the drive head (see “Cleaning the drive head” on page 23) and run “Function code 1: Run drive diagnostics” on page 26. <ul style="list-style-type: none"> <li>– If the drive diagnostic fails, replace the drive.</li> <li>– If the drive diagnostic succeeds, perform the operation that produced the initial media error.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.</p>
<p style="text-align: center;">8</p>	<p>Interface problem. The tape drive determined that a failure occurred in the tape drive hardware or in the host bus. See Chapter 5, “Resolving problems,” on page 49. If 8 was displayed while running “Function code 6: Host Interface Test”:</p> <ol style="list-style-type: none"> <li>1. Verify that the correct interface wrap tool (part number 95P6566) was attached during the test. The test will fail if the correct interface wrap tool is not attached.</li> <li>2. If the correct interface wrap tool was attached during the test, replace the drive. The error code clears when you place the tape drive in Maintenance mode.</li> </ol>
<p style="text-align: center;">9</p>	<p>Tape drive or RS-422 error. The tape drive determined that a failure occurred in the tape drive hardware or in the RS-422 connection. See “Function code 7: Run RS-422 wrap test” on page 31 or see the Library procedures to isolate the problem to the drive. The error code clears when you place the tape drive in Maintenance mode.</p>



Table 12. Error codes on the SCD (continued)

Error code	Cause and action
<p data-bbox="269 260 302 302">A</p>	<p data-bbox="388 260 1456 344">Degraded operation. The tape drive determined that a problem occurred which degraded the operation of the tape drive, but it did not restrict continued use. If the problem persists, determine whether the problem is with the drive or the media.</p> <p data-bbox="388 348 1456 432"><b>Note:</b> The drive is usable, though the SCD continues to indicate an error and the status light flashes amber. The error code might clear when you cycle power to the tape drive or place it in Maintenance mode.</p> <p data-bbox="388 457 1456 516">To determine if the problem is with the drive hardware, or the tape media, perform the following procedures:</p> <ol data-bbox="388 520 1456 730" style="list-style-type: none"> <li data-bbox="388 520 1456 638">1. If possible, run the tape cartridge in a different drive. If the operation in the other drive fails and <b>B</b> or <b>7</b> displays, replace the media. If the operation succeeds, run the Test Cartridge &amp; Media diagnostic (see "Function code E: Test cartridge &amp; media" on page 33).</li> <li data-bbox="388 642 1456 730">2. If the Test Cartridge &amp; Media diagnostic fails, replace the media. If it runs successfully, clean the failing drive and run the drive diagnostics (see "Cleaning the drive head" on page 23 and "Function code 1: Run drive diagnostics" on page 26).</li> </ol> <p data-bbox="388 735 1456 974">Once you begin this test, the diagnostic begins the loop sequence. Time the first loop by pressing the Unload button once to stop the diagnostic after the completion of the first loop, then record the time it takes for the test to complete. Compare the recorded time with the "Approximate Run Time" above. If the test runs successfully but the execution time is significantly longer than the "Approximate Run Time", run "Function code F: Write performance test" on page 34. If the Write performance test fails, replace the media and exit Maintenance mode. If the drive diagnostics run successfully, perform the operation that produced the initial drive error.</p> <ol data-bbox="388 978 1456 1012" style="list-style-type: none"> <li data-bbox="388 978 1456 1012">3. If the problem persists, replace the drive.</li> </ol> <p data-bbox="388 1037 1456 1096">If it is not possible to run the tape cartridge in a different drive, perform the following procedures:</p> <ol data-bbox="388 1100 1456 1159" style="list-style-type: none"> <li data-bbox="388 1100 1456 1159">1. Clean the failing drive and run the drive diagnostics (see "Cleaning the drive head" on page 23 and "Function code 1: Run drive diagnostics" on page 26).</li> </ol> <p data-bbox="388 1163 1456 1402">Once you begin this test, the diagnostic begins the loop sequence. Time the first loop by pressing the Unload button once to stop the diagnostic after the completion of the first loop, then record the time it takes for the test to complete. Compare the recorded time with the "Approximate Run Time" above. If the test runs successfully but the execution time is significantly longer than the "Approximate Run Time", run "Function code F: Write performance test" on page 34. If the Write performance test fails, replace the media and exit Maintenance mode. If the drive diagnostics run successfully, run the Test Cartridge &amp; media diagnostic (see "Function code E: Test cartridge &amp; media" on page 33).</p> <ol data-bbox="388 1407 1456 1507" style="list-style-type: none"> <li data-bbox="388 1407 1456 1465">2. If the Test Cartridge &amp; Media diagnostic fails, replace the media. If it runs successfully, perform the operation that produced the initial drive error.</li> <li data-bbox="388 1465 1456 1507">3. If the problem persists, replace the drive.</li> </ol>
<p data-bbox="269 1520 302 1562">C</p>	<p data-bbox="388 1520 1456 1579">The tape drive needs to be cleaned. Clean the tape drive. See "Cleaning the drive head" on page 23.</p> <p data-bbox="388 1596 1456 1625">The error code clears when you clean the tape drive or place it in Maintenance mode.</p>

Table 12. Error codes on the SCD (continued)

Error code	Cause and action
	<p>Encryption error. Displayed when the drive detects an error associated with an encryption operation. If the problem occurred while the tape drive was writing data to, or reading data from, tape:</p> <ol style="list-style-type: none"> <li>1. Check the host application to make sure that the host application is providing the correct encryption key. <ul style="list-style-type: none"> <li>• See the <i>IBM Tape Device Drivers Encryption Support</i> documentation and the <i>IBM LTO Ultrium Tape Drive SCSI Reference</i> documentation for the Sense Data returned for an encryption operation.</li> <li>• Retry the encryption operation after the host application problems have been resolved.</li> </ul> </li> <li>2. Check the operation of the tape drive by resetting the drive and running POST. See Table 7 on page 20. <ul style="list-style-type: none"> <li>• See the error code displayed on the SCD if the drive reset and POST fails.</li> <li>• Retry the encryption operation if the drive reset and POST complete without errors.</li> </ul> </li> <li>3. Check the media. <ul style="list-style-type: none"> <li>• Make sure that the correct media is being used. Data encryption is supported with LTO Ultrium 4 and 5 data cartridges only.</li> <li>• Retry the encryption operation with the tape cartridge in another encryption enabled drive. Replace the media if the problem repeats with the same tape cartridge in multiple drives.</li> </ul> </li> </ol> <p>If the problem occurred while the tape drive was running POST or diagnostics, replace the drive.</p> <p>The error code clears with the first attempted write/read after the encryption key is changed, or when the drive is placed in Maintenance mode.</p>
	<p>Write operation to a write protected cartridge has been attempted (this includes any attempt to overwrite a WORM protected tape). Make sure that the tape cartridge is the correct media type. Writes to Ultrium 2 and Ultrium 3 tape cartridges are not supported in Ultrium 5 tape drives. If the tape cartridge is the correct media type, check the write-protect switch on the cartridge. The drive will not write to a write-protected cartridge. The error code clears when you remove the tape cartridge or place the tape drive in Maintenance mode.</p>

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## Appendix D. Repairing a cartridge

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

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.

**Important:** Do not reattach the pin if you must remove more than 7 m (23 ft) of leader tape.

The following sections describe typical cartridge problems.

### Examples of cartridge problems

**Example: Split cartridge case (see “Inspect the cartridge” on page 45)**

If the cartridge case is damaged. There is a high possibility of media damage and potential loss. Complete the following steps:

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

**Example: Improper placement of the leader pin (see Figure 15 on page 66)**

The leader pin is misaligned. Complete the following steps:

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

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## Repositioning a leader pin

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

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

A leader pin that is improperly seated inside a cartridge can interfere with the operation of the drive. Figure 15 on page 66 shows a leader pin in the incorrect and correct positions.

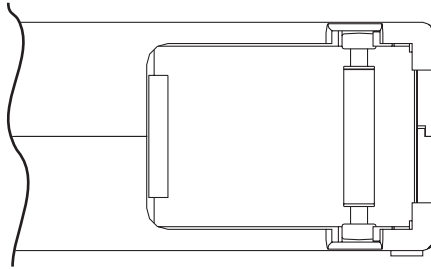


Figure 15. Leader pin in the incorrect and correct positions. The cartridge door is open and the leader pin is visible inside the cartridge.

To reposition the leader pin, see Figure 16 and complete the following steps:

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

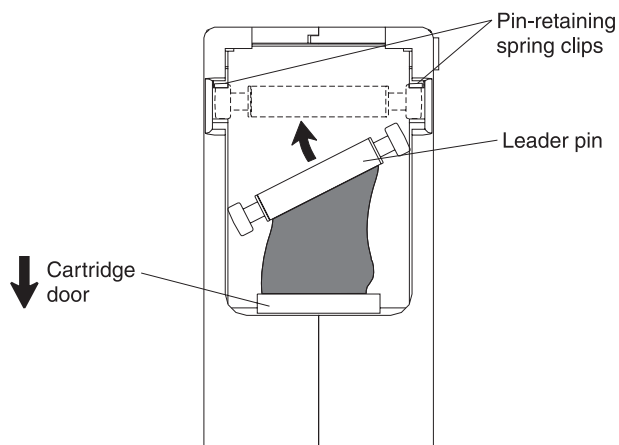


Figure 16. Placing the dislodged leader pin into the correct position

To rewind the tape, see Figure 17 and perform the steps below.

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

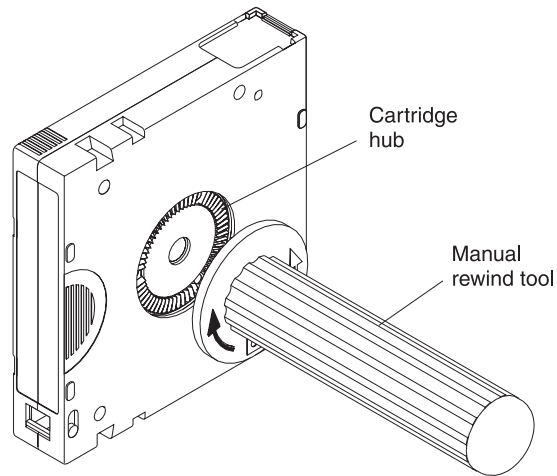


Figure 17. Rewinding the tape into the cartridge

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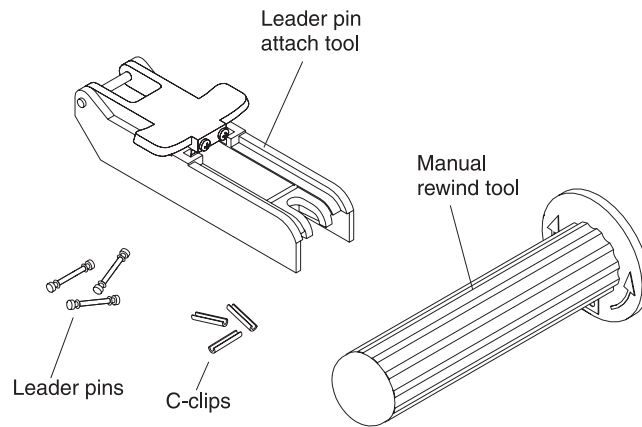
## Reattaching a leader pin

The first meter of tape in a cartridge is leader tape. Once the leader tape is removed, the likelihood of tape breakage is increased. After reattaching the leader pin, transfer data from the defective tape cartridge.

**Important:** Do not reattach the pin if you must remove more than 7 m (23 ft) of leader tape.

**Note:** Do not reuse the defective tape cartridge.

The Leader Pin Reattachment Kit contains three parts:



*Figure 18. Leader Pin Reattachment Kit*

The parts included in the Leader Pin Reattachment Kit are:

**Leader pin attach tool**

A plastic brace that holds the cartridge door open.

**Cartridge manual rewind tool**

A device that fits into the cartridge hub and lets you wind the tape into and out of the cartridge.

**Leader pins**

Extra leader pins are included.

**C-clips**

Extra C-clips are included.

**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, and might void the tape drive warranty.
- Use this procedure on your tape cartridge only when the leader pin detaches from the magnetic tape and you must copy the cartridge data onto another cartridge. After you copy the data, destroy the damaged cartridge according to the security policy for your organization. This procedure might affect the performance of the leader pin during threading and unloading operations.
- Touch only the end of the tape. Touching the tape in an area other than the end can damage the tape surface or edges, which might interfere with read or write reliability.

To reattach a leader pin by using the IBM Leader Pin Reattachment Kit, see Figure 19 and perform the steps below.

1. Attach the leader pin attach tool to the cartridge so that the hook latches into the cartridge door.
2. Pull the tool back to hold the door open, then slide the tool onto the cartridge. Open the tool pivot arm.

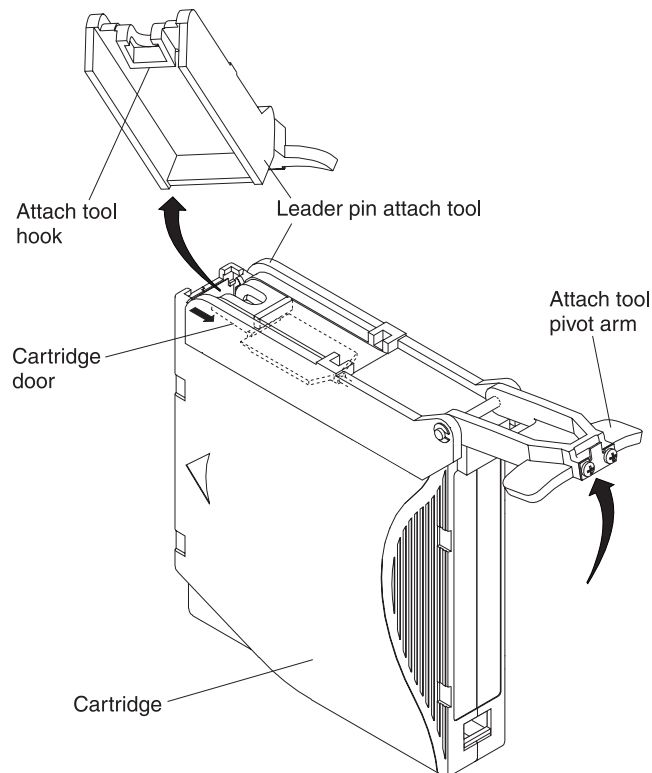
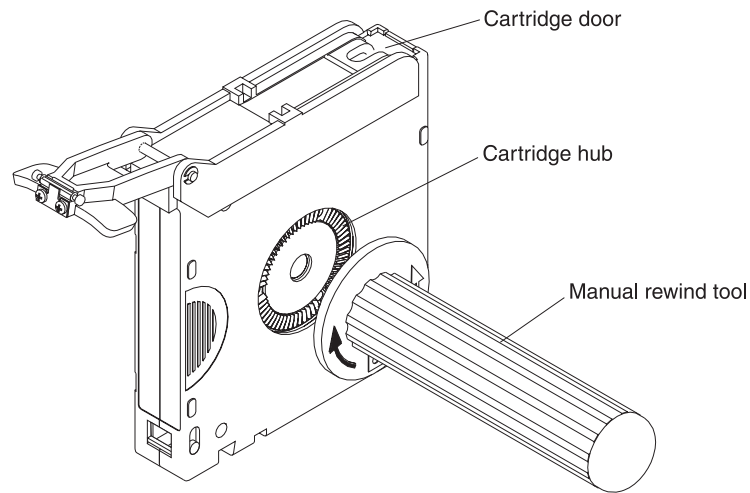


Figure 19. Attaching the leader pin attach tool to the cartridge

To find the end of the tape inside the cartridge, see Figure 20 and complete the following steps:

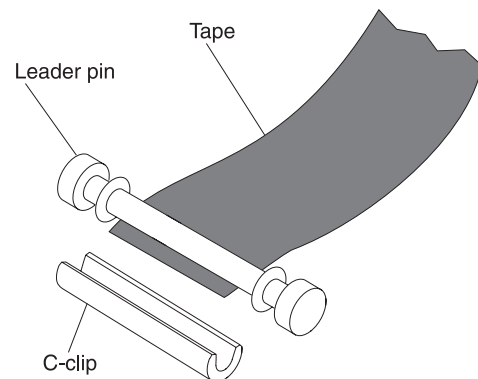
1. Attach the cartridge manual rewind tool to the cartridge hub by fitting the tool teeth between the teeth of the hub.
2. Turn the tool clockwise until you see the end of the tape inside the cartridge.
3. Slowly turn the rewind tool counterclockwise to bring the tape edge toward the cartridge door .
4. 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.
5. Remove the rewind tool by pulling it away from the cartridge. Set the tool and the cartridge aside.



*Figure 20. Winding the tape out of the cartridge*

To remove the C-clip from the leader pin, see Figure 21 and complete the following steps:

1. On the leader pin, locate the open side of the C-clip. The C-clip is a small black part that secures the tape to the pin.
2. Remove the C-clip from the leader pin by using your fingers to push the clip away from the pin. Set the pin aside and discard the clip.



*Figure 21. Removing the C-clip from the leader pin*



To attach the leader pin to the tape, see Figure 22 and complete the following steps:

1. Position the tape in the alignment groove of the leader pin attach tool.
2. Place a new C-clip into the retention groove on the leader pin attachment tool and make sure that the open side of the clip faces up.
3. Place the leader pin that you removed earlier into the cavity of the leader pin attach tool.

**Attention:** To prevent the leader pin from rolling into the cartridge, in the following step use care when folding the tape over the pin.

4. Fold the tape over the leader pin and hold it with your fingers.

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

5. Close the pivot arm of the leader pin attach tool by swinging it over the leader pin so that the C-clip snaps onto the pin and the tape.
6. Swing the pivot arm open and trim the excess tape so that it is flush with the reattached leader pin.
7. Use your fingers to remove the leader pin from the cavity in the leader pin attach tool.
8. Use the cartridge manual rewind tool to wind the tape back into the cartridge (wind the tape clockwise). Make sure that the leader pin is latched by the pin-retaining spring clips on each end of the leader pin.
9. Remove the rewind tool.
10. Remove the leader pin attach tool by lifting its end up and away from the cartridge.

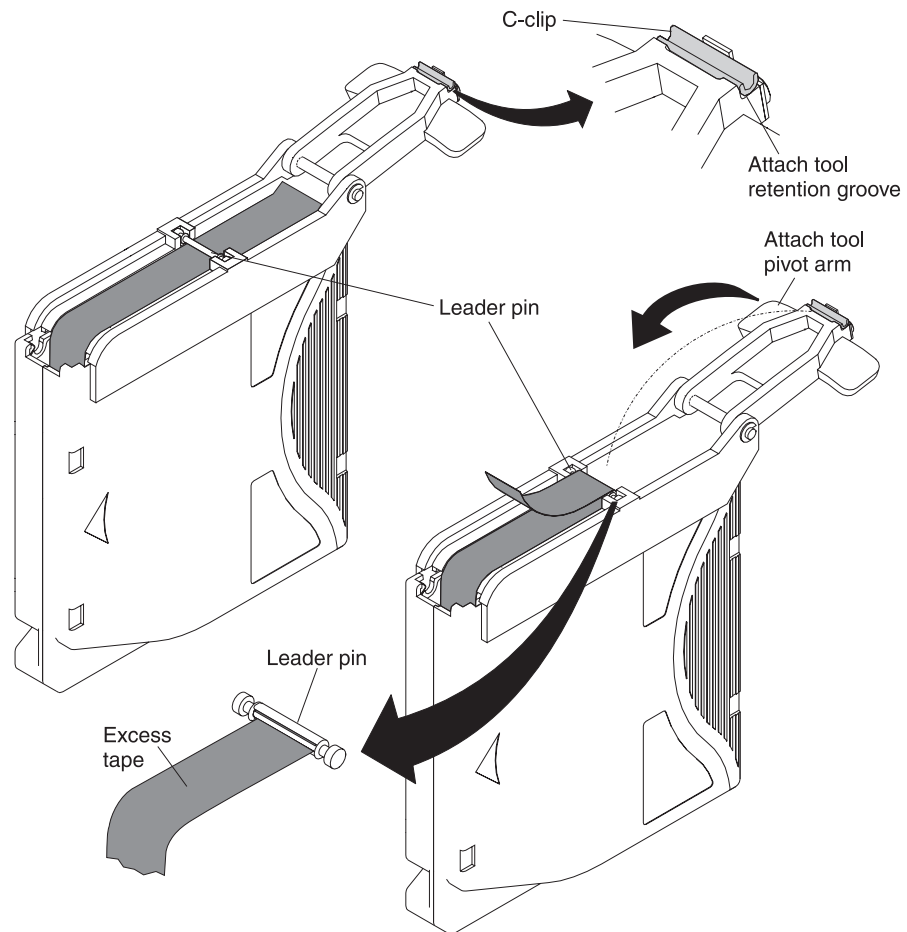


Figure 22. Attaching the leader pin to the tape



---

## Appendix E. Information for trained service personnel

### Attention

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

---

### Removing a drive from an enclosure

Drive removal procedures vary depending on the type of enclosure. The following procedure can be used if the enclosure documentation is not available for the specific enclosure type.

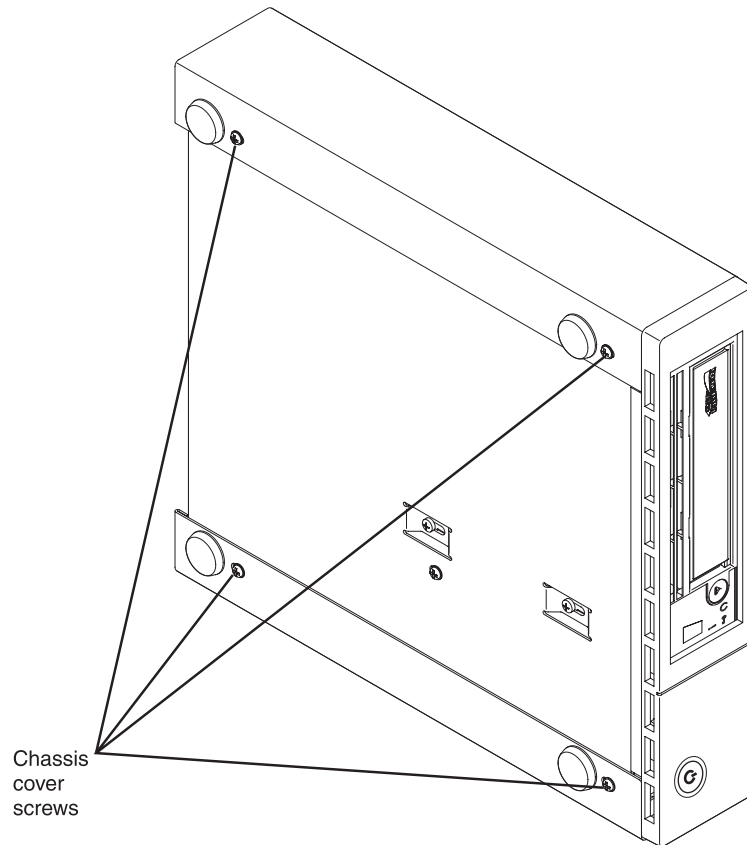
#### Removing the internal drive

This procedure is to be performed only by IBM Service Personnel.

**Note:** One of the four screws securing the cover to the chassis is a tamperproof screw. A T20 Torx tamperproof screwdriver is required to remove the cover.

#### Removing the cover

1. Unplug all cables from the rear panel of the unit.
2. Move the unit to a clean and sturdy work surface.
3. Turn the unit on its side with the bottom of the unit facing you.
4. Remove the four screws (see Figure 23 on page 74) by the feet.



*Figure 23. Removing the screws that secure the cover and internal drive*

5. Return the unit to its upright position.
6. Gently push on the rear panel of the drive to remove the chassis from the cover (see Figure 24 on page 75).

## Removing the internal drive

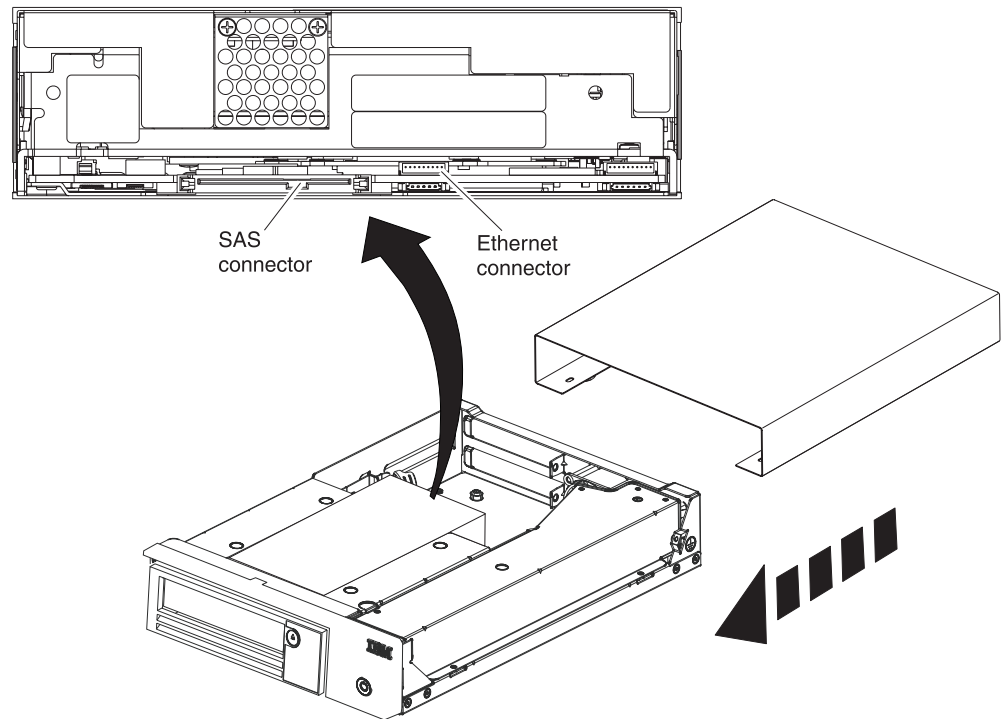


Figure 24. Removing cables from the internal drive

1. Disconnect the SAS interface cable and the Ethernet interface cable (see Figure 24) from the drive. Disconnecting the internal SAS interface cable disconnects both the SAS interface and electrical power from the drive.  
**Attention:** Do not disconnect the internal power cable.
2. Press the latch assembly to release the drive.

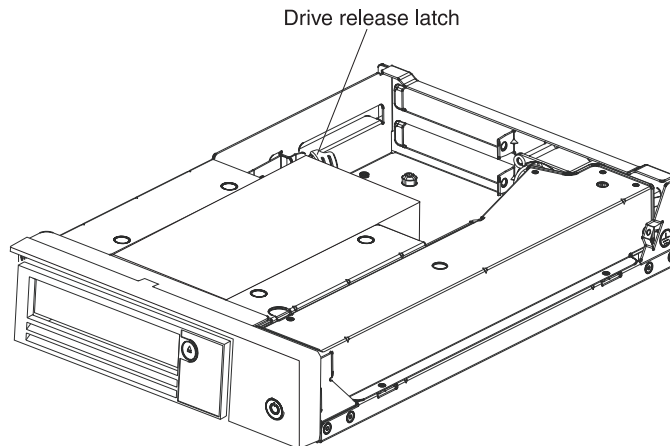


Figure 25. Releasing the drive from the chassis

3. Slide the internal drive forward toward the front of the chassis to clear the front bezel.

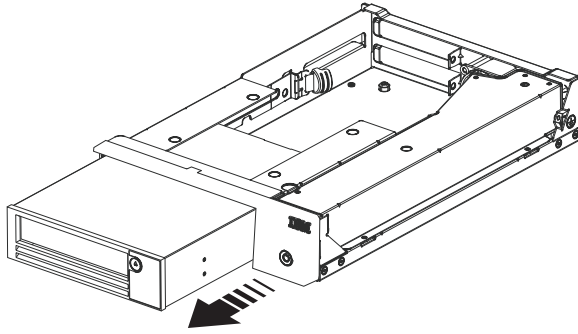


Figure 26. Sliding the drive forward

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## Important notes

Processor speed indicates the internal clock speed of the microprocessor; other factors also affect application performance.

CD or DVD drive speed is the variable read rate. Actual speeds vary and are often less than the possible maximum.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for 1024 bytes, MB stands for 1,048,576 bytes, and GB stands for 1,073,741,824 bytes.

When referring to hard disk drive capacity or communications volume, MB stands for 1,000,000 bytes, and GB stands for 1,000,000,000 bytes. Total user-accessible capacity can vary depending on operating environments.

Maximum internal hard disk drive capacities assume the replacement of any standard hard disk drives and population of all hard disk drive bays with the largest currently supported drives that are available from IBM.

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## Particulate contamination

**Attention:** Airborne particulates (including metal flakes or particles) and reactive gases acting alone or in combination with other environmental factors such as humidity or temperature might pose a risk to the tape drive that is described in this document. Risks that are posed by the presence of excessive particulate levels or concentrations of harmful gases include damage that might cause the tape drive to malfunction or cease functioning altogether. This specification sets forth limits for particulates and gases that are intended to avoid such damage. The limits must not be viewed or used as definitive limits, because numerous other factors, such as temperature or moisture content of the air, can influence the impact of particulates or environmental corrosives and gaseous contaminant transfer. In the absence of specific limits that are set forth in this document, you must implement practices that maintain particulate and gas levels that are consistent with the protection of human health and safety. If IBM determines that the levels of particulates or gases in your environment have caused damage to the tape drive, IBM may condition provision of repair or replacement of tape drives or parts on implementation of appropriate remedial measures to mitigate such environmental contamination. Implementation of such remedial measures is a customer responsibility.

*Table 13. Limits for particulates and gases*

Contaminant	Limits
Particulate	<ul style="list-style-type: none"> <li>• The room air must be continuously filtered with 40% atmospheric dust spot efficiency (MERV 9) according to ASHRAE Standard 52.2<sup>1</sup>.</li> <li>• Air that enters a data center must be filtered to 99.97% efficiency or greater, using high-efficiency particulate air (HEPA) filters that meet MIL-STD-282.</li> <li>• The deliquescent relative humidity of the particulate contamination must be more than 60%<sup>2</sup>.</li> <li>• The room must be free of conductive contamination such as zinc whiskers.</li> </ul>
Gaseous	<ul style="list-style-type: none"> <li>• Copper: Class G1 as per ANSI/ISA 71.04-1985<sup>3</sup></li> <li>• Silver: Corrosion rate of less than 300 Å in 30 days</li> </ul>
<p><sup>1</sup> ASHRAE 52.2-2008 - <i>Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size</i>. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.</p> <p><sup>2</sup> The deliquescent relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote ionic conduction.</p> <p><sup>3</sup> ANSI/ISA-71.04-1985. <i>Environmental conditions for process measurement and control systems: Airborne contaminants</i>. Instrument Society of America, Research Triangle Park, North Carolina, U.S.A.</p>	

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Telephone: +49 7032 15-2937  
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## Glossary

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

### Numbers

#### 2:1 compression

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

### A

**A** Ampere.

**ac** Alternating current.

#### access method

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

#### adapter card

A circuit board that adds function to a computer.

**adj** Adjustment.

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

#### alphanumeric

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

**alter** To change.

#### ambient temperature

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

#### ampere (A)

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

**ANSI** American National Standards Institute.

#### archive

To collect and store files in a designated place.

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

#### assigning a device

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

**assignment**

The naming of a specific device to perform a function.

**asynchronous**

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

**attention (notice)**

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

**ATTN** Attention.

**B****backup**

To make additional copies of documents or software for safekeeping.

**bar code**

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

**bar code label**

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

**bar code reader**

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

**bezel** Decorative and safety cover.

**bicolored**

Having two colors.

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

**BM or bill of materials**

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

**browser**

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

**buffer**

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

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

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

**C****capacity**

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



**cartridge manual rewind tool**

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

**cartridge storage slot**

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

**caution (notice)**

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

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

**centimeter (cm)**

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

**channel command**

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

**char** Character.

**CHK** Check.

**cleaning cartridge**

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

**command**

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

**compact disc (CD)**

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

**compression**

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

**concurrent**

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

**contingent connection**

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

**controller**

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

**CP** Circuit protector.

**ctrl** Control.

**CU** Control unit.

**D**

**danger (notice)**

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

- data** Any representations such as characters or analog quantities to which meaning is or might be assigned.
- data buffer**  
The storage buffer in the control unit. This buffer is used to increase the data transfer rate between the control unit and the channel.
- data cartridge**  
A tape cartridge dedicated to storing data. Contrast with *cleaning cartridge*.
- data check**  
A synchronous or asynchronous indication of a condition caused by invalid data or incorrect positioning of data.
- dc** Direct current.
- degauss**  
To make a magnetic tape nonmagnetic by means of electrical coils carrying currents that neutralize the magnetism of the tape.
- degausser**  
A device that makes magnetic tape nonmagnetic.
- degradation**  
A decrease in quality of output or throughput or an increase in machine error rate.
- degraded**  
Decreased in quality of output or throughput or increased machine error rate.
- deserialize**  
To change from serial-by-bit to parallel-by-byte.
- detented**  
A part being held in position with a catch or lever.
- device** Any hardware component or peripheral, such as a tape drive or tape library, that can receive and send data.
- device driver**  
A file that contains the code needed to use an attached device.
- DIAG**  
Diagnostic section of maintenance information manual.
- differential**  
See *High Voltage Differential (HVD)*.
- direct access storage**  
A storage device in which the access time is independent of the location of the data.
- DNS** Directory Name System. This allows the library to recognize text-based addresses instead of numeric IP addresses.
- download**  
To transfer programs or data from a computer to a connected device, typically a personal computer.  
  
To transfer data from a computer to a connected device, such as a workstation or microcomputer.
- DRAM**  
Dynamic random-access memory.

**drive, magnetic tape**

A mechanism for moving magnetic tape and controlling its movement.

**DRV** Drive.

**DSE** Data security erase.

**DSP** Digital signal processor.

**E**

**EBCDIC**

Extended binary-coded decimal interchange code.

**EC** Edge connector. Engineering change.

**ECC** Error correction code.

**EEPROM**

Electrically erasable programmable read-only memory.

**EIA** Electronics Industries Association.

**EIA unit**

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

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

**electronic mail**

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

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

**EPO** Emergency power off.

**EPROM**

Erasable programmable read only memory.

**EQC** Equipment check.

**equipment check**

An asynchronous indication of a malfunction.

**Error log**

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

**ESD** Electrostatic discharge.

**F**

**fault symptom code (FSC)**

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

**FC** Feature code.

**FCC** Federal communications commission.

**FE** Field engineer, customer engineer, or service representative.

**fiducial**

A target used for teaching a physical location to a robot.

**field replaceable unit (FRU)**

An assembly that is replaced in its entirety when any one of its components fails.

**file** A named set of records stored or processed as a unit. Also referred to as a dataset.

**file protection**

The processes and procedures established in an information system that are designed to inhibit unauthorized access to, contamination of, or deletion of a file.

**file transfer protocol (FTP)**

In the Internet suite of protocols, an application layer protocol that uses TCP and Telnet services to transfer bulk-data files between machines or hosts.

**firmware**

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

**FLASH EEPROM**

An electrically erasable programmable read-only memory (EEPROM) that can be updated.

**FMR** Field microcode replacement.

**format**

The arrangement or layout of data on a data medium.

**formatter**

Part of a magnetic tape subsystem that performs data conversion, speed matching, encoding, first level error recovery, and interfaces to one or more tape drives.

**FP** File protect.

**frayed** Damaged as if by an abrasive substance.

**FRU** Field replaceable unit.

**FSC** Fault symptom code.

**FSI** Fault symptom index.

**functional microcode**

Microcode that is resident in the machine during normal customer operation.

**G**

**g** Gram.

**GB** gigabyte.

**GBIC** Gigabit Interface Converter.

**Gbi** gigabit

**gigabit (Gbit)**

1 000 000 000 bits.

**gigabyte (GB)**

1 000 000 000 bytes.

**Gigabit Interface Converter (GBIC)**

Converts copper interface to optic interface.

**gnd** Ground.

**H****hertz (Hz)**

Unit of frequency. One hertz equals one cycle per second.

**hex** Hexadecimal.

**High Voltage Differential (HVD)**

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

**HVD** SCSI Bus High Voltage Differential

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

**I****IBM Ultrium Tape Drive**

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

**ID** Identifier.

**identifier (ID)**

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

**IML** Initial microprogram load.

**initial microprogram load (IML)**

The action of loading a microprogram from an external storage to writable control storage.

**initiator**

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

**INST** Installation.

**interface**

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

**interposer**

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

**intervention required**

Manual action is needed.

**INTRO**

Introduction.

**I/O** Input/output.

**IOP** Input/output processor.

**IPL** Initial program load.

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

**K****kilogram (kg)**

One thousand grams (approximately 2.2 pounds).

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

**L**

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

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

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

**LED** Light-emitting diode.

**Linear Tape-Open (LTO)**

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

**liquid crystal display (LCD)**

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

**loadable**

Having the ability to be loaded.

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

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

**LVD** SCSI Bus Low Voltage Differential

**M**

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

- magnetic tape**  
A tape with a magnetical surface layer on which data can be stored by magnetic recording.
- MAP** Maintenance analysis procedure.
- mask** A pattern of characters that controls the retention or elimination of portions of another pattern of characters. To use a pattern of characters to control the retention or elimination of portions of another pattern of characters.
- master file**  
A file used as an authority in a given job and that is relatively permanent, even though its contents may change. Synonymous with main file.
- MB** Mega Byte (usually expressed as data rate in MB/s or MB/second).
- media capacity**  
The amount of data that can be contained on a storage medium, expressed in bytes of data.
- media-type identifier**  
Pertaining to the bar code on the bar code label of the IBM Ultrium Tape Cartridge, a 2-character code, L1, that represents information about the cartridge. L identifies the cartridge as one that can be read by devices which incorporate LTO technology; 1 indicates that it is the first generation of its type.
- mega** One million of.
- meter** In the Metric System, the basic unit of length; equal to approximately 39.37 inches.
- micro** One millionth of.
- microcode**  
(1) One or more micro instructions. (2) A code, representing the instructions of an instruction set, implemented in a part of storage that is not program-addressable. (3) To design, write, and test one or more micro instructions. (4) See also *microprogram*.
- microdiagnostic routine**  
A program that runs under the control of a supervisor, usually to identify field replaceable units.
- microdiagnostic utility**  
A program that is run by the customer engineer to test the machine.
- microinstruction**  
A basic or elementary machine instruction.
- microprogram**  
A group of microinstructions that when executed performs a preplanned function.  
  
The term microprogram represents a dynamic arrangement or selection of one or more groups of microinstructions for execution to perform a particular function. The term microcode represents microinstructions used in a product as an alternative to hard-wired circuitry to implement certain functions of a processor or other system component.
- MIM** Media information message.
- mm** Millimeter.

**modifier**

That which changes the meaning.

**mount a device**

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

**MP** Microprocessor.

**ms** Millisecond.

**MSG** Message.

**multipath**

Pertaining to using more than one path.

**N**

**N/A** Not applicable.

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

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

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

**O****oersted**

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

**offline**

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

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

**OPER** Operation.

**ov** Over voltage.

**overrun**

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

**overtightening**

To tighten too much.

**P****parameter**

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

**p bit** Parity bit.

**PC** Parity check.

**PCC** Power control compartment.



- PDF** Portable Document Format.
- PE** Parity error. Product engineer.
- pick** Pertaining to the library, to remove, by means of a robotic device, a tape cartridge from a storage slot or drive.
- picker** A robotic mechanism located inside the library that moves cartridges between the cartridge storage slots and the drive.
- PM** Preventive maintenance.
- POR** Power-on reset.
- port** A physical connection for communication between the 3590 and the host processor. The 3590 has two SCSI ports.

**Portable Document Format (PDF)**

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

**PROM**

Programmable read only memory.

**PS** Power supply.

**PWR** Power.

**R**

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

**rackmount kit**

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

**RAM** Random access memory.

**Random access memory**

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

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

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

**recording density**

The number of bits in a single linear track measured per unit of length of the recording medium.

**recoverable error**

An error condition that allows continued execution of a program.

**ref** Reference.

**reg** Register.

**reinventory**

To inventory again.

**retension**

The process or function of tightening the tape onto the cartridge, if it is sensed that the tape has a loose wrap on the cartridge.

**robot** Picker.

**robotics**

Picker assembly.

**RPQ** Request for price quotation.

**R/W** Read/write.

**S**

**s** Seconds of time.

**SAC** Service Action Code. Code developed to indicate possible FRU or FRU's to replace to repair the hardware.

**SAS** Serial attached SCSI interface.

**scratch cartridge**

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

**SCSI** Small computer system interface.

**segment**

A part.

**sel** Select.

**serialize**

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

**serializer**

A device that converts a space distribution of simultaneous states representing data into a corresponding time sequence of states.

**servo, servos**

An adjective for use in qualifying some part or aspect of a servomechanism.

**servomechanism**

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

**Small Computer Systems Interface (SCSI)**

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

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

- Ultra160 SCSI: Uses a 16-bit bus and supports data rates of 80 or 160 MBps.

**SNS** Sense.

**special feature**

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

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

**SRAM**

Static random access memory.

**SS** Status store.

**ST** Store.

**standard feature**

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

**START**

Start maintenance.

**subsystem**

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

**SUPP** Support.

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

**T**

**tachometer, tach**

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

**tape cartridge**

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

**tape void**

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

**TCP/IP**

Transmission Control Protocol/Internet Protocol.

**TCU** Tape control unit.

**TH** Thermal.

**thread/load operation**

A procedure that places tape along the tape path.

**TM** Tapemark.

**U**

**UART** Universal asynchronous receiver/transmitter.

**unload**

Prepare the tape cartridge for removal from the drive.

**utilities**

Utility programs.

**utility programs**

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

**uv** Under voltage.

**V****VOLSER**

Volume serial number.

**volume**

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

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

**W**

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

**Write** Write command.

**WT** world trade.

**X**

**XR** External register.

**XRA** External register address register.

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