IBM TS3500
with ALMS

Introduction and Planning Guide

GA32-0593-08

Note

Before using this information and the product it supports, read the information in "Safety notices" on page xvii and "Notices" on page 231.

Edition notice

This edition applies to the ninth release of the *IBM TS3500 with ALMS Introduction and Planning Guide* and to all subsequent releases and modifications until otherwise indicated in new editions.

Homologation statement

This product may not be certified in your country for connection by any means whatsoever to interfaces of public telecommunications networks. Further certification may be required by law prior to making any such connection. Contact an IBM representative or reseller for any questions.

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Read this first

This is the ninth edition of the *IBM TS3500 with ALMS Introduction and Planning Guide* (October 2014). This guide is published specifically for the TS3500 tape library with the Advanced Library Management System (ALMS).

What's new in this edition (October 2014)

The new features introduced with this release require that the TS3500 tape library has ALMS, enhanced node cards, and a TS3000 system console (TSSC).

Revision bars (|) appear next to all of the information that was added or changed since the release of the last edition (GA32–0593–07). The following information is new in this edition:

- Support for the IBM® TS1150 tape drive (3592 Model E08)
- Extended information about IPv6 addresses

Eighth edition (October 2012)

The following information was new or changed in the Eighth edition:

- Support for the IBM Ultrium LTO 6 tape drive
- Support for the IBM 3592-C07 controller
- Support for an enhanced rack-mount TS3000 system console (TSSC)

Seventh edition (June 2011)

The following information was new or changed in the seventh edition:

- Introduction of shuttle technology and the TS3500 tape library shuttle complex
- Support for multiple library strings as a single library image to the host
- Updated library configuration and planning information based on shuttle complex capability and increased maximum capacity
- Support for the IBM TS1140 tape drive (3592 Model E07)
- Support for an 8 Gb backend Fibre Channel switch
- Introduction of automatic ejects for expired cleaning cartridges

Sixth edition (June 2010)

The following information was new or changed in the sixth edition:

- Information regarding Silo-style bar code label compatibility
- Revised Insert Notification and Cartridge Assignment Policy guidelines
- Introduction of the TS3500 tape library Command Line Interface (CLI)

Fifth edition (March 2010)

The following information was new or changed in the fifth edition:

- Enhanced node card prerequisite
- Support for the IBM TS1050 tape drive F5A (LTO Ultrium 5)
- Support for the Storage Authentication Service
- Updated operator and service clearance information
- Support for a floating home cell in non-HD libraries
- Support for mixed media in HD libraries with dual accessors

Fourth edition (September 2009)

The following information was new or changed in the fourth edition:

- Higher cartridge capacity (more than 6 887 storage slots)
- Enhanced node card prerequisite
- SNMP audit logging
- Tape System Reporter enhancements
- Support for the Tivoli® Key Lifecycle Manager (TKLM) for encryption key management
- Performance specifications for libraries with virtual I/O slots enabled
- Introduction of the rack-mountable TS3000 system console with optional internal modem

Third edition (December 2008)

The following information was new or changed in the third edition:

- Updated power features and power cords
- Introduction of the TS7700 Backend Switches (Models L23 and D23)

Second edition (November 2008)

The following information was new or changed in the second edition:

- Introduction of high density (HD) frames (Models S24 and S54)
- Introduction of the IBM Tape System Reporter application

First edition (September 2008)

The following information was new or changed in the first edition:

- Information specific to the TS3500 tape library with the Advanced Library Management System (ALMS)
- Introduction of the IBM TS1130 tape drives (3592 tape drive models E06 and EU6)
- Additional information about remote support security
- Addition of Secure Socket Layer (SSL) for Ethernet network security
- An embedded SMI-S agent that works with the IBM TotalStorage Productivity Center (TPC) 3.3.1 and later
- Addition of Internet Protocol version 6 (IPv6) functionality

- Updated environmental specifications
- Updated power requirements for frames in the TS3500 tape library
- Addition of library configuration prerequisites for using encryption in the TS3500 tape library
- Updated data storage values for compliance with the International System of Units (SI) measurements

Send us your feedback

Your feedback is important in helping to provide the most accurate and high-quality information. If you have comments or suggestions for improving this publication, you can send us comments by email to starpubs@us.ibm.com or use the readers' comments form at the back of this publication. Be sure to include the following information in your correspondence:

- Exact publication title
- Form number (for example, GA32–0689–00), part number, or EC level (located on the back cover)
- Page numbers to which you are referring

Note: For suggestions on operating enhancements or improvements, please contact your IBM Sales team.

Safety and environmental notices

This section contains information about safety notices that are used in this guide and environmental notices for this product.

Safety notices

Observe the safety notices when using this product. These safety notices contain danger and caution notices. These notices are sometimes accompanied by symbols that represent the severity of the safety condition.

Most danger or caution notices contain a reference number (Dxxx or Cxxx). Use the reference number to check the translation in the *IBM Systems Safety Notices*, G229-9054 manual.

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

Danger notice

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

If the symbol is...	It means...
	**DANGER: An electrical outlet that is not correctly wired could place hazardous voltage on metal parts of the system or the devices that attach to the system. It is the responsibility of the customer to ensure that the outlet is correctly wired and grounded to prevent an electrical shock.** *(D004)*

Caution notice

A caution notice calls attention to a situation that is potentially hazardous to people because of some existing condition, or to a potentially dangerous situation that might develop because of some unsafe practice. A caution notice can be accompanied by one of several symbols:

If the symbol is...	It means...
	A generally hazardous condition not represented by other safety symbols.
 Class II	This product contains a Class II laser. Do not stare into the beam. (*C029*) Laser symbols are always accompanied by the classification of the laser as defined by the U. S. Department of Health and Human Services (for example, Class I, Class II, and so forth).
	A hazardous condition due to mechanical movement in or around the product.

If the symbol is...	It means...
	This part or unit is heavy but has a weight smaller than 18 kg (39.7 lb). Use care when lifting, removing, or installing this part or unit. (*C008*)

Sample caution notices follow:

Caution

The battery is lithium ion. To avoid possible explosion, do not burn. Exchange only with the IBM-approved part. Recycle or discard the battery as instructed by local regulations. In the United States, IBM has a process for the collection of this battery. For information, call 1-800-426-4333. Have the IBM part number for the battery unit available when you call. (*C007*)

Caution

The system contains circuit cards, assemblies, or both that contain lead solder. To avoid the release of lead (Pb) into the environment, do not burn. Discard the circuit card as instructed by local regulations. (*C014*)

Caution

When removing the Modular Refrigeration Unit (MRU), immediately remove any oil residue from the MRU support shelf, floor, and any other area to prevent injuries because of slips or falls. Do not use refrigerant lines or connectors to lift, move, or remove the MRU. Use handholds as instructed by service procedures. (*C016*)

Caution

Do not connect an IBM control unit directly to a public optical network. The customer must use an additional connectivity device between an IBM control unit optical adapter (that is, fibre, ESCON, FICON®) and an external public network. Use a device such as a patch panel, router, or switch. You do not need an additional connectivity device for optical fibre connectivity that does not pass through a public network.

Environmental notices

The environmental notices that apply to this product are provided in the*Environmental Notices and User Guide*, Z125-5823-xx manual. A copy of this manual is located on the publications CD.

Laser safety and compliance

Before using the TS3500 tape library, review the following laser safety information.

Class II laser product

The TS3500 tape library is a Class II laser product. It is important for you to be aware of the laser caution label. See Figure 1 on page xix for an example of the label.

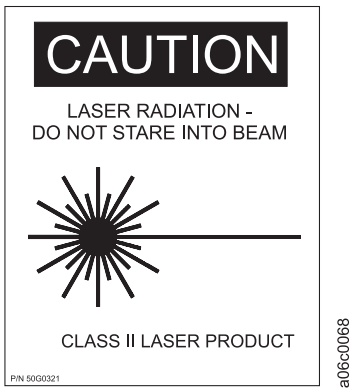


Figure 1. Laser safety caution label

This product complies with the performance standards set by the U.S. Food and Drug Administration for a Class II Laser product. This product belongs to a class of laser products that requires precautions be taken to avoid prolonged viewing of the laser beam. Under normal working conditions, you must not come in direct contact with the laser beam. This classification was accomplished by providing the necessary protective housings and scanning safeguards to ensure that laser radiation is inaccessible during operation or is within Class II limits. These products have been reviewed by external safety agencies and have obtained approvals to the latest standards as they apply to this product type.

Class I laser product

The TS3500 tape library contains a laser assembly that complies with the performance standards set by the U.S. Food and Drug Administration for a Class I laser product. Class I laser products do not emit hazardous laser radiation. Protective housing and scanning safeguards ensure that laser radiation is inaccessible during operation or is within Class I limits. External safety agencies have reviewed the library and have obtained approvals to the latest standards as they apply.

About this publication

This guide contains information about how to plan for the IBM TS3500, also known as the 3584 tape library. This guide is specific to the TS3500 tape library with ALMS.

While reading this publication, you are introduced to the TS3500 tape library and learn how it interacts in both mainframe and Open Systems environments. You learn about the library's primary components and how the library can process both Linear Tape-Open (LTO) Ultrium Tape Cartridges and IBM TotalStorage 3592 Enterprise Tape Cartridges. Methods for determining supported servers and operating systems, performance considerations, and the physical planning specifications for the TS3500 tape library are also presented here. In addition, this guide provides a list of available features that you can order to modify and enhance the functionality of all models of the TS3500 tape library. Additional chapters provide details about the requirements of the Fibre Channel interface, frame model capacities, and tape encryption. After reading this publication, you will have the necessary information to plan for the TS3500 tape library in your data storage environment.

Who should read this book

This book is intended for system planners, programmers, and administrators.

Terminology used in this book

See the “Glossary” on page 239 for definitions of terms, abbreviations, and acronyms in this publication.

Related information

Refer to the following publications and sources for more information about the TS3500 tape library and its associated products.

The most recent publications are available on the web. To ensure that you have the latest publications, visit the web at http://www.ibm.com/support/us/en/.

The most up-to-date information is available on the web in IBM Knowledge Center. Go tohttp://www.ibm.com/support/knowledgecenter/STCMML8/ to see the TS3500 customer online documentation. Or, follow the instructions on the Knowledge Center welcome page to create your own information collection:http://www-01.ibm.com/support/knowledgecenter/.

Publications about the TS3500 tape library

Note: There are two versions of the TS3500 tape library Introduction and Planning Guide, as well as two versions of the TS3500 tape library Operator Guide. One version of each document is specific to the TS3500 tape library with the Advanced Library Management System (ALMS) and provides details about features and functions that are only available for libraries with ALMS installed and enabled. Refer to the titles of each guide in order to determine which version you need.

- *IBM TS3500 Introduction and Planning Guide*, GA32-0559

- *IBM TS3500 Operator Guide*, GA32-0560
- *IBM TS3500 SCSI Reference*, GA32-0561
- *IBM TS3500 with ALMS Tape System Reporter User's Guide*, GA32-0589
- *IBM TS3500 with ALMS Introduction and Planning Guide*, GA32-0593 (This guide)
- *IBM TS3500 with ALMS Operator Guide*, GA32-0594
- *IBM TS3500 Maintenance Information* (provided with the TS3500 tape library)

IBM i, System i, and i5/OS source

For information about the IBM i, System i, and i5/OS, visit the web at http://publib.boulder.ibm.com/iseries/.

IBM Power Systems and System p source

For information about the IBM Power Systems and System p, visit the web at http://www.ibm.com/servers/eserver/pseries.

IBM System z source

For information about the IBM System z servers, visit the web at http://ibm.com/servers/eserver/zseries.

Other sources

- For a list of compatible software, operating systems, and servers for Ultrium tape drives, visit the web at http://ibm.com/storage/lto. Under**TS3500 Library**, select `Product details`. Under **Learn more**, select `Interoperability matrix` or select `Independent Software Vendor (ISV) matrix for LTO`.
- For a list of compatible software, operating systems, and servers for TS1120 and newer tape drives, visit the web at http://www.ibm.com/servers/storage/tape/drives. Under the specific tape drive, select `Product details`. Under **Learn more**, select `Interoperability matrix or Independent Software Vendor (ISV) matrix`.
- *IBM Encryption Key Manager component for the Java™ platform Introduction, Planning, and User's Guide*, GA76-0418
- *IBM Tivoli Key Lifecycle Manager Quick Start Guide*, GI11-8744
- For more information about the Tivoli Key Lifecycle Manager, visit the web: http://www-01.ibm.com/software/tivoli/products/key-lifecycle-mgr/
- To search the IBM Tivoli® Key Lifecycle Manager Information Center, visit the web: http://publib.boulder.ibm.com/infocenter/tivihelp/v2r1/index.jsp?topic=/com.ibm.tklm.doc/welcome.htm
- *IBM 3953 Tape System Introduction and Planning Guide*, GA32-0557
- *IBM 3953 Library Manager Model L05 Operator Guide*, GA32-0558
- *IBM 3953 Tape Frame Model F05 Maintenance Information* (provided with the 3953 Tape System)
- *IBM TotalStorage Enterprise Silo Compatible Tape Frame 3592 Introduction, Planning, and User's Guide* Model C20, GA32-0463
- *IBM 3592 Tape Drives and TS1120 Controller Operator Guide*, GA32-0556
- *IBM 3592 Tape Drives and TS1120 Controller Introduction and Planning Guide*, GA32-0555
- To search the *IBM 3592-C07 Customer Information Center*, visit the web at: http://publib.boulder.ibm.com/infocenter/etc/cust/index.jsp.
- *IBM 3592 Tape Drive SCSI Reference*, GA32-0562
- *IBM TS3000 and TS4500 System Console Maintenance Information*

- *IBM TS7700 Series Introduction and Planning Guide IBM TS7700, TS7700 Cache Controller, and TS7700 Cache Drawer*, GA32-0567
- To search the IBM TS7700 Information Center, visit the web here: http://publib.boulder.ibm.com/infocenter/ts7700/cust/index.jsp
- *IBM TS7510 Introduction and Planning Guide*, GC26-7767
- *IBM TotalStorage LTO Ultrium Tape Drive SCSI Reference*, GA32-0450
- *Systems Safety Notices*, G229-9054. This publication is available at http://www.ibm.com/servers/resourcelink. To access, register for a userid and password, then select `Library` in the navigation area.
- *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130
- *IBM Tape Device Drivers Programming Reference*, GA32-0566
- *Implementing IBM Tape in Linux and Windows*, SG24-6268. This book is available on the Web at http://www.redbooks.ibm.com/redpieces/pdfs/sg246268.pdf.
- *Implementing IBM Tape in Unix Systems*, SG24-6502. This book is available on the Web at http://www.redbooks.ibm.com/redbooks/pdfs/sg246502.pdf.
- *The IBM TotalStorage Tape Libraries Guide for Open Systems*, SG24-5946
- *The LTO Ultrium Primer for IBM eServer iSeries Customers*, REDP-3580. This book is available on the Web at http://www.redbooks.ibm.com/. Search on REDP-3580.
- *IBM TS3500 Tape Library Data Gathering - Introduction to Library Statistics*, a white paper that is available from your IBM Representative
- *IBM TotalStorage 3584 Tape Library Performance*, a white paper that is available from your IBM Representative
- To access installation instructions for customer-setup units (CSUs) from the web, go to http://www-03.ibm.com/servers/storage/tape/resourcelibrary.html#publications. Under **Technical support**, select `3584 Tape Library`. Then, under **Support and downloads**, select `Documentation`.
- *IBM LTO Ultrium Cartridge Label Specification (Revision 2)*. This document is available on the Web at http://www.ibm.com/servers/storage/support/lto/3584/. Under **Additional resources**, select `LTO Ultrium media`. Under **Learn more**, select `LTO label specifications`. Under **Abstract**, select the PDF file to access the document.
- *Label Specification for IBM 3592 Cartridges when used in IBM Libraries*. This document is available on the web at http://www-03.ibm.com/systems/storage/media/3592/index.html. Under **Learn more**, select `Barcode Label Specification for use with 3592 Tape Media`. You can also contact your IBM Marketing Representative for this specification.

Authorized suppliers of bar code labels

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

Attention: The IBM TS3500 is designed to work with bar code labels that meet the specifications and requirements set forth in the *IBM LTO Ultrium Cartridge Label Specification (Revision 2)* and the *Label Specification for IBM 3592 Cartridges when used in IBM Libraries*. The following label providers have demonstrated the ability to produce finished bar code labels that meet the foregoing specifications and requirements. This information is provided for the convenience of TS3500 tape library users only, and is not an endorsement or recommendation of such providers. IBM is not responsible for the quality of bar code labels procured from sources other than IBM. This information is applicable to bar code labels actually printed by the listed companies. IBM has not reviewed the quality of any labels produced by software or services offered by such companies that allow users to print labels on their own printing equipment.

Table 1. Authorized suppliers of custom bar code labels

In the Americas	In Europe and Asia
Dataware PO Box 740947 Houston, TX 77274 U.S.A. Telephone: 800-426-4844 or 713-432-1023 Fax: 713-432-1385 http://www.datawarelabels.com/	Not applicable
Tri-Optic 6800 West 117th Avenue Broomfield, CO 80020 U.S.A. Telephone: 888-438-8362 or 303-464-3508 Fax: 888-438-8363 or 303-666-2166 http://www.tri-optic.com	EDP Europe Limited 43 Redhills Road South Woodham Ferrers Chelmsford, Essex CM3 5UL U.K. Telephone: 44 (0) 1245 322380 Fax: 44 (0) 1245 323484 http://www.edpeurope.com/media-labels.html
Netc, L.L.C.[1] 100 Corporate Drive Trumbull, CT 06611 U.S.A. Telephone: 203-372-6382 Fax: 203-372-0676 http://www.NetcLabels.com	Netc Europe Ltd[1] The Old Surgery 5a The Pavement North Curry TA3 6LX Somerset U.K. Telephone: 44 (0) 1823 491439 Fax: 44 (0)1823 491373 http://www.NetcLabels.co.uk
	Netc Asia Pacific Pty Ltd[1] PO Box 872 Cooroy QLD 4563 Australia Telephone: 61 (0) 7 5442 6263 Fax: 61 (0) 7 5442 6522 http://www.NetcLabels.com.au
Note: 1. This is an authorized supplier for radio frequency identification (RFID) labels.	

Data storage values

TS3500 tape library documentation displays data storage values using both decimal (base-10) prefixes and binary (base-2) units of measurement.

Decimal units such as K, MB, GB, and TB have commonly been used to express data storage values, though these values are more accurately expressed using binary units such as KiB, MiB, GiB, and TiB. At the kilobyte level, the difference between decimal and binary units of measurement is relatively small (2.4%). This difference grows as data storage values increase, and when values reach terabyte levels the difference between decimal and binary units approaches 10%.

To reduce the possibility of confusion, the TS3500 tape library documentation represents data storage using both decimal and binary units. Data storage values are displayed using the following format:

```
#### decimal unit (binary unit)
```

By this example, the value 512 terabytes is displayed as:

```
512 TB (465.6 TiB)
```

Table 2 compares the names, symbols, and values of the binary and decimal units. Table 3 shows the increasing percentage of difference between binary and decimal units.

Table 2. Comparison of binary and decimal units and values

Decimal			Binary		
Name	**Symbol**	**Value (base-10)**	**Name**	**Symbol**	**Value (base-2)**
kilo	K	10^3	kibi	Ki	2^{10}
mega	M	10^6	mebi	Mi	2^{20}
giga	G	10^9	gibi	Gi	2^{30}
tera	T	10^{12}	tebi	Ti	2^{40}
peta	P	10^{15}	pebi	Pi	2^{50}
exa	E	10^{18}	exbi	Ei	2^{60}

Table 3. Percentage difference between binary and decimal units

Decimal Value	Binary Value	Percentage Difference
100 kilobytes (KB)	97.65 kibibytes (KiB)	2.35%
100 megabytes (MB)	95.36 mebibytes (MiB)	4.64%
100 gigabytes (GB)	93.13 gibibytes (GiB)	6.87%
100 terabytes (TB)	90.94 tebibytes (TiB)	9.06%
100 petabytes (PB)	88.81 pebibytes (PiB)	11.19%
100 exabytes (EB)	86.73 exbibytes (EiB)	13.27%

Chapter 1. Introduction

This chapter introduces the IBM TS3500, machine type 3584, formerly referred to as the 3584 tape library. The information in this chapter is specific to the TS3500 tape library with the Advanced Library Management System (ALMS).

Overview

The IBM TS3500 tape library is a highly scalable, stand-alone device that provides reliable, automated tape handling and storage for both mainframe and Open Systems environments.

Figure 2 on page 2 shows a 6-frame version of the TS3500 tape library. An individual library, or *library string*, consists of one base frame and up to 15 expansion frames and can include up to 192 tape drives and more than 20 000 tape cartridges. The flexibility to connect multiple library strings to create a *shuttle complex* greatly increases opportunities for growth, as well as the maximum cartridge capacity. In addition to scalability, the TS3500 tape library offers the following enhancements:

- Enhanced data accessibility through dual accessors that increase speed and provide failover protection
- Enhanced data security through support for tape drive encryption and write-once-read-many (WORM) cartridges
- Increased storage capacity with high-density (HD) frames that greatly increase capacity without requiring more floor space
- Increased growth flexibility with shuttle technology, even in physically constrained environments
- Greatly increased cartridge capacity in a shuttle complex without the need for additional tape drives

These features are explained in greater detail throughout this chapter.

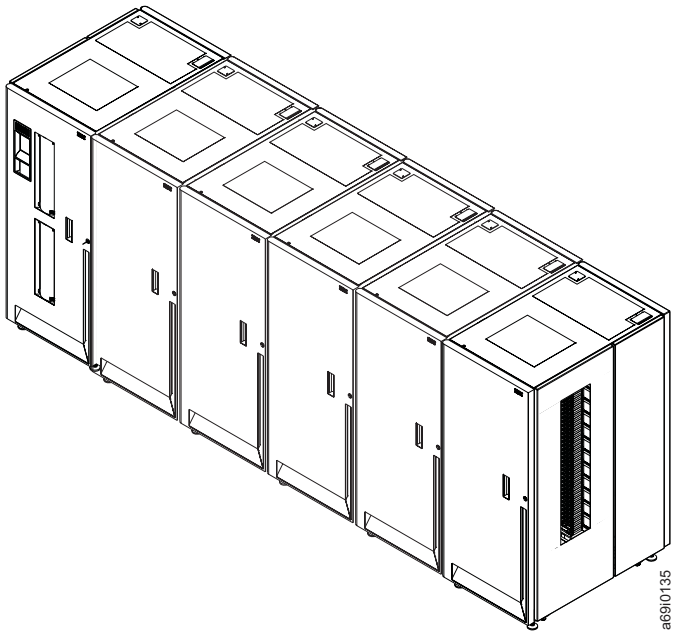


Figure 2. The TS3500 tape library

The TS3500 tape library comes with several tape drive, frame model, and feature options in order to meet your specific needs. Some additional features of the TS3500 tape library are listed below:

- Ability to attach multiple simultaneous heterogeneous servers
- Remote management using a web browser or the TS3500 Command Line Interface program
- Remote monitoring using Simple Network Management Protocol (SNMP)
- Multipath architecture
- Drive/media exception reporting
- In-depth reporting using the Tape System Reporter
- Host-based path failover
- Up to 224 I/O slots (16 I/O slots standard)

Table 4 gives potential library capacity based on supported frames and configurations.

Table 4. TS3500 tape library configurations

Supported configurations			
A library including these models	**With these drives**	**Can contain this many cartridges[1, 2]**	**And has this maximum native capacity[3]**
L5x, D5x, and S54	Ultrium tape drives	> 20 000	50 PB (44.41 PiB)
L32, D32, and S54[4]	Ultrium tape drives	> 20 000	50 PB (44.41 PiB)
L2x, D2x, and S24	3592 tape drives	> 15 000	150 PB (133.23 PiB)
L5x, D5x, S54, and SC1	Ultrium tape drives	> 300 000	750 PB (666.1 PiB)

Table 4. TS3500 tape library configurations (continued)

Supported configurations			
A library including these models	**With these drives**	**Can contain this many cartridges[1, 2]**	**And has this maximum native capacity[3]**
L32, D32, S54, and SC1[4]	Ultrium tape drives	> 300 000	750 PB (666.1 PiB)
L2x, D2x, S24, and SC1	3592 tape drives	> 225 000	2.25 EB (1.95 EiB)

Notes:

1. In order to support code level 9500 or higher, all node cards in the library must be xx3-equivalent node cards. For xx2 models, this requires a xx3 model conversion OR the enhanced node card(s) feature (FC 1700 or 1701).
2. In order to increase the maximum number of cartridges to more than 6 887, or to support a shuttle complex, logical libraries must use LTO Ultrium 4, 3592 E05, or later tape drives as control path drives. In order to support more than 6 887 cartridges, Ultrium 4 control path drives require a minimum code level of 97F0. For logical libraries with shuttle stations assigned, Ultrium 4 control path drives require a minimum code level of A480 and Ultrium 5 control path drives require a minimum code level of B170.
3. The maximum native capacity figures are based on library configurations with high density (HD) frames and all Ultrium 6 or 3592 E08 tape drives. In addition, the figures for libraries with Model SC1 (shuttle connection) are based on the maximum shuttle complex configuration.
4. In order to support Ultrium 6 tape drives, libraries with an L32 frame require enhanced grippers (FC 2205 or 2304).

For detailed information regarding tape drives supported by the TS3500 tape library, and the data rate and capacity for these drives, see "Supported tape drives" on page 17. For information regarding supported tape media, refer to "Supported tape cartridges" on page 26. For details regarding frame models and frame capacity, see "Structure of the library." For information about the shuttle complex and Model SC1, refer to "Structure of the shuttle complex" on page 15.

Structure of the library

A description of base and expansion frames, and the models of the TS3500 tape library.

The basic TS3500 tape library is a single storage unit known as the *base frame* (Models L32, L52, or L53 for LTO Ultrium tape drives, or Models L22 or L23 for 3592 tape drives). The library's scalability allows you to increase capacity by adding up to 15 additional storage units, called *expansion frames* (Models D32, D52, D53, and S54 for LTO Ultrium tape drives or Models D22, D23, and S24 for 3592 tape drives). The frames join side by side, with the base frame on the left and the expansion frame on the right. The additional expansion frames are supported by a common cartridge accessor that requires no pass-through mechanism. Frame Models D22, D23, D32, D52, and D53 can contain up to 12 Ultrium tape drives or 3592 tape drives, but cannot contain a mix of both.

High-density frames, referred to hereafter as HD frames, greatly increase library capacity. HD frame Model S54 can contain up to 1 320 Ultrium tape cartridges and HD frame Model S24 can contain up to 1 000 IBM 3592 tape cartridges. The HD frames offer increased capacity without increasing frame size or required floor space by using high density storage slots for tape cartridges, referred to hereafter as HD slots. For more information, see "High-density technology" on page 9. In

addition, HD frames can support shuttle stations that enable connections between multiple TS3500 tape library strings. For more information, see "Structure of the shuttle complex" on page 15.

Note: Base frame models L22, L23, L52, L53, and L32 are referred to hereafter as *base frames*, unless model-specific information is discussed. Expansion frame models D22, D23, D52, D53, D32, S24, and S54 are referred to hereafter as *expansion frames*, unless model-specific information is discussed.

The TS3500 tape library features an optional second cartridge accessor. If you order dual accessors, two frames that are used as *service bays* are required. Service bay A is known as Model HA1 and service bay B is a Model D23, D22, D52, D53, S24, or S54 frame. For more information, see "Dual accessors and service bays" on page 7.

Note: In order to support mixed media in an HD library with dual accessors, service bay B must be a model Dxx frame. This configuration requires feature code 1697, which ensures that the service bays provide both LTO and 3592 HD test slots.

For bulk media handling, the TS3500 tape library supports four I/O stations in newly purchased Models D23 and D53 frames. The D-frame with I/O installed is comprised of four independently accessible I/O station doors with a total of 64 slots (16 in each I/O station door). Additionally, two LED indicators are provided for each I/O station in a D-frame in order to indicate if the I/O station is empty or full and if the I/O station door is locked or unlocked. This plant feature reduces the frame storage slot capacity by 160 for a Model D23 and by 176 for a Model D53. The I/O stations increase the maximum library I/O slot capacity from 32 to 224. The multiple I/O stations can double the maximum insert and eject throughput since both accessors can be used. The D23 and D53 models remain compatible with existing Models L22, L32, L52, D22, D32, and D52.

The models of the TS3500 tape library vary depending on the type of media they contain and whether the frame is a service bay, a base frame, or an expansion frame. Table 5 lists each frame and its characteristics.

Table 5. TS3500 tape library frame models

Frame model	Type	Depth	Media type and capacity		Other
HA1	Service Bay A	Short	N/A	N/A	• Required when an optional second accessor is ordered • Contains slots for diagnostic cartridges only
L22	Base frame	Short	3592	Up to 12 drives and up to 260 cartridges	• Might require L23 model conversion OR installation of FC 1700[1]
L23	Base frame	Short	3592	Up to 12 drives and up to 260 cartridges	• Equipped with the enhanced frame control assembly • Optionally equipped with backend Fibre Channel switches
D22	Expansion frame	Short	3592	Up to 12 drives and up to 400 cartridges	• Optionally configured as service bay B • Might require D23 model conversion OR installation of FC 1701[1]

Table 5. TS3500 tape library frame models (continued)

Frame model	Type	Depth	Media type and capacity		Other
D23	Expansion frame	Short	3592	Up to 12 drives and up to 400 cartridges	• Optionally equipped with the enhanced frame control assembly • Optionally equipped with backend Fibre Channel switches • Optionally equipped with four I/O stations • Optionally configured as service bay B, if not equipped with four I/O stations
S24	Expansion frame	Short	3592	Up to 1 000 cartridges	• Optionally configured as service bay B • Optionally equipped with a shuttle station
L32	Base frame	Long	LTO Ultrium	Up to 12 drives and up to 281 cartridges	• Might require installation of FC 1700[1] • Might require installation of FC 2205 or 2304[2]
D32	Expansion frame	Long	LTO Ultrium	Up to 12 drives and up to 440 cartridges	• Might require installation of FC 1701[1]
L52	Base frame	Short	LTO Ultrium	Up to 12 drives and up to 287 cartridges	• Might require L53 model conversion OR installation of FC 1700[1]
L53	Base frame	Short	LTO Ultrium	Up to 12 drives and up to 287 cartridges	• Equipped with the enhanced frame control assembly
D52	Expansion frame	Short	LTO Ultrium	Up to 12 drives and up to 440 cartridges	• Optionally configured as service bay B • Might require D53 model conversion OR installation of FC 1701[1]
D53	Expansion frame	Short	LTO Ultrium	Up to 12 drives and up to 440 cartridges	• Optionally equipped with the enhanced frame control assembly • Optionally equipped with four I/O stations • Optionally configured as service bay B, if not equipped with four I/O stations
S54	Expansion frame	Short	LTO Ultrium	Up to 1 320 cartridges	• Optionally configured as service bay B • Optionally equipped with a shuttle station

Table 5. TS3500 tape library frame models (continued)

Frame model	Type	Depth	Media type and capacity	Other
Note: 1. Prerequisite for any frame with a node card installed in a library string with code level 9500 or higher. 2. In order to support Ultrium 6 tape drives, libraries with an L32 frame require enhanced grippers (FC 2205 or 2304).				

Models L22, D22, L23, D23, L52, D52, L53, D53, S24, and S54 are compatible with Models L32 and D32, but require additional features because they use different side and rear covers. If you change from a Model L32 or D32 to a Model D22, D23, D52, D53, S24, or S54 (or from a Model D22, D23, D52, D53, S24, or S54 to a Model D32) within the same library you may also need the appropriate side covers.

When expanding an installed library, an expansion frame is installed at the end of the library string (*end of the library string* refers to the very last frame or, if requested by the customer, the last frame before service bay B). In order to have the expansion frame installed somewhere other than the end of the library string, the IBM service representative must obtain a service contract to uninstall additional frames as necessary to accommodate the customer's request.

The IBM Tape Library Specialist Web interface and 10/100 Ethernet support are included with Models L22, L23, L52, and L53. For Model L32, they are available as feature codes 1662 and 1660, respectively.

Figure 3 shows an example of a base frame and an expansion frame. A Model L23 or L53 (base frame) is on the left. A Model D23 or D53 (expansion frame) is on the right and attaches to the base frame.

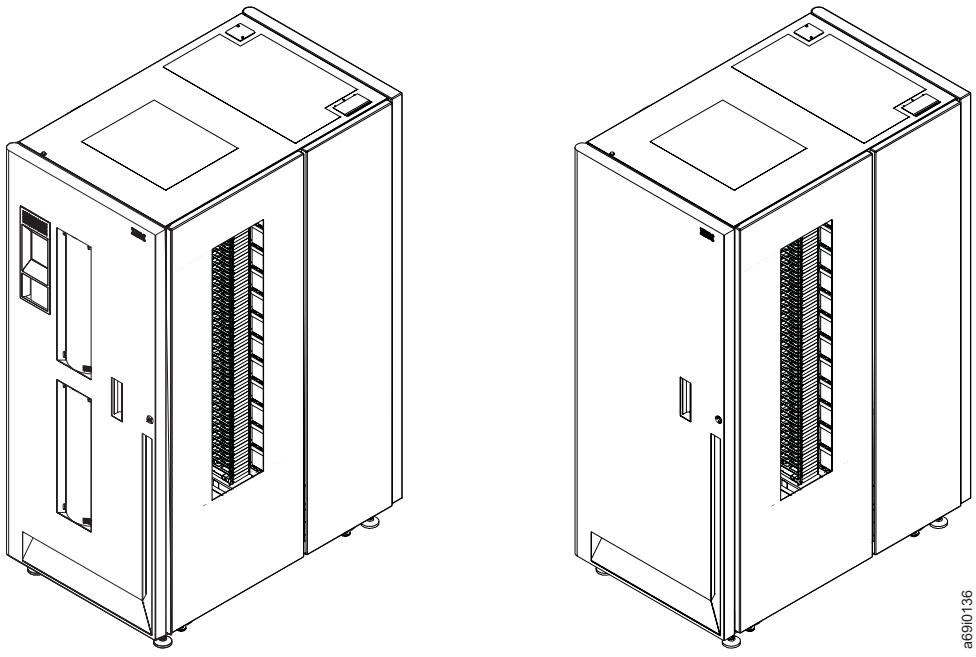


Figure 3. Frames in the IBM TS3500

Dual accessors and service bays

A description of dual accessors and service bays and how they can enhance library performance.

When an optional second accessor is installed, the TS3500 tape library features enhanced availability by using an extra accessor. The extra accessor enables the library to operate without disruption if any component of the working accessor fails.

If the library is installed with the optional second accessor, cartridge mount performance is also optimized. (A *mount* occurs when the accessor removes a cartridge from a drive, returns it to its storage slot, collects another cartridge from a random storage slot, moves it, and loads it into the drive.) The second accessor is part of feature code 1440 (Service Bay B Configuration), which can be ordered with expansion frames used as service bay B. If you order a second accessor you must also order a 3584 high availability (HA1) frame, which is also known as service bay A.

As you view the library from the front, service bay A (the HA1 frame) is on the far left and service bay B is on the far right. Figure 4 shows the location of service bays in the TS3500 tape library.

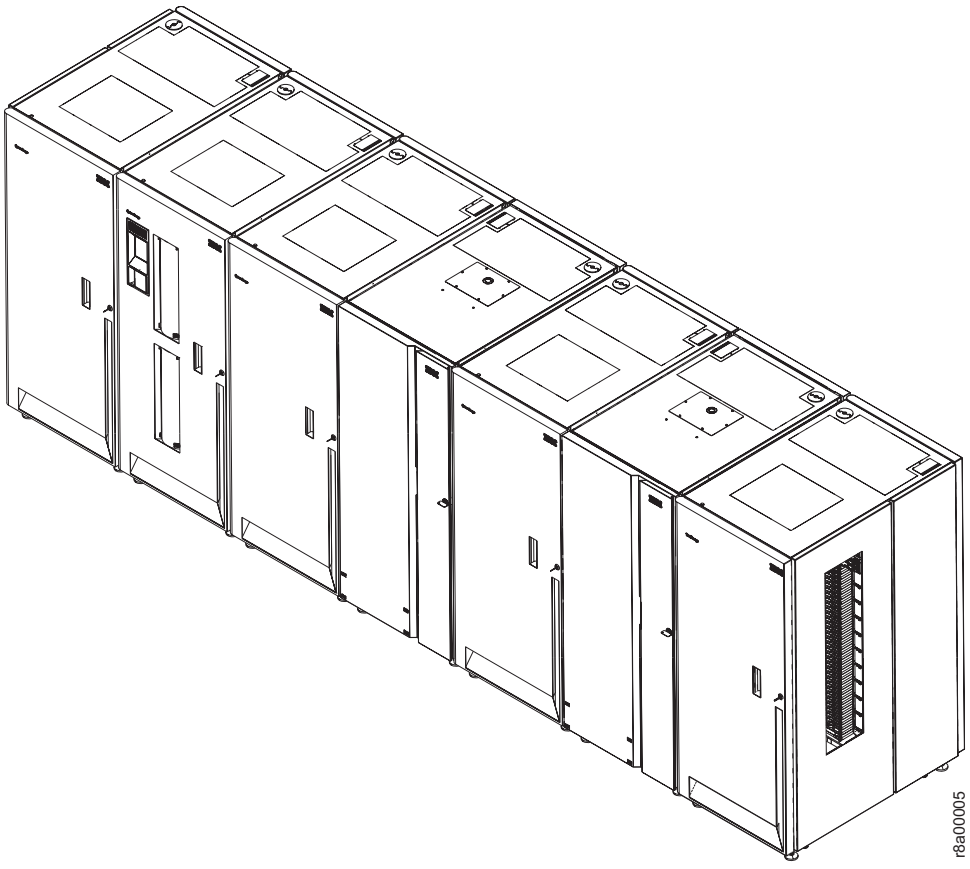


Figure 4. Location of service bays in the TS3500 tape library

When dual accessors are installed and an attached host issues a command for cartridge movement, the library automatically determines which accessor can

perform the mount in the most timely manner. If the library's primary accessor fails, the second accessor assumes control and eliminates system outage or the need for operator intervention.

Although the library uses defaults to specify the zones (areas) in which the accessors operate, you can specify particular zones by using the Tape Library Specialist Web interface. This process is called setting the preferred zone. For details, see the section about setting the preferred zone in the *IBM TS3500 with ALMS Operator Guide*.

Service bay A (the HA1 frame) contains only gripper test slots (**1** in Figure 5) for diagnostic cartridges. Service bay B contains gripper test slots **2** for diagnostic cartridges, and also contains unusable storage slots **3** . The storage slots in service bay B are not used if the frame is configured as a service bay. Figure 5 shows the location of slots in an example of a service bay.

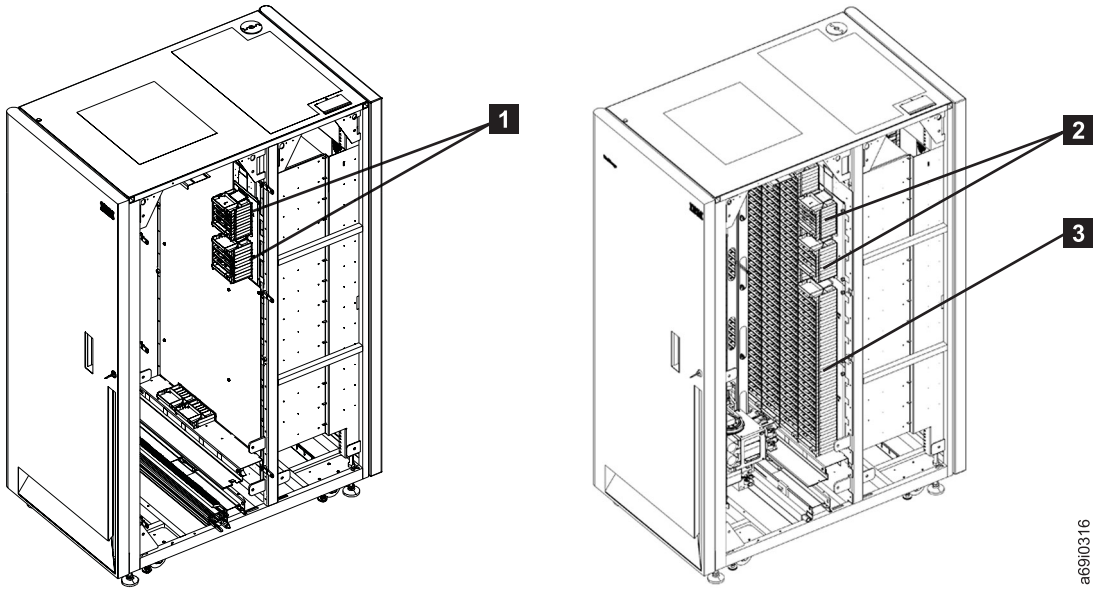


Figure 5. Cartridge slots in the service bays of the TS3500 tape library

If you already have an installed TS3500 tape library and you want to add a second accessor, your IBM service representative can add the accessor and its service bays. Converting from a single accessor to a dual accessor library requires that the service representative take down the entire library.

If your library already contains the service bays and you decide to add one or more expansion frames, your IBM service representative can convert service bay B to an expansion frame, add the new frame or frames to the right, and convert the last frame on the right to service bay B. This process requires no scheduled downtime. (*Downtime* is designed to be less than one hour.) To convert the existing service bay to an expansion frame, the service representative removes the test slots and replaces them with storage slots. Similarly, to convert an expansion frame to a service bay, the service representative removes specific storage slots and replaces them with the test slots. For more information, contact your IBM service representative.

Notes:

- If you convert an existing HD frame from a service bay to an expansion frame, a Capacity on Demand feature (1645 or 1646) is required in order to use the full capacity of the frame. If an HD frame is ordered to be used as service bay B, it does not require a Capacity on Demand feature.
- In order to support mixed media in an HD library with dual accessors, service bay B must be a model Dxx frame. This configuration requires feature code 1697, which ensures that the service bays provide both LTO and 3592 HD test slots.
- Expansion frame Model D32 cannot be used as service bay B.

For information about library availability and performance, see "Library performance" on page 87.

High-density technology

The TS3500 tape library offers high-density, storage-only frame models (HD frames) designed to greatly increase storage capacity without increasing frame size or required floor space. The new HD frames (Model S24 for 3592 tape cartridges and Model S54 for LTO tape cartridges) contain HD storage slots.

HD slots contain tape cartridges in a tiered architecture. The cartridge immediately accessible in the HD slot is a Tier 1 cartridge. Behind that is Tier 2, and so on. The maximum tier in an LTO (Model S54) HD slot is Tier 5. The maximum tier in a 3592 (Model S24) HD slot is Tier 4 because the 3592 tape cartridge is slightly longer than the LTO cartridge. The single-deep slots on the door side of HD frames are referred to as Tier 0 slots. On the left, Figure 6 shows the inside of an HD frame from the side. On the right, Figure 6 shows a top-down view of one row of an HD frame with cartridges in Tiers 0 (door side), 1, 2, and 3.

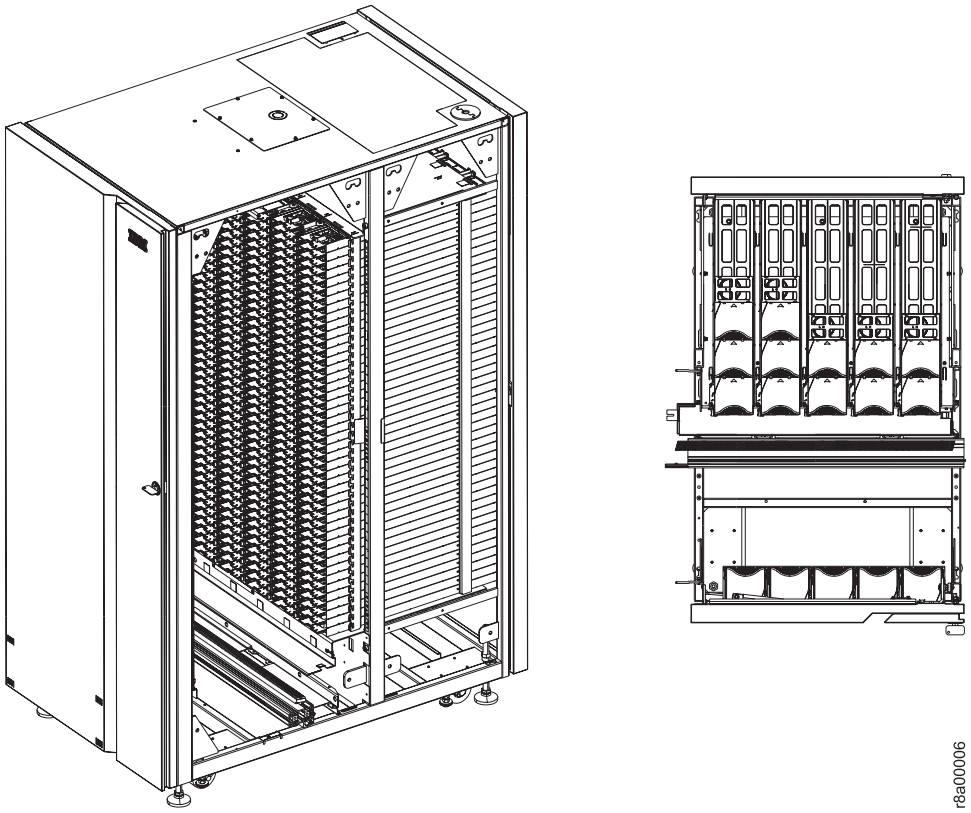


Figure 6. The HD frame (left) and top-down view of row in an HD frame (right)

All HD slots are black, however the location of the cartridge retention latch differentiates LTO HD slots from 3592 HD slots. The cartridge retention latch is on the left side of LTO HD slots and on the right side of 3592 HD slots.

Attention: The HD slots have a constant force spring for maintaining forward pressure on the tape cartridges. Use caution when you are inserting or removing cartridges from HD slots.

HD frame model S24 provides storage for up to 1 000 IBM 3592 tape cartridges. HD frame model S54 provides storage for up to 1 320 LTO tape cartridges. The base capacity of Model S24 is 600 cartridges, which are stored in Tiers 0, 1, and 2. The base capacity of Model S54 is 660 cartridges, which are stored in Tiers 0, 1, and 2. To increase capacity to the maximum for each frame, it is necessary to purchase the High Density Capacity on Demand (HD CoD) feature. This feature provides a license key that enables the use of the storage space in the remaining tiers. For more information, see "High Density Capacity On Demand" on page 56.

Note: These numbers represent raw capacity and do not reflect actual capacity. It is recommended that actual capacity does not exceed 99% of the raw capacity due to the need to maintain unused slots that are required for *shuffle* operations.

In HD frames, the cartridge accessor performs a *shuffle* operation in order to access the cartridges that are stored in Tier 2 and beyond. A shuffle is the process of moving cartridges in lower tiers into the gripper, or other available slots, in order to access cartridges in higher tiers (Tier 2 or greater). To reduce shuffle operations and take advantage of repeated accesses of certain cartridges, the role of *cartridge cache* is assigned to all single-deep (Tier 0) slots in an HD library. To maintain efficient shuffle operations, the library uses *load balancing* to store cartridges across all HD slots in the library string. In other words, all HD slots are filled to a minimum tier level until that tier is full across the library. For more information about HD frames and library performance, see "Library performance" on page 87.

Second generation HD (HD2) frames provide the following enhancements:

- Can be installed in the leftmost library position (frame position 1)
- Offer drive-capable models that support up to 16 HD2-compatible tape drives when in frame position 2 or higher

Note: Non-HD2 frames cannot be upgraded to HD2 frames.

HD frame models S24 and S54 can be attached to installed Dx2, Dx3, Lx2, and Lx3 frames and these frames can be intermixed in the same library configuration. In addition, HD frame models S24 and S54 can support shuttle stations in order to attach multiple library strings in a shuttle complex. For more information about a shuttle complex, see "Structure of the shuttle complex" on page 15.

Notes:

- If you convert an existing HD frame from a service bay to an expansion frame, a Capacity on Demand (CoD) feature (1645 or 1646) is required to use the full capacity of the frame. If an HD frame is ordered to be used as service bay B, it does not require a CoD feature.
- To support mixed media in an HD library with dual accessors, service bay B must be a model Dxx frame. This configuration requires feature code 1697, which ensures that the service bays provide both LTO and 3592 HD test slots.
- When you are expanding an installed library, an expansion frame is installed at the end of the library string. In order to have the expansion frame installed

somewhere other than the end of the library string, the IBM service representative must obtain a service contract to uninstall additional frames as necessary to accommodate the customer's request.

Note: The *end of the library string* refers to the very last frame or, if requested by the customer, the last frame before service bay B.

Components of the library

An overview of the major parts of the TS3500 tape library.

The TS3500 tape library consists of the major components shown in Figure 7 on page 14 (the figure depicts Model L53). For a more complete description of each component, see the appropriate sections in the *IBM TS3500 with ALMS Operator Guide*.

1 Library frames
The base frame (Models L53, L52, or L32 for Ultrium tape drives, and Models L23 or L22 for 3592 tape drives) and the expansion frame (Models D53, D52, D32, or S54 for Ultrium tape drives, and Models D23, D22, or S24 for 3592 tape drives). Each frame contains a rail system, cartridge storage slots, and up to 12 tape drives. The storage-only frames, Models S24 and S54, do not contain tape drives.

2 Rail system
The assembly on which the cartridge accessor moves through the library. The system includes the top and bottom rails.

3 Cartridge accessor with optimized dual-gripper transport mechanism
The assembly that moves tape cartridges between storage slots, tape drives, and the I/O stations. An optional second accessor is available with two service bays. For libraries that have mixed drive types, the optimized dual gripper can handle both Ultrium and 3592 tape cartridges.

4 Accessor controller
A circuit board that facilitates all accessor motion requests (such as calibrations, moves, and inventory updates). If your library includes a second accessor, it will also have a second accessor controller.

5 Cartridge storage slots
Cells that are mounted in the TS3500 tape library and used to store tape cartridges.

6 IBM LTO Ultrium tape drives or 3592 tape drives
Mounted in the TS3500 tape library, one or more units that read and write data that is stored on tape cartridges. IBM LTO Ultrium tape drives and 3592 tape drives may not be mixed in the same frame. IBM Ultrium tape drives use LTO Ultrium tape cartridges; 3592 tape drives use IBM 3592 tape cartridges.

7 Front door
The front door of any frame. When you order the Capacity Expansion Feature for the Model L22, L32, or L52, the storage slots inside the front door become enabled and can increase the tape library's capacity.

8 Door safety switch
A device in each frame that shuts down the motion power to the cartridge accessor whenever the front door is opened.

9 I/O stations
Up to two cartridge compartments on the front door of base frames of the TS3500 tape library that allow you to insert or remove tape cartridges without the library performing a reinventory of the frame.

10 Operator panel and operator panel controller
Located on the front of the base frame, the operator panel is the set of indicators and controls that lets you perform operations and determine the status of the library. The panel consists of the library power switch, a power-on indicator, a touch screen liquid crystal display (LCD), and the controller for the I/O stations. The operator panel controller is a circuit board that facilitates communication between the operator panel and the accessor controller.

11 Enhanced frame control assembly
An assembly of components that facilitate RS-422 communication between the drives in a frame and the accessor controller and operator panel controller. Only Models L23, D23, L53, and D53 are equipped with the enhanced frame control assembly, which includes two power supplies, both of which can provide power to the library and all drives in a frame.

12 Patch panel
A panel that houses the cable connections for the drives that use Fibre Channel interfaces. If frame is equipped with the TS7700 backend switches (not shown), the patch panel is removed.

13 Power cable hole
An optional, capped opening for a library whose power cable attaches to an outlet mounted above the library.

14 Fibre Channel cable hole
An optional, capped opening for a library whose Fibre Channel cables are routed above the library.

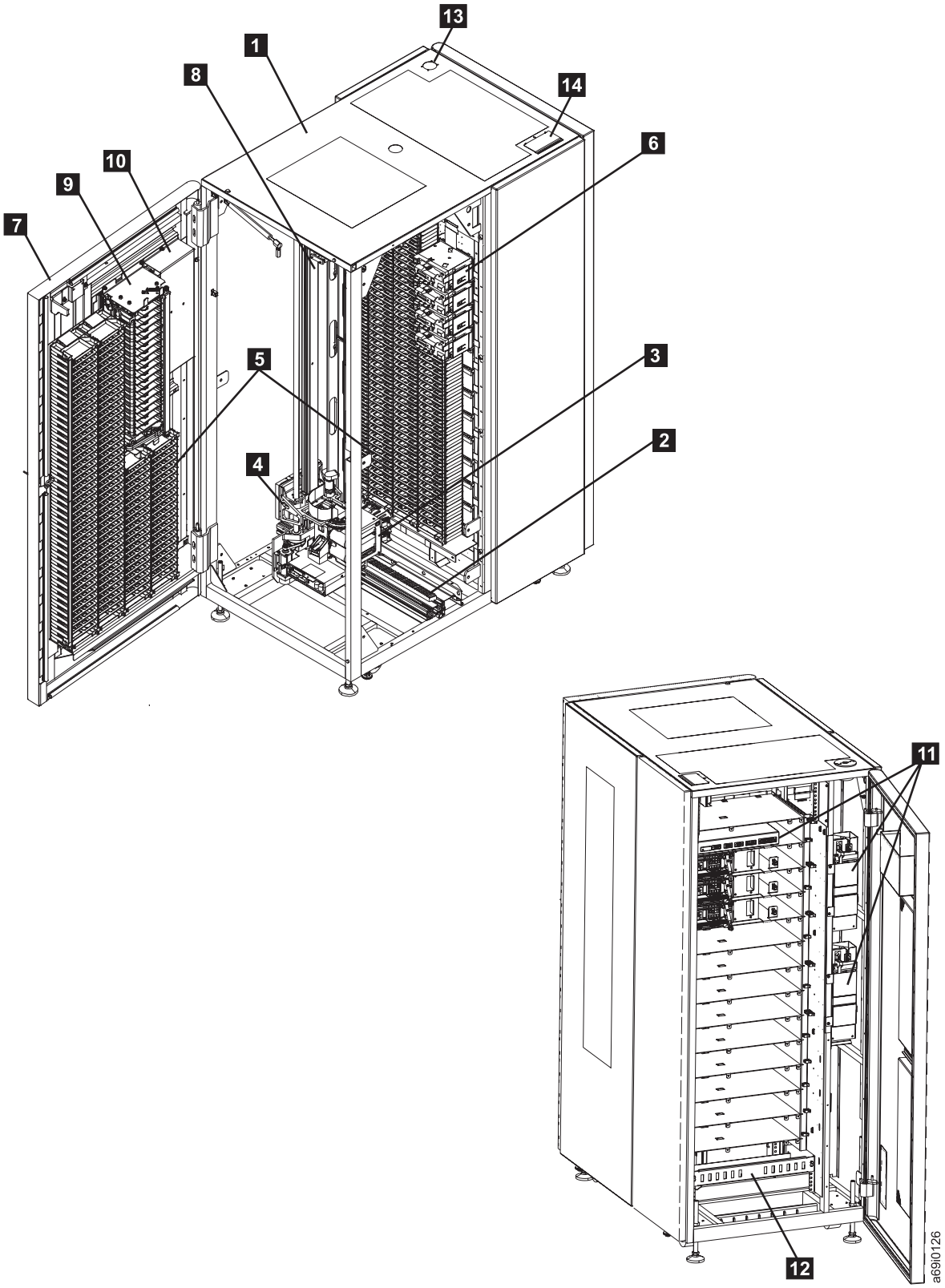


Figure 7. Components of the IBM TS3500. The front of a Model L53 is shown at the top. The rear of Model L53 is shown on the bottom.

Structure of the shuttle complex

In order to meet the needs of large data center archives that have to store increasing amounts of data, the TS3500 tape library offers shuttle technology that enables flexible library growth on a z-axis. This growth flexibility, enabled by shuttle connections between HD libraries, allows a higher maximum capacity for a single library image of multiple TS3500 library strings. This flexibility also accommodates constrained data center layouts that do not have room to expand on the x-axis, as well as data centers with large archives that exceed the maximum cartridge count of an individual TS3500 tape library string.

Unlike passthrough automation technologies that pass tape cartridges through intermediary libraries, the TS3500 tape library transports tape cartridges in shuttle cars that pass over the libraries. This method of transporting cartridges is called *direct flight*. With the direct flight capability, if there is no drive available in the home logical library, the cartridge is moved across a *shuttle connection* to a logical library with an available drive. This configuration of interconnected parallel library strings is called a *shuttle complex*. The components of a shuttle complex (shown in Figure 8 on page 16) are described below:

1 Shuttle station
The shuttle station mounts on top of an HD frame. It consists of a base pad and a shuttle slot. The shuttle slot docks into the base pad. When the shuttle slot is all the way down into the frame station it can accept or deliver a cartridge. Each shuttle station has its own import/export element (IEE) address.

2 Shuttle span
One or more shuttle spans are linked together in order to form a shuttle connection between HD frames in parallel library strings. Shorter shuttle spans support distances between library strings ranging from 762 mm (30 in) to 1 524 mm (60 in). Longer shuttle spans support distances between library strings ranging from 1 524 mm (60 in) to 2 743.2 mm (108 in).

3 Shuttle connection
A shuttle connection is comprised of one shuttle car, two or more shuttle stations, and one or more spans between these shuttle stations. Each shuttle connection supports one shuttle car.

Shuttle car (not shown)
The shuttle car is the mechanism that carries one tape cartridge through the shuttle connection to another library string. Each shuttle car carries one tape cartridge at a time.

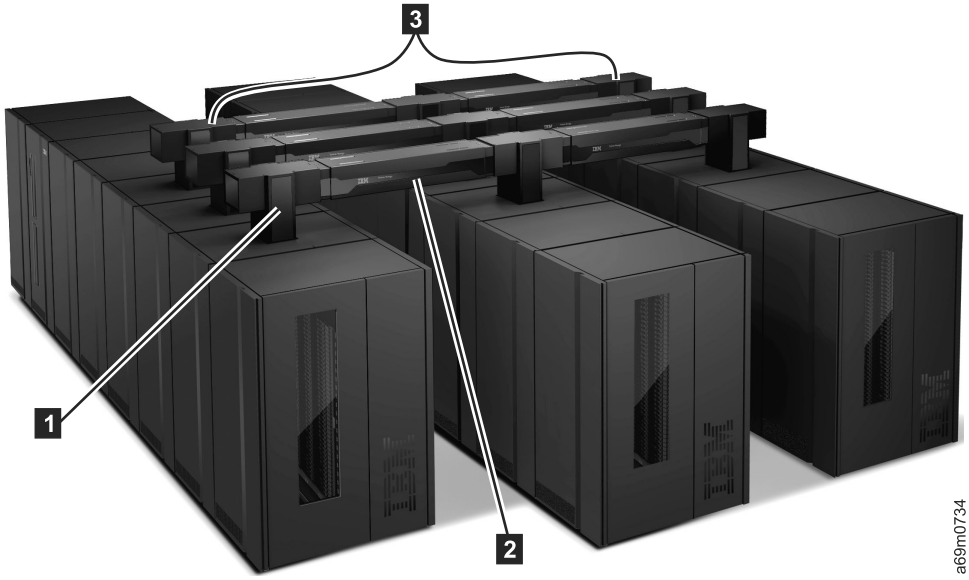


Figure 8. TS3500 tape library shuttle complex

Physical configuration of the shuttle complex

A shuttle complex is comprised of between two and 15 parallel library strings that are interconnected by shuttle connections between HD frames. Each library string in a shuttle complex has access to one or more shuttle cars that each provide at least one direct route to each of the remote library strings. (At least two direct routes are recommended for redundancy.)

A shuttle complex supports library strings with varying numbers of frames to the left or right of each connection. A shuttle complex also supports shuttle connections with varying numbers of spans. This support enables flexible shuttle complex configurations in order to accommodate most data center arrangements. It is required that the front doors of each library string in the shuttle complex face the same direction.

Shuttle connections attach to shuttle stations that are mounted on HD frames.

Logical configuration of the shuttle complex

A shuttle complex enables multiple TS3500 tape library strings to appear as a single library image to the host. Each library string is still its own SCSI library, however a library manager application such as HPSS, aggregates the multiple SCSI libraries into a single library image. This allows sharing of tape drive resources across multiple logical libraries in different library strings.

Each library string in a shuttle complex contains up to 192 logical libraries. Each shuttle station can be assigned to one logical library per library string or can remain unassigned. It is required that all shuttle stations on the same connection are assigned to logical libraries of the same media type. Shuttle stations are assigned to logical libraries through the TS3500 tape library web specialist interface.

Supported tape drives

The LTO Ultrium tape drives and the 3592 tape drives are high-performance, high-capacity data-storage units that can be installed in the TS3500 tape library. Up to 12 drives can be installed in each base and expansion frame of the library, but the two types of drives cannot be mixed in the same frame. You can identify a drive by examining the logo at the front of the drive canister or by inspecting the label at the rear of the drive canister.

Note: No drives are installed in the storage-only HD frames (Models S24 and S54).

Table 6 provides an overview of supported tape drives.

Table 6. Tape drives that are supported by the TS3500 tape library

Supported Tape Drives				
Type of Drive	**Speed of Connectivity**	**Native Data Rate**	**Native Capacity**	**Other Information**
IBM TS1060 tape drive[1, 2]	8 Gbps Fibre	160 MB/s	2 500 GB (2328.31 GiB)	Also known as the Ultrium 6 tape drive or the 3588 Model F6A
IBM TS1050 tape drive[1]	8 Gbps Fibre	140 MB/s	1 500 GB (1396.98 GiB)	Also known as the Ultrium 5 tape drive or the 3588 Model F5A
IBM TS1040 tape drive	4 Gbps Fibre	120 MB/s	800 GB (745.06 GiB)	Also known as the Ultrium 4 tape drive or the 3588 Model F4A
IBM TS1030 tape drive Model F3B	4 Gbps Fibre	80 MB/s	400 GB (372.53 GiB)	Both of these drives are also known as the Ultrium 3 tape drive
IBM 3588 tape drive Model F3A	2 Gbps Fibre	80 MB/s	400 GB (372.53 GiB)	
IBM LTO Ultrium 2 tape drive	2 Gbps Fibre 160 MB/s (LVD SCSI) 40 MB/s (HVD SCSI)	35 MB/s	200 GB (186.26 GiB)	Also known as the Ultrium 2 tape drive
IBM LTO Ultrium 1 tape drive	1 Gbps Fibre 80 MB/s (LVD SCSI) 40 MB/s (HVD SCSI)	15 MB/s	100 GB (93.13 GiB)	Also known as the Ultrium 1 tape drive
IBM TS1150 tape drive[1]	8 Gbps Fibre	360 MB/s	10 TB[6] (9.1 TiB) 7 TB[5] (6.37 TiB)	Also known as the 3592 Model E08
IBM TS1140 tape drive[1]	8 Gbps Fibre	250 MB/s	4 TB[5] (3.64 TiB) 1.6 TB[4] (1.46 TiB)	Also known as the 3592 Model E07

Table 6. Tape drives that are supported by the TS3500 tape library (continued)

Supported Tape Drives				
Type of Drive	**Speed of Connectivity**	**Native Data Rate**	**Native Capacity**	**Other Information**
IBM TS1130 tape drive	4 Gbps Fibre	160 MB/s	1 000 GB[4] (931.32 GiB) 640 GB[3] (596.05 GiB)	Also known as the 3592 Model E06 or EU6
IBM TS1120 tape drive	4 Gbps Fibre	100 MB/s	700 GB[4] (651.93 GiB) 500 GB[3] (465.66 GiB)	Also known as the 3592 Model E05
IBM 3592 tape drive Model J1A	2 Gbps Fibre	40 MB/s	300 GB (279.39 GiB)	Withdrawn from marketing as of September 2006

Notes:

1. In order to support Ultrium 5, TS1140, or later tape drives, all node cards in the library must be model xx3-equivalent node cards. For node cards in model xx2 frames, this requires a xx3 model conversion OR the enhanced node card(s) feature (FC 1700 or 1701).
2. In order to support Ultrium 6 tape drives, libraries with an L32 frame require enhanced grippers (FC 2205 or 2304).
3. JA/JW cartridge
4. JB/JX cartridge
5. JC/JY cartridge
6. JD/JZ cartridge

You or your IBM service representative can update firmware for the LTO Ultrium 2 and newer Ultrium tape drives and all 3592 tape drives without scheduling downtime. This enhancement is called a *nondisruptive drive firmware update*. It is available through the IBM Tape Library Specialist web interface and (for IBM service representatives) through CETool, but is not supported by the SCSI interface. For more information, go to the section about updating drive firmware in the *IBM TS3500 with ALMS Operator Guide*.

LTO Ultrium tape drives

There are six generations of Linear Tape-Open (LTO) Ultrium tape drives. The newest of these drives, the IBM TS1060 tape drive Model F6A, is a dual-ported drive that facilitates 8 Gbps Fibre Channel connectivity. This drive is also known as the Ultrium 6 tape drive and is differentiated by its machine type and model number 3588 F6A.

Note: In order to support Ultrium 5 and later tape drives, all node cards in the library must be model xx3-equivalent node cards. For node cards in model xx2 frames, this requires an xx3 model conversion OR the enhanced node card(s) feature (FC 1700 or 1701).

The six generations of LTO Ultrium drives are listed below:

- IBM TS1060 tape drive (8 Gbps, dual ports)
- IBM TS1050 tape drive (8 Gbps, dual ports)
- IBM TS1040 tape drive (4 Gbps, single port)

- IBM TS1030 tape drive Model F3B (4 Gbps, single port)
- IBM TS1030 tape drive Model F3A (2 Gbps, single port)
- IBM LTO Ultrium 2 tape drive (2 Gbps, single port)
- IBM LTO Ultrium 1 tape drive (1 Gbps, single port)

You can identify all Ultrium 2 and later Ultrium tape drives by the logo at the front of the drive or by the label at the rear of the drive's canister. You can identify the Ultrium 1 tape drive by the label at the rear of its canister. An Ultrium 3 write-once-read-many (WORM)-capable drive can be identified by the level of code it contains. If the code level is 54K1 or higher, the Ultrium 3 drive is capable of WORM functionality. Ultrium 3 and newer tape drives with WORM capability can recognize WORM-compatible media.

Ultrium 3 drives with WORM-capable firmware and newer Ultrium tape drives read and write non-WORM media. This means that you can load WORM-capable firmware on your Ultrium 3 and newer tape drives and use any media that are supported by these drives. In this case, only the data that is written on the WORM media is treated as WORM data; data written on other types of media can be overwritten.

Ultrium tape drives do not read from or write to 3592 tape cartridges, and 3592 tape drives do not read or write to Ultrium tape cartridges. Refer to “Mixing media in drives” on page 37 for detailed information about cartridge and drive compatibility.

The Ultrium tape drives can read tapes that have been written by non-IBM Ultrium drives. They also write to tapes that can be read by non-IBM Ultrium drives.

All generations of Ultrium tape drives and cartridges can reside in the same frame.

When a cartridge is labeled according to proper IBM bar code label specifications, the last character of its volume serial (VOLSER) number indicates the generation of the medium. For example, a cartridge with a VOLSER of 000764**L5** is an Ultrium 5 cartridge; a cartridge with a VOLSER of 000764**L4** is an Ultrium 4 cartridge; and so forth.

To enhance library performance, Ultrium 2 and newer Ultrium tape drives include speed matching, channel calibration, and power management. Speed matching dynamically adjusts the drive's native (uncompressed) data rate to the slower data rate of a server. Channel calibration customizes each read/write data channel for optimum performance. The customization enables compensation for variations in the recording channel transfer function, media characteristics, and read/write head characteristics. Power® management reduces the drive's power consumption during idle power periods.

Encryption

Ultrium 4 and later tape drives are encryption capable, which means they can convert data into a cipher that ensures data security. To perform encryption, the drive must be encryption enabled by your selection of one of three methods of encryption management. Two of these methods, system-managed and library-managed encryption, require the purchase of FC 1604 (Transparent LTO Encryption). A key is required to encrypt and decrypt the data. How a key is generated, maintained, controlled, and transmitted depends on the operating

environment where the Ultrium 4 or later tape drive is installed. Some data management applications are capable of performing key management. For an alternative solution, IBM provides a key manager that works in conjunction with the keystore of your choice to perform all necessary key management tasks. There is no recovery for lost encryption keys. For more information about encryption, see Chapter 8, "Tape encryption overview," on page 221. Also refer to the IBM Encryption Key Manager and Tivoli Key Lifecycle Manager publications listed in the **Related information** section. To choose a method of encryption management, refer to "Managing encryption" on page 222.

To ensure that your tape drive conforms to IBM's specifications for reliability, use only IBM LTO Ultrium tape cartridges. You can use other LTO-certified data cartridges, but they might not meet IBM standards of reliability.

Refer to "Drive performance" on page 81 for Ultrium tape drive performance specifications.

3592 tape drives

There are five generations of 3592 tape drives: TS1150 (Model E08), TS1140 (Model E07), TS1130 (Models E06 and EU6), TS1120 (Model E05), and J1A. All generations of 3592 tape drives and cartridges can reside in the same TS3500 tape library frame. Each generation of drive offers an increased data rate and increased native capacity from the previous model, in addition to other enhancements. Each generation of drive also offers dual-port Fibre Channel host attachment interfaces. This feature provides flexibility in an Open Systems environment because the drives can directly attach to Open Systems servers with Fibre Channel attachments. All TS1120 and later tape drives are encryption capable, however some TS1120 tape drives require feature code 5592 or 9592 in order to be encryption capable. Refer to Table 7 on page 21 for details about these and other 3592 tape drive features. For information about encryption, refer to Chapter 8, "Tape encryption overview," on page 221.

Note: The 3592 EU6 tape drive is a 3592 E05 tape drive canister upgraded to contain a Model E06 drive through the Miscellaneous Equipment Specification (MES) process. The EU6 model name is only used when information specific to the Model EU6 is discussed.

All 3592 tape drives include an RS-422 library interface port for communication with the TS3500 tape library. The 3592 tape drives use the Statistical Analysis and Reporting System to isolate failures between media and hardware. The TS1130, TS1140, and TS1150 tape drives (3592 Models E06, E07, and E08) also come with an Ethernet port, however use of this port for service or remote monitoring is not supported in a TS3500 tape library environment.

A 3592 tape drive cannot read or write to a 3590 High Performance Cartridge Tape (media type J) or to a 3590 Extended High Performance Cartridge Tape (media type K).

Table 7 on page 21 shows the basic features of each generation of the 3592 tape drive. Refer to "Drive performance" on page 81 for additional 3592 tape drive performance specifications.

Table 7. Features of the 3592 tape drive

Feature		3592 tape drives			
	TS1150 (Model E08)	**TS1140 (Model E07)**	**TS1130 (Model E06 or EU6)**	**TS1120 (Model E05)**	**Model J1A**
Native sustained data rate	360 MB/s (E08 format) 250 MB/s (E07 format)	250 MB/s (E07 format) 160 MB/s (E06 format)	160 MB/s (E06 format) 140 MB/s (E05 format) 70 MB/s (J1A format)	100 MB/s (E05 format) 50 MB/s (J1A format)	40 MB/s (J1A format)
Compressed sustained data rate (at maximum compression)	700 MB/s (E08 format)	650 MB/s (E07 format)	350 MB/s (E06 format)	280 MB/s (E05 format)	120 MB/s (J1A format)
Native Capacity	10 TB (9.1 TiB)[1] 7 TB (6.37 TiB)[2] 2 TB (1.82 TiB)[3] 900 GB (838.19 GiB)[4]	4 TB (3.64 TiB)[2] 1.6 TB (1.46 TiB)[5] 500 GB (465.66 GiB)[4]	1 000 GB (931.32 GiB)[5] 640 GB (596.05 GiB)[6] 128 GB (119.21 GiB)[7]	700 GB (651.93 GiB)[5] 500 GB (465.66 GiB)[6] 100 GB (93.13 GiB)[7]	300 GB (279.39 GiB)[6] 60 GB (58.88 GiB)[7]
Write-once-read-many (WORM) capability	Yes				
Capacity scaling and short cartridge	Yes				
Read/write capability	If encryption-enabled, reads and writes Model E08 and Model E07 encrypted format	If encryption-enabled, reads and writes Model E07 and Model E06 encrypted format	If encryption-enabled, reads and writes Model E06 and Model E05 encrypted format	Reads and writes Model E05 format	Reads and writes Model J1A format
	Reads and writes Model E08 and Model E07 format	Reads and writes Model E07 and Model E06 format	Reads and writes Model E06 and Model E05 format	Reads and writes Model J1A format	
		Reads Model E05	Reads Model J1A format		
Host (server) attachment	Supports dual-port, 8 Gbps Fibre Channel interface	Supports dual-port, 8 Gbps Fibre Channel interface	Supports dual-port, 4 Gbps Fibre Channel interface		Supports dual-port, 2 Gbps Fibre Channel interface
	Maximum interface burst transfer rate of 800 MB/s	Maximum interface burst transfer rate of 800 MB/s	Maximum interface burst transfer rate of 400 MB/s		Maximum interface burst transfer rate of 200 MB/s
	Supports N and L ports with autoconfigure				
Encryption	All TS1150 tape drives are encryption capable	All TS1140 tape drives are encryption capable	All TS1130 tape drives are encryption capable	With feature code 9592 or 5592	Not supported

Table 7. Features of the 3592 tape drive (continued)

Notes:
1. Using JD/JZ media
2. Using JC/JY media
3. Using JL media
4. Using JK media
5. Using JB/JX media
6. Using JA/JW media
7. Using JJ/JR media

The 3592 tape drives provide the following performance, capacity, and availability features:

N+1 power supplies
When installed in the TS3500 tape library frame, this helps to increase drive availability in the event of a power failure.

Media reuse
The 3592 tape drives can reuse different types of tape and multiple densities (logical formats) across various drive generations. Certain models can only support a subset of densities (such as the 3592 J1A tape drive, which can only read and write at a single density), while the later tape drives can read and write at multiple densities. Enterprise format 1 (EFMT1) records 512 tracks on 8 channels. Enterprise format 2 (EFMT2) records 896 tracks on 16 channels. Enterprise format 3 (EFMT3) records 1152 tracks on 16 channels. Enterprise format 4 (EFMT4) records 2560 tracks on 32 channels. Enterprise format 5 (EFMT5) records 5120 tracks on 32 channels. These logical formats can be divided into multiple sub-format options, such as segmentation and capacity scaling. For more information about capacity scaling and segmentation, refer to "Capacity scaling and segmentation" on page 182. For a complete matrix of read and write compatability by cartridge and format type, refer to "Mixing media in drives" on page 37.

Speed matching
When operating in a host environment where the net host data rate is less than the maximum drive native data rate, 3592 tape drives automatically perform dynamic speed matching to minimize backhitches. Dynamic speed matching adjusts the native data rate of the drive as closely as possible to the net host data rate (after data compressibility has been factored out). A reduction in backhitches improves system performance.

HRTD The HRTD directory structure, located in 3592 tape drives, allows the drive to have fast and consistent nominal and average access times for locate operations.

Channel calibration and on-the-fly adaptive equalization
To gain optimum performance, channel calibration allows the drive to automatically customize each read and write data channel. The customization compensates for variations in the recording channel transfer function, for media characteristics, and for read and write head characteristics. Initial calibration settings are calculated and stored at the time of manufacture. For optimum error rate performance, TS1120 and later tape drives also use on-the-fly adaptive equalization hardware on an ongoing basis to adjust the read equalization response.

Recursive accumulating backhitchless flush

The TS1120 and later tape drives use an algorithm known as recursive accumulating backhitchless flush (or non-volatile caching) to increase effective data rate performance from host servers that force explicit synchronize operations during write operations.

Backhitchless backspace

Backhitchless backspacing enables some backspace operations to be virtualized without physical backhitching. If you write and overwrite multiple trailer labels, this firmware feature provides major performance improvements. For more information, refer to the appendix about WORM behavior in the *IBM 3592 Tape Drive SCSI Reference*.

Capacity scaling

If you want to exchange capacity for improved access times, 3592 tape drives support multiple format options, such as scaling and segmentation modes. These tape drives can sense and report the scaling state of current medium by using the SCSI Mode Sense command and specifying Mode Page X'23'. Capacity scaling is only offered on the JA, JB, JC, and JD media types. For the exact Mode Select commands and settings necessary to invoke scaling, refer to the *IBM TS3500 SCSI Reference*.

WORM

The 3592 tape drives support write-once-read-many (WORM) behaviors and format attributes. Five WORM cartridge types are supported: JW (full length), JR (short length), JX Extended WORM cartridge (for TS1120, TS1130, and TS1140 tape drives), JY Advanced Type C WORM cartridge (for TS1140 and TS1150 tape drives), and JZ Advanced Type D WORM cartridge (for TS1150 tape drives). WORM cartridges are factory-formatted as WORM cartridges and may not be converted to data cartridges. The 3592 tape drives allow append operations to data already on WORM cartridges, but do not allow data to be overwritten under any circumstances.

Capacity-based and position-based LEOT reporting

The TS1120 and later tape drives use enhanced logic to report logical end-of-tape (LEOT) data. The drive reports LEOT based on a combination of indicators of capacity-based LEOT and position-based LEOT. These drives monitor the total accumulated physical tape files written to the cartridge and report the LEOT based on the capacity-based LEOT value, rather than reporting LEOT based on the physical position on the tape (position-based LEOT). To summarize, this technique reports LEOT based on the amount of compressed data that is recorded to the cartridge and reduces the variation in the amount of data recorded before LEOT is issued. For applications that use LEOT to stop the write process, a more consistent capacity is recorded to the media. For a higher percentage of the time, this process allows tape copies to complete without overflow.

Enhanced format for recording error-correction codes (ECCs)

The logical formats of TS1120 and later tape drives offer improved error-correction-code capabilities over the 3592 J1A and LTO formats by increasing the power of one of the two orthogonal Reed-Solomon ECCs that protect the data on tape. The correction power of the inner code is approximately double that of the 3592 J1A and thus offers superior reliability of the data.

Drive mechanical and electrical reliability

The mechanism of the TS1120 and later tape drives is specified at a mean-cycles-between-failure rate of 300,000 cycles, which is the highest

reliability rating in the industry. The mechanism contains special mechanical and electrical features to prevent damage to the media on power-down or reset. These features also prevent the dropping of the leader pin or other thread failures during similar interruptions. It also tolerates extremely high vibration and shock environments without data loss or degraded operation.

Multiple subsystem and automation support
The 3592 tape drives and their cartridges support multiple automation libraries and can be easily transported between environments.

Data compression
The 3592 tape drives use the data-compression method known as streaming lossless data compression algorithm. The compression logic for TS1120 and later tape drives operates at more than twice the overall transfer rates of the 3592 J1A tape drive.

Data buffer with read ahead feature
The 3592 J1A tape drive includes a data buffer of 134.22 MB (128 MiB). The TS1120 tape drive includes a data buffer of 536.87 MB (512 MiB). The TS1130 tape drive and TS1140 tape drive each include a data buffer of 1.07 GB (1 GiB). The TS1150 tape drive includes a data buffer of 2.15 GB (2 GiB). Along with enabling performance characteristics in buffered Write and Read commands, the data buffer also supports a Read Ahead feature. When the drive processes a command to locate or read a block, the drive automatically continues to stream down the tape and read ahead until the data buffer is full. This allows subsequent Locate or Read commands to be fulfilled from the data buffer at faster speeds, rather than requiring access to the tape.

Offboard data string searching
The TS1120 and later tape drives can search the data content of host server records for string matches. The function is called *offboard data string searching* because the data search workload can be performed offboard from the host. Each drive performs a search at its own respective maximum data rate. This greatly reduces the amount of data transfer and host search times.

Encryption
All TS1130 and later tape drives are encryption capable, which means they can convert data into a cipher that ensures data security. With IBM feature code 9592 or 5592, TS1120 tape drives are encryption capable as well. To perform encryption, the drive must be encryption-enabled by your selection of one of three methods of encryption management. A key is required to encrypt and decrypt the data. How a key is generated, maintained, controlled, and transmitted depends on the operating environment where the TS1120 and later tape drives are installed. Some data management applications are capable of performing key management. For an alternative solution, IBM provides a key manager that works in conjunction with the keystore of your choice to perform all necessary key management tasks. There is no recovery for lost encryption keys.

For more information about encryption, refer to Chapter 8, "Tape encryption overview," on page 221. Also refer to the IBM Encryption Key Manager and Tivoli Key Lifecycle Manager publications listed in the **Related information** section of this document. To choose a method of encryption management, see the section about setting a drive's method of encryption in the *IBM TS3500 with ALMS Operator Guide*.

Firmware for each model of 3592 tape drive (TS1150, TS1140, TS1130, TS1120, or J1A) only works in that specific model.

The 3592 tape drive supports four types of the IBM 3592 tape cartridge. For more information about the supported cartridges, see “Mixing media in drives” on page 37.

Supported tape cartridges

Note: Management and handling of media cartridges is a customer function and responsibility.

In the TS3500 tape library, frames that are installed with Ultrium tape drives use Ultrium tape cartridges. Frames that are installed with 3592 tape drives use 3592 tape cartridges. A frame cannot house both Ultrium tape drives and 3592 tape drives. Similarly, in an HD library, Model S24 contains HD slots that house only 3592 tape cartridges and Model S54 contains HD slots that house only Ultrium tape cartridges. However, in a library that includes both types of frames, you may insert 3592 tape cartridges into the lower I/O station of a Model L53, L52, or L32 frame for transport (by the cartridge accessor) to a Model D23, D22, or S24 frame. Similarly, you may insert Ultrium tape cartridges into the lower I/O station of a Model L23 or L22 frame for transport (by the cartridge accessor) to a Model D53, D52, D32, or S54 frame. (Note that in both of these scenarios, your library must contain an I/O station that will accept the type of cartridge that is being inserted.)

Table 8 shows the capacity of supported Ultrium tape cartridges. Table 9 shows the capacity of supported 3592 tape cartridges.

Table 8. Capacity of Ultrium tape catridges

Supported tape cartridges	Native capacity	Compressed capacity [1, 2]
IBM LTO Ultrium-6 2500 GB data cartridge	2 500 GB (2328.31 GiB)	6.25 TB (5.68 TiB)
IBM LTO Ultrium-5 1500 GB data cartridge	1 500 GB (1396.98 GiB)	3 TB (2.73 TiB)
IBM LTO Ultrium-4 800 GB data cartridge	800 GB (745.06 GiB)	1 600 GB (1 490.12 GiB)
IBM LTO Ultrium-3 400 GB data cartridge[3]	400 GB (372.53 GiB)	800 GB (745.06 GiB)
IBM 3589 Ultrium tape cartridge Models 028 and 029[4]	400 GB (372.53 GiB)	800 GB (745.06 GiB)
IBM LTO Ultrium-2 200 GB data cartridge	200 GB (186.26 GiB)	400 GB (372.53 GiB)
IBM LTO Ultrium-1 data cartridge	100 GB (93.13 GiB)	200 GB (186.26 GiB)

Notes:

1. The compressed capacity for the Ultrium 6 cartridge uses a 2.5:1 compression ratio.
2. The compressed capacity for the Ultrium 5 cartridge uses a 2:1 compression ratio.
3. This cartridge is for the Ultrium 3 tape drives with or without write once read many (WORM) capability.
4. This cartridge is for the Ultrium 3 tape drives with WORM capability.

Table 9. Capacity of 3592 tape cartridges

3592 tape cartridge	Media type	Native capacity	Compressed capacity[1]
E08 tape drive format[2, 3]	JD, JZ	10 TB (9.1 TiB)	30 TB (27.3 TiB)
	JL	2 TB (1.82 TiB)	6 TB (5.46 TiB)
	JC, JY	7 TB (6.37 TiB)	21 TB (19.1 TiB)
	JK	900 GB (838.19 GiB)	2.7 TB (2.46 TiB)

Table 9. Capacity of 3592 tape cartridges (continued)

3592 tape cartridge	Media type	Native capacity	Compressed capacity[1]
E07 tape drive format[2, 5]	JC, JY	4 TB (3.64 TiB)	12 TB (10.91 TiB)
	JB, JX	1.6 TB (1.46 TiB)	4.8 TB (4.37 TiB)
	JK	500 GB (465.66 GiB)	1.5 TB (1.36 TiB)
E06 tape drive format[5]	JB, JX	1 000 GB (931.32 GiB)	3 TB (2.73 TiB)
	JA, JW	640 GB (596.04 GiB)	1.9 TB (1.75 TiB)
	JJ, JR	128 GB (119.21 GiB)	384 GB (357.63 GiB)
E05 tape drive format[4, 5]	JB, JX	700 GB (651.93 GiB)	2.1 TB (1.91 TiB)
	JA, JW	500 GB (465.66 GiB)	1.5 TB (1.36 TiB)
	JJ, JR	100 GB (93.13 GiB)	300 GB (279.40 GiB)
J1A tape drive format[3, 4, 5]	JA, JW	300 GB (279.39 GiB)	900 GB (838.19 TiB)
	JJ, JR	60 GB (58.88 GiB)	180 GB (167.64 GiB)

Notes:

1. The 3592 tape cartridges use a 3:1 compression ratio.
2. JA, JJ, JR, and JW media are not supported by this format.
3. JB and JX media are not supported by this format.
4. JC, JK, and JY media are not supported by this format.
5. JD, JL, and JZ media are not supported by this format.

Certain restrictions apply to the use of tape cartridges with drives. For additional information about compatibility between cartridges and drives, see "Mixing media in drives" on page 37. For additional information about 3592 tape cartridges, refer to "Overview of 3592 tape drive media" on page 177. For additional information about Ultrium tape cartridges, refer to "Overview of LTO tape drive media" on page 149.

Cleaning cartridges are identified by a volume serial (VOLSER) number that begins with a prefix of `CLNI` or `CLNU` for LTO Ultrium cleaning cartridges, and `CLN` for 3592 cleaning cartridges.

Compatible servers and software

The TS3500 tape library is supported by a wide variety of servers, operating systems, and adapters. There are many ways to determine the servers and software that support the TS3500 tape library.

These attachments can change throughout the lifecycle of the product. To determine the latest attachments, or to get a comprehensive list of compatible software, perform one of the following actions:

- Visit the web:
  - For a list of compatible software, operating systems, and servers for LTO tape drives, visit the web at `http://www.ibm.com/storage/lto`. Under `TS3500 Library`, select `Product details`. Under `Learn more`, select `Interoperability matrix` or select `Independent Software Vendor (ISV) matrix for LTO`.
  - For a list of compatible software, operating systems, and servers for 3592 tape drives, visit the web at `http://www.ibm.com/servers/storage/tape/drives`.

Scroll to the correct tape drive and select `Product details`. Under `Learn more`, select `Interoperability matrix` or `Independent Software Vendor (ISV) matrix`.

  - For complete IBM storage interoperability information, including operating systems, servers, switches, and adapters supported by the TS3500 tape library in a storage-area network (SAN) configuration, visit the IBM System Storage® Interoperation Center (SSIC) at: http://www-03.ibm.com/systems/support/storage/ssic/interoperability.wss.

- Contact your IBM sales representative.

Notes:

1. IBM does not provide application software with the TS3500 tape library. To order software, contact your IBM sales representative, IBM business partner, or an independent software provider.
2. If you attach your library to a non-IBM platform with non-IBM software, it is recommended that you contact your software vendor to obtain a matrix of compatible hardware, software, firmware revisions, and adapter cards.

Supported device drivers

IBM provides device driver support for the LTO and 3592 tape drives, as well as the robotics in the TS3500 tape library.

IBM maintains the latest levels of device drivers and driver documentation on the web. Go to http://www.ibm.com/support/fixcentral and perform the following steps in order to access this material.

1. From the Fix Central Web page, select **System Storage** from the Product Group list.
2. Select **Tape systems** from the System Storage list.
3. Select **Tape drivers and software** from the Tape systems list.
4. Select **Tape device drivers** from the Tape drivers and software list.
5. Select the appropriate operating system from the Platform list and click **Continue**.
6. Select the appropriate driver from the list that displays.

For a complete description of the mtlib program and command syntax, see the *IBM Tape Device Drivers Installation and User's Guide*.

The *IBM Tape Device Drivers Installation and User's Guide* can be found on the web: http://www-01.ibm.com/support/docview.wss?rs=577&uid=ssg1S7002972 .

Communication with TSLM

The IBM Tape System Library Manager (TSLM) provides a resource management layer between applications such as Tivoli Storage Manager and the tape library hardware.

Essentially, TSLM decouples tape resources from applications. Decoupling simplifies both the aggregation and the sharing of tape resources.

TSLM provides the following benefits:

- Consolidated, mainframe-class media management services
- Centralized repository, access control, and administration
- Management beyond physical library boundaries
  - Access multiple TS3500 or TS4500 tape libraries as a single library image.
  - The libraries can be separate (at SAN distances) or connected in a shuttle complex (TS3500 tape library only)
- Dynamic sharing of resources across heterogeneous application boundaries
- Security features to allow or prevent application access to tapes
  - Helps to enable common scratch pool and private pools for every application
  - Secures the usage and visibility
- Policy-based drive and cartridge allocation
- Policy-based media-lifecycle management
- 3494 Emulation
  - Emulation of an IBM 3494 library on top of an attached IBM TS3500 or TS4500 tape library.

For more information about TSLM, see the *IBM Tape System Library Manager User's Guide* (GA32-2208).

Attachment interfaces

This section describes the types of interfaces that are available with the TS3500 tape library.

The TS3500 tape library supports the following attachment interfaces.

The SCSI Medium Changer Device, which supports:

Parallel SCSI interface
Models L32 and D32 support Ultrium 1 and Ultrium 2 tape drives with parallel SCSI low voltage differential (LVD) and high voltage differential (HVD) interfaces.

Fibre Channel interface
The library supports Ultrium tape drives and 3592 tape drives with a Fibre Channel interface.

The Ethernet 10/100 interface, and the following protocols:

Simple Network Management Protocol (SNMP)
SNMP traps are supported for drive and library events. SNMP management query functionality is supported by using a standard Management Information Block (MIB).

Hyper Text Transfer Protocol (HTTP)
An embedded web server provides a web user interface for library management and query capabilities. Except for certain service capabilities, most of the operator panel functionality is provided on the web user interface.

The TS3500 tape library supports the Ethernet 10/100 interface in auto negotiation or fixed modes of 10 Mb/s and 100 Mb/s, and by using half or full duplex.

The library cannot be directly connected to a System z® server (mainframe host) with a Fibre Connection (FICON) or Enterprise System Connection (ESCON) interface. Instead, the System z server must connect to the TS3500 tape library through one of the following configurations:

- Through a 3953 tape system and a Tape Control Unit (a TS1120 tape controller, a 3592 J70, a 3494 VTS Model B10, a 3494 VTS Model B20, or a TS7700), then to the TS3500 tape library
- Through a TS7700 with integrated library manager (TS7700 microcode level 8.5.0.x and later). Then, to the TS3500 tape library with frame model L23 or D23 equipped with one of these items:
  - 4 Gb Fibre Channel switches (feature code 4872 or 4873)
  - 8 Gb Fibre Channel switches (two units of feature code 4875 or 4877)

  Note: To support 8 Gb Fibre Channel switches, the TS7700 must be at code level 8.20.0.x or later.
- Through a 3592-C07 tape controller with integrated library manager, then to the TS3500 tape library with frame model L23 or D23 equipped with 8 Gb Fibre Channel switches (feature code 4875 or 4877)

These configurations provide the interconnection to the TS3500 tape library.

The sections that follow describe the Fibre Channel, SCSI, FICON and ESCON interfaces.

Fibre Channel interface

Several information resources are available to help users of drives that use a Fibre Channel interface.

If the symbol is...	It means...
	**Attention:** This product contains an assembly that complies with the performance standards set by the U.S. Food and Drug Administration for a Class I Laser Product. This laser assembly is registered with the Department of Health and Human Services and is in compliance with IEC825.

In the TS3500 tape library, for drives that use a Fibre Channel interface, the following information is available:

- For a list of compatible software, operating systems, and servers for LTO tape drives, visit the web at `http://www.ibm.com/storage/lto`. Under `TS3500 Library`, select `Product details`. Under `Learn more`, select `Interoperability matrix` or select `Independent Software Vendor (ISV) matrix for LTO`.
- For a list of compatible software, operating systems, and servers for 3592 tape drives, visit the web at `http://www.ibm.com/servers/storage/tape/drives`. Under the appropriate tape drive, select `Product details`. Under `Learn more`, select `Interoperability matrix` or `Independent Software Vendor (ISV) matrix`.
- For complete IBM storage interoperability information, including operating systems, servers, switches, and adapters supported by the TS3500 tape library in a storage-area network (SAN) configuration, visit the IBM System Storage Interoperation Center (SSIC) at: http://www-03.ibm.com/systems/support/storage/ssic/interoperability.wss.

Fibre Channel technology combines the best features of traditional input/output interfaces (such as the throughput and reliability of SCSI and Programmed Control Interrupt) with the best features of networking interfaces (such as the connectivity and scalability of Ethernet and Token Ring). The technology offers a transport mechanism for delivering commands, and provides high performance by allowing processing to be done in the hardware.

You can establish Fibre Channel connections between Fibre Channel ports that reside in the TS3500 tape library, one or more servers, and the network interconnecting them. The network can consist of such elements as switches, hubs, bridges, and repeaters used in the interconnection.

Small Computer System Interface

This section sets forth the conditions that apply to drives in the TS3500 tape library that use a Small Computer System Interface (SCSI) interface.

The TS3500 tape library operates as a set of SCSI-3 devices. For drives that use a SCSI interface, the following conditions apply:

- The Ultrium 2 tape drive attaches to a server through a Low Voltage Differential (LVD) Ultra160 SCSI interface or a High Voltage Differential (HVD) Ultra SCSI interface
- The Ultrium 1 tape drive attaches to a server through an LVD Ultra2 SCSI interface or an HVD Ultra SCSI interface

Each SCSI drive canister uses shielded, VHDCI, 68-pin connectors and can attach directly to a 2-byte-wide SCSI cable.

Note: The earlier version of the SCSI drive used HD68 connectors and was packaged on a tray (sled). While drive trays are still supported, they can no longer be ordered. For information about the replacement design, contact your IBM representative.

Any combination of up to two initiators (servers) and up to four targets (devices) is allowed on a single SCSI bus if the following conditions are met:

- The SCSI bus is terminated properly at each end
- Cable restrictions are followed according to SCSI-3 standards

Under the SCSI-3 protocol, this type of attachment allows cable lengths of up to 25 m (81 ft) with the appropriate cable and terminator for HVD devices and up to 12 m (39 ft) for LVD devices.

For more information about the SCSI interface, see the *IBM TS3500 SCSI Reference*.

FICON and ESCON interfaces

The FICON and ESCON interfaces used to attach the TS3500 tape library to the System z server.

The TS3500 tape library does not provide native attachment to Fibre Connection (FICON) or Enterprise System Connection (ESCON) interfaces. Instead, the TS3500 tape library attaches to the IBM System z server (mainframe host) through one of the following configurations:

- Through a 3953 tape system (3953 F05 Frame and 3953 L05 Library Manager), which allows attachment of the TS3500 tape library with 3592 tape drives (not LTO Ultrium tape drives) to the IBM System z server (mainframe host). The System z servers then attach through a FICON or ESCON interface to one of the following FICON/ESCON-enabled components:
  - IBM TS1120 tape controller Model C06 (3592 C06)
  - IBM 3592 tape controller Model J70 (3592 J70)
  - IBM 3494 virtual tape server Model B10 (3494 B10)
  - IBM 3494 virtual tape server Model B20 (3494 B20)
  - IBM TS7740 (microcode level 8.4.1.x and earlier)
- Through an IBM TS7700 with integrated library manager (microcode level 8.5.0.x and later), which allows attachment of the TS3500 tape library with 3592 tape drives (not LTO Ultrium tape drives) to the IBM System z server (mainframe host).

  Note: This configuration requires that the TS3500 tape library includes an L23 or D23 frame that is equipped with one of these items:
  - 4 Gb Fibre Channel switches (feature code 4872 or 4873)
  - 8 Gb Fibre Channel switches (two units of feature code 4875 or 4877)

  . To use the 8 Gb Fibre Channel switches, the TS7700 must be at microcode level 8.20.0.x or later.
- Through a 3592-C07 tape controller with integrated library manager, which allows attachment of the TS3500 tape library with 3592 tape drives (not LTO Ultrium tape drives) to the IBM System z server (mainframe host).

Note: This configuration requires that the TS3500 tape library includes an L23 or D23 frame that is equipped with 8 Gb Fibre Channel switches (feature code 4875 or 4877).

In each configuration, the FICON/ESCON-enabled products include attachment to a system console. It is recommended that the TS3500 tape library also be connected to a system console. This connection reduces the number of analog phone lines needed for remote support and improves collaboration between the systems in resolving hardware problems.

The library needs a minimum of two Ethernet ports: one attached to your network for use by the storage administrator and one attached to the private master console network for remote support.

Note: In the past, a library only had a single Ethernet port. To ensure a separate Ethernet connection from the library to the system console, at least one additional Model D22, D32, or D52 frame was required, with a frame control assembly (feature code 1452 or 1453) that contained a medium changer card pack (MCP) with an Ethernet connection (feature code 1660). However, with the design and inclusion of the enhanced frame control assembly in Models L23, D23, L53, and D53, and the enhanced node card upgrade (feature code 1700 or 1701) for Models L22, D22, L52, D52, L32, and D32, each frame now contains a medium changer assembly (MCA) with two Ethernet ports. This eliminates the need for an additional Model D22, D32, or D52 frame.

The TS3500 tape library feature code 2715 (TS3000 system console (TSSC) Attachment) provides an Ethernet cable for the library connection to the system console.

When a FICON/ESCON-enabled product attaches to a TS3500 tape library, the following functionality must be enabled on the tape library to ensure proper operation:

- Advanced Library Management System (ALMS)
- Cartridge assignment policy with **All Other VOLSERs** assigned to a specific logical library

Note: Insert Notification is no longer required and is not recommended.

Figure 9 on page 34 shows a diagram of how the zSeries server attaches to the TS3500 tape library. For additional information about attaching the IBM System z server to the TS3500 tape library through the 3953 tape system, see the *IBM 3953 tape system Introduction and Planning Guide*. As a TS7700 attachment example, this diagram shows a TS7700 Model TS7740 frame. For additional information about attaching the IBM System z server to the TS3500 tape library through a TS7700, refer to the *IBM TS7700 Series: TS7700, TS7700 Cache Controller, and TS7700 Cache Drawer Introduction and Planning Guide* or the *IBM TS7700 Information Center*. For additional information about attaching the IBM System z server to the TS3500 tape library through a 3592-C07 tape controller, refer to the *IBM C07 Customer Information Center*. Refer also to the *IBM TS3000 System Console (TSSC) Maintenance Information* guide.

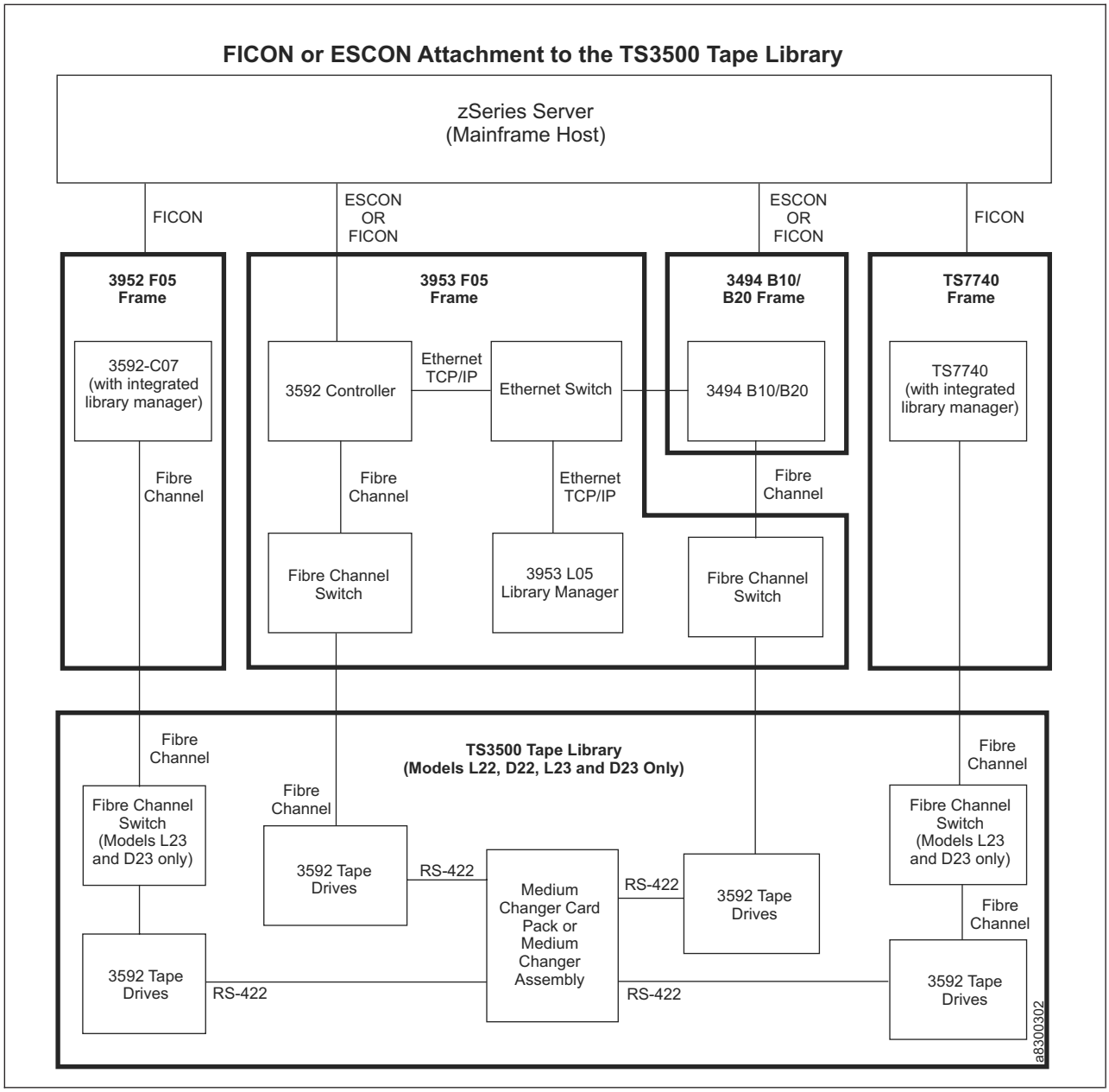


Figure 9. Attaching the TS3500 tape library to the System z server (mainframe host)

Mixing drives in frames

A matrix of the drives that are compatible in a physical frame (model) of the TS3500 tape library.

Note: If you plan to use encryption, also refer to "Configuration prerequisites for encryption" on page 225.

Table 10. Mixing drives in the physical frames of the TS3500 tape library

Drive Types	Models L22 and D22	Models L23 and D23	Models L32 and D32	Models L52 and D52	Models L53 and D53
Ultrium 6 tape drives	No	No	Yes[1,2]	Yes[1]	Yes
Ultrium 5 tape drives	No	No	Yes[1]	Yes[1]	Yes
Ultrium 4 tape drives	No	No	Yes	Yes	Yes
Ultrium 3 tape drives	No	No	Yes	Yes	Yes
Ultrium 2 tape drive	No	No	Yes	Yes	Yes
Ultrium 1 tape drive	No	No	Yes	Yes	Yes
TS1150 tape drive	Yes[1]	Yes	No	No	No
TS1140 tape drive	Yes[1]	Yes	No	No	No
TS1130 tape drive	Yes[1]	Yes	No	No	No
TS1120 tape drive	Yes	Yes	No	No	No
3592 J1A tape drive	Yes	Yes	No	No	No

1. This configuration requires an xx3 model conversion or the enhanced node card(s) feature (FC 1700 or 1701).
2. In order to support the Ultrium 6 tape drive, libraries with a Model L32 frame require enhanced grippers (FC 2205 or 2304).

Mixing drives in a logical library

This section contains information about drives that are compatible in a logical library of the TS3500 tape library.

Note: If you plan to use encryption, also refer to "Configuration prerequisites for encryption" on page 225.

The TS3500 tape library supports a mixture of Ultrium drive types in a logical library, but it does not support a mixture of Ultrium and 3592 tape drives in a logical library. Some independent software vendors (ISVs) support mixed drive types within logical libraries; others do not. Some ISVs that support mixed drive types do so with restrictions. For details, contact your ISV.

For situations where the ISV support does not exist or does not meet your requirements, the TS3500 tape library provides another option to protect your investment by partitioning the tape drives into separate logical libraries. You can customize the partition to any number of slots by using menus.

Figure 10 on page 36 shows examples of methods for mixing Ultrium drive types in a logical library.

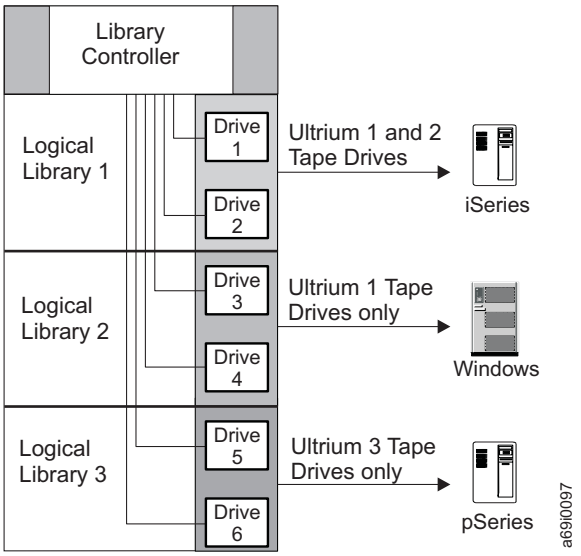


Figure 10. Examples of methods for mixing Ultrium drive types in a logical library

Mixing media in drives

Information about compatible media and drives in the TS3500 tape library.

Not all cartridges that are supported by the TS3500 tape library are compatible with all drives. Ultrium cartridges are not supported by 3592 tape drives, and 3592 tape cartridges are not supported by Ultrium drives.

When labeled according to proper IBM bar code label specifications, the last character of an Ultrium cartridge's volume serial (VOLSER) number indicates the generation of the medium. For example, a cartridge with a VOLSER of 000764L6 is an Ultrium 6 cartridge, a cartridge with a VOLSER of 000764L5 is an Ultrium 5 cartridge, and so forth. On a 3592 tape cartridge, the IBM product label represents whether it is a read/write (R/W) cartridge or a write-once-read-many (WORM) cartridge.

Table 11 gives a matrix of cartridges that are compatible with Ultrium tape drives. Table 12 on page 38 gives a matrix of cartridges that are compatible with 3592 tape drives.

Table 11. Compatibility among Ultrium tape drives and tape cartridges

Cartridge type	Drive type					
	Ultrium 6 (F6A)	**Ultrium 5 (F5A)**	**Ultrium 4 (F4A)**	**Ultrium 3 (F3A/ F3B)**	**Ultrium 2**	**Ultrium 1**
IBM 2500 GB LTO data cartridge (xxxxxxL6)	R/W	Not compatible	Not compatible	Not compatible	Not compatible	Not compatible
IBM 2500 GB LTO WORM data cartridge (xxxxxxLW)	R/W	Not compatible	Not compatible	Not compatible	Not compatible	Not compatible
IBM 1500 GB LTO data cartridge (xxxxxxL5)	R/W	R/W	Not compatible	Not compatible	Not compatible	Not compatible
IBM 1500 GB LTO WORM data cartridge (xxxxxxLV)	R/W	R/W	Not compatible	Not compatible	Not compatible	Not compatible
IBM 800 GB LTO data cartridge (xxxxxxL4)	Read only	R/W	R/W	Not compatible	Not compatible	Not compatible
IBM 800 GB LTO WORM data cartridge (xxxxxxLU)	Read only	R/W	R/W	Not compatible	Not compatible	Not compatible
IBM 400 GB LTO data cartridge (xxxxxxL3)	Not compatible	Read only	R/W	R/W	Not compatible	Not compatible

Table 11. Compatibility among Ultrium tape drives and tape cartridges (continued)

IBM 400 GB LTO WORM data cartridge (xxxxxxLT)	Not compatible	Read only	R/W	R/W	Not compatible	Not compatible
IBM 200 GB LTO data cartridge (xxxxxxL2)	Not compatible	Not compatible	Read only	R/W	R/W	Not compatible
IBM 100 GB data cartridge (xxxxxxL1)	Not compatible	Not compatible	Not compatible	Read only	R/W	R/W

Notes:

- In order to support Ultrium 5 or later tape drives, all node cards in the library must be model xx3-equivalent node cards. For node cards in model xx2 frames, this requires a xx3 model conversion OR the enhanced node card(s) feature (FC 1700 or 1701).
- The library rejects any command to move unsupported media to a drive and returns a sense key of 5 and an additional sense code/additional sense code qualifier of 30/00.

Table 12. Cartridges that are compatible with 3592 tape drives

Media	Recording format	TS1150 tape drive		TS1140 tape drive		TS1130 tape drive		TS1120 tape drive		J1A tape drive
		Encryption enabled	Encryption not enabled	Encryption enabled	Encryption not enabled	Encryption enabled	Encryption not enabled	Encryption enabled	Encryption not enabled	
JD, JZ[1], JL	EEFMT5 (encrypted E08)	R/W	Reformat	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
	EFMT5 (E08)	R/W	R/W	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
JC, JY[1], JK	EEFMT5 (encrypted E08)	R/W	Reformat	Reformat	Reformat	Not supported	Not supported	Not supported	Not supported	Not supported
	EFMT5 (E08)	R/W	R/W	Reformat	Reformat	Not supported	Not supported	Not supported	Not supported	Not supported
	EEFMT4 (encrypted E07)	R/W	Reformat	R/W	Reformat	Not supported	Not supported	Not supported	Not supported	Not supported
	EFMT4 (E07)	R/W	R/W	R/W	R/W	Not supported	Not supported	Not supported	Not supported	Not supported
JB, JX[1]	EEFMT4 (encrypted E07)	Not supported	Not supported	R/W	Reformat	Reformat	Reformat	Reformat	Reformat	Not supported
	EFMT4 (E07)	Not supported	Not supported	R/W	R/W	Reformat	Reformat	Reformat	Reformat	Not supported
	EEFMT3 (encrypted E06)	Not supported	Not supported	R/W	Reformat	R/W	Reformat	Reformat	Reformat	Not supported
	EFMT3 (E06)	Not supported	Not supported	R/W	R/W	R/W	R/W	Reformat	Reformat	Not supported
	EEFMT2 (encrypted E05)	Not supported	Not supported	Read only	Reformat	R/W	Reformat	R/W	Reformat	Not supported
	EFMT2 (E05)	Not supported	Not supported	Read only	Read only	R/W	R/W	R/W	R/W	Not supported

Table 12. Cartridges that are compatible with 3592 tape drives (continued)

JA, JW[1], JJ, JR[1]	EEFMT3 (encrypted E06)	Not supported	Not supported	Read only	Reformat	R/W	Reformat	Reformat	Reformat	Reformat
	EFMT3 (E06)	Not supported	Not supported	Read only	Read only	R/W	R/W	Reformat	Reformat	Reformat
	EEFMT2 (encrypted E05)	Not supported	Not supported	Read only	Reformat	R/W	Reformat	R/W	Reformat	Reformat
	EFMT2 (E05)	Not supported	Not supported	Read only	Read only	R/W	R/W	R/W	R/W	Reformat
	EFMT1 (J1A)	Not supported	Not supported	Read only	Read only	Read only	Read only	R/W	R/W	R/W

Notes:

1. WORM tapes (JY, JX, JW, JR, and JZ) can be reformatted only if they are initialized and labeled; if data exists on the tape, reformatting is not allowed.

Multipath architecture

The multipath architecture feature of the TS3500 tape library allows Open Systems applications to share the robotics of the library.

The TS3500 tape library features storage area network (SAN)-ready multipath architecture, which allows homogeneous or heterogeneous Open Systems applications to share the library's robotics without middleware or a dedicated server (host) acting as a library manager. The SAN-ready multipath architecture makes sharing possible by letting you partition the library's storage slots and tape drives into *logical libraries*. Servers can then run separate applications for each logical library. This partitioning capability extends the potential centralization of storage that the SAN enables. Partitioning also provides investment protection if your application does not support the mixing of drive generations and media in the same logical library. The multipath architecture is compliant with the following attachment interfaces:

- Small computer system interface (SCSI)
- Fibre channel

The multipath architecture of the TS3500 tape library is designed to provide the capability to share the library robotics. This is accomplished by partitioning the library into as many as 192 logical libraries (up to the number of drives installed), and providing each logical library its own separate and distinct drive(s), storage slots, and control paths. Input/output (I/O) slots are shared on a first come, first serve basis. This type of partitioning is designed to allow heterogeneous applications to share the library robotics independent of each other. Cartridges under library control are not shared between logical libraries, nor are they allowed to be moved between logical libraries. An example of heterogeneous sharing is a Microsoft Windows application using the drive and storage slots of one logical library, while a UNIX application uses the drive and slots of another logical library. Logical libraries can also be used for separating LTO 5 tape dives and cartridges from LTO 6 tape drives and cartridges, or 3592 tape drives and cartridges, for applications that do not support mixing the drives in the same logical library.

Whether partitioned or not, the TS3500 tape library is certified for SAN solutions (such as LAN-free backup).

The multipath architecture also lets you configure additional control paths for any one logical library. A *control path* is a logical path into the library through which a server sends standard SCSI Medium Changer commands to control the logical library. Additional control paths reduce the possibility of failure in one control path causing the entire library to be unavailable. Use of the control path failover feature further reduces that possibility.

Library sharing

The TS3500 tape library can be configured into one or more logical libraries that can be shared by multiple applications.

The default configuration for the TS3500 tape library allows a single application to operate the library through a single control path. Often, however, it is advantageous to be able to share a single library between heterogeneous or homogeneous applications. Some applications (and some servers) do not allow for sharing a library between systems. With the TS3500 tape library , however, you can create configurations that enable the library to process commands from multiple heterogeneous applications (such as an IBM System p® application and a Windows application) and multiple homogeneous applications (for example, the same application run by several System p servers).

Use the library's web interface or operator panel to perform the following actions:

- Configure the library so that it is partitioned into separate logical libraries that independently communicate with separate applications through separate control paths. This configuration (see example **1** in Figure 11 on page 42) requires no special capabilities from the server or application.
- Configure any single logical library (including the entire physical library) so that it is shared by two or more servers that are running the same application. Depending on the capabilities of the server and application, there are several ways to set up this type of configuration. Three typical ways include:
  - Configuring one server (mainframe host) to communicate with the library through a single control path; all other servers send requests to that server through a network (see example **2** in Figure 11 on page 42). This configuration is used by Tivoli® Storage Manager (TSM).
  - Configuring all of the servers to communicate with the library through a single, common control path (see example **3** in Figure 11 on page 42). This configuration is used in high-availability environments such as High-Availability Cluster Multi-Processing (HACMP™) from IBM and Systems Management Server and Clustered Server Environments from Microsoft. Multi-initiator configurations are only supported by certain adapters and independent software vendors (ISVs). Check with your ISV.
  - Configuring a single logical library to communicate with multiple servers through multiple control paths. This configuration (see example **4** in Figure 11 on page 42) requires that you add control paths. It is used by Backup, Recovery, and Media Services.

Your library configuration is not limited to the examples shown in Figure 11 on page 42. Many configurations are possible, and you can design them according to your business needs.

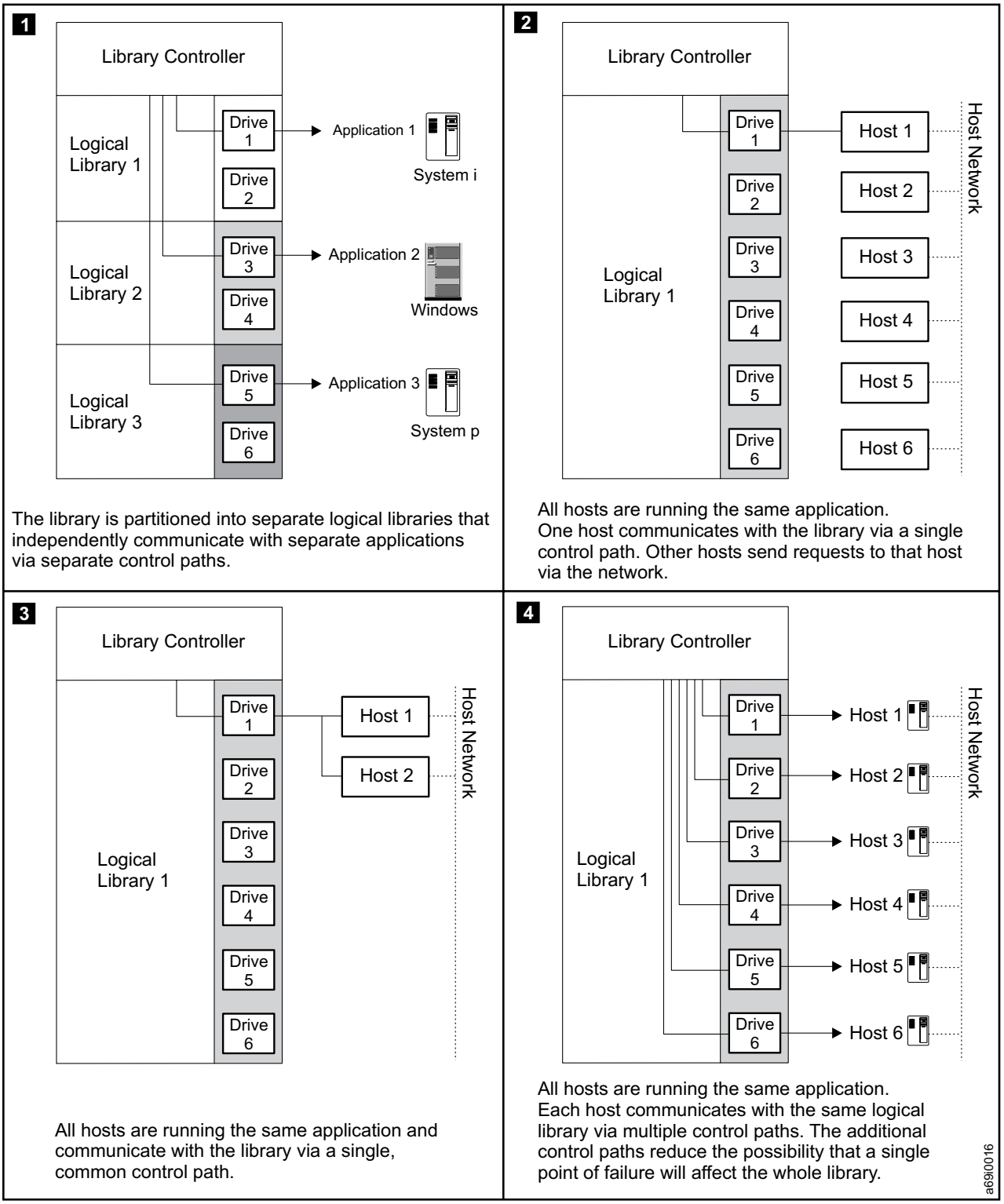


Figure 11. Examples of configurations for sharing an TS3500 tape library. Lines from one or more drives to the library controller represent control paths.

Using multiple logical libraries

The TS3500 tape library supports multiple libraries to share the physical library between applications, or to support mixed drive types for any application.

You can create multiple logical libraries by partitioning the library's tape drives and tape cartridges into two or more logical libraries. Each logical library consists of:

- Tape drives
- Tape cartridges in storage slots
- Tape cartridges in input/output (I/O) slots

Each logical library has its own control path. A control path is a logical path into the library through which a server sends standard SCSI Medium Changer commands to control the logical library. For frames that contain LTO tape drives and frames that contain 3592 tape drives, each logical library control path is available to servers through logical unit number (LUN) 1 of the first drive that is defined within that logical library. A LUN is a number used by a server to identify a drive.

In a TS3500 tape library with ALMS, a logical library can share the tape drives and storage slots of another logical library. The library also shares the I/O slots and the cartridge accessor on a first-come, first-served basis.

A frame that uses LTO tape drives can be partitioned into up to 12 logical libraries. A frame that uses 3592 tape drives can also be partitioned into up to 12 logical libraries.

Note: When naming logical libraries, developing an enterprise-wide library naming convention leads to easier management of the libraries. See the appropriate section in the *IBM TS3500 with ALMS Operator Guide* for more information.

Certain configuration prerequisites exist when using encryption in your library. For an overview of these rules, see "Configuration prerequisites for encryption" on page 225.

To create or change the configurations for your TS3500 tape library, see the *IBM TS3500 with ALMS Operator Guide*

With automatic cleaning, cleaning cartridges are shared between logical libraries, so any appropriate cleaning cartridge is used to clean a drive in any configured logical library.

Share libraries by using multiple logical libraries

Partition a TS3500 tape library into multiple logical libraries to enable simultaneous data backup and restore tasks from different applications.

You can partition the library so that it processes:

- Commands from Application 1 (about Department A) in Logical Library 1
- Commands from Application 2 (about Department B) in Logical Library 2
- Commands from Application 3 (about Department C) in Logical Library 3

In this configuration, the tape drives and cartridges of each logical library are dedicated to that library and are not shared among other libraries. Commands that are issued by the applications travel to the library through three unique control paths. So, the data processing for Department A is confined to the tape drives and

cartridges of Logical Library 1. Processing for Department B is confined to the tape drives and cartridges of Logical Library 2, and so forth.

Multiple logical libraries for mixed drive types

For applications that do not support mixed drive types and media within the same logical library, the TS3500 tape library can partition the applications.

The TS3500 tape library places the applications into multiple logical libraries to keep them separate.

For example, you can partition the following tape drives and their media into multiple and separate logical libraries:

- LTO 5
- LTO 4
- LTO 3
- LTO 2
- LTO 1

Multiple control paths

You can configure any TS3500 tape library logical library to have multiple control paths.

With the TS3500 tape library, in addition to creating multiple logical libraries, you can configure any logical library to have more than one control path. When you configure more control paths, more library-sharing configurations and options are possible. Access to the logical library is on a first-come, first-served basis. Each control path for a logical library can accept commands while the library is in use by another control path.

Note: Microsoft Windows 2000 Removable Storage Manager (RSM) does not support multiple control paths within a logical library. To use this feature, disable RSM.

To add or remove more control paths, see the *IBM TS3500 with ALMS Operator Guide*.

Multiple control paths for IBM i attachment

The use of control paths for IBM Power Systems™ running IBM i and the System i®, iSeries®, and AS/400® servers is unique. In general, every IBM i, System i, and iSeries input/output processor (IOP)-based adapter must "see" the control path that is associated with the drives to which it is connected.

The following list presents possible scenarios for IOP adapters recognizing the control paths with which they are associated.

- For a high voltage differential (HVD) small computer system interface (SCSI) LTO 1 tape drive, IBM supports single drive configurations so that every HVD LTO 1 tape drive must have a control path when connected to the System i or iSeries server.
- For HVD and low voltage differential (LVD) SCSI LTO 2 tape drives, the System i or iSeries server supports multiple drives that are connected per the IOP-based adapter. One of the drives must have a control path.
- For the Fibre Channel-attached drives, OS/400® V5R1 supports only one drive per IOP-based adapter and every drive requires a control path.

- For an OS/400 V5R2 and later Fibre Channel connection, the IOP-based adapter supports multiple drives per adapter, so that only one control path for the group of drives is required.
- For V6R1 and Power 6 hardware using the IOP-less (Smart IOA), the adapter has two Fibre Channel ports and supports multiple devices per port. At least one control path is required per IOA and per set of drives within a library partition.
- For V7R1 and Power 6 or Power 7 hardware using the IOP-less (Smart IOA), the adapter has two Fibre Channel ports and supports multiple devices per port. At least one control path is required per IOA port and per set of drives within a library partition.

Multiple control paths for control path failover

The TS3500 tape library offers an optional control path failover feature.

The control path failover feature (feature code 1682) enables the host device driver to resend a command to a different control path for the same logical library.

Advanced Library Management System

The Advanced Library Management System (ALMS) virtualizes the locations of cartridges in the TS3500 tape library.

ALMS is an extension of IBM's patented Multi-Path Architecture. With ALMS, the TS3500 tape library is the industry's first standards-based tape library to virtualize the locations of cartridges (called SCSI element addresses) while maintaining native SAN attachment for the tape drives. ALMS enables logical libraries to consist of unique drives and ranges of volume serial (VOLSER) numbers, instead of fixed locations.

When you enable ALMS with its license key, you can assign tape drives to any logical library by using the Tape Library Specialist web interface. Logical libraries can also be added, deleted, or easily changed without disruption. Storage capacity can be changed without impact to host applications.

ALMS offers dynamic management of cartridges, cartridge storage slots, tape drives, and logical libraries. It enables the TS3500 tape library to achieve unprecedented levels of integration for functionality through dynamic partitioning, storage slot pooling, and flexible drive assignment. ALMS eliminates downtime when you add Capacity On Demand (CoD) or High Density Capacity on Demand (HD CoD) storage, add or remove logical libraries, or change logical library storage allocation. ALMS also reduces downtime when you add expansion frames, add or remove tape drives, or change logical drive allocation.

ALMS provides the following capabilities:

- Dynamic partitioning (storage slot pooling and flexible drive assignment)
- The transparent ability to add or remove storage capacity to any host application
- The ability to configure drives or to configure Model L22, L23, L32, L52, or L53 storage capacity without taking the library offline
- Virtual I/O slots to automatically manage the movement of cartridges between I/O slots and storage slots

If you purchase an entry-capacity or intermediate-capacity library, you can purchase the new Entry ALMS or Intermediate ALMS at a price lower than the Full ALMS. For more information, contact your IBM marketing representative.

The sections that follow describe the capabilities of ALMS.

Dynamic partitioning

The following topics explain dynamic partitioning. Dynamic partitioning in the TS3500 tape library is comprised of storage slot pooling and flexible drive assignment.

Storage slot pooling

Storage slots are a shared resource in the TS3500 tape library.

When enabled in the TS3500 tape library, the Advanced Library Management System (ALMS) allows logical libraries to be added or deleted without disrupting operation. All storage slots are pooled (available on a first-come, first-served basis) to each logical library based on cartridge insert operations. They are a shared resource such that changes to the capacity allocation for each logical library can occur without downtime or administrator involvement. The minimum logical library simply has a name and can be thought of as a file folder that has no contents. Drives are assigned to the logical library from the Drive Assignment screen of the Tape Library Specialist web interface. Cartridges are assigned to the logical library based on their volume serial (VOLSER) numbers and by using one of the following methods, which are listed in priority order:

- Migration of static partitioning to dynamic partitioning (requires web enablement of ALMS)
- Cartridge assignment policy (automatic at the time of insertion)
- Software application move from the I/O station (based on the source application that issued the command)
- Manual assignment by an operator by using the Tape Library Specialist web interface

For information about migrating to dynamic partitioning and manually assigning cartridges to a logical library, refer to the *IBM TS3500 with ALMS Operator Guide*.

The primary and backup copies of VOLSER assignment and physical location of cartridges are stored in nonvolatile random access memory (NVRAM).

Flexible drive assignment

After you enable the Advanced Library Management System (ALMS) in the TS3500 tape library, you can assign drives to a logical library by using the Drive Assignment screen of the Tape Library Specialist Web interface. You can assign a drive to be shared by multiple logical libraries (for example, a drive used for a once-a-month job or as a temporary replacement for a failed drive). Thus, each logical library can consist of dedicated drives and shared drives. Each logical library maps a drive element address to the locations of both dedicated and shared drives. This allows multiple applications to be pre-configured to quickly use a shared drive in the future. After you pre-configure the applications for future drive usage, you must take each shared drive offline at all but one of the applications that have access to it. Otherwise, an application may attempt to use a drive that is in use by another application. This may cause failed backup jobs. Also, most applications consider the symptoms of a drive already in use to be an error that is reported as such.

The Drive Assignment Web screen supports the following capabilities which are not disruptive to other logical libraries:

- Assign the drive
- Remove the drive assignment
- Reassign the drive

When a cartridge is mounted in a shared drive, the library only accepts a demount command that is requested by the source logical library. Any demount command that is requested by another logical library is rejected.

Transparent addition or removal of storage capacity

The addition or removal of logical library capacity in the TS3500 tape library is transparent to any host application.

With the Advanced Library Management System (ALMS) enabled, you can change the total logical library capacity (quantity of accessible storage slots). The change is transparent to each host application because the value in the `Maximum Number of Cartridges` field on the Tape Library Specialist web interface is not impacted by changes to the quantity of storage slots. The additional storage slots are simply new candidates for cartridges to be moved to upon insertion.

To change the cartridge capacity of a logical library, refer to the *IBM TS3500 with ALMS Operator Guide* and see the section about changing the maximum allowable quantity of cartridges in a logical library.

Configuration of storage capacity without disruption

Capacity expansion features can be enabled to increase storage capacity without disrupting library operations.

With the Advanced Library Management System (ALMS), no downtime is required when you enable Intermediate Capacity On Demand or Full Capacity On Demand for Models L22, L23, L52, and L53 or High Density Capacity on Demand for Models S24 and S54 of the TS3500 tape library.

Virtual I/O slots

With the Advanced Library Management System (ALMS), virtual I/O slots enhance the import and export capabilities of the library.

When ALMS is enabled in a TS3500 tape library, virtual I/O slots are enabled by default so that the library automatically queues all cartridge moves between the I/O station and the storage slots. This capability makes the process of adding and removing cartridges easier and faster.

The TS3500 tape library has I/O stations with I/O slots that allow you to import and export up to 224 cartridges at any time. The I/O slots are also known as import/export elements (IEEs). Virtual I/O slots increase the quantity of available I/O slots by allowing storage slots to appear to the host as I/O slots. These storage slots are also called virtual import/export elements (VIEEs). With virtual I/O slots, the library automatically moves cartridges from the I/O stations to the storage slots, enhancing import and export performance, while also decoupling physical cartridge movement from the application thus increasing operator efficiency.

The goal of virtual I/O slots is to reduce the dependencies between the system administrator and library operator so that each performs their import and export tasks without needing the other to perform any actions.

- In a typical import scenario without virtual I/O slots, a library operator is needed to stand at the physical library and fill the I/O station with cartridges; a system administrator is needed to cause the applications to send commands for moving cartridges out of the I/O station and into library storage slots. After operators fill the I/O station with cartridges, the they must wait for the I/O station to be cleared before they are able to insert more cartridges, which means they must wait on the system administrator to clear the I/O station of each set of inserted cartridges. If the library is enabled with virtual I/O slots, the operator can continuously insert cartridges into the I/O station and the administrator does not need to issue commands to move each new set of inserted cartridges. Instead, the library automatically moves the cartridges and places them into virtual I/O slots until they are ready to be processed later as one composite set of inserted cartridges.
- In a typical export scenario without virtual I/O slots, the system administrator might need to export many cartridges from the library. However, after the I/O station is filled, the administrator must wait for the operator to physically remove cartridges from the entire I/O station before the administrator can issue another export command. This operation can be inconvenient. If the library is enabled with virtual I/O slots, the administrator does not have to wait to issue all export commands (up to 255 export commands can be issued at the same time for each logical library) and the operator can remove cartridges from the I/O stations as soon as the accessor automatically moves them from the storage slots.

With virtual I/O slots enabled, the library has various mechanisms for selecting the best storage slot location for each inserted cartridge, as well as the best accessor and I/O station for each ejected cartridge. These mechanisms vary depending on the configuration of your library.

For ejects with virtual I/O slots enabled and I/O stations in both preferred zones of a dual accessor library, the library selects the accessor and I/O stations that are in the same preferred zone as the physical slot of the cartridge to be ejected, but maintains first in, first out (FIFO) order for each zone. For ejects with virtual I/O slots enabled and I/O stations in only one zone of a dual accessor library, the library selects the accessor in that preferred zone and maintains FIFO order.

For more information, see “Cartridge assignment policy” and “Insert notification setting” on page 50.

For detailed information about import and export performance in libraries with virtual I/O slots enabled, refer to “Import and export performance with virtual I/O slots” on page 90.

Cartridge assignment policy

This section describes the cartridge assignment policy for assigning cartridges to specific logical libraries.

You identify a cartridge by affixing a label to it that bears a volume serial (VOLSER) number. The cartridge assignment policy allows you to specify one or more *ranges* of VOLSERs for logical libraries. For example, you can create a cartridge assignment policy of 36 cartridge VOLSERs that range from 000764 to

000800 for a specific logical library. Note that VOLSERs in ranges do not include the media-type indicator, such as L2, L3, JA, and so forth.

When you insert a cartridge into the library and its VOLSER is within a range, the cartridge assignment policy assigns the cartridge to its logical library. The cartridge must be of the same media type as that logical library. For example, if you create for Logical Library 1 (a library of Ultrium drives) a cartridge assignment policy of VOLSERs that range from ABC000 to ABC999 then you insert a cartridge with VOLSER ABC123, the library recognizes that VOLSER as belonging to the range and assigns it to Logical Library 1, provided that the cartridge is an Ultrium tape cartridge (and not a different media type, such as a 3592 tape cartridge).

When an unassigned cartridge is present in the I/O station, the library reads its VOLSER label and automatically assigns it to the logical library that is specified in the range of VOLSERs which was previously selected by the system administrator when creating a cartridge assignment policy. Similarly, when ALMS is enabled, if you open and close the library's front door the library automatically performs an inventory. If the library detects a newly inserted, unassigned cartridge, it assigns the cartridge to the logical library of the VOLSER range that was previously selected by the system administrator when creating a cartridge assignment policy.

A cartridge assignment policy can also be created for **All Other VOLSERs**. This represents all VOLSERs not covered by specific ranges in the cartridge assignment policy. If you do not want these cartridges to be assigned to an active logical library, then you can create a new drive-less logical library and have the **All Other VOLSERs** automatically assigned to that logical library. In this way, the drive-less logical library becomes a safe media vault. Note that a drive-less logical library consumes no additional resources in a TS3500 tape library with ALMS. Subsequently, these **All Other VOLSERs** can be manually assigned to a different logical library using the Tape Library Specialist Web interface or the TS3500 tape library Command Line Interface (CLI).

If there is no cartridge assignment policy assigned for **All Other VOLSERs**, unassigned cartridges can be assigned by one of the following methods:

- If the unassigned cartridge is in the I/O station and the Insert Notification setting is disabled, the cartridge is automatically assigned on a first-come, first-served basis
- If the unassigned cartridge is in the I/O station and the Insert Notification setting is enabled, you can assign the cartridge to a logical library by using the Settings and Insert Notification selections from the library's operator panel
- Use the cartridge assignment policy to create a new VOLSER range and then perform an inventory
- Use the Tape Library Specialist Web interface
- Use the TS3500 Tape Library CLI

Within a physical library, the maximum quantity of ranges that can be created by the cartridge policy assignment is 300.

For more information, see “Insert notification setting” on page 50 and “TS3500 Tape Library Command Line Interface” on page 57. For information about creating a new VOLSER range, performing an inventory, or assigning cartridges to a logical library, see the appropriate sections in the *IBM TS3500 with ALMS Operator Guide*.

Insert notification setting

This section describes insert notification. This is an optional setting that enables the TS3500 tape library to monitor the I/O station for new media that does not have a logical library assignment.

Note: Insert notification is no longer recommended and is not supported in any library that includes an HD frame. In HD libraries, insert notification is automatically disabled. When Insert Notification is disabled, TS7700 and 3953 L05 library manager customers should assign **All Other Volsers** to a specific logical library. Refer to "Cartridge assignment policy" on page 48 for more information.

An insert notification event can be caused if you open the I/O station door and perform one of the following actions:

- Place a cartridge into an empty I/O slot
- Move a cartridge from one I/O slot to another

If you enable the insert notification setting, when new media is detected in the I/O station the operator panel displays a message that asks you to select a logical library. Any unassigned cartridges in the I/O station are then assigned to the logical library that you select (and all other logical libraries will not be able to access the cartridges). If you do not select a logical library within 60 seconds or if you select the BACK button, the library makes the cartridges unassigned and the operator panel returns to the Activity Screen. You can later assign the unassigned cartridges by using the IBM Tape Library Specialist Web interface or the TS3500 Tape Library Command Line Interface.

For more information, see the sections about enabling or disabling the insert notification setting and assigning cartridges to a logical library in the *IBM TS3500 with ALMS Operator Guide*.

Power structure of the TS3500 tape library

This section introduces the two power structures that are offered by the TS3500 tape library.

Depending on the frames that you have, the library offers two power structures:

- For Models L22, D22, L32, D32, L52, and D52, the library offers the *frame control assembly* power structure, with the option of ordering dual AC power cords for redundancy.
- For Models L23, D23, L53, and D53, the library offers the *enhanced frame control assembly* power structure, which combines drive power, library power, and standard dual AC power cord capabilities.

The two power structures are compatible among frames in the same library. The enhanced frame control assembly is compatible with the following model conversions, which must be performed by an IBM Service Representative:

- Model L22 to L23
- Model D22 to D23
- Model L52 to L53
- Model D52 to D53
- Model L23 to L53
- Model D23 to D53
- Model L53 to L23

- Model D53 to D23

Frame control assembly and dual ac power

This section describes the frame control assembly (FCA) power structure and the optional dual ac power feature of the TS3500 tape library. This power structure and feature apply to Models L22, D22, L32, D32, L52, and D52.

The frame control assembly power structure is designed so that each Ultrium tape drive and 3592 tape drive is paired with an associated power supply. Adjacent power supplies are cabled together such that redundant power becomes a standard function. Each pairing is packaged side by side on a shelf in a frame. Drives are housed in removable canisters and power supplies are housed in fixed trays. The design enables a drive with a failed power supply to continue operating by using power from the adjacent power supply.

The library's optional dual ac power feature further enhances library availability by making another power source available in case of planned or unplanned power grid outages. The feature provides a power switch that connects to two independent ac power cords which connect to two independent branch power feeds. The power cords support 110 V ac or 220 V ac. The switch monitors the ac line voltage from the feed it uses and automatically connects to the alternate power feed if the incoming voltage is lost. Dual ac power is available when you order feature code 1901.

Enhanced frame control assembly

The enhanced frame control assembly is a power structure that combines drive power, library power, and dual ac line cord capabilities. The assembly includes only two power supplies, dual ac line cords, and a Medium Changer Assembly (MCA) unit.

The enhanced frame control assembly comes standard with Models L23 and L53, and can be ordered as a feature code for Models D23 and D53. For two or more frames that are properly configured, the assembly is constructed such that failure or repair of a single, particular part does not cause the entire system to fail or require scheduled downtime for maintenance. For example, the replacement of any single, failed power supply can be accomplished without affecting the operation of the library. The two redundant power supplies are fed directly by independent, dual ac line cords that support only 220 V ac (110 V ac is not supported). The dual ac line cords come standard on Models L23, D23, L53, and D53, and do not need to be ordered as an additional feature code.

If dual ac line cords are not desired, both power supplies can be fed by a single customer outlet by using feature code 1909 (Single Power Source Bifurcated Cable), however, feature code 1909 cannot be used if feature code 1950 (Power Distribution Unit) is installed in the same frame.

The enhanced frame control assembly is compatible with the following model conversions, which must be performed by an IBM Service Representative:

- Model L22 to L23
- Model D22 to D23
- Model L52 to L53
- Model D52 to D53
- Model L23 to L53

- Model D23 to D53
- Model L53 to L23
- Model D53 to D23

Models L23 and D23 equipped with feature code 4871 (TS7700 Backend Switches mounting hardware) must also have feature code 1950 (Power Distribution Unit), which enables dual ac power distribution to the Fibre Channel switches as well as to the enhanced frame control assembly.

Control path failover, data path failover, and load balancing

This section discusses measures that the TS3500 tape library uses to control library and data path failure, and to balance workload.

Command failures and time-outs are costly. You want your library to run smoothly and efficiently. To ensure continued processing, libraries that are equipped with Fibre Channel LTO and 3592 tape drives offer path failover and load balancing capabilities that enable the IBM device driver to resend a command to an alternate path. The alternate path can include another host bus adapter (HBA), Storage Area Network (SAN), or library control path drive. The device driver initiates error recovery and continues the operation on the alternate path without interrupting the application. Path failover and load balancing are built-in features that are enabled by using a purchased license key.

Two types of path failover capabilities exist: *control path failover (CPF)* and *data path failover (DPF)*. *Control* refers to the command set that controls the library (the SCSI Medium Changer command set on LUN 1 of the tape drives). *Data* refers to the command set that carries the customer data to and from the tape drives (the SCSI-3 Stream Commands (SSC) device on LUN 0 of the tape drives). Path failover means the same thing in both: that is, where there is redundancy in the path from the application to the intended target (the library accessor or the drive mechanism, respectively), the device driver transparently fails over to another path in response to a break in the active path.

Both types of failover include host-side failover when configured with multiple HBA ports into a switch, but CPF includes target-side failover through the control paths that are enabled on more than one tape drive. DPF includes target-side failover for the dual-ported tape drives that are supported by the TS3500 tape library.

DPF includes load balancing of the HBAs because the channel is a data-intensive path (the control path carries very little data, so load balancing is not an issue). The dynamic load balancing support optimizes resources for devices that have physical connections to multiple HBAs in the same machine. When an application opens a device that has multiple HBA paths configured, the device driver determines which path has the HBA with the lowest usage and assigns that path to the application. When another application opens a different device with multiple HBA paths, the device driver again determines the path with the lowest HBA usage and assigns that path to the second application. The device driver updates the usage on the HBA assigned to the application when the device is closed. Dynamic load balancing uses all HBAs whenever possible and balances the load between them to optimize the resources in the machine.

Both CPF and DPF require the use of the IBM device driver, and are supported exclusively with products that bear the IBM logo on the operating systems indicated in Table 13.

Table 13 summarizes the differences between CPF, DPF, and load balancing.

Table 13. Differences between CPF and DPF

Characteristic	CPF	DPF and Load Balancing for Ultrium 2 and later tape drives	DPF and Load Balancing for 3592 tape drives
Device type	SMC[1]	SSC[2]	SSC
LUN[3]	LUN 1	LUN 0	LUN 0
Host-side failover	Yes	Yes	Yes
Target-side failover	Yes	Yes[6]	Yes
IBM device driver required	Yes	Yes	Yes
Operating systems supported	AIX®, SuSE Linux, Red Hat Enterprise Linux, Solaris, Windows, HP-UX, Asian UX	AIX, SuSE Linux, Red Hat Enterprise Linux, Solaris, Windows[4](DPF only), Asian UX	AIX, SuSE Linux, Red Hat Enterprise Linux, Solaris, Windows[4] (DPF only), HP-UX, Asian UX
Order feature to obtain license key	Yes	Yes[5, 7]	No
SCSI attachment supported	Yes	No	No
Fibre Channel attachment supported	Yes	Yes	Yes

Notes:

1. SMC = SCSI-3 Medium Changer Specification (library)
2. SSC = SCSI-3 Stream Commands (drive)
3. LUN = logical unit number
4. Load balancing is not supported on Windows
5. LTO 4 and later tape drives do not require license keys at the host when configuring Data Path Failover.
6. DPF includes target-side failover for dual-ported LTO 5 and later tape drives.
7. For LTO 2 tape drives, DPF and load balancing do not require a license key on AIX.

The path failover features can be ordered from the factory, or you can order them as field upgradesit as a field upgrade. To order features, contact your IBM Sales Representative.

Note: The control path failover feature for LTO tape drives is activated by a license key that you enter at the library operator panel. The data path failover feature for LTO 1, LTO 2, and LTO 3 tape drives is activated by a license key that you enter at the host. For LTO 4 and later tape drives, license keys do not need to be entered at the host when configuring Data Path Failover.

For more information about using these features, see the *IBM Tape Device Drivers Installation and User's Guide* (GA32-0565).

Expanded I/O capacity

This section describes the extra input/output (I/O) stations that you can order for the TS3500 tape library.

To insert cartridges into and remove them from the TS3500 tape library (without requiring a reinventory), the library comes with an I/O station located on the front door of the base frame models. You can optionally order an additional I/O station for installation on base frame models.

A base frame cannot combine both the 3592 tape drive and Ultrium tape drive. However, in a library that mixes frame types, you may insert 3592 tape cartridges into the lower I/O station of a Model L53, L52, or L32 frame for transport (by the cartridge accessor) to a Model D23 or D22 frame (your library must contain an I/O station that will accept 3592 tape cartridges). Similarly, you may insert LTO Ultrium tape cartridges into the lower I/O station of a Model L23 or L22 frame for transport (by the cartridge accessor) to a Model D53, D52, or D32 frame (again, your library must contain an I/O station that will accept Ultrium tape cartridges).

The TS3500 tape library also supports an option for 64 additional I/O slots in a newly purchased Model D23 or D53 frame. A D-frame with I/O installed includes four independently accessible I/O stations. The D-frame I/O stations increase the maximum I/O slot capacity from 32 to 224. There is a maximum of three D23 or D53 I/O frames in a library. The D-frame I/O stations can double the maximum insert/eject throughput in libraries with a dual accessor. These D23 and D53 Models are compatible with existing Models L22, L32, L52, D22, and D32.

Note: The 64 additional I/O slots features (feature codes 1655 and 1656) are not supported on libraries with mixed media. In order to use this feature, the library must use all Ultrium media or all 3952 media, not a mixture of both.

Table 14 shows how I/O stations can be mixed among frames.

Table 14. Mixing I/O stations among frames of the TS3500 tape library

Type of Frame	Number of Slots in Upper I/O Stations	Number of Slots in Lower I/O Stations
L22 and L23	16 (3592)	16 (Ultrium or 3592)
L32	10 (Ultrium)	20 (Ultrium) or 16 (3592) [1]
L52 and L53	16 (Ultrium)	16 (Ultrium or 3592)
D23 (with 64 additional I/O slots)[2, 4]	32 (3592)[3]	32 (3592)[3]
D53 (with 64 additional I/O slots)[2, 4]	32 (Ultrium)[3]	32 (Ultrium)[3]

Notes:

1. The 3592 I/O station for Model L32 is included with feature code 1608.
2. For the 64 additional I/O slots option, feature code 1451 must be installed as a prerequisite, then either feature code 1655 for LTO Ultrium media, or feature code 1656 for 3592 media. When expanding an installed library, feature codes 1655 and 1656 assume the D-frame is installed at the end of the library string ("end of the library string" refers to the very last frame in a single accessor library or the last frame before SBB in HA libraries). If the customer prefers the D-frame to be installed elsewhere in the string, the Service Representative must obtain a "Services Contract" to uninstall additional frames as necessary to accommodate the customer's request.
3. Mixed media is not allowed in libraries with D-frame I/O slots. All cartridges must be either LTO Ultrium or 3592.
4. A maximum of three D-frames with I/O slots can be installed per library.

For additional information, also refer to “Virtual I/O slots” on page 47.

Increasing capacity

This section introduces information about capacity configurations for frames of the TS3500 tape library.

Depending on whether you have the Capacity Expansion feature, Capacity On Demand feature, or High Density Capacity on Demand feature installed in your library, different capacity configurations exist for the frames.

The sections that follow describe each feature.

Capacity expansion feature for Model L32

The Capacity Expansion feature (feature code 1603) is a license key that lets you enable the storage slots inside the front door of Model L32 of the TS3500 tape library. With the Capacity Expansion feature installed, the library offers 140 additional slots for Ultrium tape cartridges in the Model L32 if the second I/O station is not present and 88 additional slots if the second I/O station is present. The Capacity Expansion feature is required when you add one or more expansion frames to the base frame.

When you purchase your library, you may specify that the Capacity Expansion feature be installed at the factory, or you may order the feature later and have your IBM Service Representative install it. To order the Capacity Expansion feature, contact your IBM Sales Representative.

To determine the quantity of LTO Ultrium tape cartridges and 3592 tape cartridges that the library supports, see Chapter 7, “Frame capacity,” on page 217.

Intermediate, Full, and Capacity On Demand features for Models L22, L23, L52, and L53

In the TS3500 tape library, the initial (entry) capacity of a Model L22 or Model L23 frame is enabled to use 58 cartridge slots for 3592 tape cartridges. If you add the Intermediate Capacity or Full Capacity features, you can enable additional storage elements in the Model L22 or Model L23 to increase the available capacity to 117 cartridge slots, or from 199 to 260 cartridge slots (depending on the features that you order).

The initial capacity of a Model L52 or Model L53 frame is enabled to use 64 cartridge slots for LTO Ultrium tape cartridges. If you add the Intermediate Capacity or Full Capacity features, you can enable additional storage elements in the Model L52 or Model L53 to increase the available capacity to 129 cartridge slots, or from 219 to 287 cartridge slots (depending on the features that you order).

The Intermediate Capacity feature is available through an IBM plant site as feature code 1641 and through the field as feature code 1643.

The Full Capacity feature is available through an IBM plant site as feature code 1642 and through the field as feature code 1644. This feature is required to add a 16-slot I/O station. The Intermediate Capacity feature is a prerequisite to the Full Capacity feature. The Full Capacity feature is required when you add one or more expansion frames to a base frame.

Capacity features that are available through the field are known as Capacity On Demand.

To determine the quantity of LTO Ultrium tape cartridges and 3592 tape cartridges that the library supports, see Chapter 7, “Frame capacity,” on page 217.

High Density Capacity On Demand

This section describes the High Density Capacity on Demand features for the TS3500 tape library.

The HD Capacity on Demand feature codes provides a license key that let you enable additional storage slots in HD frames.

In the TS3500 tape library, the physical capacity, or total storage slots, is comprised of licensed and unlicensed capacity. When the number of assigned cartridges within a library reaches the licensed capacity, additional inserted cartridges are not assignable to a logical library until one of the following actions occurs:

- A cartridge is removed
- A CoD feature is purchased
- Additional slots or frames are added to the library

The capacity utilization of the library can be monitored through the Tape Library Web specialist.

The initial (base) capacity for Model S24 is 600 slots and for Model S54 is 660 slots. Additional capacity for Models S24 and S54 can be purchased with the High Density Capacity on Demand (HD CoD) features that provide a license key to non-disruptively increase the licensed capacity. Unlike other Capacity on Demand features, the HD CoD feature allows the additional licensed capacity to be used in any HD frame in the library string.

Feature code 1645 adds 400 slots of capacity to Model S24. Feature code 1646 adds 660 slots of capacity to Model S54.

To determine the quantity of LTO Ultrium tape cartridges and 3592 tape cartridges that the library supports, see Chapter 7, “Frame capacity,” on page 217.

Web interface

This section gives basic information about the IBM Tape Library Specialist, the Web interface for the TS3500 tape library.

The Tape Library Specialist Web interface enables operators and administrators of the TS3500 tape library to manage storage devices from any location in an enterprise. The Tape Library Specialist allows you to communicate directly with your library and perform a full range of user, operator, and administrator tasks without being at the operator panel. The Web interface is included with Models L22, L23, L52, and L53, and is available as feature code 1662 for Model L32.

The Tape Library Specialist requires a Category 5 Ethernet cable (not supplied with the tape library). It may be installed by you or your IBM Service Representative.

You can use the Tape Library Specialist Web interface to download the following flat files, which contain information for analyzing the library, drives, Fibre Channel ports, and the health of the cartridges. Information is available from Ultrium 2 and newer Ultrium tape drives and from all 3592 tape drives.

- Library Statistics.csv - contains information about the maximum cartridge residency, mount, and eject times, average cartridge residency, mount, and eject

times, and total cartridge inserts, mounts and ejects. The information is provided for each hour of a 24-hour period and for each logical library. **Note:** To obtain this log, your library must include Model L23 or L53.

- Drive Statistics.csv - contains information about each drive's last mount; only installed drives are shown in the drive statistics log.
- Port Statistics.csv - contains Fibre Channel port information about the last mount; only installed drives with Fibre Channel ports are shown in the port statistics log.
- Mount History.csv - includes statistics about the last 100 cartridges that were demounted in the library and information about the 3592 E05 (at firmware level 16E4 or later), Ultrium 4, and newer tape drives that is derived from the customer-centric Statistical Analysis and Reporting System (ccSARS).

The TS3500 tape library downloads the files in comma-separated value (.csv) format. You can use the data to identify storage area network (SAN), drive, or media performance trends. The .csv file format can easily be imported into most spreadsheet and database programs.

For more information about using the Tape Library Specialist Web interface, see the section about operating the library from the Web in the *IBM TS3500 with ALMS Operator Guide*.

TS3500 Tape Library Command Line Interface

The TS3500 Tape Library Command Line Interface (CLI) program provides the ability to access TS3500 tape library functions through a CLI.

In order to use the TS3500 Tape Library CLI, the following prerequisites apply:

- The TS3500 tape library must be at firmware level 8xxx (or higher).
- The Advanced Library Management System (ALMS) must be installed and enabled.
- Secure Socket Layer (SSL) for the Web must be disabled.

The TS3500 Tape Library CLI, along with additional information including supported actions and command parameters, can be found here: http://www-01.ibm.com/support/docview.wss?uid=ssg1S4000854.

IBM Tape System Reporter

The IBM Tape System Reporter application is a Java-based monitoring server with an optional Windows-based graphical user interface (GUI) that allows you to monitor and gather data for multiple libraries. You can generate general and specific data reports for the multiple tape cartridges, tape drives, and frames that you are monitoring.

The IBM Tape System Reporter application enables operators and administrators of the TS3500 tape library to monitor and report on storage devices from any location in an enterprise environment. This application communicates directly with the library to collect and store pertinent data enabling you to generate and view performance trends. The IBM Tape System Reporter application is bundled with your Advanced Library Management System (ALMS) purchase.

Data is available from 3592 tape drives (models J1A, E05, E06, EU6, E07, and E08) and from LTO 2 and newer LTO tape drives.

The ccSARS data is available from 3592 E05, LTO 4, and newer tape drives.

Notes:

1. Data is not collected for the LTO Ultrium 1 tape drive.
2. Use of the IBM Tape System Reporter application requires that you establish database connectivity through firewalls and to any tape libraries that it is monitoring.

The IBM Tape System Reporter application operates by collecting information from the TS3500 tape library, aggregating the data in a database, and providing you the ability to generate a report. You can generate a General SQL Query or custom report on the utilization and performance of tape cartridges, tape drives, and the tape library. The application can be installed by you or by IBM Lab Services. Figure 12 illustrates how the Tape System Reporter application collects information from the tape libraries, aggregates the data in a database, and provides you with the opportunity to generate a general query or custom report.

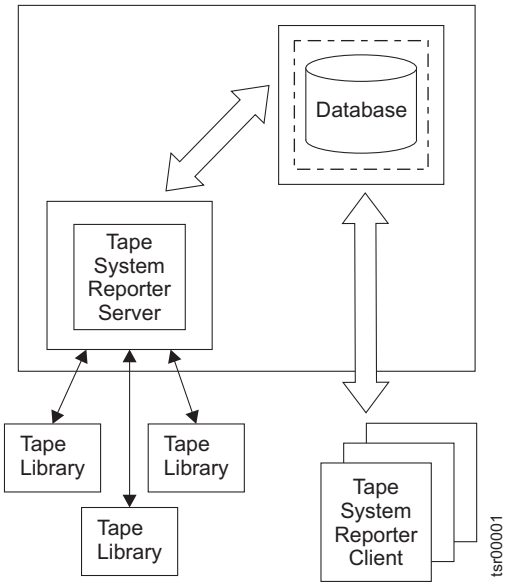


Figure 12. Tape System Reporter data flow

Note: It is suggested that you install the Tape System Reporter application on a dedicated server machine that is separate from your client machine or machines. This is particularly effective when workload balancing is a consideration.

For more information about the prerequisites for using the IBM Tape System Reporter, installing and setting up the application, working with the Apache Derby, DB2®, or Oracle databases, and generating reports, refer to the *IBM Tape System Reporter User's Guide* (GA32-0589). You can also find information about the IBM Tape System Reporter on the web at http://www-01.ibm.com/support/docview.wss?uid=ssg1S4000680.

Remote support

Remote support for the TS3500 tape library involves the use of a Call Home feature to detect and solve problems. Also, remote support requires several important security functions.

Optional remote support is available for the TS3500 tape library through its Call Home capability. The Call Home feature uses a modem connection or system console to report failures that are detected by the library or a tape drive. Whenever a failure is detected, Call Home sends detailed error information to IBM (home). The IBM service representative can then prepare an action plan to handle the problem before traveling to the library. The library might also periodically send support information (such as configuration, library and drive code versions, and error logs) to IBM.

The Call Home feature of the TS3500 tape library has three different, but related, capabilities: Problem Call Home, Heartbeat Call Home, and Test Call Home. The TS3500 tape library sends data files that might be helpful to Support Center personnel for all three types of Call Home. These data files include library error logs and configuration information, such as the Machine Reported Product Data (MRPD) log. The MRPD file contains the following information about the machine (library):

- The number of frames and drives
- The model and serial number of each frame
- The type and serial number of each drive
- The code version of the library and each drive
- Any machine-detectable features such as additional I/O stations, capacity expansion

If a Problem Call Home is initiated, the library also sends the tape library logs and drive logs that are related to the problem.

Problem Call Home
The TS3500 tape library or one of its drives detects a problem and the library initiates a Call Home operation. This Call Home operation creates a Problem Management Record (PMR) in the IBM Remote Technical Assistance Information Network (RETAIN). This is a single page of text data that helps the support center or service representative determine an action plan and a list of parts (called field replaceable units or FRUs).

Heartbeat Call Home
The TS3500 tape library sends the Heartbeat Call Home on a scheduled basis to ensure proper Call Home function. By default, the Heartbeat Call Home is sent once per week, one hour after a power cycle, and one hour after a code update is complete.

Test Call Home
When servicing the library, the service representative can issue a Test Call Home operation to RETAIN from the operator panel of the TS3500 tape library. The library allows the service representative to include drive dumps in the Test Call Home for analysis, rather than collect dumps by using CETool and transmitting them through an IBM messaging system. In this way, a drive dump can be accessed by Support Center personnel through the Call Home database.

Remote support through a modem

This section describes remote support to the TS3500 tape library (or its drives) through a modem.

Hardware requirements for remote support by modem vary, depending on whether you already have one or more IBM tape products that have the remote support capability. Table 15 on page 60 indicates the requirements.

Table 15. Requirements for remote support (the Call Home feature)

Quantity of IBM Tape Products with Remote Support Capability	Requirement
1	Remote Support Facility (modem and cable; feature code #2710)
2	Remote Support Switch (feature code #2711). This feature applies only if you are attaching multiple libraries to one modem. While still valid, this feature can no longer be ordered.
3 or more	Remote Support Attachment (cable; feature code #2712)

Remote support through a system console

Remote support for the TS3500 tape library is available through a system console.

A system console is a service tool that is present in most environments where one or more FICON/ESCON-enabled products, such as the IBM TS7700, are connected to a System z server (mainframe host).

The TS3000 system console (TSSC) provides the same functionality to attach a TS3500 tape library that is connected to an Open Systems server. The TSSC is a personal computer (PC), complete with an Ethernet port. A customer rack-mountable version of the TS3000 system console is available by ordering feature code 2732. Table 16 lists the desktop and rack-mountable system consoles that can be ordered for the library.

Table 16. Desktop and rack mountable TS3000 system consoles.

Feature Code	Supported Models	Customer-Setup Unit (CSU)	Description
2720[1]	L22, L23, L32, L52, L53	No	Desktop TS3000 system console
2724	L22, L23, L52, L53	No	Rack-mount TS3000 system console (This feature provides the enhanced rack-mountable TS3000 system console and an Ethernet cable for connection of one machine to an IBM-supplied modem. This feature replaces feature codes 2730 and 2732.)
2730[2]	L22, L23, L32, L52, L53	No	Customer rack-mountable TS3000 system console (TSSC) (provides a 1U server, keyboard, display, mouse, bifurcated cables, connectors, 115 V ac cables, and Ethernet switch for customer-provided 19-inch rack)
2732[3]	L22, L23, L32, L52, L53	No	Customer rack-mountable TS3000 system console (TSSC) (provides a server, keyboard, display, mouse, and Ethernet switch). This feature replaces FC 2730 and includes the console upgrade previously provided as FC 2719. (Prerequisite for modem call home: FC 2733[4] in approved countries or an external modem that is supported by the TSSC server)

Table 16. Desktop and rack mountable TS3000 system consoles (continued).

Feature Code	Supported Models	Customer-Setup Unit (CSU)	Description
Note: 1. Feature code 2720 withdrawn from marketing on October 31, 2008. 2. Feature code 2730 withdrawn from marketing on January 15, 2010. 3. Feature code 2732 withdrawn from marketing on July 27, 2012. 4. Feature code 2733 provides an internal modem that is installed in the TSSC. Refer to "Feature codes for elements in the library" on page 139 for details and a list of supported countries.			

The rack-mount system console (FC 2724) comes with an Ethernet cable for connection of one machine to an IBM-supplied modem. Feature code 2734 provides one USB modem for use with FC 2724.

The customer rack-mountable TSSC (FC 2732) comes with serial cables and a Keyboard Video Mouse (KVM). Feature code 2733 installs one internal modem in the TSSC. The TSSC is preloaded with software and is tested prior to shipment.

When the TS3500 tape library is in an environment that includes a system console, IBM recommends that the library perform the Electronic Customer Care (ECC) Call Home function through the system console instead of through a direct modem connection. (There is a feature for call home support via modem from the IMC, but the default method is broadband via the ECC).

To perform an ECC Call Home operation through a system console, the TS3500 tape library sends Call Home information across a private Ethernet connection to the system console. The system console then performs the ECC Call Home operation and sends the information to the IBM Remote Technical Assistance Information Network (RETAIN) through the system console's modem or Ethernet (broadband) connection.

For remote support through a system console, the TS3500 tape library needs a minimum of two Ethernet ports: one attached to your network for use by your administrator and one attached to the private system console network for remote support. New frame models L23 and L53 provide two Ethernet ports per frame so no additional features are necessary. Frame models L22, L32, and L52 require an Lx3 model conversion or the enhanced node card feature (FC 1700) in order to support the dual Ethernet port requirement.

The library feature code 9217 provides an Ethernet cable for the remote support connection from the TS3500 tape library to a system console.

Figure 13 on page 62 shows the attachment of a system console to the TS3500 tape library for remote support. (Refer to Table 17 on page 62.)

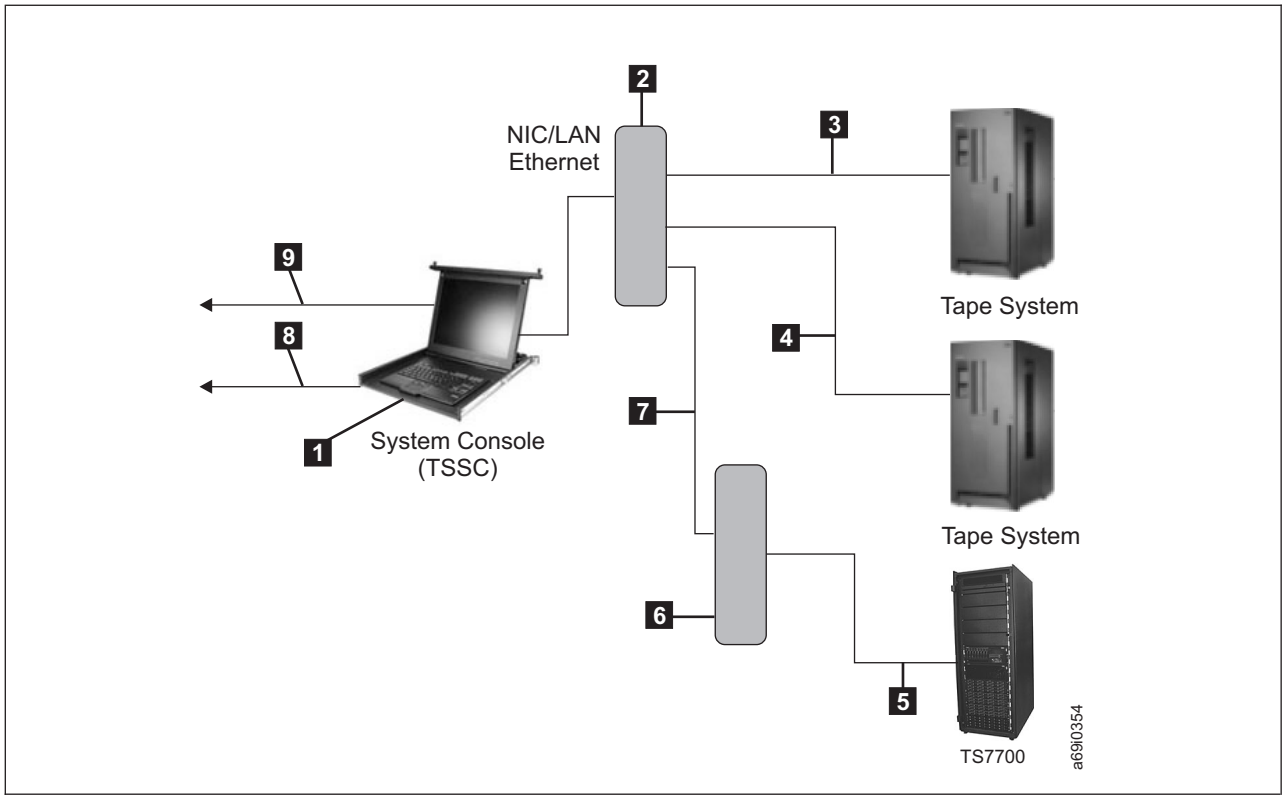


Figure 13. Remote support system console connection diagram

Table 17. System console components.

1 Rackmount system console (FC 2724)	**6** Ethernet switch expansion (FC 2704)
2 Ethernet switch provided with FC 2714	**7** Cable supplied with FC 2714
3 Cable supplied with FC 2724	**8** Customer-supplied phone line
4 Cable supplied with FC 2715	**9** Customer-supplied Ethernet connection
5 Cable supplied with FC 2714	

Table 18 on page 63 presents the capabilities of remote support with a system console.

Note: All of the listed capabilities do not apply to every product type. For example, the TS3500 tape library does not use wellness checking, daily log file storage, or code image broadcast.

Table 18. Remote support capabilities.

Location	Event	Support
Customer site	Call Home events	• Error initiated • Heartbeat (regular interval) • Test
	System console support capability	• Error-initiated problem reporting for up to 43 subsystems • Staged, error-specific data gathering • Subsystem and system console heartbeat reporting • Wellness checking • Log file storage (daily) • Code image and documentation repository (from media and RETAIN Fix Distribution Library)
	System console and remote support service tools	• Code image broadcast • Call home event log review • End-of-call completion report
IBM support	System console remote access	• Authenticated, secure remote access • Simultaneous call in and call home • Data transmission (TCP/IP) supported
	IBM call home database	• 24/7 access by IBM support staff • Error analysis and search capability

Complete information on how to configure the TSSC for ECC Call Home is in the *IBM TS3000 system console Maintenance Information* publication.

Remote support security

The TS3000 system console provides Ethernet connectivity to all attached systems through a private internal network. This section describes the security design for remote support of the network-attached devices.

Up to two modems can be attached to the TSSC. The TSSC provides Point-to-Point Protocol (PPP) connectivity through the modems to the private Ethernet network.

The TSSC also provides optional Ethernet outbound connectivity through the customer's network to the IBM service support system, RETAIN®. All inbound communication over this connection is restricted. The TSSC uses the following protocols to port numbers:

- HTTPS: Port 443
- HTTP: Port 80
- DNS: Port 53

For outbound and bi-directional data to and from RETAIN®, the system console uses the ports (by default) as shown in Table 19 .

Table 19. Default system console ports for outbound and bi-directional data to and from RETAIN®

Port	Type of data	Direction	Protocol
67/68	DHCP	outbound	UDP/IP
80	HTTP	bi-directional	TCP/IP
161/162	SNMP	outbound	TCP/IP
443	SSL	bi-directional	TCP/IP
1443	TKLM/ISKLM Server (LME Only)	outbound	TCP/IP
3801	TKLM/ISKLM Server (LME Only)	outbound	TCP/IP

Figure 14 on page 65 shows an overview of network connectivity.

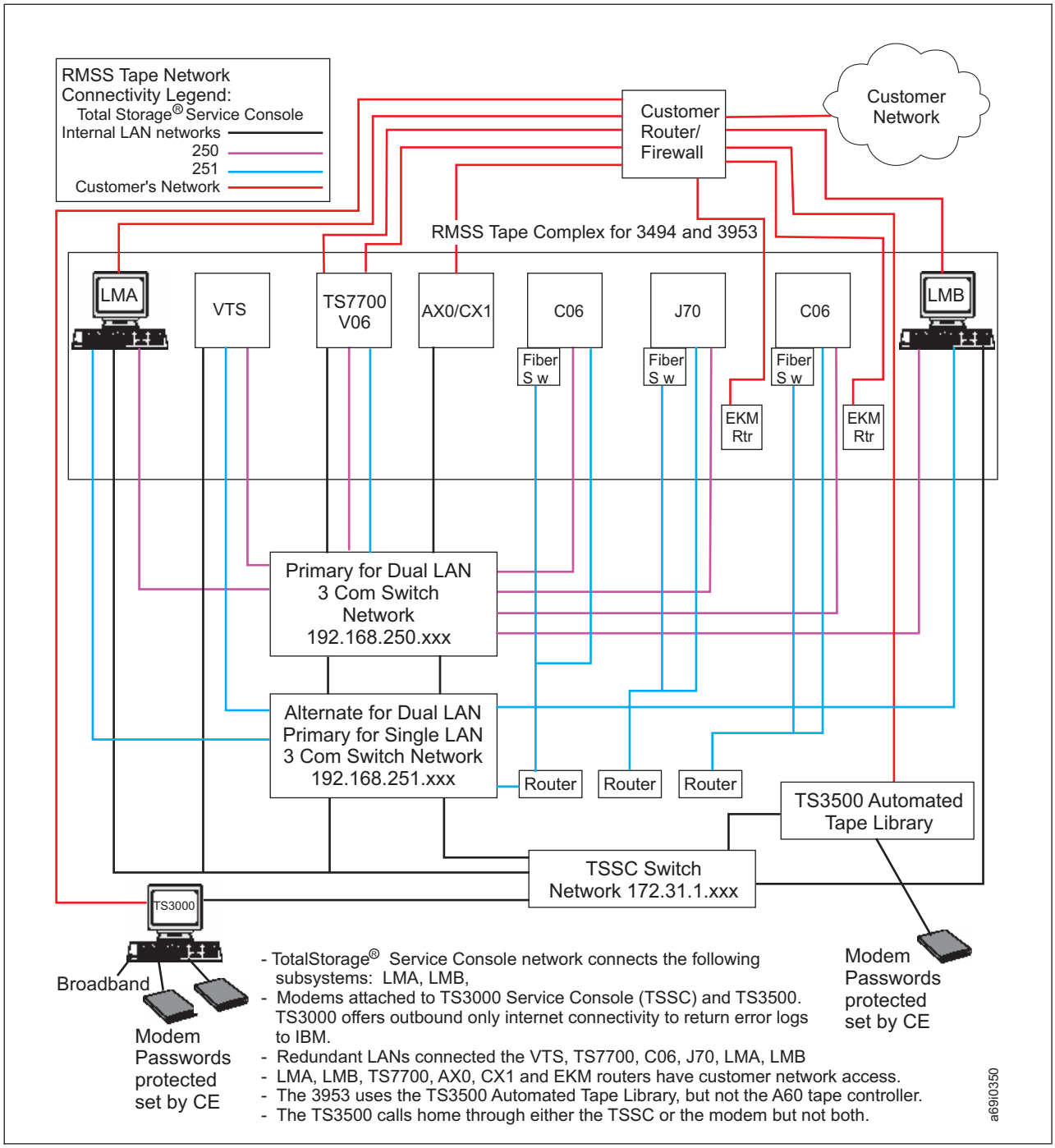


Figure 14. Attachment of the system console to the TS3500 tape library and the 3953 tape system for remote support

Dial-out security features

Dial-out is used by the Call Home feature to send service-related information from the attached systems to the IBM service support system, RETAIN®; and to optionally send a pager message to a customer-designated number. Dial-out is available through the TSSC and the modem. Dial out security properties for the attached systems are as follows:

1. Dial-out is from the customer location to the IBM connection point. The IBM service support system (RETAIN®) does not initiate connections to the attached systems.

2. Dial-out through the TSSC can either be over a modem connection or over an outbound Ethernet connection to the customer network. All outbound traffic is limited to HTTP, HTTPS, and DNS information. All service-related data is communicated using HTTPS and is therefore encrypted.
3. The data exchanged between the attached systems and RETAIN® is service-related data. The protocol used is specific to this application and not publicly available.
4. On the first data exchange of each transmission, RETAIN® validates that the calling system is entitled to service. If the calling system is not validated, it is disconnected.
5. The default setting for the Call Home feature is enabled. The Call Home feature can be disabled by an IBM service representative.

None of the customer data stored on the tape or in memory for the TS3500 tape library is transmitted or accessed in a Call Home session. Call Home is enabled or disabled by a CETool menu selection. When properly configured, Call Home uses an IBM Global Services secure network or an internet connection. A unique account code is used that establishes connections only to RETAIN®.

Dial-in security features

Dial-in is used by IBM service representatives to log on and provide service support. Dialing in through the modem and TSSC (or WTI switch for legacy systems) provides connectivity to the 3953 and 3494 tape library managers. All dial-in connectivity to the TSSC must be through a modem connection. The optional Ethernet connection restricts all incoming traffic. Separate logon IDs are required for access to each attached system.

Note: The TS3500 tape library does not support dial-in.

The TSSC supports the following data security requirements when properly configured:

- Customer data, stored on tape or in memory, can not be transmitted or accessed in remote support sessions.
- Remote dial-in is enabled or disabled through an operator panel or web specialist menu selection by the customer. Remote dial-in is disabled by default. When remote dial-in is enabled, it is enabled for 24 hours by default.
- Remote dial-in requires a password for access. The password is managed by the customer.

The following dial-in security properties are available:

Modem
The default modem setting for dial-in is no password required. A password can be specified by the customer and set by the IBM Service Representative.

WTI Switch (used with some legacy systems)
The WTI Switch has a default password. A different password can be set locally by the IBM Service Representative.

Security for Encryption Support

Encryption support in the TS3500 tape library and 3592 tape controllers (models C07, C06 and J70) allow system-managed tape encryption on IBM System z

platforms. An IBM service representative installs routers between the internal LAN network, which is connected to the controllers, and the customer's LAN network. The router provides access to the customer's key manager. Network traffic through this router is outbound only. The Network Address Translation (NAT) function in the router prevents externally-initiated connections to any internal components.

Port information for firewall environments

Table 20 shows the only ports that are required to be opened on the firewall for environments where the tape configuration is separated from the LAN-attached hosts and/or Web clients by a firewall. All other ports may be closed.

Table 20. Port Information for firewall environments

Function	Port	Direction (from library)	Protocol
Library Operations	3494	Bi-directional	TCP
TotalStorage® Specialist	80	Inbound	TCP
SNMP Traps	161/162	Bi-directional	UDP
Encryption key manager	1443	Outbound	SSL
Encryption key manager	3801	Outbound	TCP
LDAP	389	bi-directional	TCP and UDP
LDAP over TLS/SSL	636	bi-directional	TCP and UDP
Kerberos	88	bi-directional	TCP and UDP
HTTPS	443	bi-directional	TCP

Note: The TS3000 system console uses the following ports:

- HTTPS: Port 443
- HTTP: Port 80
- DNS: Port 53

HTTPS: Port 443; HTTP: Port 80; and DNS: Port 53.

Port information communications can be initiated either by the tape library or by the host. Typically, the library only initiates a connection when responding to the host; however, in the case of unsolicited messages such as statistics notifications and operator interventions, the library initiates a connection through port 3494. If the library manager needs to make a connection to the host, it chooses a temporary port and uses that port to make an outbound connection to a 3494 listening port on the host. When the host has a message to deliver to the library manager, it chooses its own ephemeral port by which to make an outbound connection to listening port 3494 on the library manager. The connection is only maintained for the duration required to pass a single message, and then it is disabled.

Table 20 describes the minimum level of connectivity required to perform library operations. Other ports that could be opened up on the firewall, but are not necessary in order to have full functionality include:

- The standard HTTP port, 80, allows inbound communication to the library from the IBM Tape Library Specialist (IBM's Enterprise Storage Resource Management solution).
- Ports 161 and 162 are the standard ports for sending SNMP traps. The tape library can be configured to send traps to SNMP target machines. In this case,

the firewall needs to allow outbound connections from the library from its port 161 to port 162 on the listening SNMP target machine.

Remote support security for the TS3500

This section describes remote support security for the TS3500 tape library through a system console.

A system console is a service tool that is present in most environments where one or more FICON/ESCON-enabled products, such as the TS7700, are connected to a zSeries® server (mainframe host).

Figure 15 illustrates all of the external communication connections to the TS3500 tape library control system.

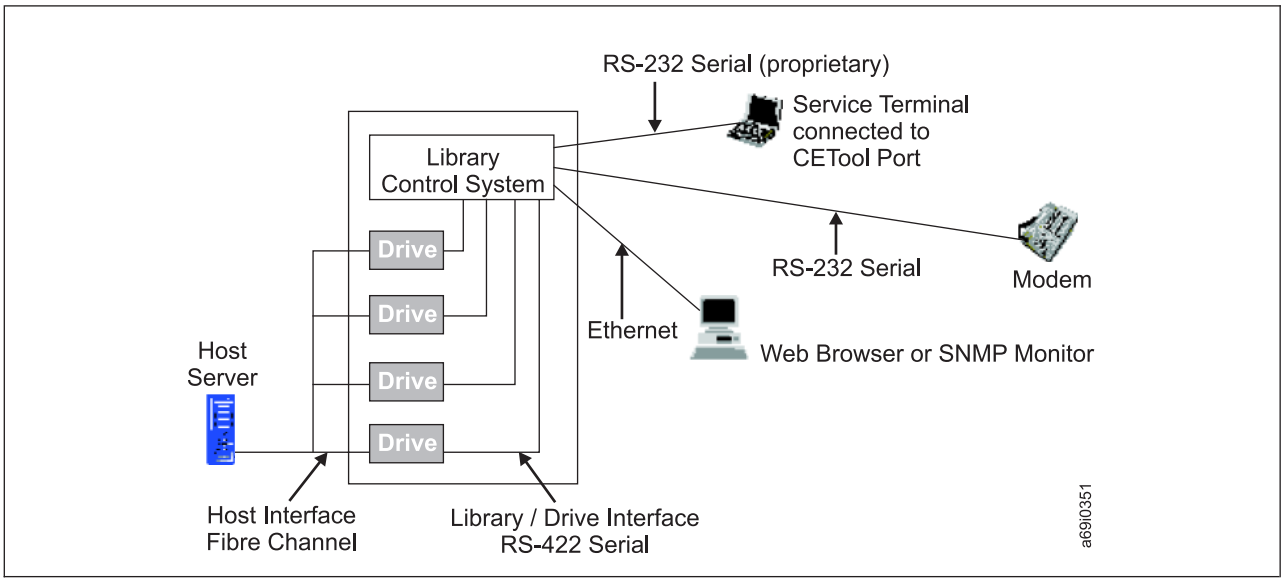


Figure 15. External communication connections to the TS3500 tape library control system

The host interface is provided by the drives. The library communicates with the drives though the Library/Drive Interface. The CETool port, Ethernet port, and modem port do not have any direct access to the Library/Drive Interface. All communication between the various interfaces is through the library control system.

All library communication requires explicit support by the library firmware running in the library control system. The library firmware does not provide capability for any of the following functions:

- Answering an incoming call to the modem.
- Communications between the Ethernet port and the modem port.
- Communications between the Ethernet port and the CETool port.
- Communications between the CETool port and the modem port.
- Accessing data from tape cartridges through the Library/Drive Interface.
- Sending or receiving data from tape cartridges through any port.

For more information about installing and using the CETool, see the *IBM TS3500 Maintenance Information* manual.

Security considerations when using the TS3500 tape library Specialist Web Interface

This section describes remote support security for the TS3500 tape library through a system console when using the Tape Library Specialist Web interface.

The TS3500 tape library does not allow any access to customer data, and it does not allow FTP or TELNET type operations. It only provides those functions that are specifically coded in the library firmware. The only files it can offload are library logs, drive logs, a backup of the nonvolatile random access memory (NVRAM) configuration information for the library, and certain usage and error statistics files. It cannot be used to read or write a customer cartridge or otherwise access customer data.

The Tape Library Specialist Web interface allows the customer to set up an administrator password, and no one without the password can use the Tape Library Specialist Web interface to do anything to the library. The Tape Library Specialist Web interface also provides several levels of access through roles. These roles have lower levels of access than the administrator.

In addition, when password protection is enabled, the Tape Library Specialist Web also provides an option to authenticate through the Storage Authentication Service (SAS). interface.

See the section about Web security in the *IBM TS3500 with ALMS Operator Guide*.

Security concerns when using the Tape Library Specialist Web interface are similar to those of using the operator panel. For example:

- A specialist user could move a cartridge from one location to another within the library, potentially confusing a host application or making a cartridge unavailable by moving it to a different partition.
- A user could re-configure the library, possibly causing problems at the hosts because of changes in partitioning or device IDs.
- A remote user could update library or drive firmware. However, since the library and drives ignore any firmware they do not recognize, the only exposure is to loading down-level firmware.

These security concerns can be addressed by using the password, user role, and authentication features provided by the Tape Library Specialist Web interface, and by enabling SNMP audit logging. When SNMP audit logging is enabled, the library sends notifications when certain events occur in the library.

Security considerations for the IBM TS3500 tape library RS/232 Port

This section describes security information for the IBM TS3500 tape library RS/232 Port through the debug/CETool interface.

When servicing a TS3500 tape library, IBM Service Representatives may connect a service terminal (laptop computer) to an RS-232 serial port on the TS3500 tape library. Serial port J1 (also known as the CETool Port) provides an interface which allows IBM Service Representatives to send messages to the library and receive information from the library. This is a proprietary interface which provides specific commands and only passes the data associated with those commands.

A program called CETool.exe is used to interface with the library through this port. The CETool program provides the following capabilities:

- Update library or drive firmware by transferring a library code image or a drive code image from the service terminal to the library
- Get error and statistics logs and configuration information from the library and drive
- Configure the library settings related to the Call Home facility
- Back up and restore the library non-volatile random access memory (NVRAM) (configuration data)
- Correct a tape drive serial number that has been corrupted
- Specify whether to report 5 characters or 7 characters of the library serial number in inquiry data

The CETool Port interface does not provide any capability to access data that has been written on the tape cartridges within the library. In addition, the CETool Port interface does not provide any capability to access any Ethernet network connected to the library.

For more information about installing and using the CETool, see the *IBM TS3500 Maintenance Information* manual.

Methods of cleaning drives

This section describes the methods of cleaning that the TS3500 tape library uses for its drives.

Notes:

- It is the operator's responsibility to monitor cleaning cartridge usage.
- Automatic cleaning is always enabled with the Advanced Library Management System (ALMS).

The head of every tape drive in the tape library must be kept clean to prevent errors that are caused by contamination. To help you keep the drives clean, IBM provides a cleaning cartridge with the library. Whenever a drive determines that it needs to be cleaned, it alerts you with a message on the library's display or host console. The library uses the cleaning cartridge to clean the drive with whatever cleaning method that you choose. In all methods, cleaning is performed after the data cartridge is unloaded from the drive and before the next load.

Two methods of cleaning are available:

Automatic cleaning (preferred)
Automatic cleaning enables the library to automatically respond to any tape drive's request for cleaning and to begin the cleaning process. The cleaning process is transparent to any host application that uses the library. Automatic cleaning is required, and cannot be disabled, in libraries with the Advanced Library Management System (ALMS).

Manual cleaning
Manual cleaning requires that you select a menu option from the library's operator panel or Tape Library Specialist web interface to clean one or more of the tape drives. Manual cleaning is always supported, regardless of whether automatic cleaning is enabled or disabled.

TapeAlert support

The TS3500 tape library is compatible with TapeAlert technology, which provides error and diagnostic information about the drives and the library to the host application.

The library provides this error and diagnostic information as TapeAlert *flags* that are reported to the application by the SCSI LOG SENSE command.

For a list of the TapeAlert flags for the drives and the library, see the appropriate section in the *IBM TS3500 with ALMS Operator Guide*.

SNMP messaging

The Simple Network Management Protocol (SNMP) allows the TS3500 tape library to send alerts over a LAN network to a monitoring server.

Occasionally, the TS3500 tape library might encounter a situation that you want to know about. These can be conditions that affect library performance, such as an open door that causes the library to stop, or user actions that you want to have logged, such as a cartridge move or export that is specifically initiated from the Tape Library Specialist web interface or the library's operator panel. SNMP messages can alert you of these conditions.

The library provides a standard TCP/IP protocol called SNMP to send alerts about conditions (such as an opened door) over a TCP/IP LAN network to an SNMP monitoring server. These alerts are called SNMP traps. Using the information supplied in each SNMP trap, the monitoring server (together with customer-supplied software) can alert operations staff of possible problems or operator interventions that occur. Many monitoring servers (like NetView) can be used to send email or pager notifications when they receive an SNMP alert (for more information, see your NetView documentation or the manuals for your network management application).

The monitoring server must be loaded with systems management software that can receive and process the trap. SNMP supports a get and get-response mechanism for an operator to gather more information about a problem or query the library about its current status. Through a monitoring server, the operator issues a "get" via SNMP to request information about the library. A get-response is the information that is provided in response to the get. This type of support generally requires an up-to-date library Management Information Base (MIB). The library's MIB contains units of information that specifically describe an aspect of a system, such as the system name, hardware number, or communications configuration.

IBM provides the MIBs that are supported by the library. They include:

- IBM 3584 MIB for Version 1 or Version 2c traps
- Storage Networking Industry Association (SNIA) Storage Media Library (SML) MIB Version 1.12
- SNIA SML MIB Version 1.20b

Refer to “Obtaining MIBs” on page 72 for step-by-step instructions for downloading the correct MIB for your operating system.

An operator cannot change library settings by using SNMP. Settings can only be changed by using the Tape Library Specialist web interface or the library's operator panel.

Figure 16 shows the flow of SNMP communication from the library over the Ethernet local area network (LAN) to an SNMP monitoring server.

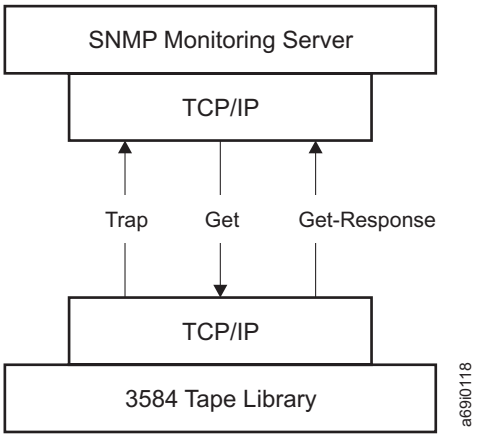


Figure 16. The SNMP messaging system

For information about interpreting an SNMP trap or using SNMP MIBs to monitor your library, see the appropriate sections in the *IBM TS3500 Operator Guide*. For information about SNMP audit logging, refer to "SNMP audit logging."

Additional information is available in *Implementing IBM Tape in Linux and Windows*; this book is available on the web at `http://www.redbooks.ibm.com/abstracts/sg246268.html?Open`. Also see *Implementing IBM Tape in Unix Systems*; this book is available on the Web at `http://www.redbooks.ibm.com/redbooks/pdfs/sg246502.pdf`.

Obtaining MIBs

To obtain the latest MIBs, visit the web at: http://www.ibm.com/support/fixcentral and perform the following steps:

1. From the Fix Central web page, select **System Storage** from the Product Group menu.
2. Select **Tape systems** from the System Storage menu.
3. Select **Tape autoloaders and libraries** from the Tape Systems menu.
4. Select **TS3500 Tape Library** from the Tape autoloaders and libraries menu and click **Continue**. The Select fixes page displays.
5. Select the appropriate microcode level for your library. A sign on page displays.
6. Log on with your user ID and password in order to view available MIB files for download.

SNMP audit logging

Simple Network Management Protocol (SNMP) audit logging provides logging information about specific TS3500 tape library user actions.

The TS3500 tape library provides various interfaces, other than the host application, that allow a user to configure different library or drive settings, move cartridges within or out of the library, and perform other actions. In order to provide additional capabilities for monitoring these actions and the physical security of the library, the TS3500 tape library provides notifications, in the form of SNMP traps, that provide a log of when certain activities are performed.

SNMP audit logging sends the log information over a TCP/IP LAN network to an SNMP monitoring server, just as SNMP traps are sent for library alerts. By default, SNMP audit logging is disabled, however, you can enable SNMP audit logging using the TS3500 tape library Specialist Web interface.

The following events are logged when SNMP audit logging is enabled:

- Log in attempt granted or denied
- Logout (timeout, logout, or force logout)
- Any configuration change
- Any data or cleaning cartridge move initiated from a library user interface
- Any code load operation (library or drive) initiated from a library user interface and not associated with a FRU replacement
- Any prepare or finish service procedure initiated from a library user interface including set storage slot offline or online
- Any drive serial number change not associated with a FRU replacement
- Any drive power cycle initiated from a library user interface
- Any node card reset initiated from a library user interface

Notes:

- Each login and logout is only logged if security is enabled.
- Door open is logged whether or not SNMP Audit Logging is enabled.

The following information is provided in the logs for each of the events listed above:

- Machine type, model, and serial number of the reporting machine
- The UserID initiating the event
- Level of severity
- Trap ID
- Description of the event

Note: The UserID is only applicable for the web when security is enabled and for operations performed from the operator panel.

SMI-S support

This section describes the Storage Management Initiative - Specification (SMI-S) service provided by the TS3500 tape library.

SMI-S defines a standard interface for interoperable, extensible, and secure management of heterogeneous and distributed storage systems. This interface uses an object-oriented, XML-based, messaging-based protocol designed to support the specific requirements of managing devices such as the TS3500 tape library in a storage environment. The SMI-S specification describes the information available to a WBEM client, such as the IBM Tivoli Storage Productivity Center (TPC), from an SMI-S-compliant CIM WBEM Server such as the TS3500 tape library. This SMI-S standard storage management interface is developed by the Storage Network Industry Association (SNIA).

The TS3500 tape library provides native support for SMI-S. It is no longer necessary to run a proxy SMI-S agent on a separate Linux machine. All of the functions present in the proxy SMI-S agent are replicated in this embedded

version. In addition, this embedded version includes support for asset reporting on each installed frame in the TS3500 tape library.

New base frame models L23 and L53 come with support for the embedded SMI-S Agent. Other frame models, however, require upgrades in order to support the embedded SMI-S Agent. The following table displays the frame models and required upgrades.

Table 21. Required upgrade for those frames providing Ethernet attachment to the SMI-S Agent

Frame model	Required upgrade
L22, D22	Installation of feature code 1700 or 1701 **or** model conversion to L23 or D23
L23, D23	No upgrade required
L32, D32	Installation of feature code 1700 or 1701
L52, D52	Installation of feature code 1700 or 1701 **or** model conversion to L53 or D53
L53, D53	No upgrade required

The TS3500 tape library SMI-S HTTP service operates on the library Ethernet interface IP address on port 5988 by default. The SMI-S service agent can be enabled and disabled using the library Web interface (see the appropriate section in the *IBM TS3500 with ALMS Operator Guide*). The TS3500 tape library embedded SMI-S service uses "root/ibm" as the Namespace. Namespace is a configuration parameter needed to access the SMI-S service for an SMI-S client such as TPC.

The user authentication and security (SSL) for the SMI-S service works in conjunction with the Web service. When the Web user accounts are enabled, the same user accounts and passwords are used for SMI-S service authentication. When Web SSL is enabled, the SMI-S HTTPS service is enabled on port 5989 and the SMI-S HTTP service is disabled on port 5988.

An SMI-S profile is a subset of the SMI-S standard that supports interoperability in managing specific products such as tape libraries. A profile is a vertical slice through the SMI-S standard defining physical, logical, and behavioral elements required for interoperability.

The TS3500 tape library embedded SMI-S service supports the following profiles:

Table 22. Embedded SIM-S Agent Profiles

Profile	Sub Profiles	SMI-S Version
Server Profile	n/a	1.2
Storage Media Library		1.2
	Limited Access Port	1.2
	Chassis	1.2
	FC Port	1.2
	Software	1.2
	Physical Package	1.2

Note: Two versions of the embedded SMI-S agent are supported by the TS3500 tape library. The initial version (v1.1), released with code level 7050, does not

require the Advanced Library Management System (ALMS). The full version (v1.2), released with code level 8160, requires that ALMS is installed and enabled on your library.

To learn more about the Tivoli Storage Productivity Center, go to `http://www.ibm.com/systems/storage/software/`. To learn more about SMI-S and SNIA, go to `http://www.snia.org/`.

Secure Socket Layer (SSL) functionality

The TS3500 tape library supports secure socket layer (SSL), which is a protocol for transmitting private documents across the Internet.

Important: Enabling SSL for TS3500 web communications introduces significant delays for the display of some TS3500 web pages.

Secure socket layer uses a cryptographic system that uses these two keys to encrypt data:

- a public key known to everyone
- a private key known only to the recipient of the message

Many web sites use this protocol to obtain confidential user information, such as credit card numbers. By convention, uniform resource locators (URLs) that require an SSL connection start with https: instead of http:.

The TS3500 tape library provides the ability to enable or disable SSL for web browser communication. The action is performed using the Tape Library Specialist web specialist.

Storage Authentication Service

The Storage Authentication Service (SAS) is an option for web login requests on the TS3500 tape library.

Note: TS3500 Storage Authentication Service is not supported with Tivoli Storage Productivity Center V5.1 and later.

Remote authentication is supported on a TS7700 virtualization engine or TS3500 tape library using the Tivoli Secure Authentication Service client and server, and the WebSphere® Federated Repositories. The TS7700 virtualization engine or TS3500 tape library must connect to a System Storage Productivity Center (SSPC) appliance or a server using Tivoli Storage Productivity Center (TPC). The SAS client is integrated into the TS7700 virtualization engine microcode or the TS3500 tape library firmware, while the SAS server and the WebSphere Federated Repositories are integrated into TPC 4.1 and later. TPC is available as a software-only package or as an integrated solution on the SSPC appliance.

When SAS is enabled, the TS3500 tape library passes user authentication requests to the SAS server on the SSPC or TPC, where they are forwarded to the customer's Lightweight Directory Access Protocol (LDAP) or Microsoft Active Directory (AD) server. The LDAP or AD server then authenticates the user's ID and password. If they are valid, then one or more user groups are assigned. The TS3500 tape library then assigns the user a role based on the LDAP or AD group.

This central repository allows you to accomplish the following security tasks from a single interface, without logging in to a TS3500 tape library:

- Add or remove a user
- Reset or change a password
- Assign, change, or delete the LDAP or AD group of a user

A central repository can also simplify the process of responding to new security requirements for one or more tape libraries. For instance, rules for passwords can be changed in one location without reconfiguring multiple, affected machines. By comparison, when local authentication is employed, each individual machine maintains an internal database of user IDs, with corresponding passwords and roles.

LDAP dependency

The WebSphere Federated Repositories component of the SSPC or TPC receives authentication requests from the TS3500 tape library through the SAS. The SAS passes user ID and password information to the LDAP or AD server.

The LDAP or AD server returns authentication status to the SSPC or TPC, which forwards the authentication status through the SAS to the TS3500 tape library . The LDAP or AD server attached to the SSPC or TPC manages the following information:

User ID
A string to identify a specific user

User password
A password for each user ID

Groups
Strings to identify one or more groups of users. The TS3500 tape library maps each LDAP group to a TS3500 tape library role.

Each user is defined as a member of one or more groups, meaning the user assumes the roles defined by those groups.

Notes:

- The User ID and User password cannot exceed 15 characters. LDAP users that exceed this maximum might not be able to authenticate to the TS3500 Tape Library Specialist Web interface when SAS is enabled.
- The maximum length of a group is 15 characters. Groups exceeding 15 characters in length will not map to a defined role in the TS3500 tape library.

Mapping groups to roles

When a user is successfully authenticated using the Storage Authentication Service, the resulting user information includes a list of groups that the user belongs to. You can use the to define how groups are mapped to roles. For successful authorization, at least one LDAP group in the list must have the same name as a role that is defined in the TS3500 tape library. The first LDAP group to match a role determines the role of the user. Avoid ambiguity of multiple matches by making sure that only one group matches a role in the TS3500 tape library.

Note: Prior to firmware level A040, a user in an Admin LDAP group is required to enable and disable SAS.

For more information about TPC, visit the web at http://www-03.ibm.com/systems/storage/software/center/index.html. For additional information about TPC security features, including how to use Microsoft Active Directory for authentication, visit the web at http://publib.boulder.ibm.com/infocenter/wasinfo/v7r0/index.jsp?topic=/com.ibm.websphere.base.doc/info/aes/ae/cwim_fedrepos.html.

IPv6 functionality

The TS3500 tape library supports internet protocol (IP) addresses in IPv4 and IPv6 formats.

Internet protocol version 6 (IPv6) is designed to allow the Internet to grow steadily, both in terms of the number of hosts connected and the total amount of data traffic transmitted. Both the operator panel and the Tape Library Specialist Web interface allow the definition of IPv4 and IPv6 addresses. The Key Proxy determines the IP version used and presents the correct IP address and parameters to the IP Stack.

IPv4 and IPv6 address formats

Octets or segments, or a combination of both, make up Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) addresses.

An IPv4 address has the following format: `x . x . x . x` where *x* is called an *octet* and must be a decimal value between 0 and 255. Octets are separated by periods. An IPv4 address must contain three periods and four octets. The following examples are valid IPv4 addresses:

- `1 . 2 . 3 . 4`
- `01 . 102 . 103 . 104`

The following example shows a screen that uses IPv4 addresses.

```
Ethernet IPv4               Panel 0175

Current Settings Frame 1:

MAC Address: 18:36:F3:98:4F:9A
IP Address (IPv4):  19.117.63.126
Subnet Mask (IPv4): 255.255.253.0
Gateway (IPv4):     19.117.63.253

Ethernet Mode:  Manual IP Entry

Press ENTER to Change Settings

[BACK]  [ UP ]  [DOWN]   [ENTER]
```

An IPv6 address can have either of the following two formats:

- Normal - Pure IPv6 format
- Dual - IPv6 plus IPv4 formats

An IPv6 (Normal) address has the following format: `y : y : y : y : y : y : y : y` where *y* is called a *segment* and can be any hexadecimal value between 0 and FFFF. The segments are separated by colons - not periods. An IPv6 normal address must have eight segments, however a short form notation can be used in the Tape Library Specialist Web interface for segments that are zero, or those that have leading zeros. The short form notation can not be used from the operator panel.

The following list shows examples of valid IPv6 (Normal) addresses:

- 2001 : db8: 3333 : 4444 : 5555 : 6666 : 7777 : 8888
- 2001 : db8 : 3333 : 4444 : CCCC : DDDD : EEEE : FFFF
- : : (implies all 8 segments are zero)
- 2001: db8: : (implies that the last six segments are zero)
- : : 1234 : 5678 (implies that the first six segments are zero)
- 2001 : db8: : 1234 : 5678 (implies that the middle four segments are zero)
- 2001:0db8:0001:0000:0000:0ab9:C0A8:0102 (This can be compressed to eliminate leading zeros, as follows: 2001:db8:1::ab9:C0A8:102)

The following example shows a screen that uses IPv6 addresses:

```
Ethernet IPv6               Panel 0178

Current Settings
Frame 1, Port B

MAC Address: 18:36:F3:98:4F:9A
Manual IP (IPv6):  684D:1111:222:3333:4444:5555:6:77
DHCP IP (IPv6): Disabled
Stateless Auto IP (IPv6): 0:0:0:0:0:0:0:0

Press ENTER to Change Settings

[BACK]  [ UP ]  [DOWN]   [ENTER]
```

An IPv6 (Dual) address combines an IPv6 and an IPv4 address and has the following format: y : y : y : y : y : y : x . x . x . x. The IPv6 portion of the address (indicated with y's) is always at the beginning, followed by the IPv4 portion (indicated with x's).

- In the IPv6 portion of the address, *y* is called a *segment* and can be any hexadecimal value between 0 and FFFF. The segments are separated by colons - not periods. The IPv6 portion of the address must have six segments but there is a short form notation for segments that are zero.
- In the IPv4 portion of the address *x* is called an *octet* and must be a decimal value between 0 and 255. The octets are separated by periods. The IPv4 portion of the address must contain three periods and four octets.

The following list shows examples of valid IPv6 (Dual) addresses:

- 2001 : db8: 3333 : 4444 : 5555 : 6666 : 1 . 2 . 3 . 4
- : : 11 . 22 . 33 . 44 (implies all six IPv6 segments are zero)
- 2001 : db8: : 123 . 123 . 123 . 123 (implies that the last four IPv6 segments are zero)
- : : 1234 : 5678 : 91 . 123 . 4 . 56 (implies that the first four IPv6 segments are zero)
- : : 1234 : 5678 : 1 . 2 . 3 . 4 (implies that the first four IPv6 segments are zero)
- 2001 : db8: : 1234 : 5678 : 5 . 6 . 7 . 8 (implies that the middle two IPv6 segments are zero)

Subnet masks (IPv4) and prefixes (IPv6)

Subnet masks (IPv4) and prefix lengths (IPv6) identify a range of IP addresses that are on the same network.

IPv4 subnet masks

All IP addresses are divided into portions. One part identifies the network (the network number) and the other part identifies the specific machine or host within the network (the host number). Subnet masks (IPv4) and prefixes (IPv6) identify the range of IP addresses that make up a subnet, or group of IP addresses on the same network. For example, a subnet can be used to identify all the machines in a building, department, geographic location, or on the same local area network (LAN).

Dividing an organization's network into subnets allows it to be connected to the Internet with a single shared network address. Subnet masks and prefixes are used when a host is attempting to communicate with another system. If the system is on the same network or subnet, it attempts to find that address on the local link. If the system is on a different network, the packet is sent to a gateway that then routes the packet to the correct IP address. This routing is called Classless-InterDomain Routing (CIDR).

In IPv4, the subnet mask `255.255.255.0` is 32 bits and consists of four 8-bit octets. The address: `10.10.10.0` subnet mask `255.255.255.0` means that the subnet is a range of IP addresses from `10.10.10.0 - 10.10.10.255.`

The prefix-length in IPv6 is the equivalent of the subnet mask in IPv4. However, rather than being expressed in four octets like it is in IPv4, it is expressed as an integer between 1 through 128. For example: `2001:db8:abcd:0012::0/64` specifies a subnet with a range of IP addresses from:
`2001:db8:abcd:0012:``0000:0000:0000:0000 -`
`2001:db8:abcd:0012:ffff:ffff:ffff:ffff`. The portion in bold is called the network portion of the IP address, or the prefix. The non-bold portion is called the host portion of the IP address, since it identifies an individual host on the network.

IPv6 addresses

An IPv6 address is eight groupings of numbers:

- **Network address** - the first three groupings of numbers (first 48 bits) in the subnet mask
- **Subnet address** - the fourth grouping of numbers (the 49th through 64th bits) in the subnet mask
- **Device address** - the last four groupings of numbers (the last 64 bits) in the subnet mask

For example, in the following IPv6 address:

```
2001:db8:abcd:0012:0000:0000:0000:0000
```

The network address is `2001:db8:abcd`, and the subnet address is `12` (using the short form notation and eliminating the leading zeroes). Together, these two groupings are the IPv6 *prefix*. The device address in the example is `0000:0000:0000:0000`.

Each device in the network has a unique device address. But, the network address and subnet address portions of the IPv6 address are the same for every device in the network. So, the first four groupings of numbers in every IPv6 address remain constant, and the last four groupings of numbers vary with each device. You can simplify your list of devices by substituting a prefix-length in place of the device address portion of the IPv6 address. The prefix-length specifies a range of devices.

It is expressed as a slash (/), followed by an integer between 1 through 128. For example, a prefix-length of /64 specified like this: 2001:db8:abcd:0012::/64 tells the system to divide the network into 64 subnetworks. Each subnetwork contains 1/64th of the devices on the network. Table 23 shows the resulting network ranges for prefix lengths of IPv6 addresses.

Table 23. Network ranges for prefix lengths of IPv6 addresses.

Expanded notation of IPv6 address at start of the range	IPv6 address (condensed notation)	IPv6 Address with prefix length	Device range in subnetwork
2001:0DB8:ABCD:0012:0000:0000:0000:0000	2001:DB8:ABCD:12::	2001:db8:abcd:0012::0/64	2001:0DB8:ABCD:0012:0000:0000:0000:0000 - 2001:0DB8:ABCD:0012:FFFF:FFFF:FFFF:FFFF
2001:0DB8:ABCD:0012:0000:0000:0000:0000	2001:DB8:ABCD:12::	2001:db8:abcd:0012::0/80	2001:0DB8:ABCD:0012:0000:0000:0000:0000 - 2001:0DB8:ABCD:0012:0000:FFFF:FFFF:FFFF
2001:0DB8:ABCD:0012:0000:0000:0000:0000	2001:DB8:ABCD:12::	2001:db8:abcd:0012::0/96	2001:0DB8:ABCD:0012:0000:0000:0000:0000 - 2001:0DB8:ABCD:0012:0000:0000:FFFF:FFFF
2001:0DB8:ABCD:0012:0000:0000:0000:0000	2001:DB8:ABCD:12::	2001:db8:abcd:0012::0/112	2001:0DB8:ABCD:0012:0000:0000:0000:0000 - 2001:0DB8:ABCD:0012:0000:0000:0000:FFFF
2001:0DB8:ABCD:0012:0000:0000:0000:0000	2001:DB8:ABCD:12::	2001:db8:abcd:0012::0/128	2001:0DB8:ABCD:0012:0000:0000:0000:0000 - 2001:0DB8:ABCD:0012:0000:0000:0000:0000

Drive performance

Performance data for Ultrium and 3592 tape drives.

Table 24 provides drive performance of the Ultrium tape drives with different media. Table 25 on page 82 provides drive performance of the 3592 tape drives. Table 26 on page 83 provides additional information for 3592 media.

Table 24. Performance specifications of the Ultrium tape drives

Performance Parameter	Tape drive					
	Ultrium 6	**Ultrium 5**	**Ultrium 4**	**Ultrium 3**	**Ultrium 2**	**Ultrium 1**
Sustained data rate (native)[1]	160 MB/s (L6 media)	N/A	N/A	N/A	N/A	N/A
	140 MB/s (L5 media)	140 MB/s (L5 media)	N/A	N/A	N/A	N/A
	120 MB/s (L4 media)	120 MB/s (L4 media)	120 MB/s (L4 media)	N/A	N/A	N/A
	N/A	80 MB/s (L3 media)[2]	80 MB/s (L3 media)	80 MB/s (L3 media)	N/A	N/A
	N/A	N/A	35 MB/s (L2 media)	35 MB/s (L2 media)	35 MB/s (L2 media)	N/A
	N/A	N/A	N/A	20 MB/s (L1 media)	20 MB/s (L1 media)	15 MB/s (L1 media)
Sustained data rate (L6 media compressed at 2.5:1 compression; L5 and earlier media compressed at 2:1 compression)	400 MB/s (L6 media)	N/A	N/A	N/A	N/A	N/A
	280 MB/s (L5 media)	280 MB/s (L5 media)	N/A	N/A	N/A	N/A
	240 MB/s (L4 media)	240 MB/s (L4 media)	240 MB/s (L4 media)	N/A	N/A	N/A
	N/A	160 MB/s (L3 media)[2]	160 MB/s (L3 media)	160 MB/s (L3 media)	N/A	N/A
	N/A	N/A	70 MB/s (L2 media)	70 MB/s (L2 media)	70 MB/s (L2 media)	N/A
	N/A	N/A	N/A	40 MB/s (L1 media)	40 MB/s (L1 media)	30 MB/s (L1 media)
Maximum sustained data rate (at maximum compression)	745 MB/s	745 MB/s	340 MB/s (read) 350 MB/s (write)	175 MB/s	110 MB/s	60 MB/s
Burst data rate for Fibre Channel drives	800 MB/s	800 MB/s	400 MB/s	400 MB/s	200 MB/s	100 MB/s
Burst data rate for Low Voltage Differential (LVD) SCSI drives	N/A	N/A	N/A	N/A	160 MB/s (Ultra160)	80 MB/s (Ultra2)
Burst data rate for High Voltage Differential (HVD) SCSI drives	N/A	N/A	N/A	N/A	40 MB/s (Ultra)	40 MB/s (Ultra)
Time to load, thread, and initialize a cartridge	12 seconds			15 seconds		20 seconds

Table 24. Performance specifications of the Ultrium tape drives (continued)

Performance Parameter	Tape drive					
	Ultrium 6	**Ultrium 5**	**Ultrium 4**	**Ultrium 3**	**Ultrium 2**	**Ultrium 1**
Time to unload cartridge from load point	17 seconds			15 seconds		18 seconds
Average search time to first byte of data (load time)	60 seconds		57 seconds	49 seconds		73 seconds
Notes: N/A = not applicable. 1. All sustained data rates are dependent on the entire data path (from data source to host system to tape drive). 2. Read only						

Table 25. Performance specifications of the 3592 tape drives

Performance parameter		Tape drive			
	TS1150 tape drive	**TS1140 tape drive**	**TS1130 tape drive**	**TS1120 tape drive**	**3592 Model J1A tape drive**
Sustained data rate (native)[1]	360 MB/s (E08 format)	N/A	N/A	N/A	N/A
	250 MB/s (E07 format)	250 MB/s (E07 format)	N/A	N/A	N/A
	N/A	160 MB/s (E06 format)	160 MB/s (E06 format)	N/A	N/A
	N/A	N/A	140 MB/s (E05 format)	100 MB/s (E05 format)	N/A
	N/A	N/A	70 MB/s (J1A format)	50 MB/s (J1A format)	40 MB/s (J1A format)
Compressed sustained data rate (at maximum compression)	700 MB/s (E08 format)	650 MB/s (E07 format)	350 MB/s (E06 format)	280 MB/s (E05 format)	120 MB/s (J1A format)
Burst data rate for Fibre Channel devices	800 MB/s	800 MB/s	400 MB/s		200 MB/s
Load-to-ready time	12 seconds	15 seconds	13 seconds		19 seconds
Unload time	36 seconds[2]	36 seconds[2]	23 seconds[2]		21 seconds
Maximum rewind time (100% scaled media)	94 seconds (100% scaled JD)	Not supported	Not supported	Not supported	Not supported
	76 seconds (100% scaled JC)	76 seconds (100% scaled JC)	Not supported	Not supported	Not supported
	Not supported	72 seconds (100% scaled JB)		90 seconds (100% scaled JB)	Not supported
	Not supported	Not supported	55 seconds (100% scaled JA)	66 seconds (100% scaled JA)	77 seconds (100% scaled JA)

Table 25. Performance specifications of the 3592 tape drives (continued)

Maximum rewind time (20% scaled media)	34 seconds (20% scaled JD)	Not supported	Not supported	Not supported	Not supported
	26 seconds (20% scaled JC)	26 seconds (20% scaled JC)	Not supported	Not supported	Not supported
	Not supported	24 seconds (20% scaled JB)			Not supported
	Not supported	Not supported	18 seconds (20% scaled JA)		18 seconds (20% scaled JA)
Average rewind time(100% scaled media)	50 seconds (100% scaled JD)	Not supported	Not supported	Not supported	Not supported
	42 seconds (100% scaled JC)	42 seconds (100% scaled JC)	Not supported	Not supported	Not supported
	Not supported	38 seconds (100% scaled JB)		47 seconds (100% scaled JB)	Not supported
	Not supported	Not supported	29 seconds (100% scaled JA)	35 seconds (100% scaled JA)	Not supported
Average rewind time(20% scaled media)	20 seconds (20% scaled JD)	Not supported	Not supported	Not supported	Not supported
	17 seconds (20% scaled JC)	17 seconds (20% scaled JC)	Not supported	Not supported	Not supported
	Not supported	15 seconds (20% scaled JB)			Not supported
	Not supported	Not supported	11 seconds (20% scaled JA)		Not supported
Average block locate time from load point	See Table 26				

Notes:

1. All sustained data rates are dependent on the entire data path (from data source to host system to tape drive).
2. 40 seconds after encryption key change

Table 26. Average block locate time from load point for 3592 tape cartridge in 3592 tape drives

Type of 3592 tape cartridge	Average Block Locate Time from Load Point[1]					Comments[2]
	TS1150 tape drive	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A tape drive	
JA cartridge type - 100% scaled	Not supported	Not supported	28 seconds	33 seconds	40 seconds	JA cartridge type at full, unscaled capacity (EFMT1 300 GB [279.39 GiB]; EFMT2 and EEFMT2 500 GB [465.66 GiB]; EFMT3 and EEFMT3 640 GB [596.04 GiB])

Table 26. Average block locate time from load point for 3592 tape cartridge in 3592 tape drives (continued)

Type of 3592 tape cartridge	Average Block Locate Time from Load Point[1]					Comments[2]
	TS1150 tape drive	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A tape drive	
JA cartridge type - 20% scaled	Not supported	Not supported	11 seconds		12 seconds	JA cartridge type at scaled capacity with 0x35 setting (EFMT1 format 60 GB [55.88 GiB]; EFMT2 and EEFMT2 100 GB [93.13 GiB]; EFMT3 and EEFMT3 128 GB [119.21 GiB])
JB cartridge type - 100% scaled	Not supported	37 seconds		45 seconds	Not supported	JB cartridge type at full, unscaled capacity (EFMT2 and EEFMT2 700 GB [651.93 GiB]; EFMT3 and EEFMT3 1 000 GB [931.32 GiB]; EFMT4 and EEFMT4 1 600 GB [1 396.98 GiB])
JB cartridge type - 20% scaled	Not supported	15 seconds			Not supported	JB cartridge type at scaled capacity with 0x35 setting (EFMT2 and EEFMT2 140 GB [130.39 GiB]; EFMT3 and EEFMT3 200 GB [182.26 GiB]; EFMT4 and EEFMT4 320 GB [298.02 GiB])
JC cartridge type (100% scaled)	40	40 seconds	Not supported	Not supported	Not supported	JC cartridge type at full, unscaled capacity (EFMT4 and EEFMT4 4 TB [3.64 TiB])

Table 26. Average block locate time from load point for 3592 tape cartridge in 3592 tape drives (continued)

Type of 3592 tape cartridge	Average Block Locate Time from Load Point[1]					Comments[2]
	TS1150 tape drive	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A tape drive	
JC cartridge type (20% scaled)	12	12 seconds	Not supported	Not supported	Not supported	JC cartridge type at scaled capacity with 0x35 setting (EFMT4 and EEFMT4 800 GB [745.06 GiB]
JD cartridge type (100% scaled)	45 seconds	Not supported	Not supported	Not supported	Not supported	JD cartridge type at full, unscaled capacity (EFMT5 and EEFMT5 10 TB [9.1 TiB TiB])
JD cartridge type (20% scaled)	13 seconds	Not supported	Not supported	Not supported	Not supported	JD cartridge type at scaled capacity with 0x35 setting (EFMT5 and EEFMT5 800 GB [745.06 GiB]
JJ cartridge type	Not supported	Not supported	11 seconds		12 seconds	Economy - short length (EFMT1 60 GB [55.88 GiB]; EFMT2 and EEFMT2 100 GB [93.13 GiB]; EFMT3 and EEFMT3 128 GB [119.21 GiB])
JK cartridge type	11 seconds	11 seconds	Not supported	Not supported	Not supported	Advanced Economy Type C - short length (EFMT4 and EEFMT4 500 GB [465.66 GiB])
JL cartridge type	13 seconds	Not supported	Not supported	Not supported	Not supported	Advanced Economy Type D - short length (EFMT5 and EEFMT5 2 TB [1.8 TiB])

Table 26. Average block locate time from load point for 3592 tape cartridge in 3592 tape drives (continued)

Type of 3592 tape cartridge	Average Block Locate Time from Load Point[1]					Comments[2]
	TS1150 tape drive	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A tape drive	
JW cartridge type	Not supported	Not supported	28 seconds	33 seconds	40 seconds	WORM - standard length (EFMT1 300 GB [279.39 GiB]; EFMT2 and EEFMT2 500 GB [465.66 GiB]; EFMT3 and EEFMT3 640 GB [596.04 GiB])
JX cartridge type	Not supported	37 seconds		45 seconds	Not supported	Extended WORM (EFMT2 and EEFMT2 700 GB [651.93 GiB]; EFMT3 and EEFMT3 1 000 GB [931.32 GiB]; EFMT4 and EEFMT4 1 600 GB [1490.12 GiB])
JY cartridge type	40 seconds	40 seconds	Not supported	Not supported	Not supported	Advanced Type C WORM (EFMT4 and EEFMT4 4 TB [3.64 TiB])
JZ cartridge type (100% scaled)	45 seconds	Not supported	Not supported	Not supported	Not supported	Advanced Type D WORM cartridge type at full, unscaled capacity (EFMT5 and EEFMT5 10 TB [9.1 TiB])
JZ cartridge type (20% scaled)	11 seconds	Not supported	Not supported	Not supported	Not supported	Advanced Type D WORM type at scaled capacity with 0x35 setting (EFMT5 and EEFMT5 800 GB [745.06 GiB]

Table 26. Average block locate time from load point for 3592 tape cartridge in 3592 tape drives (continued)

Type of 3592 tape cartridge	Average Block Locate Time from Load Point[1]					Comments[2]
	TS1150 tape drive	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A tape drive	
JR cartridge type	Not supported	Not supported	11 seconds		12 seconds	Economy WORM - short length (EFMT1 60 GB [55.88 GiB]; EFMT2 and EEFMT2 100 GB [93.13 GiB]; EFMT3 and EEFMT3 128 GB [119.21 GiB])

Notes:

1. For an encrypted format, an additional 5 seconds may be required to obtain a encryption key to read the first block accessed on the cartridge.
2. Encrypted format is referred to as EEFMT2 (for E05), EEFMT3 (for E06), EEFMT4 (for E07), and EEFMT5 (for E08).

By using the built-in data-compression capability of the tape drives, you can achieve greater data rates than the native data transfer rate. However, the actual throughput is a function of many components, such as the host system processor, disk data rate, block size, data compression ratio, interconnect (for example, SCSI or Fibre Channel), and system or application software.

For maximum performance with SCSI drives, multiple SCSI buses may be required and the TS3500 tape library devices must be the only target devices that are active on each SCSI bus. For more information, see the section about the SCSI interface in the *IBM TS3500 with ALMS Operator Guide*.

Library performance

The library performance values show the relative performance of the systems and are not meant to be absolute indicators of performance in your specific environment. Performance values, such as cartridge inventory times, mount performance, and cartridge move time, are obtained for the TS3500 tape library using specific measurements.

Performance values for the TS3500 tape library, whether measured on test systems or modeled through simulations, are based on a fixed set of workload assumptions to ensure accurate comparisons; however, the results are not evaluated in all production environments.

Some of the specific assumptions may not pertain to a given operating environment. Actual performance may vary. Accordingly, the performance information for this product does not constitute a performance guarantee or warranty. Verify that the performance of the library is acceptable in your specific environment.

The sections that follow describe the library's performance.

Inventory times

This section describes inventory times for frames in the TS3500 tape library and inventory with audit times for HD frames.

The typical time required for the TS3500 tape library to inventory cartridges is less than 60 seconds per frame.

An inventory operation includes a check to determine whether each cartridge storage slot in the library is empty or full, and a scan of the bar code labels. An inventory occurs whenever you:

- Power on the TS3500 tape library
- Issue the SCSI Initialize Element Status with Range command
- Select the appropriate menu options from the Tape Library Specialist Web interface (see the section about performing an inventory of the library in the *IBM TS3500 with ALMS Operator Guide*)
- Select Inventory from the Manual Operations menu on the library's operator panel
- Close the front door after manually accessing the inventory

Note: The TS3500 tape library tracks the logical location of all of its elements by performing an automatic inventory as required (if you issue the SCSI Initialize Element Status command, it is allowed but ignored). The automatic inventory improves application performance.

When the library performs an automatic inventory because the front door was closed, the inventory occurs only for those frames whose doors have been opened.

Inventory with audit times

The process of moving cartridges in an HD slot in order to scan each barcode label is referred to as an *audit*. For all inventory operations, an HD slot is only audited when one of the following changes occurs:

- A Tier 1 cartridge barcode label has changed
- Enough Tier 1 barcode labels have changed in a column to warrant an audit of the entire column of HD slots

An audit can also be requested via the Tape Library Specialist Web interface or by using a vendor-specific SCSI command.

Note: It is recommended that manual access of HD slots be limited to the initial bulk loading of the frame.

The typical time required for the TS3500 tape library to audit cartridges is less than 30 seconds per full HD slot. The typical time required for the TS3500 tape library to audit a column of full HD slots in a Model S54 frame is less than 10 minutes and in a Model S24 frame is less than 8 minutes. If the inventory with audit includes column 9 of an HD frame at the end of a library string, the inventory could take an additional 3 to 6 minutes.

Mount performance and cartridge move time

This section describes mount performance and cartridge move times for the TS3500 tape library.

Mounts per hour is a measure of the overall capability of the cartridge accessor and tape drives. It is defined as the number of cartridges that the TS3500 tape

library can mount in one hour. A mount, often called the demount and mount cycle, involves the following steps: (1) removing the cartridge from a drive; (2) returning it to a storage slot; (3) collecting another cartridge from a random storage slot; (4) moving it to the drive; and (5) loading the cartridge into the drive.

Move time is the time required for the cartridge accessor to pick a cartridge from a random slot, move the cartridge to a drive, pivot (if required), and insert the cartridge into the drive.

Table 27 shows the mount performance and average move time for a TS3500 tape library without dual accessors and without HD frames.

Table 27. Mount performance and move time for drives in a TS3500 tape library without dual accessors and without HD frames

Library Configuration	Drives in Frame 1		Drives in Center Frame	
	Mounts Per Hour	Average Move Time in Seconds	Mounts Per Hour	Average Move Time in Seconds
1 frame	550	2.7	N/A	N/A
2 frames	520	2.6	N/A	N/A
4 frames	410	3.3	430	2.9
6 frames	350	3.8	380	3.3
8 frames	310	4.4	350	3.7
12 frames	255	5.3	300	4.3
16 frames	215	6.2	260	4.7
Specifications were produced from models, but are consistent with test results.				

Table 28 shows the mount performance for a TS3500 tape library with dual accessors but without HD frames.

Table 28. Mount performance for drives in a TS3500 tape library with dual accessors but without HD frames

Library Configuration (Active Frames[1])	Mounts Per Hour[2]
4 frames	1000
6 frames	900
8 frames	800
12 frames	700
16 frames	600

Notes:

1. Active frames are all frames in a dual-accessor library except service bay frames.
2. Specifications were produced from models, but are consistent with test results. This data assumes that the library is partitioned into at least two logical libraries, such that each of the cartridges located in the two zones are mounted in drives within each zone with no accessor path overlap. Detailed performance data and tips about maximizing the performance of a TS3500 tape library are available in the *IBM 3584 Tape Library Performance* white paper. For information about this document, contact your IBM Representative.

In order to understand how HD frames affect mount performance and cartridge move time, refer to "HD frame performance considerations" on page 91.

Import and export performance with virtual I/O slots

This topic describes import and export performance in the TS3500 tape library with virtual I/O slots enabled.

Virtual I/O slots increase the quantity of available I/O slots by allowing storage slots to appear to the host as I/O slots. With virtual I/O slots, the library automatically moves cartridges between the I/O stations and the storage slots. In this way, the library enhances its import and export capabilities.

Imports per hour and average I/O station drain time can vary depending on whether a library has single or dual accessors, and whether the library has HD frames. *Imports per hour* is defined as the average number of cartridges imported in one hour. *Average I/O station drain time* is defined as the time it takes one active accessor to import 16 cartridges from one I/O station into the library. Both specifications assume there is no other activity in the library.

Table 29 shows the imports per hour and average I/O station drain time using one active accessor in a TS3500 tape library with virtual I/O slots enabled, but without HD frames. Table 30 shows imports per hour in a TS3500 tape library with dual active accessors and virtual I/O slots enabled, but without HD frames.

Table 29. Specifications for imports per hour and average I/O station drain time for a TS3500 tape library using one active accessor

Library configuration	I/O station in frame 1		I/O station in center frame	
	Imports per hour[1]	**Average I/O Station Drain Time (in Seconds)[1]**	**Imports per hour[1]**	**Average I/O Station Drain Time (in Seconds)[1]**
1 frame	829	69	N/A	N/A
2 frames	725	79	N/A	N/A
4 frames	640	90	678	85
6 frames	585	98	639	90
8 frames	536	107	603	95
12 frames	466	123	556	103
16 frames	412	139	513	112

Notes:

1. The following library setup was used to obtain the stated performance data:
   - ALMS and virtual I/O slots are enabled
   - Cartridge assignment policy is setup for each logical library
   - No HD frames

Table 29 lists the specifications for import performance only. Export performance is designed to be within 20% of import performance when cartridges are being exported from tier 0 and tier 1 slots. In other words, for recently used cartridges and all cartridges in non-HD frames, exports per hour will be between 80% to 100% of imports per hour, and average I/O station fill time will be between 100% to 120% of the average I/O station drain time.

Table 30. Specifications for imports per hour for a TS3500 tape library with dual active accessors and I/O Stations in both accessor zones

Library configuration (active frames)[1]	Imports per hour[2,3]
4 frames	1400

Table 30. Specifications for imports per hour for a TS3500 tape library with dual active accessors and I/O Stations in both accessor zones (continued)

6 frames	1300
8 frames	1200
12 frames	1100
16 frames	1000

Notes:

1. Active frames are all frames in a dual-accessor library, except for service bays.
2. The following library setup was used to obtain the stated performance data:
   - ALMS and virtual I/O slots are enabled
   - Cartridge assignment policy is setup for each logical library
   - No HD frames
3. The data assumes that the library is partitioned into two separate zones, such that the cartridges assigned to the logical libraries in the two zones are imported and exported using the I/O stations within each zone with no accessor path overlap.

Table 30 on page 90 lists the specifications for import performance only. Export performance is designed to be within 20% of import performance when cartridges are being exported from tier 0 and tier 1 slots. In other words, for recently used cartridges and all cartridges in non-HD frames, exports per hour range between 80% and 100% of imports per hour.

Import and export performance is impacted in a library with HD frames. For more information, refer to "HD frame performance considerations."

HD frame performance considerations

In HD frames, the cartridge accessor performs a *shuffle* operation in order to access the cartridges stored in Tier 2 and beyond. A shuffle is the process of moving cartridges in lower tiers into the gripper, or other available slots, in order to access cartridges in higher tiers (Tier 2 or greater). In order to reduce the occurrence of shuffle operations, and to take advantage of repeated accesses of certain cartridges, the role of *cartridge cache* is assigned to all single-deep (Tier 0) slots in an HD library. In order to maintain efficient shuffle operations, the library performs a *load balancing* of the tiers, which stores cartridges across all HD slots in the library string. In other words, all HD slots are filled to a minimum tier level until that tier is full across the library. This reduces the need to access cartridges in higher tiers.

The mount performance for a TS3500 tape library that includes HD frames is dependent on the library configuration and cartridge usage. For most configurations, the impact is not noticeable. For configurations with high accessor utilization (as measured in mounts per hour), the overall reduction in mount performance compared to a TS3500 tape library without HD frames can range from no impact to a worst-case 50% reduction in mounts per hour (for a 99% full library in which all expansion frames are HD frames). This reduction in mount performance is determined by the distribution of tiers that cartridges are mounted from and the need to destage least-recently-used (LRU) cartridges from the cartridge cache. The library configuration and cartridge usage influences the reduction in mount performance in the following ways:

- Each non-HD frame in the configuration increases the mounts from Tier 0

- Unlicensed capacity decreases the mounts from the highest tiers and decreases the time required for shuffle operations (load balancing ensures the highest tiers are the last ones utilized)
- Lower capacity utilization decreases the mounts from the highest tiers and decreases the time required for shuffle operations (load balancing ensures the highest tiers are the last ones utilized)
- A higher ratio of cartridges that are mounted more than once (*cartridge cache hits*) increases the mounts from Tiers 0 and 1
- Cartridge eject operations prior to mount operations reduce the need to destage LRU cartridges (this is because eject operations empty some Tier 0 slots)

Eject and insert performance can also be impacted for a TS3500 tape library that includes HD frames. The impact to eject performance is determined by factors similar to mount performance (distribution of tiers from which cartridges are ejected). The impact to insert performance is different because inserts tend to go to HD frames since Tier 0 slots are nominally kept full. This impact to insert performance is determined by the following factors:

- A shorter time delay between eject and insert operations increases the inserts to non-HD frames (this is because eject operations will empty some number of Tier 0 slots)
- A shorter distance between the I/O stations used for inserts and the HD frames decreases the insert move time to those frames

For more information about HD frames, see “High-density technology” on page 9.

Shuttle complex performance considerations

In order to move a cartridge from one library string to another, the cartridge is first placed in a shuttle car by the cartridge accessor. The cartridge is then moved across the shuttle connection and is removed by the cartridge accessor at the destination library. The time for the shuttle car to move from one library to the next varies based on installation distances, but is as low as five seconds in optimal configurations.

Mount performance and cartridge move time in a shuttle complex depends on the overall configuration of the complex, including the length of the shuttle connections and the location of the available drive. In order to maximize performance, the application should only use remote tape drives if all drives are full in the home logical library. In addition, the application can further maximize performance in a shuttle complex by supporting a "floating home library" algorithm so that cartridges make one-way trips rather than round trips across shuttle connections. However, a "floating home library" algorithm increases the need for customer monitoring for an imbalance of cartridges across libraries that can lead to a full, or nearly full, capacity utilization of a library string.

Chapter 2. Physical planning specifications

This chapter describes the physical planning specifications for the TS3500 tape library and also provides planning considerations for a TS3500 tape library shuttle complex.

For optimum operation of the TS3500 tape library, make sure that you place it in an environment that meets the requirements described in the following sections. For proper performance in a TS3500 tape library shuttle complex, also review and understand the physical requirements for this configuration.

The library, individual library frames, and shuttle complex components are installed by an IBM service representative.

Height and length of the frames of the library

This topic provides the height of TS3500 tape library frames to help plan for shipment and installation.

Each frame of the TS3500 tape library has a set of casters and four leveling jack screws. The casters and leveling jackscrews that attach to the TS3500 tape library affect its height.

- The nominal height from the bottom of the jack screws to the top of the frame is 1840 mm (72.4 in.). This height can vary by ±40 mm (±1.6 in.).
- The shipping height of the library (on its casters and with jack screws raised and not including the pallet) is 1 800 mm (70.9 in.).
- The height of a frame with a shuttle connection is 2 275 mm (89.57 in.).

For detailed information about the physical specifications of each library frame, refer to the topic about the frame model physical specifications. To calculate the length of your fully configured library, or fully configured shuttle complex, refer to the topic about clearance specifications for the library.

Library placement

To ensure optimal performance, the TS3500 tape library must be placed in a location that meets certain requirements and environmental specifications.

To avoid damage to the library, tape drives, and tape media, place the TS3500 tape library away from equipment that produces any of the following pollutants (such as laser printers, ultrasonic humidifiers, and ionizers):

- Airborne dust
- Particulate pollution
- Corrosive fumes

Refer to “Environmental specifications” on page 119 for detailed information about gaseous and particulate contamination.

Physical specifications for Models L22 and D22

This section gives physical specifications (such as height, width, depth, and weight) of Models L22 and D22 of the TS3500 tape library.

Table 31. Physical characteristics of the TS3500 tape library, Models L22 and D22

Physical Characteristic	**Measurement**	
Height of L22 and D22 frames (on casters)	1800 mm (70.9 in.)	
Width of L22 frame with covers	782 mm (30.8 in.)	
Width of L22 or D22 frame without covers[1]	725 mm (28.5 in.)	
Depth of L22 or D22 frame (including front and rear doors)	1212 mm (47.72 in.)	
Weight of second accessor	15.1 kg (33.3 lbs)	
	Model L22	**Model D22**
Weight of base frame with 1 drive and 0 cartridges[2]	364 kg (802 lb)	N/A[3]
Weight of base frame with 12 drives and maximum cartridges (238 for 3592 Tape Cartridges)[2]	534 kg (1178 lb)	N/A
Weight of expansion frame with 0 drives and 0 cartridges[2]	N/A	270 kg (596 lb)
Weight of expansion frame with 12 drives and maximum cartridges (360 for 3592 tape cartridges)[2]	N/A	494 kg (1089 lb)

Notes:

1. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
2. The weight with cartridges assumes a cartridge weight of .242 kg (.534 lb) for a standard 3592 tape cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.
3. N/A = Not applicable.

Physical specifications for Models L23 and D23

This section gives physical specifications (such as height, width, depth, and weight) of Models L23 and D23 of the TS3500 tape library.

Table 32. Physical characteristics of the TS3500 tape library, Models L23 and D23

Physical Characteristic	**Measurement**	
Height of L23 and D23 frames (on casters)	1800 mm (70.9 in.)	
Width of L23 frame with covers	782 mm (30.8 in.)	
Width of L23 or D23 frame without covers[1]	725 mm (28.5 in.)	
Depth of L23 or D23 frame (including front and rear doors)	1212 mm (47.72 in.)	
Weight of second accessor	15.1 kg (33.3 lbs)	
	Model L23	**Model D23**
Weight of base frame with 1 drive and 0 cartridges[2]	361 kg (796 lb)	N/A
Weight of base frame with 12 drives, maximum (238[2]) 3592 tape cartridges, and backend Fibre Channel switches[3]	525.75 kg (1 160 lb)	N/A
Weight of expansion frame with 0 drives and 0 cartridges and 4 I/O stations[2]	N/A	296 kg (645 lb)
Weight of expansion frame with 12 drives, maximum (360[2]) 3592 tape cartridges, and backend Fibre Channel switches[3]	N/A	487.75 kg (1 075 lb)

Notes: N/A = Not applicable.

1. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
2. The weight with cartridges assumes a cartridge weight of .242 kg (.534 lb) for a standard 3592 tape cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.
3. The weight of the backend Fibre Channel switches includes the required power distribution unit, cables, and mounting hardware.

Physical specifications for Models L32 and D32

This section gives physical specifications (such as height, width, depth, and weight) of Models L32 and D32 of the TS3500 tape library.

Table 33. Physical characteristics of the TS3500 tape library, Models L32 and D32

Physical Characteristic	**Measurement**	
Height of L32 and D32 frames (on casters)	1800 mm (70.9 in.)	
Width of frame with covers	748 mm (29.4 in.)	
Width of frame without covers[1]	725 mm (28.5 in.)	
Depth of L32 or D32 frame (including front and rear doors)	1520 mm (59.8 in.)	
	Model L32	**Model D32**
Weight of base frame with 1 drive and 0 cartridges[2]	425 kg (937 lb)	N/A
Weight of base frame with 12 drives and maximum cartridges (227 for Ultrium tape cartridges)[2]	570 kg (1256 lb)	N/A
Weight of expansion frame with 0 drives and 0 cartridges[2]	N/A	355 kg (784 lb)
Weight of expansion frame with 12 drives and maximum cartridges (396 Ultrium tape cartridges)[2]	N/A	558 kg (1229 lb)

Notes: N/A = Not applicable.

1. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
2. The weight with cartridges assumes a cartridge weight of .206 kg (.454 lb) for a standard LTO Ultrium tape cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.

Physical specifications for Models L52 and D52

This section gives physical specifications (such as height, width, depth, and weight) of Models L52 and D52 of the TS3500 tape library.

Table 34. Physical characteristics of the TS3500 tape library, Models L52 and D52

Physical Characteristic	**Measurement**	
Height of L52 and D52 frames (on casters)	1800 mm (70.9 in.)	
Width of L52 frame with covers	782 mm (30.8 in.)	
Width of L52 or D52 frame without covers[1]	725 mm (28.5 in.)	
Depth of L52 or D52 frame (including front and rear doors)	1212 mm (47.72 in.)	
Weight of second accessor	15.1 kg (33.3 lbs)	
	Model L52	**Model D52**
Weight of base frame with 1 drive and 0 cartridges[2]	366 kg (806 lb)	N/A
Weight of base frame with 12 drives and maximum cartridges (262 for Ultrium tape cartridges)[2]	526 kg (1160 lb)	N/A
Weight of expansion frame with 0 drives and 0 cartridges[2]	N/A	274 kg (604 lb)
Weight of expansion frame with 12 drives and maximum cartridges (396 for Ultrium tape cartridges)[2]	N/A	483 kg (1065 lb)

Notes: N/A = Not applicable.

1. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
2. The weight with cartridges assumes a cartridge weight of .206 kg (.454 lb) for a standard LTO Ultrium tape cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.

Physical specifications for Models L53 and D53

This section gives physical specifications (such as height, width, depth, and weight) of Models L53 and D53 of the TS3500 tape library.

Table 35. Physical characteristics of the TS3500 tape library, Models L53 and D53

Physical Characteristic	**Measurement**	
Height of L53 and D53 frames (on casters)	1800 mm (70.9 in.)	
Width of L53 frame with covers	782 mm (30.8 in.)	
Width of L53 or D53 frame without covers[1]	725 mm (28.5 in.)	
Depth of L53 or D53 frame (including front and rear doors)	1212 mm (47.72 in.)	
Weight of second accessor	15.1 kg (33.3 lbs)	
	Model L53	**Model D53**
Weight of base frame with 1 drive and 0 cartridges[2]	363 kg (799 lb)	N/A
Weight of base frame with 12 drives and maximum (262[2]) Ultrium tape cartridges	481 kg (1061 lb)	N/A
Weight of expansion frame with 0 drives and 0 cartridges and 4 I/O stations[2]	N/A	296 kg (654 lb)
Weight of expansion frame with 12 drives and maximum (396[2]) Ultrium tape cartridges	N/A	440 kg (970 lb)

Notes: N/A = Not applicable.

1. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
2. The weight with cartridges assumes a cartridge weight of .206 kg (.454 lb) for a standard LTO Ultrium tape cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.

Physical specifications for HA1 Frame

This section gives the height, width, depth, and weight of the HA1 frame of the TS3500 tape library.

If your TS3500 tape library contains a second accessor, the following are the physical specifications for the HA1 frame (service bay A).

Table 36. Physical characteristics of the HA1 frame (service bay A)

Physical Characteristic	**Measurement**
Height of HA1 frames (on casters)	1800 mm (70.9 in.)
Width of HA1 frame without covers (see Note)	725 mm (28.5 in.)
Depth of HA1 frame	1212 mm (47.72 in.)
Weight of HA1 frame	261 kg (575 lb)
Note: Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.	

Physical specifications for Model S24

This section gives physical specifications (such as height, width, depth, and weight) for Model S24 of the TS3500 tape library.

Table 37. Physical characteristics of the TS3500 tape libraryModel S24

Physical Characteristic	Measurement
Height of S24 frame (on casters)	1 800 mm (70.9 in.)
Height of S24 frame with shuttle station[3]	2 275 mm (89.57 in.)
Width of S24 frame with covers	782 mm (30.8 in.)
Width of S24 frame without covers[1]	725 mm (28.5 in.)
Depth of S24 frame (including front and rear doors)	1 212 mm (47.72 in.)
Weight of base frame with 0 cartridges	285.8 kg (630 lb)
Weight of base frame with shuttle station and 0 cartridges[3]	302 kg (665.8 lb)
Weight of frame with maximum (1 000) 3592 tape cartridges[2]	526.2 kg (1 160 lb)
Weight of frame with shuttle station and maximum (1 000) 3592 tape cartridges[3]	542.4 kg (1 195.79 lb)

Notes:

1. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
2. The weight with cartridges assumes a cartridge weight of .242 kg (.534 lb) for a standard 3592 tape cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.
3. One shuttle station can optionally be mounted on a Model S24 frame in a TS3500 tape library shuttle complex.

Physical specifications for Model S54

This section gives physical specifications (such as height, width, depth, and weight) for Model S54 of the TS3500 tape library.

Table 38. Physical characteristics of the TS3500 tape library, Model S54

Physical Characteristic	Measurement
Height of S54 frame (on casters)	1 800 mm (70.9 in.)
Height of S54 frame with shuttle station[3]	2 275 mm (89.57 in.)
Width of frame with covers	782 mm (30.8 in.)
Width of frame without covers[1]	725 mm (28.5 in.)
Depth of S54 frame (including front and rear doors)	1 212 mm (47.72 in.)
Weight of base frame with 0 cartridges	290.3 kg (640 lb)
Weight of base frame with shuttle station and 0 cartridges[3]	306.5 kg (675.72 lb)
Weight of frame with maximum cartridges (1 320 Ultrium tape cartridges)[2]	562.5 kg (1 240 lb)
Weight of frame with shuttle station and maximum (1 320) Ultrium tape cartridges[3]	578.7 kg (1 275.82 lb)

Notes:

1. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
2. The weight with cartridges assumes a cartridge weight of .206 kg (.454 lb) for a standard LTO Ultrium tape cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.
3. One shuttle station can optionally be mounted on a Model S54 frame in a TS3500 tape library shuttle complex.

Floor requirements

The TS3500 tape library must be placed on floor space that meets the following specifications. Use the list of allowable variances for floor stability, unevenness, and point load bearing qualities to determine where the TS3500 tape library is placed.

Install the library on a raised or solid floor. The floor must have a smooth surface and, if raised, must not have ventilation panels beneath the leveling jackscrews. If carpeted, ensure that the carpet is approved for computer-room applications.

To accommodate unevenness in the floor, you can raise or lower the leveling jack-screws to the following specifications:

- Maximum allowable variance must not exceed 7 mm (.27 inches) per 76 mm (3 inches).
- Maximum out-of-level condition must not exceed 40 mm (1.6 inches) over the entire length and width of the library.

The floor on which the TS3500 tape library is installed must be able to support:

- Up to 4.8 kilograms per square centimeter (68.6 pounds per square inch) of point loads that are exerted by the leveling jack-screws.
- Up to 211 kilograms per square meter (43.4 pounds per square foot) of overall floor loading.

The number of point loads that is exerted depends on the number of frames that make up the library. There are four point loads per frame (at the corners of each frame).

Delivery route

The TS3500 tape library must be delivered using a planned route. Guidelines for planning the delivery route are specified in the “Delivery route” section.

Check the delivery route that the library must travel from your loading dock to the installation location. Ensure that the library will fit through all doors, hallways, and elevators.

You must remove the library from the pallet and place it at the final location before you call your IBM Service Representative to arrange for the installation. Refer to the instructions on the shipping carton for correct unpacking procedures.

Delivery and subsequent transportation of the equipment

Prepare the environment to accept the new product based on the installation planning information provided by the IPR or IBM-authorized service provider. Prepare the final installation site in advance of the equipment delivery to assist professional movers or riggers to then transport the equipment to the final installation site within the computer room. If, for some reason, this is not possible at the time of delivery, make arrangements to have professional movers or riggers return to finish the transportation at a later date.

Note: You must use professional movers or riggers to relocate and, if necessary, dispose of equipment. The IBM-authorized service provider will perform only minimal frame repositioning within the computer room, as needed, to perform required service actions.

Security

The equipment must be located so that access to the equipment can be controlled and monitored. Consider all of these recommended security measures when you are determining where to locate your TS3500 tape library.

Library location

You are responsible for the security of the TS3500 tape library, the cartridges that are contained within the library, and shelf-resident cartridges. To prevent unauthorized access to data, IBM recommends locating the TS3500 tape library and all shelf-resident cartridges in an area where access is controlled.

Locking mechanisms

The I/O stations have locking mechanisms that prevent you from opening an I/O station door when the accessor is manipulating cartridges in a station. The library's front door has a key lock. The key-lock is the same for every front door, and the keys are shipped with the library. The library's rear door has a different key lock. The key lock is the same for every rear door and the keys are shipped with the library.

Onsite security measures

You are also responsible for evaluating, selecting, and implementing security features, administrative procedures, and appropriate controls in application systems and communication facilities.

Data security

Data security is the responsibility of the application program that controls the library. If you are an administrator or superuser, you can enable or disable security for the operator panel. If you enable security, you can provide further protection by creating a password. You can also specify a timeout period, which, when exceeded, causes the operator panel to lock.

Move restraints

The TS3500 tape library has several move restraints (adjustable points) that you can use to restrain the unit from potential movement (such as an earthquake). Use the diagram as a guide to help you locate the move restraints.

Restraining points are at the bottom of the unit (see **1** in Figure 17 on page 105). Affix restraints to each of the four points (two on each long side) and secure the library as needed. The restraint points provide threaded holes, thread size M10.

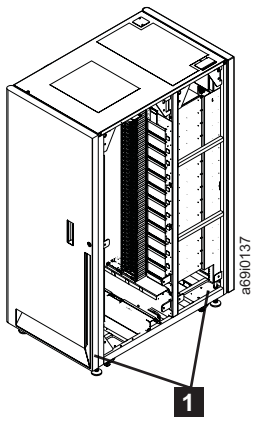


Figure 17. Location of restraining points. Two restraining points are on each long side of the library.

Clearance specifications for the library

Clearances are required around the TS3500 tape library to enable access for you or IBM service representatives to use or work on the library. Use this information when you are determining the location and position of your library.

Plan for appropriate clearances around your TS3500 tape library.

Operator clearance is required in front of all frames. Service clearance is required as follows:

- In front of and behind all frames
- At one or both ends of the library, depending on the following conditions:
  - At both ends if the library contains service bay frames
  - At either the left or the right end, if the library contains no service bay frames

    Note: Libraries with service clearance on the right end only (as you face the front door of the library) also require visual access on the left end as determined by the local service team. This visual access allows the IBM Service Representative to see the two-character display on the left side of the cartridge accessor.

Ensure that service clearance space does not overlap into high-traffic walkways where service activity might impede pedestrian traffic. As you plan clearances, consider leaving extra room on the right end of the library (as you face the front door of the library) for future expansion.

Clearance specifications for models of the Library

This section helps you to calculate the length of a TS3500 tape library and the clearances for service.

Table 39 on page 106 shows the length of the TS3500 tape library both with and without service bays and including side clearances; Figure 18 on page 107 shows the location of the clearances for Models L22, D22, L23, D23, L52, D52, L53, D53, S24, S54, and the service bays. Figure 19 on page 108 shows the location of the clearances for Models L32 and D32.

Table 39. Clearance requirements for the TS3500 tape library. The table gives the clearances for a library both with and without service bays.

Number of Active Frames	Length of A in Figure 18 on page 107 or in Figure 19 on page 108 (Not Including Service Bays) (see Notes 1, 2, and 3)	Length of A in Figure 18 on page 107 or in Figure 19 on page 108 (Including Service Bays) (see Notes 1 and 2)
1	1 544 mm (60.79 in.)	Not applicable
2	2 298 mm (90.47 in.)	4 569 mm (179.88 in.)
3	3 052 mm (120.16 in.)	5 324 mm (209.61 in.)
4	3 806 mm (149.84 in.)	6 079 mm (239.33 in.)
5	4 560 mm (179.53 in.)	6 833 mm (269.02 in.)
6	5 314 mm (209.21 in.)	7 588 mm (298.74 in.)
7	6 068 mm (238.90 in.)	8 342 mm (328.43 in.)
8	6 822 mm (268.58 in.)	9 097 mm (358.15 in.)
9	7 576 mm (298.27 in.)	9 852 mm (387.87 in.)
10	8 330 mm (327.95 in.)	10 606 mm (417.56 in.)
11	9 084 mm (357.64 in.)	11 361 mm (447.28 in.)
12	9 838 mm (387.32 in.)	12 115 mm (476.97 in.)
13	10 592 mm (417.01 in.)	12 870 mm (506.69 in.)
14	11 346 mm (446.69 in.)	13 625 mm (536.42 in.)
15	12 100 mm (476.38 in.)	14 379 mm (566.10 in.)
16	12 863 mm (506.42 in.)	15 134 mm (595.3 in.)

Note:

1. For Models L22, D22, L23, D23, L52, D52, L53, D53, S24, S54, and the service bays, the size of a clearance is measured by its depth from the outside of the frame and its width along the library. At the ends of the library, the depth of the service clearance is measured from the front of the library to the rear. In Figure 18 on page 107, B refers to the distance (2737 mm or 107.8 in.) that is the total service clearance between the front and the rear of the library.
2. For Models L32 and D32, the size of a clearance is measured by its depth from the outside of the frame and its width along the library. At the ends of the library, the depth of the service clearance is measured from the front of the library to the rear. In Figure 19 on page 108, B refers to the distance (3044 mm or 119.8 in.) that is the total service clearance between the front and the rear of the library.
3. For libraries with service clearance on the right end only (as you face the front door), visual access is also required on the left end as determined by the local service team. This visual access allows the IBM Service Representative to see the 2-character display on the left side of the cartridge accessor.

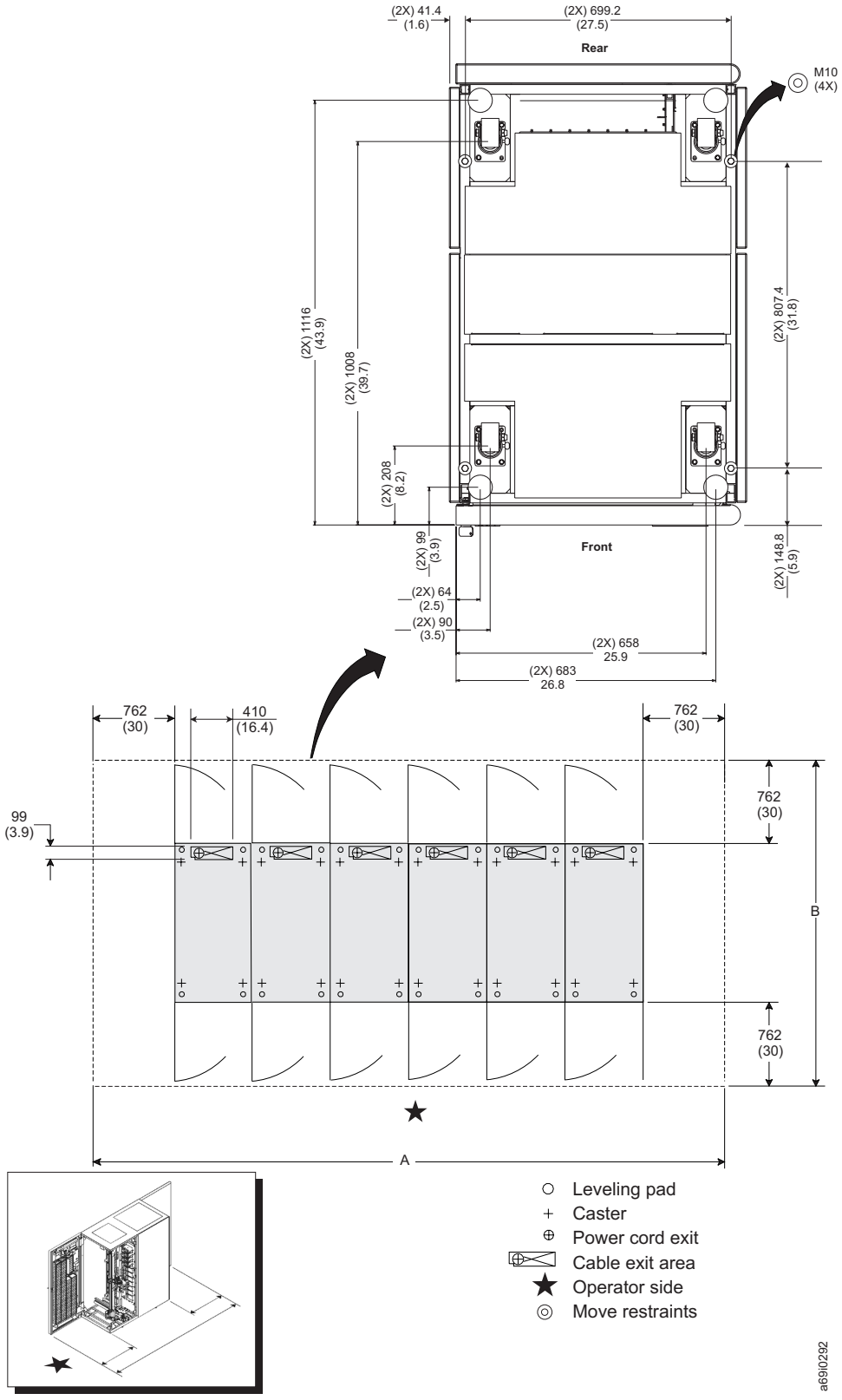


Figure 18. Size of operator and service clearances for the IBM TS3500, Models L22, D22, L23, D23, L52, D52, L53, D53, S24, S54, and the service bays. The top measurements are in millimeters; the bottom measurements are in inches. The service clearance area (and operator clearance area at the front of both frames) is denoted by dotted lines.

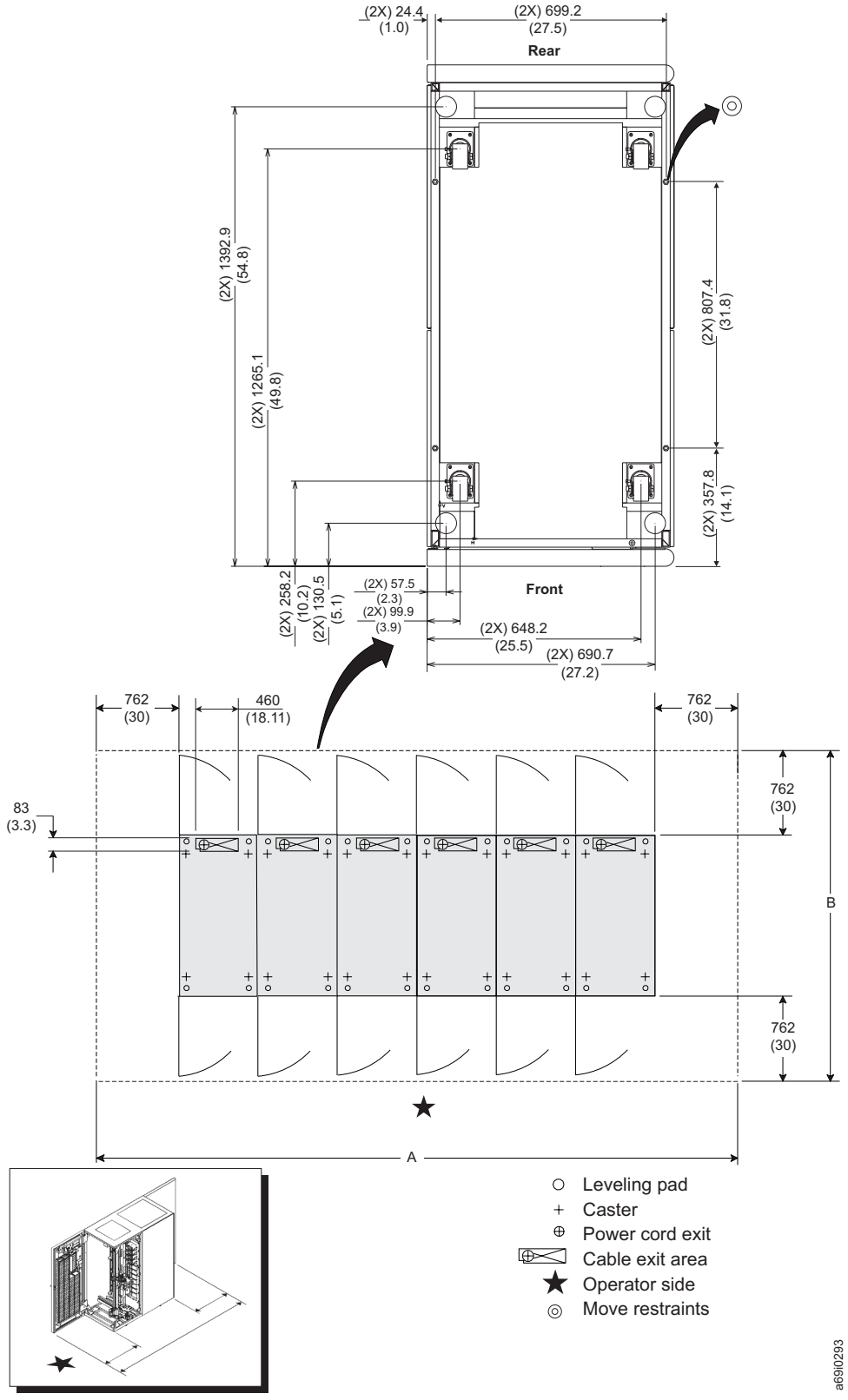


Figure 19. Size of operator and service clearances for the IBM TS3500, Models L32 and D32. The top measurements are in millimeters; the bottom measurements are in inches. The service clearance area (and operator clearance area at the front of both frames) is denoted by dotted lines.

Clearance specifications for the shuttle complex

This topic provides dimensions of a TS3500 tape library shuttle complex and helps you to calculate the required clearances for access and service.

The clearance specifications for a TS3500 tape library shuttle complex vary depending on the selected configuration. Be sure to consider the following items when designing and installing your shuttle complex:

- Service and operator clearance around each library string in the shuttle complex
- Height of ceiling and ceiling-mounted appliances

  Note: A minimum ceiling height of 8 feet is required for shuttle complex installation and service.
- Fire-suppression system and position of ceiling-mounted sprinkler heads

Figure 20 on page 110 shows a shuttle complex of two parallel six-frame library strings. The ★ indicates the operator side of the library. As shown, the front doors of each library string in a shuttle complex must face the same direction.

Variable dimension **A**, in Figure 20 on page 110, shows the width of the walkway between library strings. When the short span is ordered (feature code 1850), **A** can range from 762 mm (30 in.) to 1 524 mm (60 in.). When the long span is ordered (feature code 1851), **A** can range from 1 524 mm (60 in.) to 2 743 mm (108 in.). A tolerance of +/− 50 mm (2 in.) can be applied to the maximum dimension of the short span and the minimum dimension of the long span in order to allow for flexibility in space planning. Dimension **B** shows the minimum height of the walkway between connected library strings. This is the distance from the floor to the bottom of the shuttle connection. Variable dimension **C** shows the distance between shuttle connections. If shuttle connections are mounted on adjacent frames, the distance between them is 418 mm (16.5 in.). If there are additional frames between shuttle connections, it is necessary to add 782 mm (30.8 in.) per interim frame to this figure in order to determine the distance between shuttle connections. Dimension **D** shows the maximum height of the shuttle complex. This is the maximum distance from the floor to the top of a shuttle connection. Note that a minimum ceiling height of 8 feet is required for shuttle complex installation and service.

Although perfect alignment of the two HD frames attached by a shuttle span results in the best appearance, the two parallel library strings may be slightly offset in the X-axis. The maximum allowable offset can be determined using the following formula:

Maximum offset in X = 0.13 x A

For example, if the two parallel library strings are 30 inches apart, the maximum allowable offset is 3.9 inches.

Each library string in a shuttle complex must also adhere to the operator and service clearance requirements that are detailed in “Clearance specifications for models of the Library” on page 105.

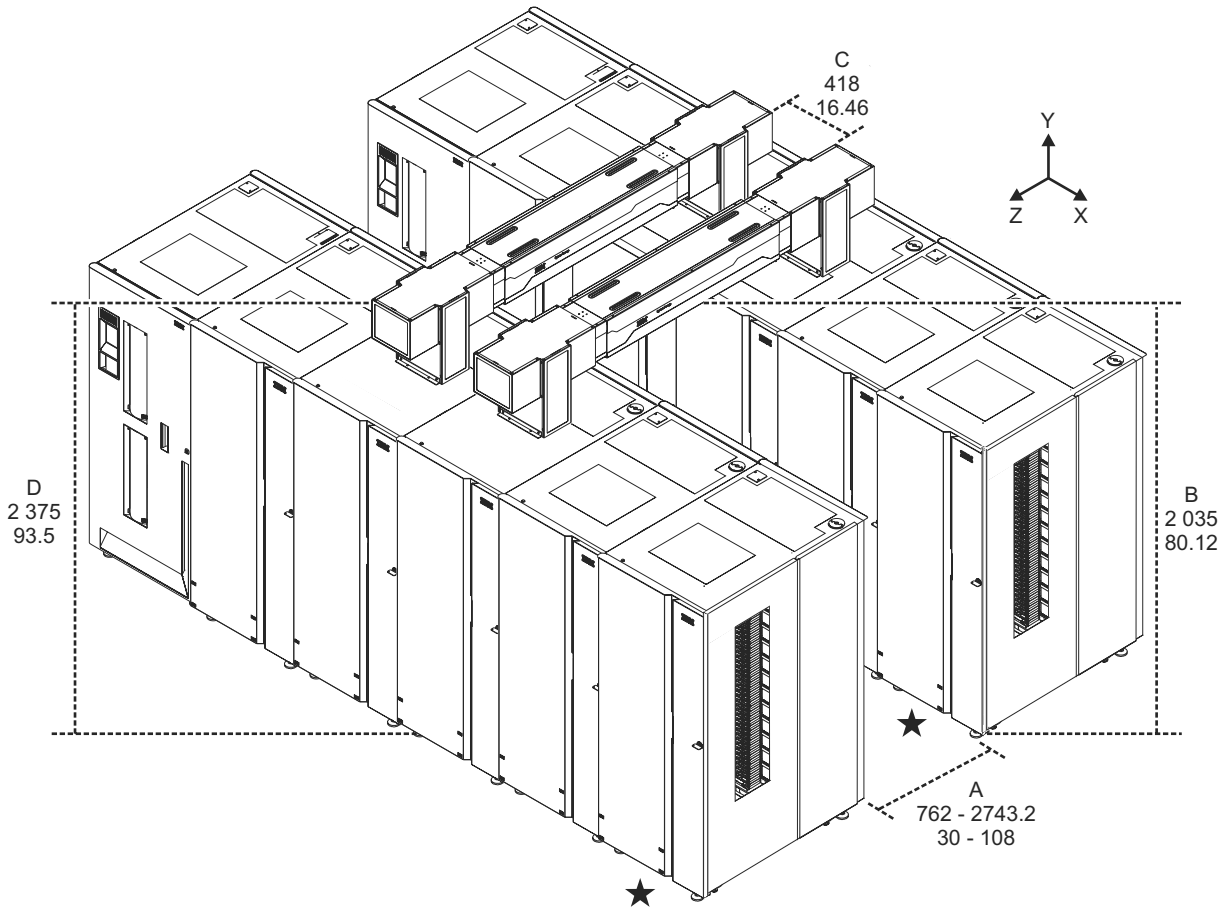


Figure 20. Shuttle complex dimensions and clearances

Routing Fibre Channel cables through the top of a frame

It is possible to route Fibre Channel cables from servers through the top of a frame in the TS3500 tape library. This routing method is an alternative to routing the Fibre Channel cables through the bulkhead at the bottom rear of the TS3500 tape library, and might be necessary if the equipment is installed on a non-raised (solid) floor.

Procedure

Note:

When your library is installed on a solid (non-raised) floor, your IBM Service Representative can route the power cables through the top of the library during installation. For more information, see the Installation chapter of the *IBM TS3500 Maintenance Information* guide.

1. Open the cable access door at the top of the frame (see **1** in Figure 21 on page 111, and Figure 22 on page 111).

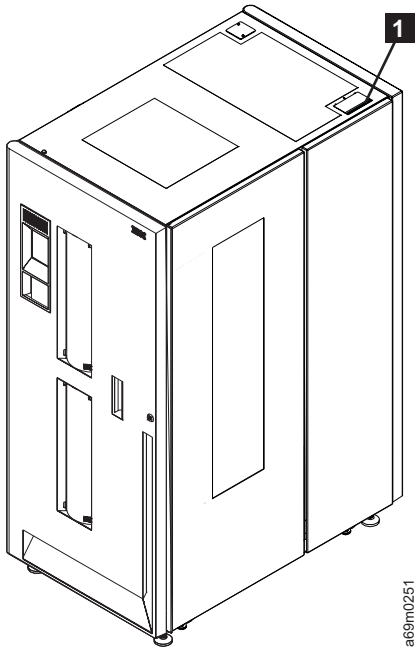


Figure 21. Opening for routing Fibre Channel cables from servers through the top of a frame

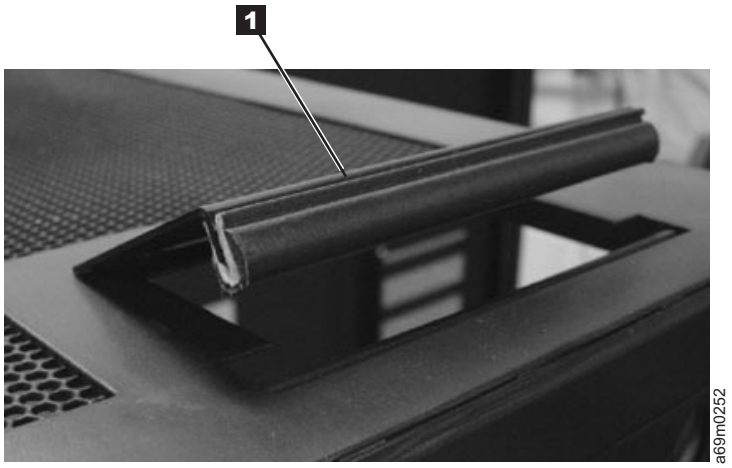


Figure 22. Opening the cable access door at the top of a frame

2. Route Fibre Channel cables from the servers into the cable access door and down to the bulkhead assembly.
3. Open the rear door of the frame.
4. Attach the Fibre Channel cables to the appropriate location in the bulkhead.
5. Use the hook and loop ties to secure the Fibre Channel cables along the left side of the frame.
6. After you route the cables inside the frame, position them as shown in Figure 23 on page 112

   Note: Ensure that all Fibre Channel cables are parallel to each other as shown. Do not cross one cable over the other, as this could damage the cable.

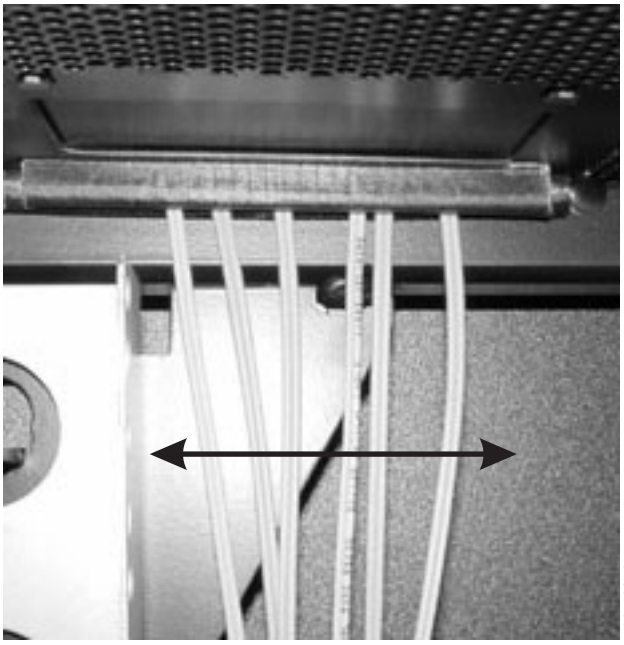


Figure 23. Positioning the Fibre Channel cable inside the frame

7. Position all of the Fibre Channel cables outside the frame as shown in Figure 24.

Figure 24. Positioning the Fibre Channel cable outside the frame

8. Carefully close the cable access door. Padding on the door holds the cables in place safely and securely.

Routing cables through the top for installations on a solid floor

It is possible to route the power cables through the top of a TS3500 tape library. This routing method might be necessary if the equipment is installed on a non-raised (solid) floor.

When your TS3500 tape library is installed on a solid (non-raised) floor, your IBM Service Representative can route the power cables through the top of the library. For information about this procedure refer to the section titled "Attach Power and Bring-Up," located in the Installation chapter of the *IBM TS3500 Maintenance Information* guide.

Mounting a web camera

You can mount a web camera in any frame of a TS3500 tape library after the mounting hardware feature has been installed by an IBM service representative. However, certain clearances are necessary to accommodate the mounting hardware and the camera.

Before you begin

A customer-supplied web camera can be installed in any frame to visually monitor the location of the library's robotics. Feature code 1530, web camera mounting hardware, is required in order to install a web camera. The maximum camera dimensions can vary, however no part of the camera should extend more than 60 mm (2.36 in.) from the center of the tripod mount. This ensures sufficient clearance (as shown in Figure 28 on page 115) so that accessor movement is not obstructed.

About this task

The camera mount (feature code 1530) can be mounted on the front or rear frame support.

Procedure

1. If the camera mount is installed on the front frame support, route the camera cables through the existing frame cable clamps (**1** in Figure 25 on page 114) along the top of the frame. Ensure the cables do not interfere with accessor operation.

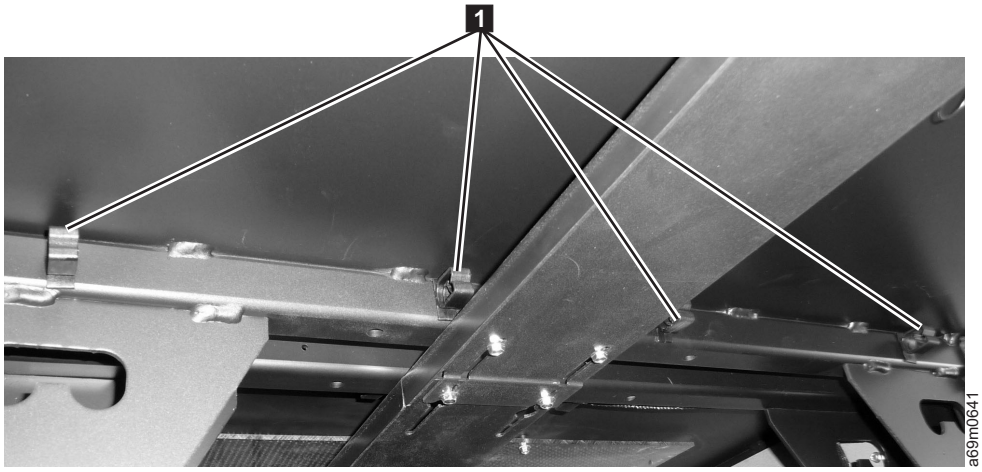


Figure 25. Cable restraint clamps

2. Route the ends of the camera cables out of the opening at the rear of the frame (**1** in Figure 26). The cables can then be routed either out of the top of the frame (where drive cables exit) or out of the bottom of the frame. Secure all cables inside the rear of the frame using existing clamps.

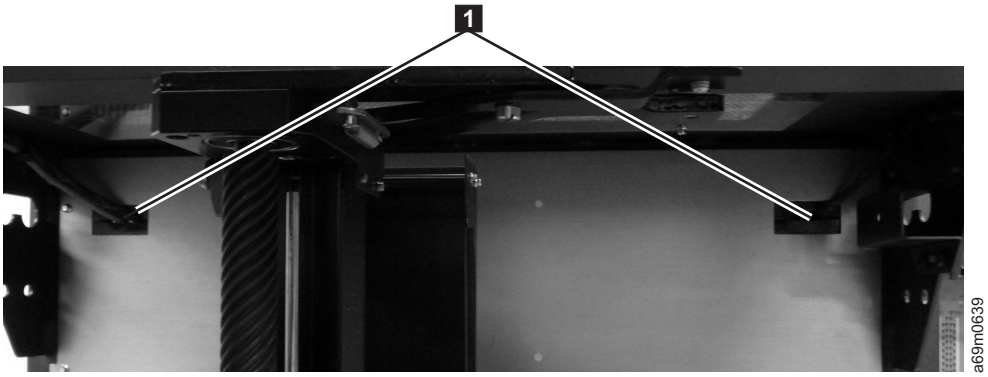


Figure 26. Rear frame openings

3. Attach the web camera to the mounting hardware as shown in Figure 27 on page 115.

   Note: The video camera must be positioned at least 13 mm (0.5 in.) from the accessor to avoid possible collision (see Figure 28 on page 115).

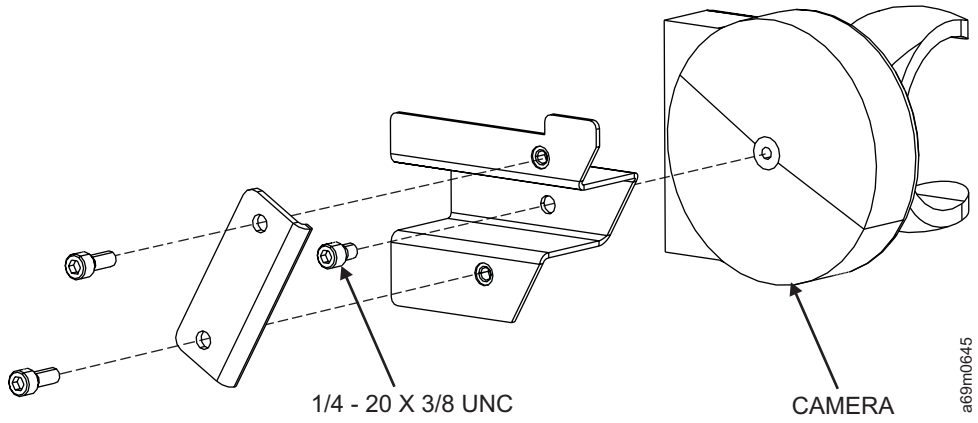


Figure 27. Camera mounting example

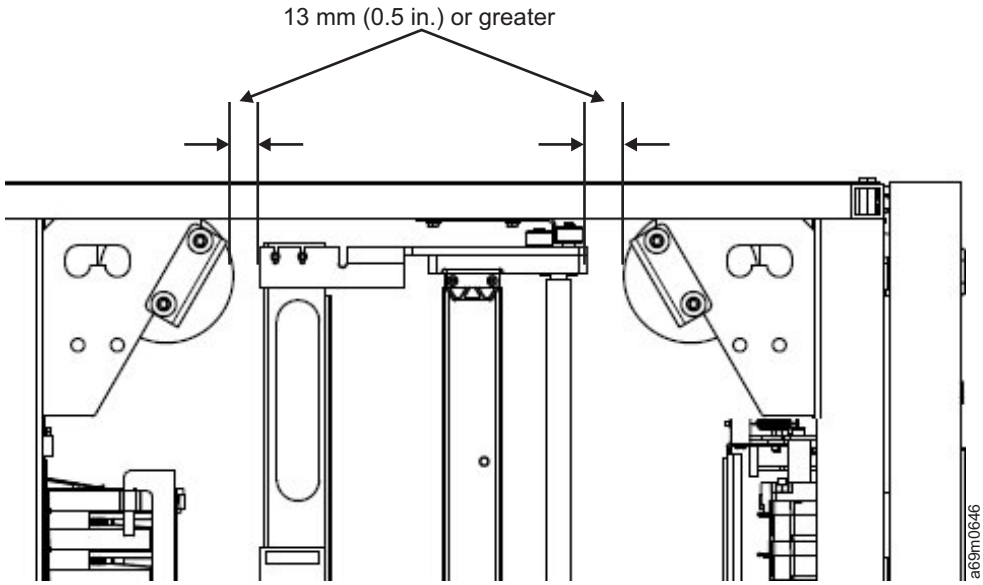


Figure 28. Camera clearance from accessor

Fire suppression for the library

A fire-suppression system is the responsibility of the customer. This topic provides a general statement about fire-suppression systems for the TS3500 tape library.

A fire-suppression system is the responsibility of the customer

Attention: For advice about selecting a fire-suppression system that provides the correct level of coverage and protection, consult your insurance underwriter, and local fire marshal (or local building inspector). IBM designs and manufactures equipment to internal and external standards that require certain environments for reliable operation. Because IBM does not test any equipment for compatibility with fire-suppression systems, IBM does not make compatibility claims of any kind nor does IBM provide recommendations on fire-suppression systems.

The TS3500 tape library is constructed to allow third-party installation of fire-suppression equipment. When deciding whether to implement fire-suppression

equipment, refer to your local and national standards and regulations.

Fire suppression for Models L32 and D32

This section describes the features of frame models L23 and D23 to be used for a fire suppression system.

Each L32 or D32 frame in the TS3500 tape library has an allowable area on the top that may be cut to allow entrance of pipes, conduits, or other parts (see **1** in Figure 29). The area is 82.7 mm (3.3 in.) wide by 504.7 mm (19.8 in.) long. The equipment can extend through the top cover for a maximum intrusion of 175 mm (6.9 in.).

Note: Do not cut the opening larger than required.

Within the frame, a depth of 175 mm (6.9 in.) is available for installing pipes, sensors, sprinklers, or other components. Piping, conduits, and cabling can be run from frame to frame only if they stay within an allowable area (see **2** in Figure 29) and do not interfere with library components.

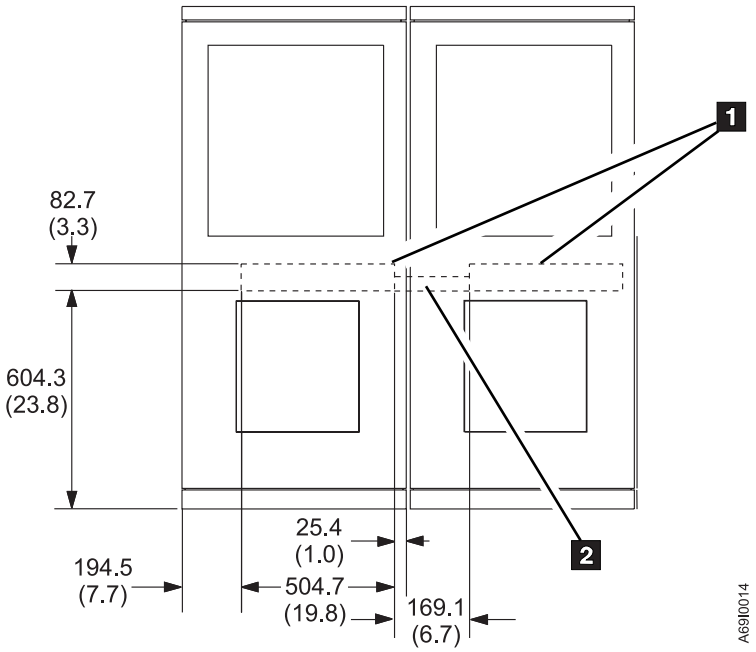


Figure 29. Allowable area for mounting fire-suppression equipment (top view of Model L32 or D32 frames)

Fire suppression for all other models

This section describes the tape library frame features provided for a fire suppression system.

Each L22, D22, L23, D23, L52, D52, L53, D53, and HA1 frame in the TS3500 tape library has an allowable area on the top that may be cut to allow entrance of pipes, conduits, or other parts (see **1** in Figure 30 on page 117). The area is 82.7 mm (3.3 in.) wide by 504.7 mm (19.8 in.) long. The equipment can extend through the top cover for a maximum intrusion of 175 mm (6.9 in.).

Note:

1. Do not cut the opening larger than required.

2. Models L22, D22, L23, D23, L52, D52, L53, D53, S24, S54, and the HA1 frame are equipped with a single perforated receptacle (**2** in Figure 30) in diameters of both 30 mm (1.2 in.) and 50 mm (2.0 in.).

Within the frame, a depth of 175 mm (6.9 in.) is available for installing pipes, sensors, sprinklers, or other components. Piping, conduits, and cabling can be run from frame to frame only if they stay within an allowable area (see **3** in Figure 30) and do not interfere with library components.

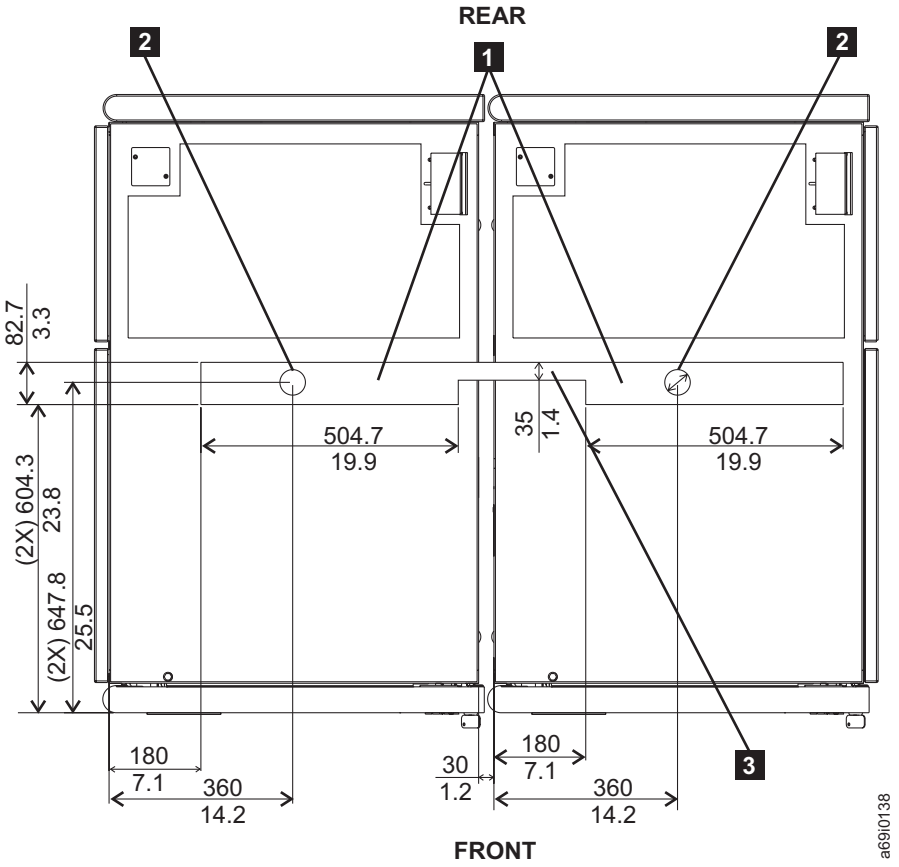


Figure 30. Allowable area for mounting fire-suppression equipment (top view of Models L22, D22, L23, D23, L52, D52, L53, D53, S24, S54, or the HA1 frame)

Attachment of cables, wiring, and pipes between frames

Attachment of cables, wiring, and pipes between frames of the TS3500 tape library requires a unique procedure.

A side view of the area available to run cables, wiring, and pipes between frames of the TS3500 tape library is shown in Figure 31. The area is a triangular section that is 81 mm (3.2 inches) wide by 140 mm (5.5 inches) long (see **1** in Figure 31). Your fire-suppression mechanical equipment must fit within the allowable area or be installed outside the library.

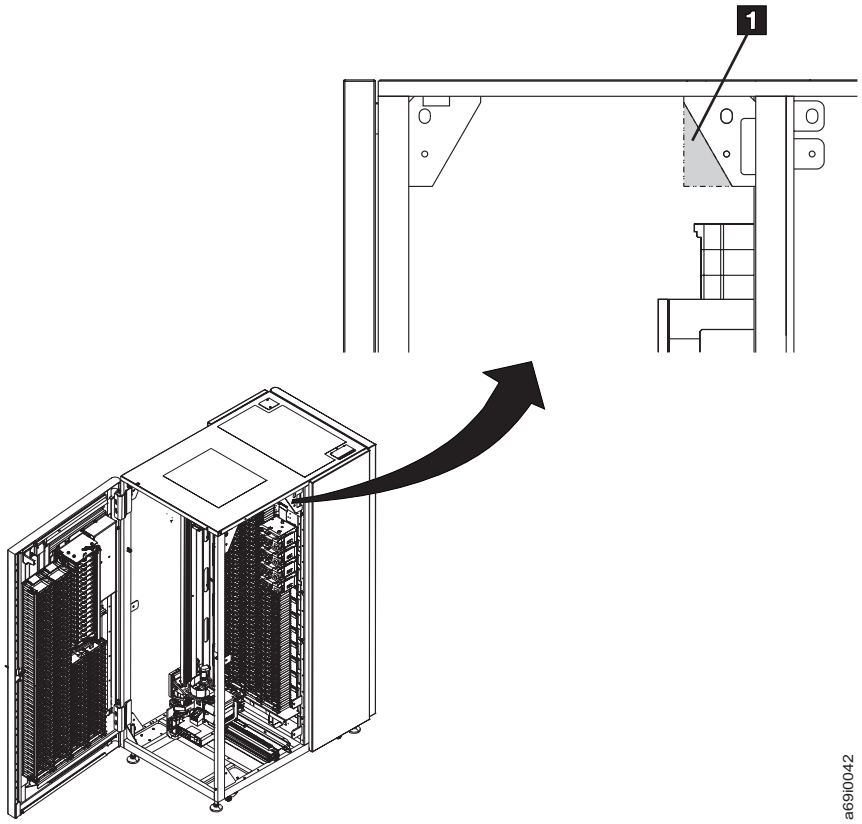


Figure 31. Location for routing fire-suppression equipment between frames

All water systems must be external to the library's frame, with mechanical support provided for piping. Sprinkler heads that extend through the top of the frame must not extend more than 175 mm (6.9 inches) below the top of the frame.

Route gaseous system piping with discharge nozzles inside the frames just below the top of the frame and within the 175-mm (6.9-inches) specification. The discharge nozzles can extend vertically no lower than 175 mm (6.9 inches) from the top of the frame. Gas cylinders and control equipment must be external to the library. IBM does not supply heat or smoke detectors.

Environmental specifications

The TS3500 tape library is compliant with the environmental guidelines set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE). Use the tables that list the environmental guidelines and acceptable levels of gas and particulate exposure to help you determine where to place the .

The information in Table 40 is excerpted from *Thermal Guidelines for Data Processing Environments*, published in 2011 by ASHRAE. Table 41 lists specifications for exposure to gaseous and particulate contaminants.

If the symbol is... It means...

Attention: The environments in Table 40 refer to the hardware of the TS3500 tape library and may lead to temperatures greater than allowable for the cartridges and media stored in the library. For frames that contain LTO tape cartridges or IBM 3592 Enterprise Tape Cartridges, refer to their environmental and shipping specifications. Then, adjust the operating environment for the library accordingly.

Refer to the topics *Environmental and shipping specifications for LTO cartridges* and *Environmental and shipping specifications for 3592 cartridges*.

Table 40. Equipment environment specifications for the IBM TS3500

Product operation[1, 2]							**Product power off** [2, 3]		
Dry-bulb temperature		Humidity range Non-condensing		Maximum dew point	Maximum elevation	Maximum rate of change[6] (°/hour)	Dry-bulb temperature	Relative humidity (%)	Maximum dew point
Allowable[4]	Recommended[5]	Allowable (% RH)	Recommended						
15 to 32°C (60 to 90°F)	18 to 25°C (64 to 80°F)	20 to 80	5.5°C (42°F) DP to 60% RH and 15°C (60°F)	17°C (63°F)	3050 m (10 000 ft.)	5°C/20 (41°F/20)	5 to 45°C (41 to 113°F)	8 to 80	27°C (81°F)

Notes:

1. Product equipment is powered on.
2. Tape products require a stable and more restricted environment (similar to Class 1). Typical requirements: minimum temperature is 15°C (60°F), maximum temperature is 32°C (90°F), minimum relative humidity is 20%, maximum relative humidity is 80%, maximum dew point is 22°C (72°F), rate of change of temperature is less than 2°C/h (36°F/h), rate of change of humidity is less than 5% RH per hour, and no condensation.
3. Product equipment is removed from the original shipping container and installed but not in use, for example, during repair, maintenance, or upgrade.
4. Derate maximum dry-bulb temperature 1°C/300 m (34°F/984 ft.) above 900 m (2 953 ft.).
5. Derate maximum recommended dry-bulb temperature 1°C/300 m (34°F/984 ft.) above 1 800 m (5 905 ft.)
6. 5°C/h (41°F/h) for data centers employing tape drives and 20°C/h (68°F/h) for data centers employing disk drives.

Table 41. Gas and particulate exposure

Contaminate	**Requirement**
Gaseous contamination	Severity level G1 as per ANSI/ISA 71.04-1985[1], which states that the reactivity rate of copper coupons shall be less than 300 Angstroms per month (Å/month, ≈ 0.0039 µg/cm² - hour weight gain)[2]. In addition, the reactivity rate of silver coupons shall be less than 300 Å/month (≈ 0.0035 µg/cm² - hour weight gain)[3]. The reactive monitoring of gaseous corrosivity should be conducted approximately 5 cm (2 in.) in front of the rack on the air inlet side at one-quarter and three-quarter frame height off the floor or where the air velocity is much higher.
Particulate contamination	Data centers must meet the cleanliness level of ISO 14644-1 class 8. For data centers without airside economizer, the ISO 14644-1 class 8 cleanliness might be met simply by the choice of the following filtration: • The room air might be continuously filtered with MERV 8 filters. • Air entering a data center might be filtered with MERV 11 or preferably MERV 13 filters. For data centers with airside economizers, the choice of filters to achieve ISO class 8 cleanliness depends on the specific conditions present at that data center. The deliquescent relative humidity of the particulate contamination should be more than 60% RH.3[4]. Data centers must be free of zinc whiskers[5].

Table 41. Gas and particulate exposure (continued)

Contaminate	Requirement
Notes:	
1. ANSI/ISA-S71.04. 1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*, Instrument Society of America, Research Triangle Park, NC, 1985.	
2. The derivation of the equivalence between the rate of copper corrosion product thickness growth in Å/month and the rate of weight gain assumes that Cu_2S and Cu_2O grow in equal proportions.	
3. The derivation of the equivalence between the rate of silver corrosion product thickness growth in Å/month and the rate of weight gain assumes that Ag_2S is the only corrosion product.	
4. 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.	
5. Surface debris is randomly collected from 10 areas of the data center on a 1.5 cm diameter disk of sticky electrically conductive tape on a metal stub. If examination of the sticky tape in a scanning electron microscope reveals no zinc whiskers, the data center is considered free of zinc whiskers.	

Acoustical specifications

Several conditions must be in place to accommodate the acoustical specifications of the TS3500 tape library. This topic provides a general statement about the acoustical specifications. (For acoustical specifications by frame model, refer to the "Acoustical specifications for models L25, D25, L55, and D55" topic.)

When the TS3500 tape library is both operating and idling, the following conditions apply:

- Power is on.
- All air-moving devices are operating.
- Tape cartridges are loaded in all drives.

When the library is operating the cartridge accessor loads, unloads, or moves tape cartridges. When the library is idling the accessor does not move.

The TS3500 tape library is a Category 1 product as defined in C-S 1-1710-006.

Acoustical specifications for Models L32 and D32

This topic provides acoustical specifications for Models L32 and D32 of the TS3500 tape library.

Table 42. Noise emission values for the IBM TS3500, Models L32 and D32

Declared Sound Power Level L_{WAd}		Mean A-weighted Sound Pressure Level at the 1 m (Bystander) Positions $<L_{pA}>_m$	
Operating (bels)	**Idling (bels)**	**Operating (dB)**	**Idling (dB)**
7.5 B	7.4 B	54 dB	51 dB
All measurements are in accordance with ANSI S12.10, and conform with ISO 9296.			

Acoustical specifications for Models L22, D22, L52, and D52

This topic provides acoustical specifications for Models L22, D22, L52, and D52 of the TS3500 tape library.

Note: No additional noise is created by adding frame models HA1, S24, or S54.

Table 43. Noise emission values for the IBM TS3500, Models L22, D22, L52, and D52 filled with Ultrium tape drives or 3592 tape drives

Declared Sound Power Level L_{WAd}		Mean A-weighted Sound Pressure Level at the 1 m (Bystander) Positions $<L_{pA}>_m$	
Operating (bels)	**Idling (bels)**	**Operating (dB)**	**Idling (dB)**
7.5 B	7.2 B	57 dB	53 dB
The machines emit no prominent tones or impulsive noise. All measurements are in accordance with ISO 7779, and reported in conformance with ISO 9296.			

Acoustical specifications for Models L23, D23, L53, and D53

This topic provides acoustical specifications for Models L23, D23, L53, and D53 of the TS3500 tape library.

Note: No additional noise is created by adding frame models HA1, S24, or S54.

Table 44. Noise emission values for the IBM TS3500, Models L23, D23, L53, and D53 filled with Ultrium tape drives or 3592 tape drives

Declared Sound Power Level L_{WAd}		Mean A-weighted Sound Pressure Level at the 1 m (Bystander) Positions $<L_{pA}>_m$	
Operating (bels)	**Idling (bels)**	**Operating (dB)**	**Idling (dB)**
7.5 B	7.2 B	55 dB	53 dB
The machines emit no prominent tones or impulsive noise. All measurements are in accordance with ISO 7779, and reported in conformance with ISO 9296.			

Power and cooling requirements

This section introduces the power and cooling specifications for the two power structures that are used by TS3500 tape library frames.

Power and cooling for components of the TS3500 tape library are provided by the frame in which they are housed. The power structure is the frame control assembly, which is used by models L22, D22, L32, D32, L52, and D52.

Power and cooling specifications for Models L22, D22, L32, D32, L52, and D52

This section gives an overview of the power and cooling requirements of Models L22, D22, L32, D32, L52, and D52 of the TS3500 tape library.

For models L22, D22, L32, D32, L52, and D52, each base frame and each expansion frame that contains drives has its own frame control assembly (FCA). The FCA receives ac power from a customer-supplied outlet and, in turn, provides ac power to all tape drives within the frame. The FCA and tape drives have their own cooling as part of their packages, but air must be allowed to flow freely from the top of the library.

Note: In order for air to flow freely from the top of the library, do not stack cartridges, books, or other materials on the top of the library.

For redundancy, the FCA in the base frame (models L22, L32, or L52) contains two dc power supplies for the accessor. As an option, an additional dc power supply for the accessor can be added to any expansion frame (models D22, D32, or D52) that has an FCA installed. The FCA is not required in expansion frames that contain no tape drives.

Each frame receives single-phase (200–240 V ac) power on its own power cord from a customer-supplied outlet.

Countries in North America have the option of operating at 100–127 V ac power. In addition, each frame also has the option of receiving ac power from two independent line cords (feature code 1901). For more information about these options, refer to the following topics:

- “Power cords for Models L32 and D32” on page 128
- “Power cords for Models L22, D22, L52, and D52” on page 131

For libraries that include a second accessor and the high-availability Model HA1, at least one D22, D32, or D52 frame (not a service bay) must be equipped with a frame control assembly (feature code 1452 for Model D32 or feature code 1453 for Models D22 and D52). In addition, and at least one additional 37 V dc power supply (feature code 1902 is required. It is recommended that, where possible, you order two 37 V dc power supplies (feature code 1902) plus a dual line cord (feature code 1901) for each L-frame and D-frame with an FCA.

Power and cooling specifications for Models L23, D23, L53, and D53

This section gives an overview of the power and cooling requirements of Models L23, D23, L53, and D53 of the TS3500 tape library.

For Models L23, D23, L53, and D53, each base frame and expansion frame that contains drives has its own enhanced frame control assembly. The enhanced frame control assembly receives single-phase power (200-240 V ac only) from two customer-supplied outlets or optionally from an adjacent powered frame when using feature codes 1950 and 9989. The enhanced frame control assembly then provides dc power to all tape drives within the frame as well as to the accessor. Like the frame control assembly, the enhanced frame control assembly and tape drives have their own cooling, but require free airflow.

Note: In order to ensure free airflow, do not stack cartridges, books, or other materials on top of the library.

For redundancy, the enhanced frame control assembly contains two dc power supplies, each with its own ac line cord. Under normal conditions, the tape drives and the accessor draw power from both of the power supplies. However, in the event of a failed power supply or loss of ac power on either line cord, each power supply is capable of providing all power needs so that library operation is not disrupted. The enhanced frame control assembly is required in expansion frames that contain tape drives and the 4 I/O door option (feature code 1656).

For libraries that include a second accessor and the high-availability Model HA1, at least one D23 or D53 frame (not a service bay) must be equipped with an enhanced frame control assembly (feature code 1451).

The backend 4 Gb and 8 Gb Fibre Channel switches (FC 4872, 4873, 4875, or 4877) are only supported on models L23 and D23. Each L23 and D23 frame with one of these features installed must also install FC 1950 (power distribution unit), which provides the additional connections that are required for powering the backend switches as well as the enhanced frame control assembly. FC 1950 may also be installed in L23, D23, L53 and D53 frames to power adjacent frames and reduce the number of customer-supplied outlets that are required to power the library. Refer to “Powering adjacent frames” on page 134 for more information.

When ordering FC 1950 for a frame, customers must also order one of the power cord features (FC 9954, 9955, 9956, 9957, 9958, 9959, 9966) that are specifically for use only with FC 1950. Each 995x or 9966 power cord feature supplies two line cords for connection to two customer-supplied ac outlets. Refer to the 995x and 9966 feature descriptions for the specific outlet types.

Note: Frames with FC 1950 and 995x or 9966 line cords require two 30–32 A customer-supplied outlets, which are different outlet types than the 15–20 A customer-supplied outlets needed for frames without feature code 1950. Adding FC 1950 to an existing frame requires the customer to provide different outlets as part of the installation.

Power requirements for frames

A description of the power requirements for frames in the TS3500 tape library.

Table 45 lists the electrical characteristics for the TS3500 tape library frame models.

Table 45. Electrical characteristics of the TS3500 tape library frame models

Electrical characteristic	Rating[2]	
	TS3500 tape library	**Models L22, D22, L32, D32, L52, D52**
Nameplate electrical limits[1]	200–240 V ac, 8.0 A, 50–60 Hz, 1.6 kVA, single phase	100–127 V ac, 12.0 A, 50–60 Hz, 1.2 kVA, single phase
		200–240 V ac, 8.0 A, 50–60 Hz, 1.6 kVA, single phase
Inrush current	150 A @ 200–240 V ac (peak for 1/2 cycle)	100 A @ 120 V ac, 200 A @ 240 V ac (peak for 1/2 cycle)
Leakage current	1 mA	8 mA maximum with 12 drive power supplies installed

Notes:

1. Maximum certified electrical limits for a single frame. Nameplate limits should not be used to calculate product power or cooling requirements.
2. Models HA1, SC1, S24, and S54 do not connect to external ac power.

Table 46 lists the power consumption of the TS3500 tape library models, power consuming features, and drive canisters.

Table 46. Power consumption of TS3500 tape library frame models, power consuming features, and drive canisters

Models	Power consumption (Watts)		
	Off[7]	**Idle**	**Max. continuous (not peak)**
L32, L22, L52	7	200	260
D32, D22, D52[2]	7	200	200
L23, L53[1]	13	142	202
D23, D53[1,2]	13	103	103
S24, S54[3]	0	5	5
HA1[4]	0	24	85
SC1 (FC 1850 and 1851)[8]	0	11	20
Feature Codes			
FC 1503 and 1504 (Drive mounting kit for xx2 models)[5]	0	15	20
FC 1513, 1514, and 1515 (Drive mounting kit for xx3 models)[5]	0	4	7
FC 1950 PDU	5	17	17

Table 46. Power consumption of TS3500 tape library frame models, power consuming features, and drive canisters (continued)

FC 4872 TS7700 backend 4 Gb switches (2x)	0	113	113
FC 4875 TS7700 backend 8 Gb switches (2x)	0	86	86
Tape drives[6]			
TS1120 (3592 Models E05 and J1A)	0	27	42
TS1130 (3592 Model E06)	0	17	46
TS1140 (3592 Model E07)	0	23	50
TS1150 (3592 Model E08)	0	23	47
TS1030 (LTO 3588 F3B)	0	20	34
TS1040 (LTO 3588 F4A)	0	18	36
TS1050 (LTO 3588 F5A)	0	12	28
TS1060 (LTO 3588 F6A)	0	9	32

Notes:

1. These models come equipped with dual ac line cords. The figures in this table show the total power consumed, including power consumed by redundant power supplies. Each individual line cord supplies approximately half of the power.
2. Frames with no frame control assembly (FCA) or enhanced FCA consume no power and require no cooling.
3. S-frame power is for internal lighting and is provided by the power supplies in frames that are equipped with power.
4. The HA1 frame is not connected to ac power. The power shown is the total consumed by the second accessor and is provided by the power supplies in frames that are equipped with power.
5. Drive mounting kit power includes ac/dc conversion losses in drive power supplies (including redundant power), but does not include power consumed by the drive canister.
6. Drive power includes the drive and canister cooling fan, but does not include power losses in external ac or dc drive power supplies. Idle power is consumed when the drive has no tape cartridge loaded. Maximum continuous power is consumed when the drive is actively writing to a tape cartridge.
7. "Off" refers to power consumed when the library is connected to an ac power source and the library on/off switch is set to off.
8. Model SC1 power is provided by the library frames to which it connects. The idle power is the power consumed by each shuttle station when no shuttle car is present. The maximum continuous power is the power consumed by the shuttle station when the shuttle car is present.

In order to calculate the total power consumption (in watts) of a particular library configuration, multiply the quantity of each power consuming item in the

configuration by the corresponding value in Table 46 on page 124 and calculate the total. In order to calculate the total cooling required by the library (in Btu/hr), multiply the total power in watts by 3.4. To convert Btu/hr to kBtu/hr, divide your result by 1000.

Table 47 provides a sample calculation of total power and cooling requirements for a TS3500 tape library configuration consisting of one L23 with ten TS1130 tape drives and mounting kits, four D23 models each containing six TS1130 tape drives and mounting kits, one D23 with no drives or enhanced FCA feature (FC 1451), two S24 models, and one HA1 model.

Table 47. Sample calculation of total library power consumption and cooling requirements.

This model	With this feature code	And these tape drives	Quantity	Power (Watts)		
				Off	Idle	Max. continuous
L23	1515[1]		1	13	142	202
			10	0	40	70
		TS1130	10	0	170	460
D23 (with FC 1451[2])	1515		4	52	412	412
			24	0	96	168
		TS1130	24	0	408	1104
D23 (without FC 1451)	N/A	N/A	1	0	0	0
S24	N/A	N/A	2	0	10	10
HA1	N/A	N/A	1	0	24	85
Total power consumption:				**65**	**1302**	**2511**
Total cooling requirement (kBtu/hr):				**0.2**	**4.4**	**8.5**

Notes:

1. FC 1515: Tape drive mounting kit for L23 and D23 frames.
2. FC 1451: Enhanced frame control assembly for D23 and D53 frames.

Library power consumption is dynamic and usage dependent. Short peaks might exceed the maximum continuous power values. Typical average power consumption is lower than the calculated maximum continuous value because all drives are not likely to be active simultaneously.

Power requirements for remote support features

This section describes the power requirements for the remote support features of the TS3500 tape library.

Table 48 lists the power requirements for the devices that comprise remote support.

Table 48. Power requirements for remote support features

Feature code	Description	Input voltage (see note)	Hertz	Power usage
2710	Remote support facility	115 or 230 V ac	50 or 60	16 W
2711	Remote support switch	115 or 230 V ac	50 or 60	5 W
2714	LAN switch	115 or 230 V ac	50 or 60	Minimum 50 W Maximum 120 W
2724	TS3000 system console (1U rack mount)	115 or 230 V ac	50 or 60	Minimum 50 W Maximum 300 W
2730	TS3000 system console (1U rack mount with one internal modem)	115 or 230 V ac	50 or 60	Minimum 80 W Maximum 300 W
	Monitor and keyboard (1U rack mount)	115 or 230 V ac	50 or 60	Minimum 15 W Maximum 70 W
	LAN switch (16 port 1U rack mount)	115 or 230 V ac	50 or 60	Minimum 50 W Maximum 120 W
	Modem (internal)	115 or 230 V ac	50 or 60	16 W
	Modem	115 or 230 V ac	50 or 60	16 W
2732	TS3000 system console (1U rack mount with optional internal modem [FC 2733])	115 or 230 V ac	50 or 60	Maximum 600 W
	Monitor and keyboard (1U rack mount)	115 or 230 V ac	50 or 60	Minimum 15 W Maximum 70 W
	Local area network (LAN) switch (16 port 1U rack mount)	115 or 230 V ac	50 or 60	Minimum 50 W Maximum 120 W
Note: Input voltage must be supplied by a customer-provided outlet.				

Remote support feature 2724 includes one 2 m (6.5 ft.) ac power cord with an IEC-320 C14 plug that is suitable for plugging into a customer-supplied power distribution unit (PDU) with a C13 outlet. Feature 2734 is a USB modem that derives its power from the USB port on feature 2724 and does not require external ac power.

Remote support feature 2732 includes ac power cords with IEC-320 C14 plugs that are suitable for connecting to a customer-supplied power distribution unit (PDU). Two PDU outlets are required. Remote support features 2710, 2711, and 2714 are supplied with ac power cords with plugs appropriate for the country code where the order is shipped.

Power cords for Models L32 and D32

This section describes the power cords used with models L32 and D32 of the TS3500 tape library.

The appropriate power cord for the TS3500 tape library is attached at the factory (based on the destination code of your country or region). Chicago, Illinois (U.S.A.) requires a 1.8 m (6 ft) power cord (feature code 9986). Power cords used in the United States and Canada are listed by the Underwriter's Laboratories and certified by the Canadian Standards Association. Table 49 on page 129 lists the 200–240 V ac power cords and Table 50 on page 130 lists the 100–127 V ac power cords to use with the library. (The term "power cord" refers to the cable that connects the library to the receptacle.) Refer to Figure 32 on page 130 and match the number that is beside each receptacle to the receptacle number listed in the tables.

Be aware that each frame that contains a frame control assembly (FCA) is protected by a main line circuit protector in the FCA. Each FCA must be further protected by a circuit breaker of the proper rating at the service rail (customer outlet).

The service rating for all 200–240 V ac plug types is as follows:

- Maximum voltage: 250 V ac
- Current: see Table 49
- Phases: 1
- Wires: 3

Table 49. Specifications for 200–240 V ac power cord used with the IBM TS3500, Models L32 and D32

Length and Type of Power Cord	Single Branch Circuit 30 A Service Rating		Dual AC Line Cords 15 A Service Rating (Feature Code 1901)	
	Part Number and Feature Code	Type of Service Receptacle	Part Number and Feature Code	Type of Service Receptacle
4.3 m (14 ft) non-watertight twistlock (default in the U.S., Canada, Japan, Korea, Philippines, and Taiwan)	11F0113 / 9987	NEMA L6-30R (receptacle 3)	14F1550 / 9987	NEMA L6-15R (receptacle 2)
4.3 m (14 ft) (in countries or regions other than the U.S., Canada, Japan, Korea, Philippines, and Taiwan)	46F6063 / None	Per local requirements	36L8823 / None	IEC 309 Type 2P+GND, 16 A for example, Hubbell HBL316R6W (receptacle 6)
4.3 m (14 ft) watertight (in the U.S., Canada, Japan, Korea, Philippines, and Taiwan)	46F4594 / 9988	Russellstoll connectors 3933 or 9C33U0 or receptacles 3753 or 9R33U0W (receptacle 5)	86F2646 / 9988	Russellstoll connectors 3913U2 or 9C23U2 or receptacles 3743U2 or 9R23U2W (receptacle 4)
1.8 m (6 ft) watertight (in Chicago, Illinois, U.S.)	46F4593 / 9986	Russellstoll connectors 3933 or 9C33U0 or receptacles 3753 or 9R33U0W (receptacle 5)	86F2645 / 9986	Russellstoll connectors 3913U2 or 9C23U2 or receptacles 3743U2 or 9R23U2 (receptacle 4)

The service rating for all 100–127 V ac plug types is as follows:

- Maximum voltage: 125 V ac
- Current: see Table 50
- Phases: 1
- Wires: 3

Table 50. Specifications for 100–127 V ac power cords used with the TS3500 tape library, models L32 and D32

Length and type of power cord	Single branch circuit 20 A service rating		Dual ac line cords 20 A service rating (feature code 1901)	
	Part number and feature code	Type of service receptacle	Part number and feature code	Type of service receptacle
4.3 m (14 ft) non-watertight twistlock (in the U.S. and Canada)	19P5903 / 9951 and 9987	NEMA L5-20R (receptacle 1)	12J5117 / 9951 and 9987	NEMA L5-20R (receptacle 1)
1.8 m (6 ft) non-watertight twistlock (in Chicago, Illinois, U.S.)	19P5904 / 9951 and 9986	NEMA L5-20R (receptacle 1)	12J5115 / 9951 and 9986	NEMA L5-20R (receptacle 1)

Refer to Figure 32 and match the number that is beside each receptacle to the number in each table.

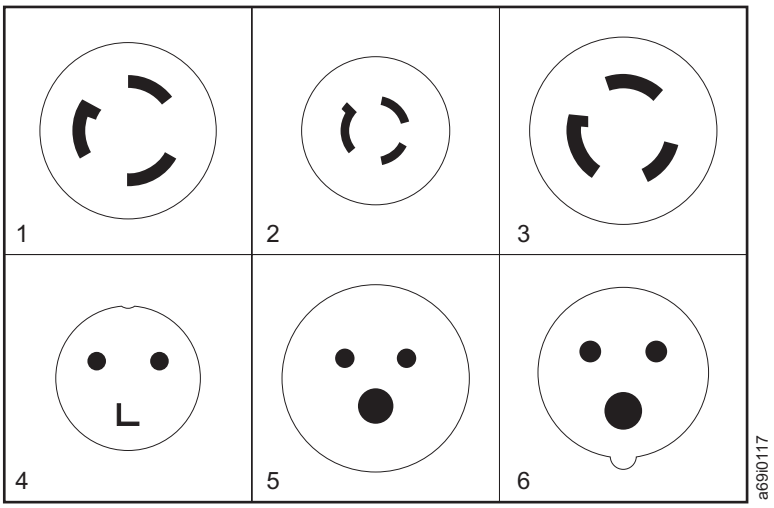


Figure 32. Types of receptacles for power cords used by models L32 and D32 of the TS3500 tape library

Power cords for Models L22, D22, L52, and D52

This section describes the power cords used with models L22, D22, L52, and D52 of the TS3500 tape library.

Refer to Figure 33 on page 132 and match the number that is beside each receptacle to the receptacle number listed in the table.

Table 51. Specifications for power cords used with the L22, D22, L52, and D52

Length and Type of Power Cord	Part Number and Feature Code	Type of Service Receptacle
4.3 m (14 ft) international 250 V ac, 30 A. This is the default power cord, if no other feature is specified, in all countries except the United States, Canada, Japan, Korea, Philippines, and Taiwan.	46F6063 or 23R2333 / 9960	No connector (a connector can be attached per local requirements)
1.8 m (6 ft) watertight, 250 V ac, 30 A (used in Chicago, Illinois, U.S.)	46F4593 / 9961	Russellstoll 3753 or 9R33UOW receptacle, or a Russellstoll 3933 or 9C33UO connector (receptacle 5)
4.3 m (14 ft) non-watertight, twistlock 250 V ac, 30 A. This is the default power cord if no other feature is specified in the United States, Canada, Japan, Korea, Philippines, and Taiwan.	11F0113 / 9962	NEMA L6-30R (receptacle 3)
4.3 m (14 ft) watertight, 250 V ac, 30 A (used in U.S., Canada, Asia/Pacific)	46F4594 / 9963	Russellstoll 3753 or 9R33UOW receptacle, or a Russellstoll 3933 or 9C33UO connector (receptacle 5)
1.8 m (6 ft) non-watertight, 110 V ac, 20 A (used in Chicago, Illinois, U.S.)	19P5904 / 9964	NEMA L5-20R (receptacle 1)
4.3 m (14 ft) non-watertight, 110 V ac, 20 A (used in the U.S. and Canada only)	19P5903 / 9965	NEMA L5-20R (receptacle 1)
Dual 4.3 m (14 ft) non-watertight, international 250 V ac, 16 A single phase. This power cord is used In all countries except the United States, Canada, Japan, Korea, Philippines, and Taiwan. If no other feature is specified, this is the default power cord that is supplied when the dual ac power feature (1901) is ordered.	36L8823 / 9970	IEC-309 2P +GND 16 A (receptacle 6)
Dual 1.8 m (6 ft) watertight, 250 V ac, 15 A (Used in Chicago, Illinois, U.S.)	86F2645 / 9971	Russellstoll 3743U2 or 9R23U2W receptacles, or Russellstoll 3913U2 or 9C23U2 connectors (receptacle 4)
Dual 4.3 m (14 ft) non-watertight, twistlock 250 V ac, 15 A. This is the default power cord if no other feature is specified in the United States, Canada, Japan, Korea, Philippines, and Taiwan.	14F1550 / 9972	NEMA L6-15R (receptacle 2)
Dual 4.3 m (14 ft) watertight, 250 V ac, 15 A. This feature is available in the United States, Canada, Japan, Korea, Philippines, and Taiwan.	86F2646 / 9973	Russellstoll 3743U2 or 9R23U2W receptacles, or Russellstoll 3913U2 or 9C23U2 connectors (receptacle 4)
Dual 1.8 m (6 ft), 110 V ac, 20 A (Used in Chicago, Illinois, U.S.)	12J5115 / 9974	NEMA L5-20R (receptacle 1)
Dual 4.3 m (14 ft), 110 V ac, 20 A (Used in U.S. and Canada only)	12J5117 / 9975	NEMA L5-20R (receptacle 1)

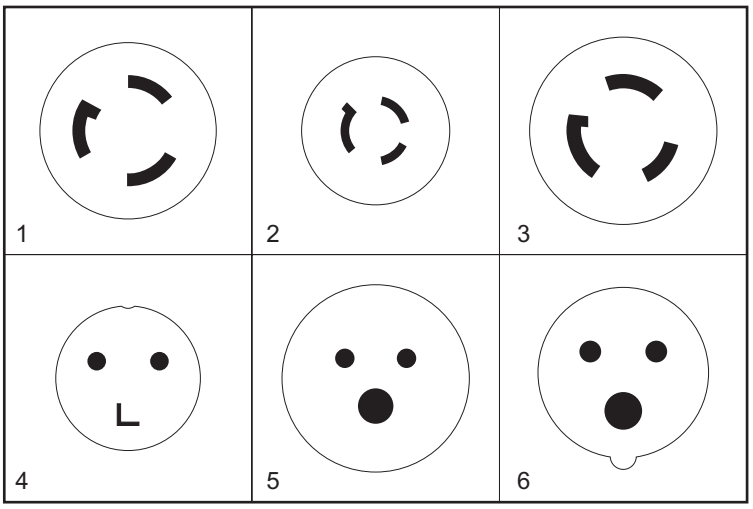


Figure 33. Types of receptacles for power cords used by Models L22, D22, L52, and D52 of the TS3500 tape library

Power cords for Models L23, D23, L53, and D53

This topic describes the power cords used with models L23, D23, L53, and D53 of the TS3500 tape library.

Refer to Figure 34 on page 134 and match the number that is beside each receptacle to the receptacle number listed in the table.

Table 52. Specifications for power cords used with the IBM TS3500, Models L23, D23, L53, and D53

Length and Type of Power Cord	Part Number and Feature Code[1]	Type of Service Receptacle
Dual 4.3 m (14 ft.) watertight, international 250 V ac, 16 A single phase. This power cord is for countries other than the United States and Canada (IEC-309)	45E2699 / 9970	IEC-309 2P +GND 16 A Uses receptacle #2
Dual 4.3 m (14 ft.) watertight, 250 V ac, 20 A single phase. This power cord is for the United States and Canada (IEC-309).	23R9540 / 9970	Hubbell HBL320R6W, IEC-309 2P +GND 20 A Uses receptacle #2
Dual 4.3 m (14 ft.) non-watertight, twistlock 250 V ac, 15 A. This power cord is for the United States and Canada.	39M5114 / 9972	NEMA L6-15R Uses receptacle #1
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 10 A, IRAM 2073. This power cord is for Argentina.	39M5066 / 9976	Uses receptacle #3
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 15 A, Earth Pin InMetro NBR 14136. This power cord is for Brazil.	39M5238 / 9977	Uses receptacle #4
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 10 A, AS/NZS 3112/2000. This power cord is for Australia and New Zealand.	39M5100 / 9978	Uses receptacle #3
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 15 A, JIS C8303, C8306. This power cord is for Japan.	39M5184 / 9979	Uses receptacle #5

Table 52. Specifications for power cords used with the IBM TS3500, Models L23, D23, L53, and D53 (continued)

Length and Type of Power Cord	Part Number and Feature Code[1]	Type of Service Receptacle
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 10 A, GB 2099.1, 1002. This power cord is for China.	39M5204 / 9980	Uses receptacle #3
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 15 A, with earth pin KS C8305, K60884-1. This power cord is for Korea.	39M5217 / 9981	Uses receptacle #6
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 10 A, CNS 10917-3. This power cord is for Taiwan.	39M5252 / 9982	Uses receptacle #5
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 16 A, SANS 164-1. This power cord is for South Africa.	39M5142 / 9983	Uses receptacle #7
Dual 4.3 m (14 ft.) 250 V ac, 15A, single phase line cord, non-watertight twistlock 20A receptacles. This power cord is for US and Canada.	23R9760 / 9984	NEMA L6-20R Uses receptacle #8
Dual 4.3 m (14 ft.) 250 V ac, 15A, single phase line cord, watertight 15A plugs. This power cord is for US and Canada.	23R9972 / 9985	Russellstoll 3743U2 or 9R23U2W receptacles, or Russellstoll 3913U2 or 9C23U2 connectors Uses receptacle #9
Dual 4.3 m (14 ft.) non-watertight, 250 V ac, 10 A power cord with IEC 60320 C14 connector. This power cord may be used world wide to connect to spare outlets on FC 1950 PDUs in an adjacent library frame or to a customer-provided PDU that is mounted external to the library frames.	46X7337 / 9989	IEC 60320 C13 Uses receptacle #13
Dual 4.3 m (14 ft.) power cords with NEMA L6–30P non-watertight 30A plug, 200–240 V ac, 30 Amps. This power cord is for US, Canada, Latin America, and Japan.	39M5416 / 9954 (Used with FC 1950 only)	NEMA L6–30R Uses receptacle #10
Dual 4.3 m (14 ft.) power cords with watertight Russellstoll 3750DP 30A plug, 200–240 V ac, 30 Amps. This power cord is used in US, Chicago, Canada, Latin America, and Japan.	39M5418 / 9955 (Used with FC 1950 only)	Russellstoll 3753 or 9R33UOW receptacle, or a Russellstoll 3933 or 9C33UO connector Uses receptacle #11
Dual 4.3 m (14 ft.) power cords with IEC-309 p+n+g 32A plug, 200–240 V ac single phase, 32 Amps. This power cord is used in Europe, the Middle East, and Africa.	39M5414 / 9956 (Used with FC 1950 only)	IEC-309 p+n+g Uses receptacle #2
Dual 4.3 m (14 ft.) power cords with PDL 56P332 32A plug, 200–240 V ac single phase, 32 Amps. This power cord is used in Australia and New Zealand.	39M5419 / 9957 (Used with FC 1950 only)	1–gang, 3–pin 32A socket, PDL 56SO332 or equivalent Uses receptacle #12
Dual 4.3 m (14 ft.) non-watertight power cords with 30A plug type Shin Ju SJ-3302, 200–240 V ac, 30 Amps. This power cord is used in North and South Korea.	39M5420 / 9958 (Used with FC 1950 only)	200–250 V ac single phase Uses receptacle #3

Table 52. Specifications for power cords used with the IBM TS3500, Models L23, D23, L53, and D53 (continued)

Length and Type of Power Cord	Part Number and Feature Code[1]	Type of Service Receptacle
Dual 4.3 m (14 ft.) power cords, unterminated (without a power plug), 200–240 V ac single phase, 30 Amps maximum, with IRAM and BSMI agency certifications. Wire size 4 mm^2. This is the recommended cord for Argentina, Taiwan, Europe, the Middle East, and Africa if an unterminated power cord is preferred.	23R7324 / 9959 (Used with FC 1950 only)	Not specified (no plug supplied)
Dual 4.3 m (14 ft.) power cords, unterminated (without a power plug), 200–240 V ac single phase, 30 Amps maximum, with CCC certification. This is the recommended power cord for China.	23R9543 / 9966 (Used with FC 1950 only)	Not specified (no plug supplied)
Note: 1. Each feature code ships two power cords so that dual power is supported.		

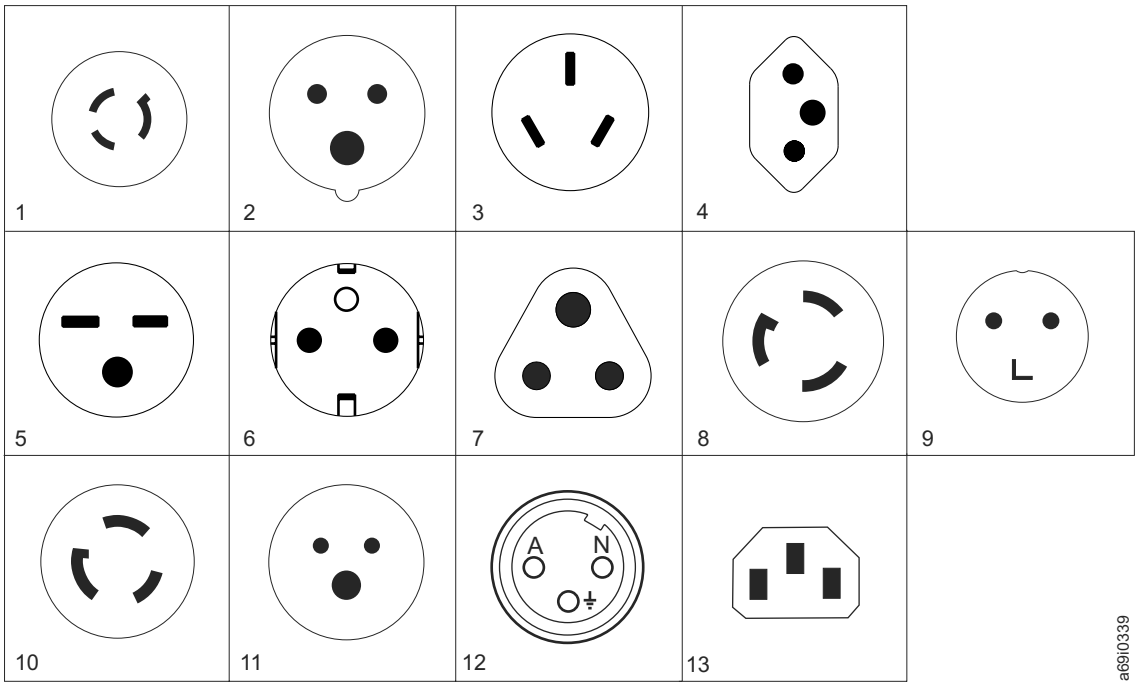


Figure 34. Types of receptacles for Models L23, D23, L53, and D53 of the TS3500 tape library

Note: For more information about FC 9989, refer to the topic about powering adjacent frames.

Powering adjacent frames

This topic describes how to power models L23, D23, L53 and D53 using power distribution units (PDUs) and power cords to adjacent frame PDUs in order to reduce the number of required facility outlets.

A library frame with PDUs (FC 1950) installed can power up to two adjacent frames by specifying power cord FC 9989 on each of the adjacent frames and plugging the cords into the spare outlets on the FC 1950 PDUs. Figure 35 on page 135

135 shows the first adjacent frame cord plugging into the upper PDU receptacles and the second adjacent frame power cord plugging into the lower PDU receptacles. The adjacent frames that receive power through FC 9989 can be up to three frames away from the frame with FC 1950. By using adjacent frame power cords, customers can power up to three frames from only two facility outlets.

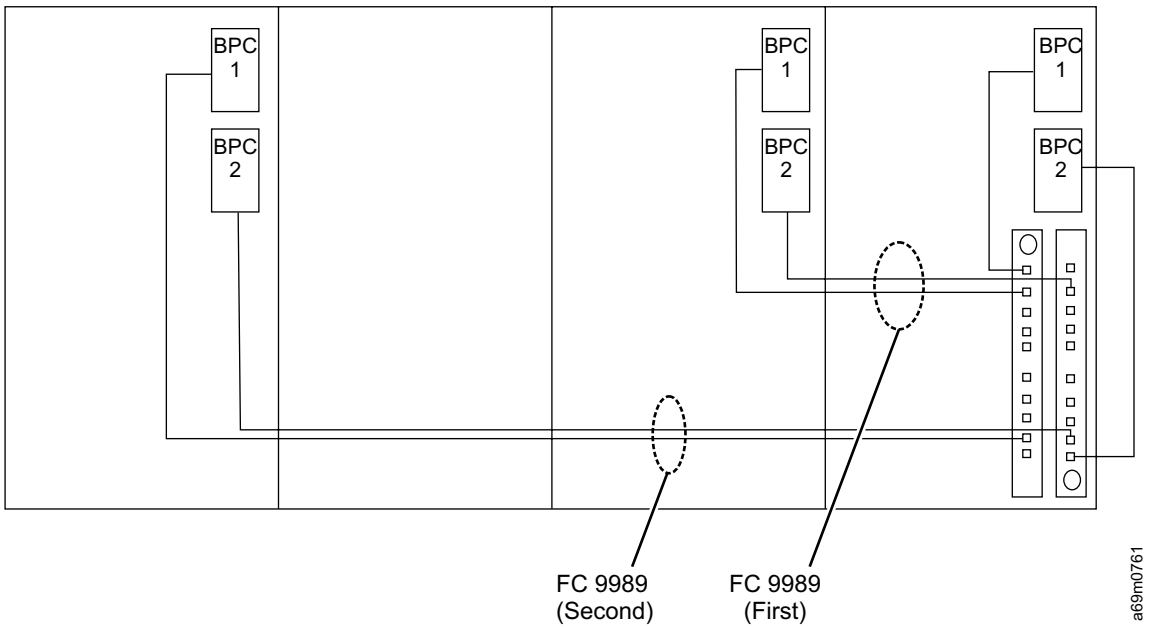


Figure 35. FC 9989 cable positions

Recommended customer circuit breakers for Models of the TS3500 tape library

This topic provides the recommended maximum and minimum circuit breaker ratings for TS3500 tape library frame models.

Maximum rating:	20 A (32 A if feature 1950 is installed)
Minimum rating:	10 A (20 A if feature 1950 is installed)

Chapter 3. Standard features of the Library

This section introduces a pictorial representation of the elements of the TS3500 tape library and the feature codes for those elements.

When ordering the TS3500 tape library, you can use feature codes to perform the following actions:

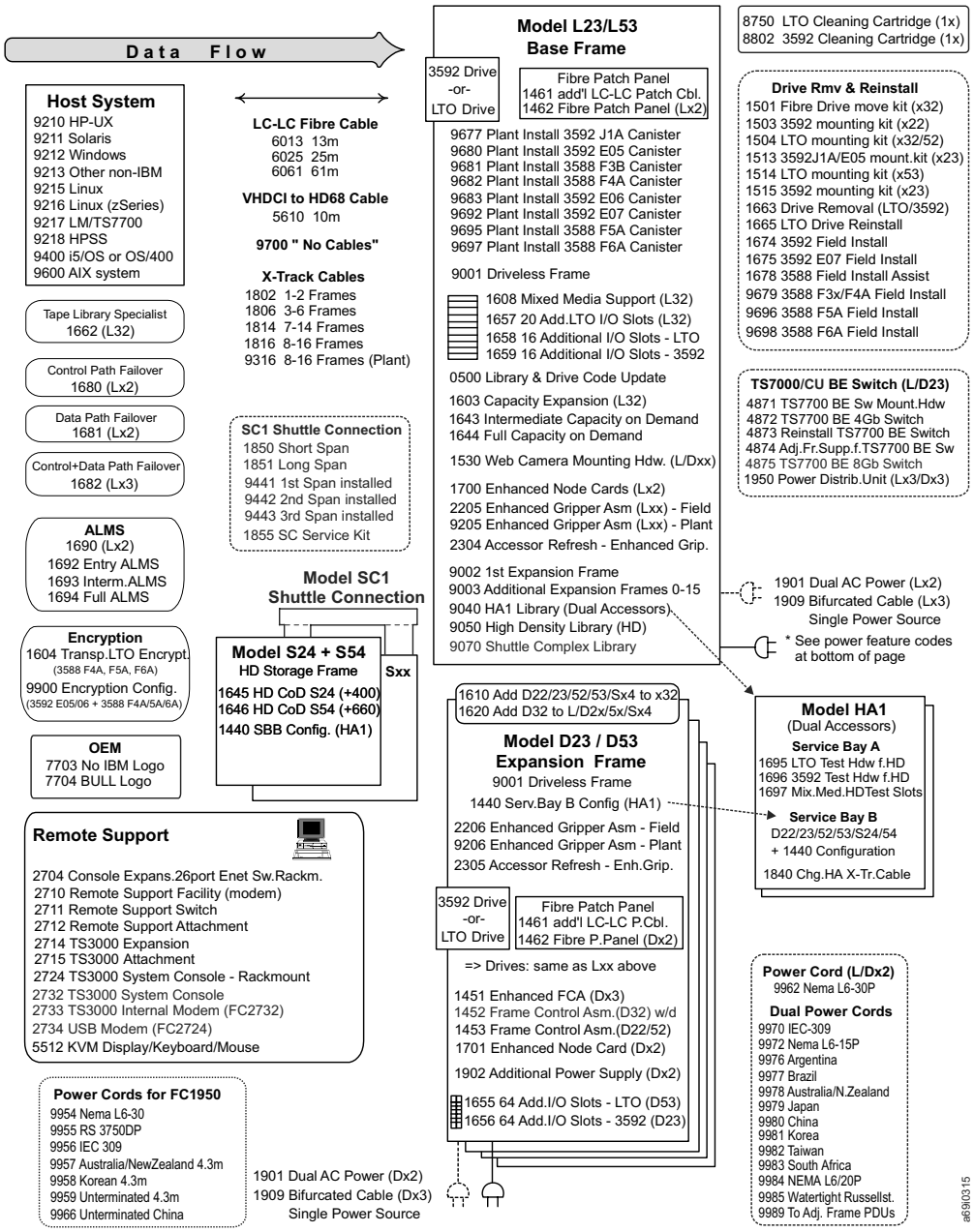
- Specify plant or field installation of tape drives
- Specify host configurations
- Identify the specific attachment type
- Order open systems device drivers

Elements in the library

This section provides a flowchart of the elements that are available for a TS3500 tape library.

Figure 36 shows the elements in the TS3500 tape library. Depending on the model of the library, different features are available.

Figure 36. Elements in the TS3500 tape library



Feature codes for elements in the library

This topic describes the feature codes for the TS3500 tape library and indicates to which model each feature applies and whether or not the feature can be installed by the customer.

A customer-setup unit (CSU) is a feature that you, as the customer, can install when the feature is ordered as a field upgrade. Detailed instructions are included when you order and receive these features. To access the instructions from the web, go to `http://www-03.ibm.com/servers/storage/tape/resource-library.html#publications`. Under `Technical support`, select `3584 Tape Library`. Then, under `Choose your task`, select `Documentation`. Should you choose not to install a CSU, IBM can install it for an additional charge.

Table 53 lists the feature codes for the models of the TS3500 tape library.

Table 53. Feature codes for the models of the TS3500 tape library

Feature Code	Model	CSU	Description
0500	L22, L23, L32, L52, L53	No	One-time library and drive code update (by IBM service representative)
1440	D22, D23, D52, D53, S24, S54	No	Service Bay B configuration with accessor
1451[3]	D23, D53	No	Enhanced frame control assembly (does not apply to D22, D32, or D52 models)
1452[1, 21]	D32	No	Frame control assembly (This feature has been withdrawn from marketing.)
1453[21]	D22, D52	No	Frame control assembly (This feature has been withdrawn from marketing.)
1461	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	No	Additional LC-to-LC drive-to-patch-panel cable for 3592 or LTO 5 and newer tape drives (Do not order if FC 4871 is installed.)
1462	L22, D22, L32, D32, L52, D52	No	Fibre Channel patch panel
1501	L32, D32	No	Fibre Channel tape drive move kit
1503[15]	L22, D22	No	3592 Fibre Channel tape drive mounting kit
1504[14]	L32, D32, L52, D52	Yes	LTO Fibre Channel tape drive mounting kit
1513[15]	L23, D23	No	3592 Fibre Channel tape drive mounting kit (This feature applies to 3592 J1A and E05 drives only.)
1514[14]	L53, D53	Yes	LTO Fibre Channel tape drive mounting kit
1515[15]	L23, D23	No	3592 Fibre Channel tape drive mounting kit (This feature applies to all 3592 drives.)
1530	L22, D22, L52, D52, L23, D23, L53, D53	No	Web camera mounting hardware (This feature provides the mounting hardware only. The web camera is supplied by the customer.)
1603	L32	No	Capacity expansion
1604[18]	L22, L23, L32, L52, L53	Yes	Transparent LTO Encryption. (Provides license keys to enable transparent LTO encryption on LTO Ultrium 4 and newer Ultrium tape drives.)
1608	L32	No	Mixed media/D22/D23 support
1610	D22, D23, D52, D53, S24, S54	No	Add D22/D23/D52/D53/S24/S54 to existing L32 or D32 **Prerequisite:** FC 9002 or 9003

Table 53. Feature codes for the models of the TS3500 tape library (continued)

Feature Code	Model	CSU	Description
1620	D32	No	Add D32 to existing L22, D22, L23, D23, L52, D52, L53, D53, S24, or S54 **Prerequisite:** FC 9002 or 9003
1643	L22, L23, L52, L53	Yes	Intermediate Capacity on Demand (installed but not enabled)
1644[1]	L22, L23, L52, L53	Yes	Full Capacity on Demand (installed but not enabled) **Prerequisite:** FC 1643
1645	S24	Yes	High Density Capacity on Demand
1646	S54	Yes	High Density Capacity on Demand
1655[12]	D53	No	64 Additional I/O Slots - LTO (Plant-only) **Prerequisite:** FC 1451
1656[12]	D23	No	64 Additional I/O Slots - 3592 (Plant-only) **Prerequisite:** FC 1451
1657	L32	No	20 additional I/O slots for LTO cartridges
1658[2]	L22, L23, L52, L53	No	16 additional I/O slots for LTO cartridges
1659[2]	L22, L23, L52, L53	No	16 additional I/O slots for 3592 cartridges
1660[3]	L32, D22, D32, D52	No	10/100 Ethernet support
1662[3]	L32	No	Tape Library Specialist Web interface
1663	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	No	Drive removal (This feature applies to all Ultrium and 3592 tape drives and is used only when drives are removed and not replaced.)
1665[14]	L32, D32, L52, D52, L53, D53	No	LTO Ultrium tape drive reinstall
1674[15]	L22, D22, L23, D23	No	3592 tape drive field install (This feature applies to 3592 tape drive models J1A, E05, E06, and EU6.) **Prerequisite:** FC 1515
1675[15]	L22, D22, L23, D23	No	3592 E07 and E08 tape drive field install **Prerequisite:** FC 1690
1678	L32, D32, L52, D52, L53, D53	No	3588 tape drive field install assist. Feature code 1678 provides a charge for an IBM Representative to install or reinstall the 3588 Fibre Channel tape drive ordered through FC 9679. Customers are not required to order FC 1678 when ordering a 3588 drive.
1680	L22, L32, L52	Yes	Control path failover
1681	L22, L32, L52	Yes	Data path failover (Prerequisite: FC 1680)
1682	L23, L53	Yes	Path failover
1690	L22, L23, L32, L52, L53	Yes	Advanced Library Management System (ALMS)
1692	L22, L23, L52, L53	Yes	Entry ALMS
1693	L22, L23, L52, L53	Yes	Intermediate ALMS **Prerequisite:** FC 1692
1694	L22, L23, L52, L53	Yes	Full ALMS **Prerequisite:** FC 1693

Table 53. Feature codes for the models of the TS3500 tape library (continued)

Feature Code	Model	CSU	Description
1695	HA1	No	LTO test hardware for high density frames (This feature is required if any HD frame is installed on a High Availability subsystem with an L32, L52, or L53 base frame.)
1696	HA1	No	3592 test hardware for high density frames (This feature is required if any HD frame is installed on a High Availability subsystem with an L22 or L23 base frame.)
1697	HA1	No	Mixed media HD test slots (This feature is required if an HD frame is installed on a mixed media High Availability subsystem.) **Prerequisites:** FC 1695 or 1696
1700[16]	L22, L32, L52	No	Enhanced Node Cards
1701[16]	D22, D32, D52	No	Enhanced Node Card
1802[4]	L22, L23, L32, L52, L53	No	1- to 2-frame X-track cable
1806[5,6]	L22, L23, L32, L52, L53	No	3- to 6-frame X-track cable
1814[7,8,9]	L22, L23, L32, L52, L53	No	7- to 14-frame X-track cable
1816[10]	L22, L23, L32, L52, L53	No	8- to 16-frame X-track cable
1840	L22, L23, L32, L52, L53	No	Change HA X-track cable
1850	SC1	No	Short span (This feature provides shuttle station components and a short span.)
1851	SC1	No	Long span (This feature provides shuttle station components and a long span.)
1855	SC1	No	Shuttle complex service and install kit (This feature provides a ladder and installation tools.)
1901	L22, D22, L32, D32, L52, D52	No	Dual ac power
1902	D22, D32, D52	No	Additional redundant (37 V) power supply
1909	L23, D23, L53, D53	No	Single Power Source Bifurcated Cable. (Allows attachment of an xx3 frame to a single power outlet while maintaining drive redundant power).
1950[17]	L23, D23, L53, D53	No	Power distribution unit (Supports up to any combination of three pairs of power cords for FC 4875 on same frame and FC 9989 on adjacent frames.) **Prerequisites:** One of FC 9954, 9955, 9956, 9957, 9958, 9959, or 9966
2205	L22, L23, L32, L52, L53	No	Enhanced grippers and pivot (This field-only feature is for Lx2 and Lx3 models without FC 9205.)
2206	D22, D52, D23, D53	No	Enhanced grippers and pivot for high availability (This field-only feature applies to D frames with Service Bay B that do not have FC 9206.)
2304	L22, L23, L32, L52, L53	No	Accessor refresh with enhanced grippers and pivot

Table 53. Feature codes for the models of the TS3500 tape library (continued)

Feature Code	Model	CSU	Description
2305	D22, D52, D23, D53	No	Accessor refresh with enhanced grippers and pivot for HA (This field-only feature applies to models with FC 1440.)
2704	L22, L23, L52, L53	No	Console expansion 26 port Ethernet switch (This feature provides a 26 port Ethernet switch and attachment cable for connection to TS3000 system console (TSSC). Up to 24 additional connections are provided by this feature for connection of FC 2714, 2715, or another FC 2704.)
2710	L22, L23, L32, L52, L53	No	Remote support facility
2711	L22, L32, L52	No	Remote support switch
2712	L22, L23, L32, L52, L53	No	Remote support attachment
2714[21]	L22, L23, L32, L52, L53	No	TS3000 Expansion (This feature has been withdrawn from marketing.)
2715	L22, L23, L32, L52, L53	No	TS3000 attachment cable (to attach a unit to the Ethernet switch provided by feature code 2720 or 2714)
2719[21]	L22, L23	No	TS3000 Upgrade (This feature has been withdrawn from marketing.)
2720[21]	L22, L23, L32, L52, L53	No	Desktop TS3000 System Console (TSSC) (This feature has been withdrawn from marketing.)
2724	L22, L23, L52, L53	No	Rackmount TS3000 system console (TSSC) (This feature provides the enhanced rack-mountable TS3000 system console (TSSC) and an Ethernet cable for connection of one machine to an IBM supplied modem. This feature replaces feature codes 2722, 2730, and 2732.)
2730[21]	L22, L23, L32, L52, L53	No	Customer rack-mountable TS3000 System Console (TSSC) (This feature has been withdrawn from marketing.)
2732[21]	L22, L23, L32, L52, L53	No	Rack-mountable TS3000 system console (TSSC) (TSSC) (This feature has been withdrawn from marketing.)
2733[19, 21]	L22, L23, L32, L52, L53	No	TS3000 Internal Modem (This feature has been withdrawn from marketing.)
2734	L22, L23, L52, L53	No	USB modem (This feature provides a USB modem for use with FC 2724.)
4871	L23, D23	No	TS7700 backend Fibre Channel switches mounting hardware **Prerequisites:** FC 1950 and FC 9217
4872[20, 21]	L23, D23	No	TS7700 4 Gb Fibre Channel backend switches (This feature has been withdrawn from marketing.)
4873	L23, D23	No	Reinstall TS7700 backend Fibre Channel switches **Prerequisite:** FC 4871
4874	L23, D23	No	Adjacent frame support for TS7700 backend Fibre Channel switches

Table 53. Feature codes for the models of the TS3500 tape library (continued)

Feature Code	Model	CSU	Description
4875	L23, D23	No	8 Gb Fibre Channel switch (One switch is provided per feature. The TS7700 requires two switches per frame. The customer must specify FC 4875 or FC 4877.) **Prerequisites:** FC 1950 and FC 9217
4876	L23, D23	No	3592-C07 backend Fibre Channel switch mounting hardware (This feature provides mounting hardware for one switch.)
4877	L23, D23	No	Reinstall 3592-C07 backend 8 Gb Fibre Channel switch (This feature reinstalls one switch.)
4878	L23, D23	No	Adjacent frame support for 3592-C07 backend 8 Gb Fibre Channel switches (This feature provides one 5-meter [16.4-foot] cable. Customer must order one per drive for one switch or two per drive for two switches.)
5512	L22, L23, L52, L53	No	KVM Display, Keyboard, Mouse
5922	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	Yes	SC-to-LC Fibre Channel cable, 22 m (72 ft) (withdrawn as of 12/2006)
6013	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	Yes	LC-to-LC Fibre Channel cable, 13 m (43 ft)
6025	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	Yes	LC-to-LC Fibre Channel cable, 25 m (82 ft)
6061	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	Yes	LC-to-LC Fibre Channel cable, 61 m (200 ft)
8750	L32, D32, L52, D52, L53, D53	No	Ultrium cleaning cartridge
8802	L22, D22, L23, D23	No	3592 cleaning cartridge
9001	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	No	Frame without drives (if you have a library with both LTO frames (x32, x52, x53) and 3592 frames (x22, x23), and you want to configure the library for mixed media, you must have at least one drive of each type (LTO and 3592) installed in the library before you can configure mixed media) **Prerequisite:** Lxx frames need FC 9022 in order to support this feature.
9002	L22, L23, L32, L52, L53	No	First expansion frame attachment **Prerequisite:** FC 1644
9003	L22, L23, L32, L52, L53	No	Additional expansion frame attachment
9040	L22, L23, L32, L52, L53	No	High availability library
9050	L22, L23, L32, L52, L53	No	High density library **Prerequisites:** FC 2205, FC 2304, or FC 9205. If FC 9040 is installed, FC 2206, FC 2305, or FC 9206 is also required for that library string. FC 1700 or 1701 is also a prerequisite on Lx2 and Dx2 models if total capacity is greater than 6 887 slots.
9070	L22, L23, L32, L52, L53	No	Shuttle complex library **Prerequisite:** TSSC (FC 2720, 2730, or 2732) Models Lx2 and Dx2 require enhanced node cards (FC 1700 or 1701).

Table 53. Feature codes for the models of the TS3500 tape library (continued)

Feature Code	Model	CSU	Description
9205	L23, L53	No	Enhanced grippers and pivot
9206	D23, D53, S24, S54	No	Enhanced grippers and pivot for HA
9210	L22, L23, L32, L52, L53	No	Attached to HP-UX System
9211	L22, L23, L32, L52, L53	No	Attached to Sun Solaris System
9212	L22, L23, L32, L52, L53	No	Attached to Windows System
9213	L22, L23, L32, L52, L53	No	Attached to other non-IBM system
9215	L22, L23, L32, L52, L53	No	Attached to Linux System (other)
9216	L22, L32, L52	No	Attached to System z Linux System
9217	L22, L23, L32, L52, L53	No	Attached to LM/TS7700/3592-C07
9218	L22, L23, L32, L52, L53	No	Attached to HPSS
9316[11]	L22, L23, L32, L52, L53	No	8- to 16-frame X-track cable (plant)
9400	L22, L23, L32, L52, L53	No	Attached to i5/OS™ or OS/400 System
9441	SC1	No	First shuttle span installed (This feature tracks the number of shuttle spans in a shuttle connection. No hardware is included.)
9442	SC1	No	Second shuttle span installed (This feature tracks the number of shuttle spans in a shuttle connection. No hardware is included.)
9443	SC1	No	Third shuttle span installed (This feature tracks the number of shuttle spans in a shuttle connection. No hardware is included.)
9600	L22, L23, L32, L52, L53	No	Attached to AIX System
9677[15]	L22, L23, D22, D23	No	3592 J1A tape drive plant install
9678	L52, L53, D52, D53	No	3588 F3A tape drive plant install
9679[13]	L32, L52, L53, D32, D52, D53	Yes	3588 F3A/F3B/F4A tape drive customer field install (see feature code 1678)
9680[15]	L22, D22, L23, D23	No	3592 E05 tape drive plant install
9681	L52, D52, L53, D53	No	3588 F3B tape drive plant install
9682[14]	L53 , D53	No	3588 F4A tape drive plant install **Prerequisite:** FC 1514
9683[15]	L23, D23	Yes	3592 E06 tape drive plant install **Prerequisite:** FC 1515
9692[15]	L23, D23	No	3592 E07 tape drive plant install **Prerequisite:** FC 1515
9695[14]	L53, D53	No	3588 F5A tape drive plant install **Prerequisite:** FC 1514
9696[14]	L32, L52, L53, D32, D52, D53	Yes	3588 F5A tape drive customer field install (see feature code 1678) **Prerequisites:** FC 1700 on Lx2 models, FC 1702 on Dx2 models, and 169x (ALMS) on Lxx models
9697[14]	L53, D53	Yes	3588 F6A tape drive plant install **Prerequisites:** FC 1514, libraries with a Model L32 frame also require enhanced grippers (FC 2205 or 2304)

Table 53. Feature codes for the models of the TS3500 tape library (continued)

Feature Code	Model	CSU	Description
9698[14]	L32, D32, L52, D52, L53, D53	No	3588 F6A tape drive customer field install (see feature code 1678) **Prerequisites:** FC 1700 on Lx2 models, FC 1702 on Dx2 models, 169x (ALMS) on Lxx models, libraries with a Model L32 frame also require enhanced grippers (FC 2205 or 2304)
9699[15]	L23, D23	No	3592 E08 tape drive plant install **Prerequisite:** FC 1515
9700	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	No	No host cables from plant
9724	L32, D32, D42	No	OEM power cord
9900	L22, D22, L23, D23, L32, D32, L52, D52, L53, D53	No	Encryption Configuration
9954	L23, D23	No	Dual Nema L6–30 Power Cords (Used with FC 1950 only)
9955	L23, D23	No	Dual RS 3750DP Power Cords (Used with FC 1950 only)
9956	L23, D23	No	Dual IEC 309 Power Cords (Used with FC 1950 only)
9957	L23, D23	No	Dual 4.3 m Power Cords - Australia/New Zealand (Used with FC 1950 only)
9958	L23, D23	No	Dual 4.3 m Power Cords - Korea (Used with FC 1950 only)
9959	L23, D23	No	Dual Unterminated Power Cords (Used with FC 1950 only)
9966	L23, D23	No	Dual Unterminated Power Cords - China CCC cert. (Used with FC 1950 only)
9962	L22, D22, L52, D52	No	Power cord, non-watertight, 4.3 m (14 ft.)
9970	L22, D22, L23, D23, L52, D52, L53, D53	No	Dual 4.3 Meter Power Cord Watertight: Provides dual 4.3 meter (14-foot) 250 V ac power cords with IEC 309 2P+GND watertight connectors. For countries other than the United States and Canada the connector is rated at 16A (plug type Hubbell HBL316P6W or equivalent) for connection to Hubbell type HBL316R6W or equivalent receptacles. In the United States and Canada the connector is rated at 20A (plug type Hubbell HBL320P6W) for connection to Hubbell type HBL320R6W or equivalent receptacles. This is the default power cord if no other feature is specified, in all countries except Argentina, Australia, Brazil, Canada, China, Japan, Korea, New Zealand, Philippines, South Africa, Taiwan, and the United States. This feature should be ordered with FC 1901.
9972	L22, D22, L23, D23, L52, D52, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), twistlock 250 V ac, 15 A. This power cord is for the United States and Canada. This feature should be ordered with FC 1901.

Table 53. Feature codes for the models of the TS3500 tape library (continued)

Feature Code	Model	CSU	Description
9976	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 10 A, with IRAM 2073 plug. This power cord is for Argentina.
9977	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 15 A, with Earth Pin InMetro NBR 14136 plug. This power cord is for Brazil.
9978	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 10 A, with AS/NZS 3112/2000 plug. This power cord is for Australia and New Zealand.
9979	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 15 A, with JIS C8303, C8306 plug. This power cord is for Japan.
9980	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 10 A, with GB 2099.1, 1002 plug. This power cord is for China.
9981	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 15 A, with earth pin KS C8305, K60884-1 plug. This power cord is for Korea.
9982	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 10 A, with CNS 10917-3 plug. This power cord is for Taiwan.
9983	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 16 A, with SANS 164-1 plug. This power cord is for South Africa.
9984	L23, D23, L53, D53	No	NEMA L6/20P. Dual 4.3 m (14 ft.) 250 V ac, 15A single phase line cord assemblies with NEMA L6-20P non-watertight twistlock 20A plugs. UL / CSA certified for use in US and Canada. Mates with customer-supplied NEMA L6-20R receptacles.
9985	L23, D23, L53, D53	No	Watertight 15A/250V Russellstoll. Dual 4.3 m (14 ft.) 250 V ac, 15A single phase line cord assemblies with watertight 15A Russellstoll plugs (RS p/n 3720DPU2). UL / CSA certified for use in US and Canada. Mates with customer-supplied Russellstoll 3743U2 or 9R23U2W receptacles.
9989	L23, D23, L53, D53	No	Dual power cords, non-watertight, 4.3 m (14 ft.), 250 V ac, 10 A, with IEC 309 C14 plugs. These power cords are for use with adjacent frame PDUs (FC 1950) or external (customer-supplied) PDUs.

Notes:

1. The Full Capacity Storage feature (FC 1644) is required to attach the optional expansion frame Models D22, D32, or D52.
2. The Full Capacity Storage feature (FC 1644) is required to add an Additional I/O Slots feature (FC 1658 or FC 1659).
3. With feature code 1451, feature codes 1660 and 1662 are standard in Models L22, L23, L52, L53, D23, and D53.

4. Required when you have 3 to 16 frames and you want to remove frames such that 1 or 2 frames remain. This requirement does not apply to a library that contains dual accessors.
5. Required when you have 1 to 2 frames and you want to add frames for a total of 3 to 6 frames. This requirement does not apply to a library that contains dual accessors.
6. Required when you have 7 to 16 frames and you want to remove frames for a total of 3 to 6 frames. This requirement does not apply to a library that contains dual accessors.
7. Required when you have 1 to 6 frames and you want to add one frame for a total of 7 frames. This requirement does not apply to a library that contains dual accessors.
8. Required when you have 1 to 6 frames and you want to add frames for a total of 8 to 14 frames. This requirement does not apply to a library that contains dual accessors.
9. Required when you have 8 to 16 frames, when you have feature code 1816 or 9316 installed, and when you want to remove frames such that you have a total of 7 frames. This requirement does not apply to a library that contains dual accessors.
10. Required when you have 1 to 14 frames, when feature code 9316 is not installed, and when you want to add frames for a total of 15 to 16 frames. This requirement does not apply to a library that contains dual accessors.
11. Must be added to any IBM TS3500 that comes from the plant and has 15 to 16 frames (14 or 15 Model D22, 32, or 52 expansion frames attached to the Model L22, 32, or 52). This requirement does not apply to a library that contains dual accessors.
12. Maximum limit of 3 per subsystem (no mixed media support). These feature codes assume that the 4-I/O door frame is installed at the end of the library string. ("String" refers to the very last frame in a single accessor library or the last frame before SBB in HS for both HA and single accessor libraries.) If the customer prefers that the 4-I/O door frame be installed elsewhere in the string, the service representative must obtain a "Services Contract" to uninstall additional frames as necessary to accommodate the customer's request.
13. This feature (FC 9679) indicates that one 3588 tape drive Model F3A or F3B will be field installed into a 3584 Model D32, D52, D53, L32, L52, or L53. If it is added to the order of a new 3584 frame coming from the plant, it indicates that the drive will be installed in the field rather than at the plant. Installation of a 3588 tape drive canister requires that a LTO Fibre Drive Mounting Kit feature (FC 1504 on the Model D32, D52, L32, or L52; FC 1514 on the Model D53 or L53) be installed in the 3584 Frame to contain the canister. The 3588 Model F3A or F3B tape drive must be separately ordered through FC 9679. Because the 3588 tape drive is designated as customer setup, if assistance is required to field install the drive, the 3588 tape drive Field Install Assist feature (FC 1678) should be ordered.
14. The quantity of the LTO Fibre Drive Mounting Kit feature (FC 1504 or FC 1514) must be equal to or greater than the quantity of LTO Fibre Channel tape drives installed (FC 9678, FC 9679, FC 9681, FC 9682, 9684, and FC 1479) plus Fiber Channel tape drives reinstalled with feature FC 1665).
15. The quantity of the 3592 Fibre Drive Mounting Kit feature (FC 1503, FC 1513 or FC 1515) must be equal to or greater than the quantity of 3592 tape drives installed (FC 1674, FC 1675, FC 9677, FC 9680, FC 9683, FC 9692, or FC 9699.)
16. In order to support Ultrium 5 tape drives in any library configuration, or to support more than 6 887 slots in an xx2 library with an Sx4 frame, all node

cards in the library must be xx3-equivalent node cards. This requires a xx3 model conversion OR the Enhanced Node Card(s) feature (FC 1700 or 1701).

17. Frames with FC 1950 require higher rated customer facility outlets (30-32 Amp) than frames without feature code 1950. Refer to "Power cords for Models L23, D23, L53, and D53" on page 132 for the specific outlet type and power rating requirements for the associated line cord features 9954, 9955, 9956, 9957, 9958, 9959 or 9966.
18. FC 1604 is required for encryption on Ultrium 4 and newer Ultrium tape drives if using library-managed (LME) or system-managed (SME) encryption, but not if using application-managed encryption (AME).
19. FC 2733 is qualified for use in the following countries: Argentina, Australia, Bahrain, Bolivia, Brazil, Canada, Chile, China CCC, China NALTE, Colombia, Costa Rica, Croatia, Ecuador, Egypt, Guatemala, Guyana, Honduras, Hong Kong, India, Indonesia, Israel, Japan, Jordan, Kazakhstan, Kyrgyzstan, Korea, Kuwait, Lebanon, Malaysia, Macau, Mexico, Morocco, New Zealand, Nicaragua, Oman, Panama, Pakistan, Paraguay, Peru, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Sri Lanka, Suriname, Taiwan, Thailand, Turkey, UAE, Ukraine, Uruguay, United States, Vietnam, Venezuela, Austria, Belgium, Bulgaria, Cyprus, Czech Rep., Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK. Oversea areas part of EU: Portugal: Acores, Madeira; Spain: Canarias; France: Guyane, Guadeloupe, Martinique, Reunion; USA: includes US Territories: Puerto Rico, US Virgin Islands, Northern Mariana, Guam
20. Two 31 meter Fibre Channel cables for connecting the backend switches to the TS7700 are included with TS7700 feature code 5759.
21. The following features have been withdrawn from marketing:
    - Feature code 2719 was withdrawn from marketing in September 2010.
    - Feature code 2720 was withdrawn from marketing in October 2008.
    - Feature code 2730 was withdrawn from marketing in January 2010.
    - Feature code 1452 was withdrawn from marketing in December 2010.
    - Feature code 1453 was withdrawn from marketing in December 2008.
    - Feature codes 2714, 2732, and 2733 were withdrawn from marketing in July 2012.
    - Feature code 4872 was withdrawn from marketing in August 2011.

Chapter 4. Using LTO tape drive media

The section introduces information about using LTO tape drive media.

The IBM TS3500 automates the storage and movement of IBM LTO tape cartridges.

Overview of LTO tape drive media

Within the TS3500 tape library and subject to certain restrictions, the supported LTO tape drives use the following cartridge types.

- IBM 2500 GB LTO Data Cartridge (LTO 6 cartridge without WORM capability)
- IBM 2500 GB LTO WORM Data Cartridge (LTO 6 cartridge)
- IBM 1500 GB LTO Data Cartridge (LTO 5 cartridge without WORM capability)
- IBM 1500 GB LTO WORM Data Cartridge (LTO 5 cartridge)
- IBM 800 GB LTO Data Cartridge (LTO 4 cartridge without WORM capability)
- IBM 800 GB LTO WORM Data Cartridge (LTO 4 cartridge)
- IBM 400 GB LTO WORM Data Cartridge (LTO 3 cartridge)
- IBM 400 GB LTO Data Cartridge (LTO 3 cartridge without WORM capability)
- IBM 200 GB LTO Data Cartridge (LTO 2 cartridge)
- IBM 100 GB LTO Data Cartridge (LTO 1 cartridge)
- IBM Universal LTO Cleaning Cartridge
- IBM LTO Cleaning Cartridge
- Diagnostic cartridge

Figure 37 shows an IBM LTO data cartridge.

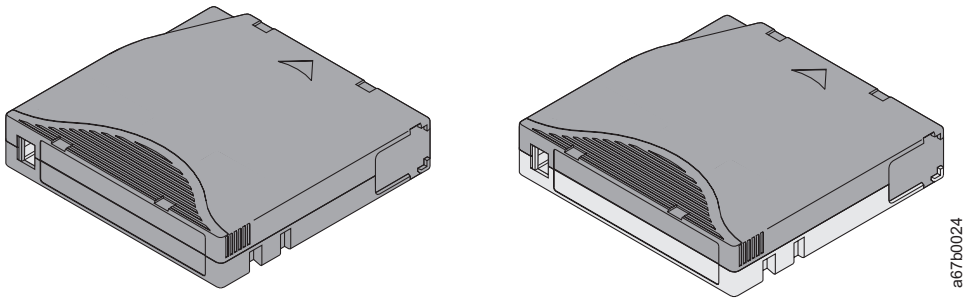


Figure 37. An IBM LTO data cartridge for LTO tape drives

WORM functionality for LTO tape drives and media

This topic describes the write-once-read-many (WORM) functionality that is used by the LTO Ultrium 3 and newer tape drives and supported cartridges.

The LTO 3 and later tape drives include the WORM feature, which is supported by the IBM LTO WORM Data Cartridge (formerly the IBM 3589 Ultrium Tape Cartridge Models 028 and 029). All IBM LTO 3 tape drives with firmware levels of 54K1 or higher and all later LTO drives support the WORM function. An LTO 3 or later tape drive with WORM capability can recognize WORM-compatible media.

More information and the required drive firmware can be found at the following URL: http://www.ibm.com/servers/storage/support/lto/3584/downloading.html

The IBM LTO WORM Data Cartridge is only for use on Ultrium 3 and later tape drives with WORM capable-microcode. The cartridge is designed for applications such as archiving and data retention, and is also suitable for applications that require an audit trail. The cartridge works with the Ultrium 3 and later tape drives to prevent the alteration or deletion of user data.

Additionally, IBM has taken the following steps to reduce tampering with data:
- The bottom of the WORM cartridge is molded in a color (gray) that is different from rewritable cartridges.
- A unique format is factory-written on each WORM cartridge.
- The WORM cartridge's memory, along with its unique format, protects the WORM character of the media.

Based on LTO technology, the format for the LTO WORM data cartridge provides the following capacities:

Table 54. LTO WORM cartridge capacities

Cartridge type	Native capacity	Compressed capacity†
LTO 6	2 500 GB (2 328.31 GiB)	6.25 TB (5.68 TiB)
LTO 5	1 500 GB (1396.98 GiB)	3 TB (2.73 TiB)
LTO 4	800 GB (745.05 GiB)	1 600 GB (1490.12 GiB)
LTO 3	400 GB (372.53 GiB)	800 GB (745.05 GiB)
† The compressed capacity for the LTO 6 cartridge uses a 2.5:1 compression ratio. The compressed capacity for LTO 5 and earlier LTO cartridges use a 2:1 compression ratio.		

LTO data cartridge

This section describes the capacity, construction, operation, and components of the IBM LTO data cartridge.

The IBM LTO 6 cartridge is black with a silk screen label on top that specifies "Ultrium 6 - 2500 GB." The IBM LTO 5 cartridge is burgundy with a silk screen label on the top that specifies "Ultrium 5 - 1500 GB." The IBM LTO 4 cartridge is green with a silk screen label on the top that specifies "Ultrium 4 - 800 GB." The IBM LTO 3 cartridge is blue-gray. The IBM LTO 2 cartridge is purple, and the LTO 1 cartridge is black. WORM data cartridges are two tones in order to distinguish them from other data cartridges. Each WORM cartridge is the color as the same generation of data cartridge on the top, but it is gray on the bottom. All generations of cartridges contain 1/2-inch, dual-coat, metal-particle tape. Capacity for the four types of cartridges is as follows:

- LTO 6 and LTO 6 WORM cartridges have a native data capacity of 2 500 GB (2 328.31 GiB) (6.25 TB [5.68 TiB] at 2.5:1 compression)
- LTO 5 and LTO 5 WORM cartridges have a native data capacity of 1 500 GB (1396.98 GiB) (3 TB [2.73 TiB] at 2:1 compression)
- LTO 4 and LTO 4 WORM cartridges have a native data capacity of 800 GB (745.05 GiB) (1.6 TB [1.46 TiB] at 2:1 compression)
- LTO 3 and LTO 3 WORM cartridges have a native data capacity of 400 GB (372.53 GiB) (800 GB [745.05 GiB] at 2:1 compression)
- LTO 2 cartridge has a native data capacity of 200 GB (186.26 GiB) (400 GB [372.53 GiB] at 2:1 compression)
- LTO 1 cartridge has a native data capacity of 100 GB (93.13 GiB) (200 GB [186.26 GiB] at 2:1 compression)

When processing tape in the cartridges, the LTO tape drives use a linear, serpentine recording format. The LTO 6 drives read and write data on 2 176 tracks and the LTO 5 drives read and write data on 1 280 tracks. The LTO 4 drives read and write data on 896 tracks; the LTO 3 drives read and write data on 704 tracks; the LTO 2 drives read and write on 512 tracks; and the LTO 1 drives read and write on 384 tracks. LTO 1 and LTO 2 drives read and write eight tracks at a time. The Ultrium 3 drives read and write 16 tracks at a time when using an Ultrium 3 cartridge and 8 tracks at a time when using Ultrium 1 or 2 cartridges. The LTO 4 drives read and write 16 tracks at a time when using Ultrium 4 and Ultrium 3 cartridges and read 8 tracks at a time when using Ultrium 2 cartridges. The LTO 5 and LTO 6 drives read and write 16 tracks at a time. The first set of tracks 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 tape is full, or until all data is written. For additional information about LTO tape drive and cartridge compatability, refer to
“Mixing media in drives” on page 37.

Figure 38 on page 152 shows the IBM LTO data cartridge and its components.

#	Component	#	Component
1	LTO cartridge memory	4	Write-protect switch
2	Cartridge door	5	Label area
3	Leader pin	6	Insertion guide

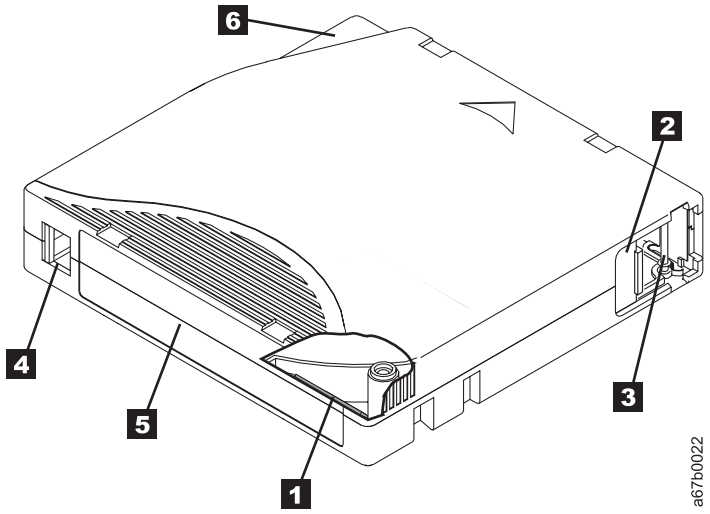


Figure 38. The IBM LTO data cartridge

All generations of the IBM LTO data cartridge include a Linear Tape-Open Cartridge Memory (LTO-CM) chip (**1** in Figure 38), that contains information about the cartridge and the tape (such as the name of the manufacturer that created the tape), as well as statistical information about the cartridge's use. The LTO-CM enhances the efficiency of the cartridge. For example, the LTO-CM stores the end-of-data location, which when you next insert a cartridge and issue the Write command, 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 you unload a tape cartridge, the tape drive writes any pertinent information to the cartridge memory. The storage capacity of the LTO-CM is 4096 bytes.

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

The write-protect switch **4** prevents data from being written to the tape cartridge. The label area **5** provides a location for you to place a label. Affix only a bar code label. When affixing a label, place it only in the recessed label area. A label that extends outside of the recessed area can cause loading problems in the internal drive or in the TS3500 tape library. The insertion guide **6** is a large, notched area that prevents you from inserting the cartridge incorrectly. You can order tape cartridges with the bar code labels included, or you can order custom labels.

Generation 3 and later generations of the LTO data cartridge have a nominal cartridge life of 20,000 load and unload cycles. Generations 1 and 2 of the LTO data cartridge have a nominal cartridge life of 10,000 load and unload cycles.

LTO cleaning cartridge

The IBM LTO cleaning cartridge is used to clean LTO tape drives.

To maintain the operating efficiency of the drive, IBM supplies a cleaning cartridge with the first frame of each media type. Each drive determines when it needs to be cleaned and alerts the library. Depending on which cleaning method you choose (automatic or manual), the library uses the cleaning cartridge to automatically clean the drive or you are required to select menus to initiate cleaning.

Note: The volume serial (VOLSER) number on the cleaning cartridge's bar code label must begin with **CLNI** or **CLNU**, or the library treats the cleaning cartridge as a data cartridge during an inventory.

The IBM LTO Cleaning Cartridge (known as the universal cleaning cartridge) and the LTO Cleaning Cartridge are compatible with all LTO tape drives. To enable your LTO 1 drive to use these cartridges, update the drive with the latest drive firmware (for instructions, see the section for updating drive firmware in the *IBM TS3500 with ALMS Operator Guide*).

Before a drive can be cleaned, ensure that a cleaning cartridge is loaded in the library (to determine whether one or more cleaning cartridges are loaded, see the section about removing a cleaning cartridge in the *IBM TS3500 with ALMS Operator Guide*). You can load multiple cleaning cartridges and store them in any cartridge storage slots except the slot that is reserved for the diagnostic cartridge (see the section about inaccessible storage slots in the *IBM TS3500 with ALMS Operator Guide*).

The TS3500 tape library monitors the use of all cleaning cartridges. The IBM cleaning cartridges are valid for 50 uses. When the cartridge expires, the library displays the following sample message on the Activity screen (where xx equals characters of the cartridge's VOLSER):

```
Remove CLNUxxL1
Cleaning Cartridge Expired
```

You can also enable automatic eject of expired cleaning cartridges through the Tape Library Specialist web interface by selecting **Settings** > **Library** > **Cartridges**.

Note: The cartridge's LTO-CM chip tracks the number of times that the cartridge is used. It is the operator's responsibility, however, to monitor the use of all cleaning cartridges and to remove and replace expired cartridges as necessary. Refer to the appropriate sections in the *IBM TS3500 with ALMS Operator Guide* in order to perform any of the following tasks:

- Determine cleaning cartridge usage
- Enable or disable automatic cleaning
- Learn how to use SNMP traps to receive notification about expired cartridges
- Remove a cleaning cartridge
- Enable or disable automatic ejects of expired cleaning cartridges

LTO diagnostic cartridge

An IBM service representative uses the LTO diagnostic cartridge to ensure that the LTO tape drives run correctly and to specification.

The LTO diagnostic cartridge is a cartridge with known good media that is reserved for diagnostic purposes only. One cartridge slot is reserved in the first LTO frame for the LTO diagnostic cartridge. The slot is located at Column 1, Row 1.

Note: A new diagnostic cartridge is shipped with the LTO drive field install feature if it is the first drive of that type in the frame.

The volume serial (VOLSER) number for a diagnostic cartridge is represented as `DG IxxLy`, where `xx` equals alphanumeric characters and `y` equals the generation of the cartridge type. The characters of the VOLSER are white on a black background.

Table 55. Compatibility of diagnostic cartridges with LTO tape drives.

Cartridge generation (y)	LTO tape drives					
	LTO6	**LTO5**	**LTO4**	**LTO3**	**LTO2**	**LTO1**
5	Yes	Yes	No	No	No	No
4	No	Yes	Yes	No	No	No
3	No	No	Yes	Yes	No	No
2	No	No	No	Yes	Yes	No
1	No	No	No	No	Yes	Yes

Because internal diagnostics for the LTO tape drive do not permit it to write to a WORM cartridge, all diagnostic tests that are selected from the operator panel and performed in maintenance mode will cause the drive to eject a WORM cartridge and issue error code 7 on its single-character display. To run diagnostics, use a non-WORM cartridge.

LTO bar code label

Each LTO data, cleaning, and diagnostic cartridge that is processed by the TS3500 tape library must bear a bar code label.

The bar code label contains:

- A volume serial (VOLSER) number that you can read
- A bar code that the library can read

When read by the library's bar code reader, the bar code identifies the cartridge's VOLSER to the tape library. The bar code also tells the library whether the cartridge is a data, cleaning, or diagnostic cartridge. In addition, the bar code includes the two-character media-type identifier Lx, where x equals 1, 2, 3, 4, 5, 6, T, U, V, or W. L identifies the cartridge as an LTO cartridge. 1 indicates that the cartridge is the first generation of its type. 2, 3, 4, 5, or 6 indicates that the cartridge is the second, third, fourth, fifth, or sixth generation of its type; T indicates that the cartridge is generation 3 WORM cartridge; U indicates that the cartridge is generation 4 WORM cartridge; V indicates that the cartridge is a generation 5 WORM cartridge; and W indicates that the cartridge is a generation 6 WORM cartridge. Figure 39 on page 156 shows a sample bar code label for the LTO 3 Tape Cartridge.

You can order tape cartridges with the labels included, or you can order custom labels. The bar code must meet predefined specifications. They include (but are not limited to):

- Eight uppercase alphanumeric characters, where the last two characters must be L1, L2, L3, L4, L5, L6, LT, LU, LV, or LW
- Label and printing to be non-glossy
- Nominal narrow line or space width of 0.423 mm (0.017 in.)
- Wide to narrow ratio of 2.75:1
- Minimum bar length of 11.1 mm (0.44 in.)

To determine the complete specifications of the bar code and the bar code label, visit the web at http://www-304.ibm.com/support/docview.wss?uid=ssg1S7000429 to download the *IBM LTO Ultrium Cartridge Label Specification*. You can also contact your IBM Sales Representative for this specification.

When attaching a bar code label to a tape cartridge, place the label only in the recessed bar code label area. A label that extends outside of the recessed area can cause loading problems in the drive or the library.

Attention: Do not place any type of mark on the white space at either end of the bar code. A mark in this area may prevent the TS3500 tape library from reading the label.

You can use the Tape Library Specialist web interface to configure the library so that it reports to the server all eight characters of the VOLSER on the bar code label or only the first six characters. To configure a six-character VOLSER, refer to the section about enabling or disabling the reporting of a six-character VOLSER in the *IBM TS3500 with ALMS Operator Guide*.

Note: If you suspect that the library is having problems reading the bar code labels, you can slow the scanner speed as part of problem determination. You may choose to slow the scanner speed rather than replace all labels, or you might want

to slow the scanner speed while you wait for an opportunity to re-label the media. Depending on the severity of the problem, the error recovery procedure (ERP) for poor labels might greatly exceed the time lost by slowing the scanner. If you have cartridge bar code labels that meet the LTO bar code label specification, there is no need to slow the scanner speed. For information about slowing the scanner speed, see the section about adjusting the scanner speed in the *IBM TS3500 with ALMS Operator Guide*.

To order bar code labels, see "Ordering bar code labels for LTO tape cartridges" on page 175.

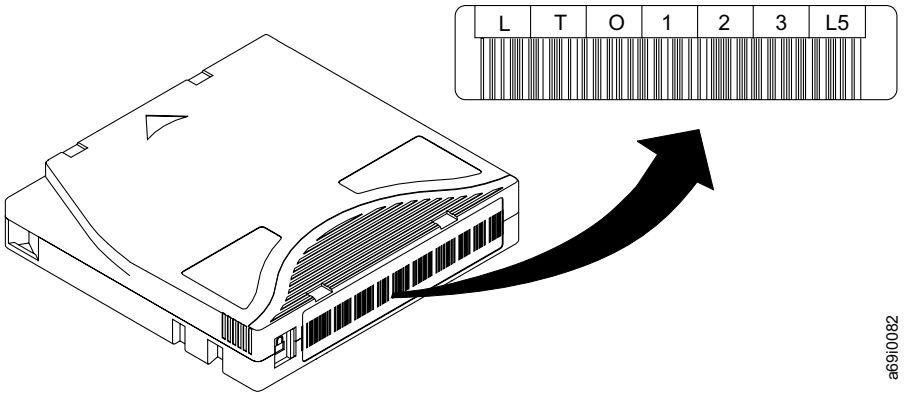


Figure 39. Sample bar code label on the LTO 5 tape cartridge. The volume serial number (LTO123) and bar code are printed on the label.

Guidelines for using LTO bar code labels

The guidelines listed in this topic must be followed when using LTO bar code labels.

Apply the following guidelines whenever you use LTO bar code labels:

- Use only IBM-approved bar code labels.
- Do not reuse a label or reapply a used label over an existing label.
- Before you apply a new label, remove the old label by slowly pulling it at a right angle to the cartridge case.
- Use peel-clean labels that do not leave a residue after they are removed. If there is glue residue on the cartridge, remove it by gently rubbing it with your finger. Do not use a sharp object, water, or a chemical to clean the label area.
- Examine the label before you apply it to the cartridge. Do not use the label if it has voids or smears in the printed characters or bar code (an application's inventory operation will take much longer if the bar code label is not readable).
- Remove the label from the label sheet carefully. Do not stretch the label or cause the edges to curl.
- Position the label within the recessed bar code label area.
- With light finger pressure, smooth the label so that no wrinkles or bubbles exist on its surface.
- Verify that the label is smooth and parallel, and has no roll-up or roll-over. The label must be flat to within 0.5 mm (0.02 in.) over the length of the label and have no folds, missing pieces, or smudges.
- Do not place other machine-readable labels on other surfaces of the cartridge. They might interfere with the ability of the bar code reader to read the bar code.

Setting the write-protect switch on an LTO tape cartridge

Use the write-protect switch to prevent data from being written to an LTO tape cartridge.

The position of the write-protect switch on an LTO tape cartridge (see **1** in Figure 40) determines whether you can write to the tape:

- If the switch is set to (solid red), data cannot be written to the tape.
- If the switch is set to unlocked (black void), data can be written to the tape.

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

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

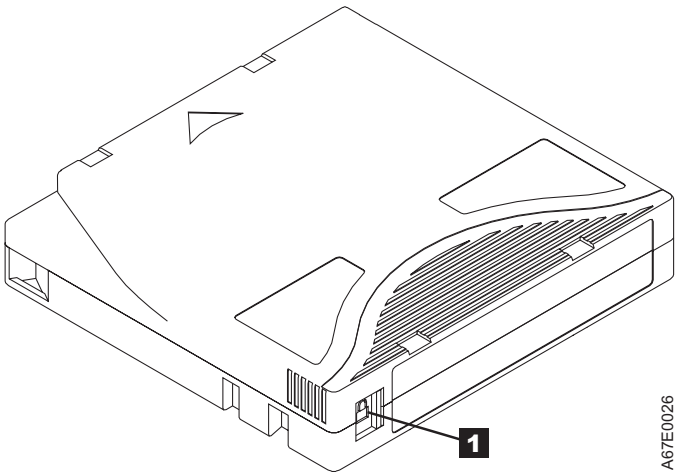


Figure 40. Setting the write-protect switch on an LTO tape cartridge

Handling LTO tape cartridges

Incorrect handling or an incorrect environment can damage IBM LTO tape cartridges or their magnetic tape. To avoid damage to your tape cartridges and ensure the continued high reliability of your IBM LTO tape drives, handle them properly as described in the following topics.

If the symbol is...	It means...
	**Attention:** Do not insert a damaged tape cartridge into your TS3500 tape library. A damaged cartridge can interfere with the reliability of a drive and may void the warranties of the drive and the cartridge. Before inserting a tape cartridge, inspect the cartridge case, cartridge door, and write-protect switch for breaks. If you need to recover data from a damaged cartridge, contact your IBM Service Representative.

Provide training for using LTO tape cartridges

Provide proper training for people using LTO tape cartridges.

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

Ensure proper packaging of LTO tape cartridges

LTO tape cartridges must be packed and shipped according to specific guidelines in order to ensure they are not damaged during transport.

Adhere to the following guidelines when packaging or shipping LTO tape cartridges:

- When you ship a cartridge, ship it in its original or better packaging.
- Always ship or store a cartridge in a jewel case.
- Use only a recommended shipping container that securely holds the cartridge in its jewel case during transportation. LTO Turtle Cases (by Perm-A-Store) have been tested and found to be satisfactory (see Figure 41). They are available at `http://www.turtlecase.com`.

Figure 41. Tape cartridges in a Turtle Case

- Never ship a cartridge in a commercial shipping envelope. Always place it in a box or package.
- If you ship the cartridge in a cardboard box or a box of a sturdy material, ensure that the following precautions are taken:
  - Place the cartridge in polyethylene plastic wrap or bags to protect it from dust, moisture, and other contaminants.
  - Pack the cartridge snugly to ensure that it does not move around.
  - Double-box the cartridge (place it inside a box, then place that box inside the shipping box) and add padding between the two boxes (see Figure 42 on page 160).

Figure 42. Double-boxing tape cartridges for shipping

Provide proper acclimation and environmental conditions for LTO tape cartridges

Certain conditions are required to ensure the safety and quality of LTO tape cartridges.

- Before you use a cartridge, let it acclimate to the normal operating environment for 1 hour. If you see condensation on the cartridge, wait an additional hour.
- Ensure that all surfaces of a cartridge are dry before inserting it.
- Do not expose the cartridge to moisture or direct sunlight.
- Do not expose recorded or blank cartridges to stray magnetic fields greater than 50 oersteds (4000 ampere/meter), such as 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 proper conditions for storing and shipping the cartridges.

Perform a thorough inspection of LTO tape cartridges

Inspect LTO tape cartridges to ensure they are not damaged before using them with your LTO tape drives and tape library.

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

1. Inspect the packaging to determine if the cartridge was handled roughly.

   Note: 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.
2. Inspect the cartridge for damage before using or storing it.
3. Inspect the rear of the cartridge (the part that you load first into the tape load compartment) and ensure that there are no gaps in the seam of the cartridge case. (Refer to **1** in Figure 43 on page 161. If there are gaps in the seam, the leader pin may be dislodged and may need to be repositioned.)

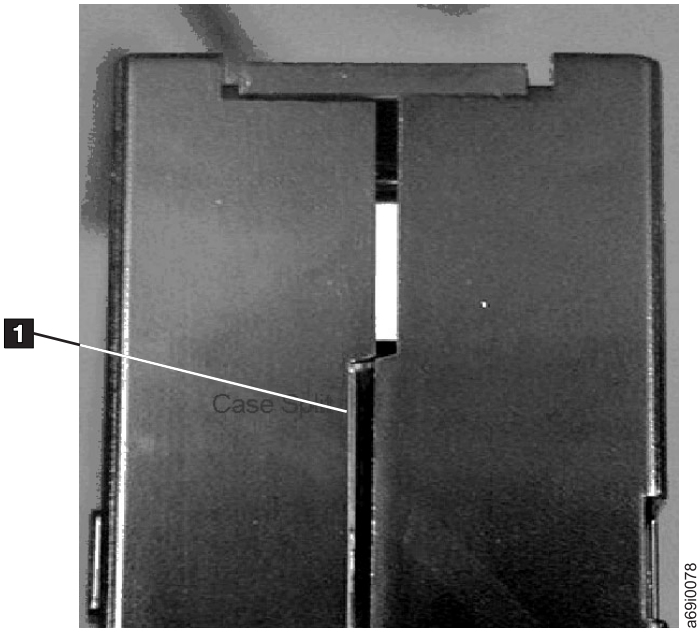


Figure 43. Gap in cartridge seam

Handle the LTO tape cartridge carefully

Handle the LTO tape cartridges carefully to ensure they do not get damaged.

- Do not drop the LTO tape cartridge. If the cartridge drops, slide the cartridge door back and ensure that the leader pin is properly positioned in the pin-retaining spring clips. If the leader pin has become dislodged, perform the procedure to reposition it.
- Do not handle tape that is outside the cartridge. Handling the tape can damage the tape's surface or edges, which may interfere with read or write reliability. Pulling on tape that is outside the cartridge can damage the tape and the brake mechanism in the cartridge.
- Do not stack more than six cartridges.
- Do not degauss a cartridge that you intend to reuse. Degaussing makes the tape unusable.

Examples of problems with LTO tape cartridges

Occasionally you might encounter a problem with an LTO tape cartridge. If you do, you can try to resolve the problem and avoid any data loss.

Example: Split cartridge case

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

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

Example: Improper placement of leader pin

The leader pin is misaligned. Perform the following steps to determine the cause and recover data:

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

Repositioning or reattaching a leader pin in an LTO tape cartridge

Use the following procedures to move a leader pin into its proper position in an LTO tape cartridge, or to reattach the pin if it has separated from the tape.

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

If you see this symbol:	**Take this action:**
	**Attention:** Use a repaired tape cartridge only to recover data and move it to another cartridge. Continued use of a repaired cartridge might void the warranties of the drive and the cartridge.

Repositioning a leader pin in an LTO tape cartridge

Before you begin

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

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

About this task

A leader pin that is improperly positioned inside an LTO tape cartridge can interfere with the operation of the drive. Figure 44 on page 164 shows a leader pin in the incorrect **1** and correct **2** positions.

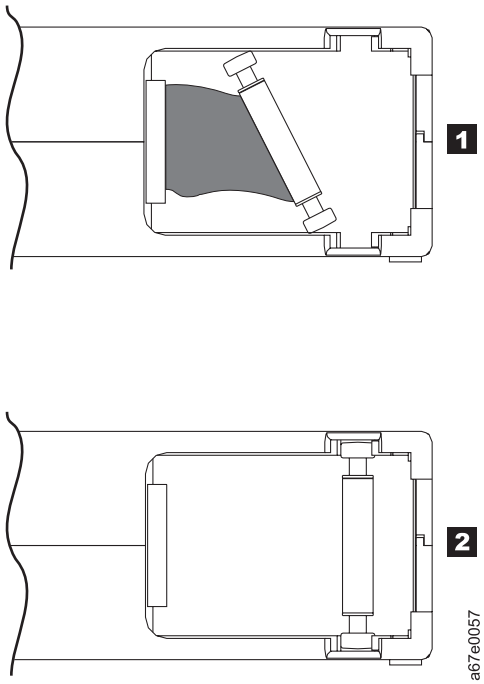


Figure 44. Leader pin in the incorrect and correct positions in an LTO tape cartridge. The cartridge door is open and the leader pin is visible inside the cartridge.

Procedure

Complete the following steps to reposition a leader pin:

1. Slide open the cartridge door (**1** in Figure 45 on page 165) and locate the leader pin **2** . You may need to shake the cartridge gently to roll the pin toward the door.
2. With plastic or blunt-end tweezers, grasp the leader pin and position it in the pin-retaining spring clips **3** .
3. Press the leader pin gently into the clips until it snaps into place and is firmly seated. Ensure that there are no gaps in the seam of the cartridge **4** .

   Note: If gaps exist, do not continue with this procedure and do not use the cartridge. Instead, contact your IBM service representative.
4. Close the cartridge door.

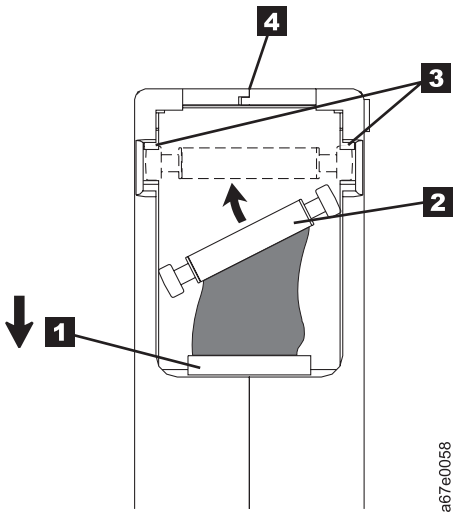


Figure 45. Placing the dislodged leader pin into the correct position. The cartridge door is open to show the leader pin.

5. To rewind the tape, insert the cartridge manual rewind tool (**1** in Figure 46) into the cartridge's hub **2** and turn it clockwise until the tape becomes taut.

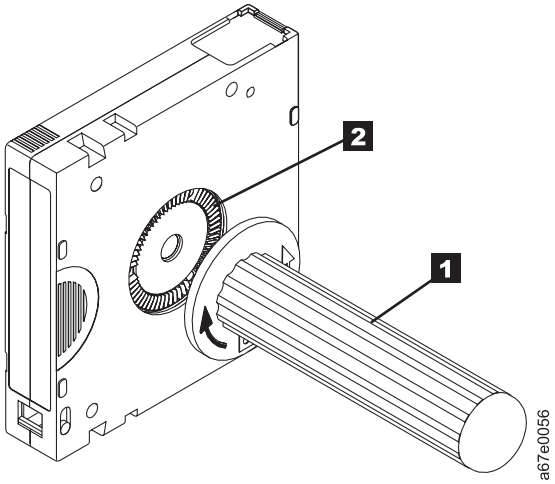


Figure 46. Rewinding the tape into the cartridge

6. Remove the rewind tool.

Reattaching a leader pin in an LTO tape cartridge

Reattach a leader pin if it has become detached from the magnetic tape and you must copy the cartridge's data onto another cartridge.

Before you begin

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

The Leader Pin Reattachment Kit contains three parts:

- **Leader pin attach tool** (see 1 in Figure 47). A plastic brace that holds the cartridge door open.
- **Cartridge manual rewind tool** (see 2 in Figure 47). A device that fits into the cartridge's hub and lets you wind the tape into and out of the cartridge.
- **Pin supplies** (see 3 in Figure 47). Leader pins and C-clips.

Attention:

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

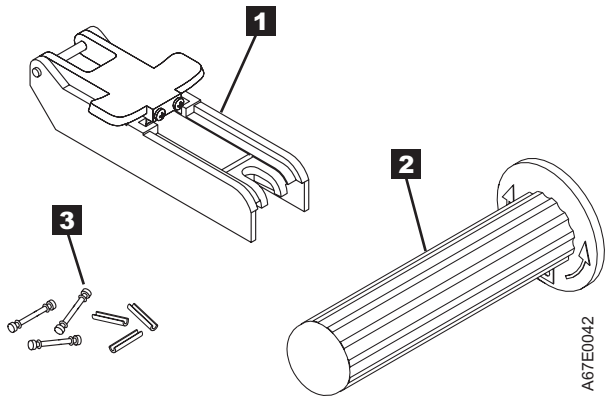


Figure 47. Leader Pin Reattachment Kit

Procedure

To reattach a leader pin by using the IBM Leader Pin Reattachment Kit, perform the following steps:

1. Attach the leader pin attach tool (1 in Figure 48 on page 167) to the cartridge 2 so that the tool's hook 3 latches into the cartridge's door 4 . Pull the tool back to hold the door open, then slide the tool onto the cartridge.

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

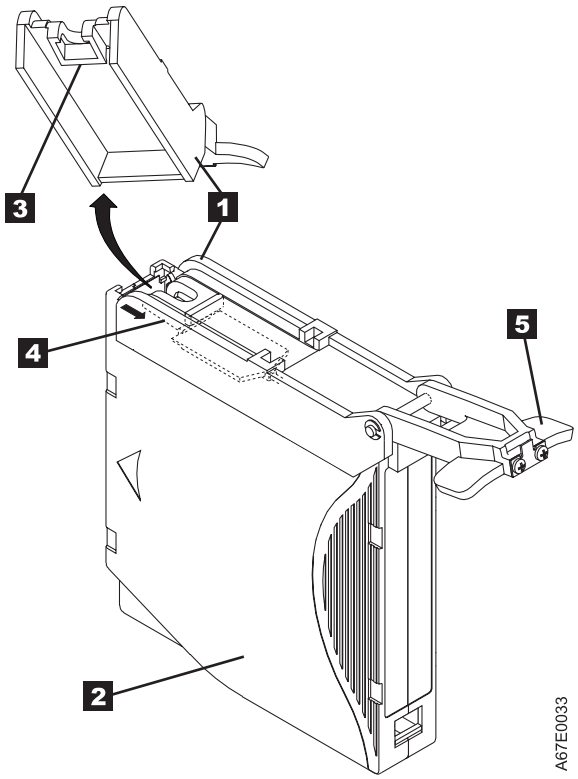


Figure 48. Attaching the leader pin attach tool to an LTO tape cartridge. To hold the cartridge door open, hook the tool into the door and pull the tool back.

2. To find the end of the tape inside the cartridge, attach the cartridge manual rewind tool (**1** in Figure 49 on page 168) to the cartridge's hub **2** by fitting the tool's teeth between the teeth of the hub. Turn the tool clockwise until you see the end of the tape inside the cartridge. Then, slowly turn the rewind tool counterclockwise to bring the tape edge toward the cartridge door **3** .
3. Continue to turn the rewind tool counterclockwise until approximately 13 cm (5 in.) of tape hangs from the cartridge door. If necessary, grasp the tape and pull gently to unwind it from the cartridge.
4. Remove the rewind tool by pulling it away from the cartridge. Set the tool and the cartridge aside.

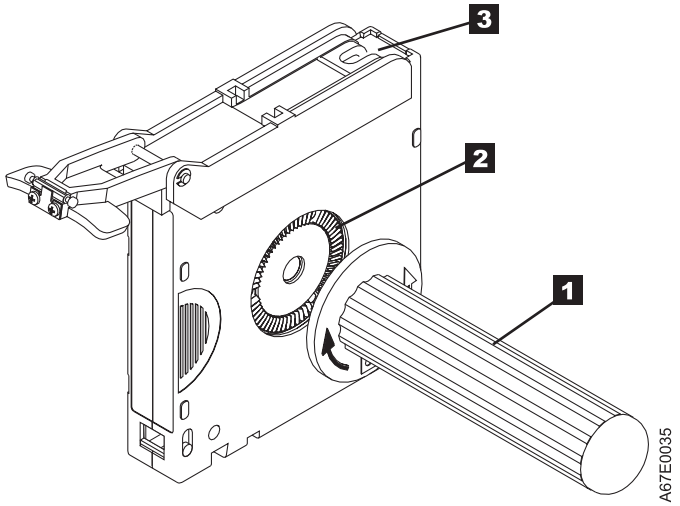


Figure 49. Winding the tape out of the LTO tape cartridge. Turn the cartridge manual rewind tool clockwise to see the end of the tape, then turn it counterclockwise to bring the tape to the cartridge door.

5. On the leader pin (**1** in Figure 50), locate the open side of the C-clip **2** . The C-clip is a small black part that secures the tape **3** to the pin.
6. Remove the C-clip from the leader pin by using your fingers to push the clip away from the pin. Set the pin aside and discard the clip.

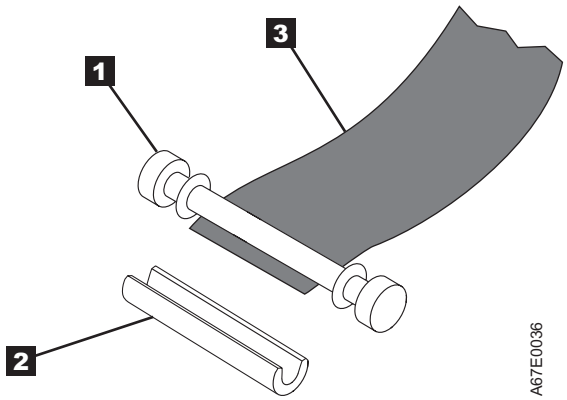


Figure 50. Removing the C-clip from the leader pin. Use your fingers to push the C-clip from the leader pin.

7. Position the tape in the alignment groove of the leader pin attach tool (see **1** in Figure 51 on page 169).
8. Place a new C-clip into the retention groove **2** on the leader pin attachment tool and make sure that the clip's open side faces up.
9. Place the leader pin (from step 6) into the cavity **3** of the leader pin attach tool.
10.

    Attention: To prevent the leader pin from rolling into the cartridge, in this step, use care when folding the tape over the pin.
    Fold the tape over the leader pin and hold it with your fingers (see Figure 51 on page 169).

    Note: Use care to ensure that the tape is centered over the leader pin. Failure to properly center the tape on the pin will cause the repaired cartridge to fail.

When the tape is properly centered, a 0.25-mm (0.01-in.) gap exists on both sides of the pin.

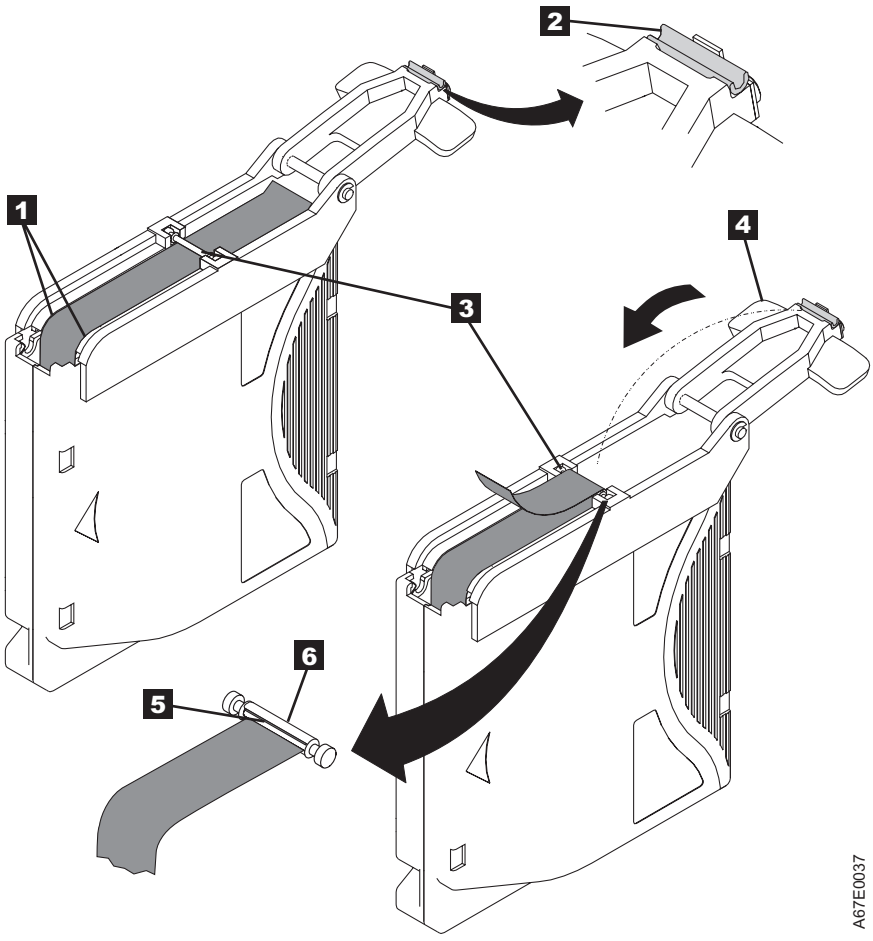


Figure 51. Attaching the leader pin to the tape

11. Close the pivot arm **4** of the leader pin attach tool by swinging it over the leader pin so that the C-clip snaps onto the pin and the tape.
12. Swing the pivot arm open and trim the excess tape **5** so that it is flush with the reattached leader pin **6**.
13. Use your fingers to remove the leader pin from the cavity **3** in the leader pin attach tool.
14. Use the cartridge manual rewind tool to wind the tape back into the cartridge (wind the tape clockwise). Ensure that the leader pin is latched by the pin-retaining spring clips on each end of the leader pin.
15. Remove the rewind tool.
16. Remove the leader pin attach tool by lifting its end up and away from the cartridge.

Environmental and shipping specifications for LTO tape cartridges

There are specific operating, storage, and shipping specifications for LTO tape cartridges.

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

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

Attention: Depending on how many drives you have installed in the frame of a TS3500 tape library, the temperature inside the frame might be as high as 5°C (9°F) above the temperature outside the frame. To ensure continued reliability of your media, be sure to take this temperature difference into account when you set up the environment around your library.

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 56 gives the environment for operating, storing, and shipping LTO tape cartridges.

Table 56. Environment for operating, storing, and shipping the LTO tape cartridges

Environmental Specifications				
Environmental Factor	**Operating**	**Operational Storage[1]**	**Archival Storage[2]**	**Shipping**
Temperature	10 to 45°C (50 to 113°F)	16 to 32°C (61 to 90°F)	16 to 25°C (61 to 77°F)	-23 to 49°C (-9 to 120°F)
Relative humidity (noncondensing)	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)
Magnetic field	Stray magnetic field at any point on tape not to exceed 50 oersteds (4000 ampere/meter).			

Notes:

1. Operational storage equals less than 6 months.
2. Archival storage equals greater than 6 months.

Disposing of LTO tape cartridges

Dispose of LTO tape cartridges according to federal and other regulations.

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

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

If a tape cartridge must be disposed of in a secure manner, you can erase the data on the cartridge by using a high-energy ac degausser (use a minimum of 2800 oersteds over the entire space that the cartridge occupies). Degaussing makes the cartridge unusable.

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

Ordering additional LTO cartridges and media supplies

Order additional LTO tape cartridges and other related media supplies by using any of the methods described in this topic.

You can use one of the following methods to order the cartridges and media supplies shown in Table 57:

- Order from your IBM Sales Representative or any authorized IBM Business Partner.
- Order by calling 1-888-IBM-MEDIA.
- Order through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`).

Note: For cartridges with preapplied bar code labels, specify the volume serial (VOLSER) characters that you want. If you would like cartridges with radio frequency identification (RFID) labels, also specify the correct feature code from the table below.

Table 57. Ordering LTO cartridges and media supplies

Supply Item	Method of Ordering	Feature Codes for RFID Labels
IBM LTO Ultrium 2500 GB Data Cartridge Bar code labels are preapplied to cartridges.	Specify Machine Type 3589 Model 550 and the VOLSER characters that you want. If you would like RFID[1] labels, also specify the feature code provided.	FC 5510
IBM LTO Ultrium 2500 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 650.	N/A
IBM LTO Ultrium 2500 GB WORM Data Cartridge Bar code labels are preapplied to cartridges.	Specify Machine Type 3589 Model 570 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	FC 5710
IBM LTO Ultrium 2500 GB WORM Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 670.	N/A
IBM LTO Ultrium 1500 GB Data Cartridge Bar code labels are preapplied to cartridges.	Specify Machine Type 3589 Model 014 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	FC 1421
IBM LTO Ultrium 1500 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 015.	N/A

Table 57. Ordering LTO cartridges and media supplies (continued)

Supply Item	Method of Ordering	Feature Codes for RFID Labels
IBM LTO Ultrium 1500 GB WORM Data Cartridge Bar code labels are preapplied to cartridges.	Specify Machine Type 3589 Model 034 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	FC 3421
IBM LTO Ultrium 1500 GB WORM Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 035.	N/A
IBM LTO Ultrium 800 GB WORM Data Cartridge Bar code labels are preapplied to cartridges.	Specify Machine Type 3589 Model 032 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	FC 3221
IBM LTO Ultrium 800 GB WORM Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 033.	N/A
IBM LTO Ultrium 800 GB Data Cartridge Bar code labels are preapplied to cartridges. Specify the feature code if you would like RFID labels.	Specify Machine Type 3589 Model 010 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	FC 1021
IBM LTO Ultrium 800 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 011.	N/A
IBM LTO Ultrium 400 GB WORM Data Cartridge Bar code labels are preapplied to cartridges. Specify the feature code if you would like RFID labels.	Specify Machine Type 3589 Model 028 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	FC 2821
IBM LTO Ultrium 400 GB WORM Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 029.	N/A
IBM LTO Ultrium 400 GB Data Cartridge Bar code labels are preapplied to cartridges. Specify the feature code if you would like RFID labels.	Specify Machine Type 3589 Model 008 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	FC 0821
IBM LTO Ultrium 400 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 009.	N/A
IBM LTO Ultrium 200 GB Data Cartridge Bar code labels are preapplied to cartridges. Specify the feature code if you would like RFID labels.	Specify Machine Type 3589 Model 006 and the VOLSER characters that you want. If you would like RFID labels, also specify the feature code provided.	6021
IBM LTO Ultrium 200 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 007.	N/A

Table 57. Ordering LTO cartridges and media supplies (continued)

Supply Item	Method of Ordering	Feature Codes for RFID Labels
IBM LTO Ultrium Cleaning Cartridge (universal cleaning cartridge for use with all Ultrium tape drives) VOLSER labels are included.	Specify Machine Type 3589 Model 004 and the VOLSER characters that you want.	N/A
Jewel Case for IBM LTO Ultrium 400 GB WORM Data Cartridge	Order the jewel case as feature code 8000. This case can also be used for the Ultrium 2 and Ultrium 1 Tape Cartridges.	N/A
Leader Pin Reattachment Kit	Order as part number 08L9129.	N/A
Notes: 1. RFID = radio frequency identification. 2. N/A = Not applicable.		

Ordering bar code labels for LTO tape cartridges

Order labels from one of the following authorized suppliers of bar code labels for LTO tape cartridges.

Bar code labels with volume serial (VOLSER) numbers are required for LTO tape cartridges that are read by the TS3500 tape library. You can order these labels separately from the IBM data cartridges and cleaning cartridges.

Attention: The TS3500 tape library is designed to work with bar code labels that meet the specifications and requirements set forth in the *IBM LTO Ultrium Cartridge Label Specification (Revision 2)*. The label providers listed below have demonstrated the ability to produce finished bar code labels that meet the foregoing specifications and requirements. This information is provided for the convenience of TS3500 tape library users only, and is not an endorsement or recommendation of such providers. IBM is not responsible for the quality of bar code labels procured from sources other than IBM. This information is applicable to bar code labels actually printed by the listed companies. IBM has not reviewed the quality of any labels produced by software or services offered by such companies that allow users to print labels on their own printing equipment.

Table 58. Authorized suppliers of custom bar code labels

In the Americas	In Europe and Asia
Dataware PO Box 740947 Houston, TX 77274 U.S.A. Telephone: 800-426-4844 or 713-432-1023 Fax: 713-432-1385 http://www.datawarelabels.com/	Not applicable
Tri-Optic 6800 West 117th Avenue Broomfield, CO 80020 U.S.A. Telephone: 888-438-8362 or 303-464-3508 Fax: 888-438-8363 or 303-666-2166 http://www.tri-optic.com	EDP Europe Limited 43 Redhills Road South Woodham Ferrers Chelmsford, Essex CM3 5UL U.K. Telephone: 44 (0) 1245 322380 Fax: 44 (0) 1245 323484 http://www.edpeurope.com/media-labels.html
Netc, L.L.C.[1] 100 Corporate Drive Trumbull, CT 06611 U.S.A. Telephone: 203-372-6382 Fax: 203-372-0676 http://www.NetcLabels.com	Netc Europe Ltd[1] The Old Surgery 5a The Pavement North Curry TA3 6LX Somerset U.K. Telephone: 44 (0) 1823 491439 Fax: 44 (0)1823 491373 http://www.NetcLabels.co.uk
	Netc Asia Pacific Pty Ltd[1] PO Box 872 Cooroy QLD 4563 Australia Telephone: 61 (0) 7 5442 6263 Fax: 61 (0) 7 5442 6522 http://www.NetcLabels.com.au

Note:

1. This is an authorized supplier for radio frequency identification (RFID) labels.

Chapter 5. Using 3592 tape drive media

The TS3500 tape library automates the storage and movement of IBM 3592 tape cartridges.

Overview of 3592 tape drive media

Use the table below to view characteristics of the various cleaning and data cartridges used by the 3592 tape drive(s) in the TS3500 tape library.

The 3592 tape drive uses twelve different data cartridge types and a cleaning cartridge. Characteristics of these cartridges are summarized in Table 59 on page 178.

Figure 52 shows an IBM 3592 tape cartridge.

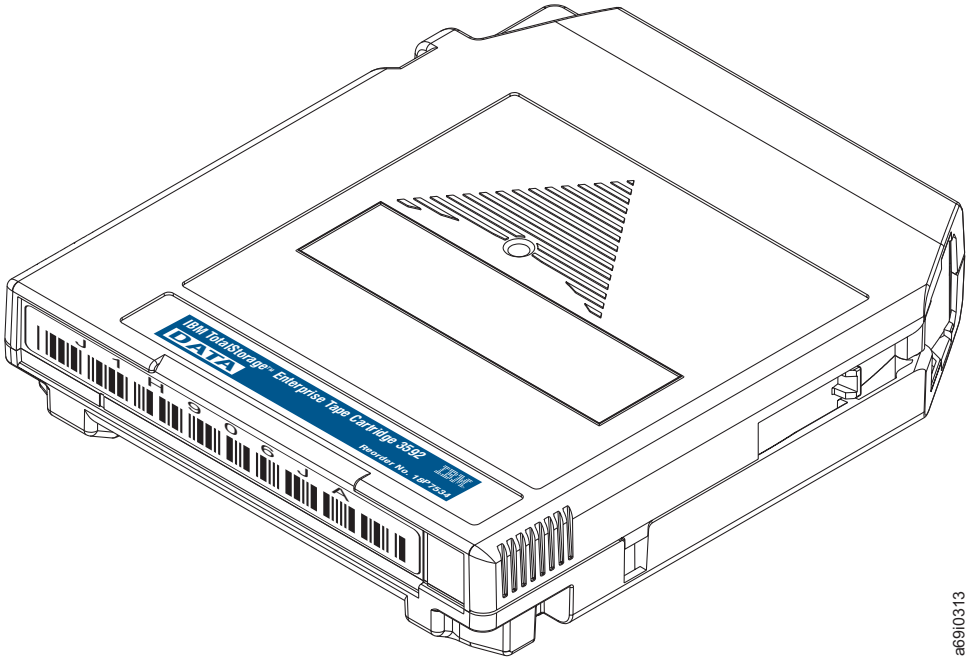


Figure 52. IBM 3592 tape cartridge

Cartridges can be distinguished by the text on the product label, as well as by the color of the cartridge case. Table 59 on page 178 displays the differences between the 3592 tape cartridges.

Table 59. Types of IBM 3592 tape cartridges

Text on product label and type of media[1]	Native capacity					Case color	Label, door, and write-protect switch color	Part number
	TS1150 (Model E08)	TS1140 (Model E07)	TS1130 (Model E06/EU6)	TS1120 (Model E05	J1A			
Data, JA	Not supported	640 GB (596.04 GiB) E06 format 500 GB (465.66 GiB) E05 format Read-only J1A format[2,3]	640 GB (596.04 GiB) E06 format 500 GB (465.66 GiB) E05 format 300 GB (279.39 GiB) J1A format	500 GB (465.66 GiB) E05 format 300 GB (279.39 GiB) J1A format	300 GB (279.39 GiB) J1A format	Black	Dark blue	18P7534
Extended data, JB	Not supported	1 600 GB (1490.12 GiB) E07 format 1 000 GB (931.32 GiB) E06 format 700 GB (651.93 GiB) E05 format	1 000 GB (931.32 GiB)	700 GB (651.93 GiB	Not supported	Black	Dark green	23R9830
Advanced Type C data, JC	7 TB (6.37 TiB) E08 format 4 TB (3.64 TiB) E07 format	4 TB (3.64 TiB)E07 format	Not supported	Not supported	Not supported	Black	Dark purple	46X7452
Advanced Type D read/write, JD	10 TB (9.1 TiB)[2,4] E08 format	Not supported	Not supported	Not supported	Not supported	Black	Burnt orange	2727263
Economy, JJ	Not supported	128 GB (119.21 GiB) E06 format 100 GB (93.13 GiB) E05 format Read-only J1A format[2,3]	128 GB (119.21 GiB) E06 format 100 GB (93.13 GiB) E05 format 60 GB (58.88 GiB) J1A format	100 GB (93.13 GiB) E05 format 60 GB (58.88 GiB) J1A format	60 GB (58.88 GiB) J1A format	Black	Light blue	24R0316

Table 59. Types of IBM 3592 tape cartridges (continued)

Text on product label and type of media[1]	Native capacity					Case color	Label, door, and write-protect switch color	Part number
	TS1150 (Model E08)	TS1140 (Model E07)	TS1130 (Model E06/EU6)	TS1120 (Model E05	J1A			
Advanced Type C economy, JK	900 GB (838.19 GiB) E08 format500 GB (465.66 GiB) E07 format	500 GB (465.66 GiB)	Not supported	Not supported	Not supported	Black	Light purple	46X7453
Advanced Type D economy, JL	2 TB (1.82 TiB)[2,4] E08 format	Not supported	Not supported	Not supported	Not supported	Black	Apricot	2727264
Economy WORM, JR	Not supported	128 GB (119.21 GiB) E06 format 100 GB (93.13 GiB) E05 format Read-only J1A format[2,3]	128 GB (119.21 GiB) E06 format 100 GB (93.13 GiB) E05 format 60 GB (58.88 GiB) J1A format	100 GB (93.13 GiB) E05 format 60 GB (58.88 GiB) J1A format	60 GB (58.88 GiB) J1A format	Platinum (silvery gray)	Light blue	24R0317
WORM, JW	Not supported	640 GB (596.04 GiB) E06 format 500 GB (465.66 GiB) E05 format Read-only J1A format[2,3]	640 GB (596.04 GiB) E06 format 500 GB (465.66 GiB) E05 format 300 GB (279.39 GiB) J1A format	500 GB (465.66 GiB) E05 format 300 GB (279.39 GiB) J1A format	500 GB (465.66 GiB) E05 format 300 GB (279.39 GiB) J1A format	Platinum (silvery gray)	Dark blue	18P7538
Extended WORM, JX	Not supported	1 600 GB (1490.12 GiB) E07 format 1 000 GB (931.32 GiB) E06 format 700 GB (651.93 GiB) E05 format	1 000 GB (931.32 GiB)	700 GB (651.93 GiB)	Not supported	Platinum (silvery gray)	Dark green	23R9831

Table 59. Types of IBM 3592 tape cartridges (continued)

Text on product label and type of media[1]	Native capacity					Case color	Label, door, and write-protect switch color	Part number
	TS1150 (Model E08)	TS1140 (Model E07)	TS1130 (Model E06/EU6)	TS1120 (Model E05	J1A			
Advanced Type C WORM, JY	7 TB (6.37 TiB) E08 format 4 TB (3.64 TiB) E07 format	4 TB (3.64 TiB) E07 format	Not supported	Not supported	Not supported	Platinum (silvery gray)	Dark purple	46X7454
Advanced Type D WORM, JZ	10 TB (9.1 TiB)[2,4] E08 format	Not supported	Not supported	Not supported	Not supported	Platinum (Silvery gray)	Burnt orange	2727265
Cleaning, CLNxxxJA[5]	N/A	N/A	N/A	N/A	N/A	Black	Gray	18P7535

Notes:

1. This designation appears as the last two characters on standard bar code labels. In addition, for cleaning cartridges, the first three characters of the volume serial (VOLSER) number are CLN.
2. For more information about microcode level requirements for use with Model E07 and Model E08 media, see online TS1140 (Model E07) and TS1150 (Model E08) documentation available in IBM Knowledge Center. This information is also available in *IBM 3592 Tape Drives and TS1120 Controller Operator Guide*, GA32-0556.
3. The 3592-E07 supports reading JA, JJ, JR, and JW cartridges only with a microcode level updated to D3I3_5CD or later.
4. The 3592-E08 supports reading and writing JD, JL, and JZ media cartridges only with a microcode level updated to D314_460 or later.
5. Where xxx equals three numerals. All generations of 3592 tape drives can use this cleaning media. A native capacity value is not applicable for cleaning media, which is shown in this table row by the entry "N/A".

Note: In addition to these cartridges, there is a Customer Engineer (CE) diagnostic cartridge for use by IBM service representatives only. The VOLSER for this cartridge is "CE xxxJJ" or "CE xxxJK", where a space occurs after "CE" and "xxx" equals three numerals.

The 3592 tape drive does not support LTO formats.

Firmware for each type of 3592 tape drive (TS1150, TS1140, TS1130, TS1120 and J1A) will not work in any other 3592 tape drive.

You can update the firmware of a 3592 tape drive without scheduling downtime. This enhancement is called a *nondisruptive drive firmware update*. It is available through the IBM Tape Library Specialist web interface and (for IBM service representatives) through CETool, but. is not supported by the Small Computer System Interface (SCSI). For more information, go to the section about updating drive firmware in the *IBM TS3500 with ALMS Operator Guide*.

WORM functionality for 3592 tape drives and media

Write-once-read-many (WORM) cartridges are designed for applications such as archiving and data retention, and to prevent the alteration or deletion of user data. They are also suitable for applications that require an audit trail.

All 3592 tape drives with the appropriate microcode version installed are capable of reading and writing WORM cartridges. The TS1120 and later 3592 tape drives support WORM behaviors and format attributes. These tape drives support the following five WORM media types:

JW (full length)
Supported by J1A, TS1120, and TS1130 tape drives.

JR (short length)
Supported by J1A, TS1120, and TS1130 tape drives.

JX (extended)
Supported by TS1120, TS1130, and TS1140 tape drives.

JY (advanced)
Supported by TS1140 and TS1150 tape drives.

JZ (advanced)
Supported by the TS1150 tape drive.

WORM cartridges are formatted at the factory and cannot be converted to data cartridges. The WORM tape media are formatted differently than the standard read/write media. One field in the manufacturer's servo track tape identifier on the tape designates that the medium is WORM. In addition, the cartridge memory (CM) has a WORM indicator byte in the cartridge type field. Both of these conditions must be true for the drive to work with a WORM cartridge. If one condition is true and the other is false, an `ATTN DRV - Invalid Cartridge` message displays. When the drive senses that a cartridge is a WORM cartridge, the microcode prohibits the changing or altering of user data that is already written on the tape. The microcode tracks the last appendable point on the tape with an overwrite-protection pointer that is stored in the CM. Statistical Analysis and Reporting System (SARS) data can be written and updated on WORM tapes because the SARS data is not in the user area of the tape.

Each WORM cartridge is identified by using a unique cartridge identifier (UCID) that is permanent and locked, which provides another level of security for data that must be maintained. This permanent locked information is stored in both the cartridge CM and on the tape itself, and can also be associated with the unique bar code volume serial (VOLSER) number.

Some records retention and data security applications require the WORM function of tape data storage. This WORM function is accomplished on the 3592 tape drive by a combination of microcode controls in the drive and a WORM tape cartridge. Special tamper-proofing techniques and checking prevent WORM cartridges from being transported to or from a data cartridge shell or cartridge memory and being inadvertently processed as a read/write cartridge. The drive microcode leverages this support by providing an interface and control mechanisms that allow an application or system to manage as needed. The control and status mechanisms for this can be found primarily in mode pages X'23' and X'24'. For more information, see the *IBM 3592 Tape Drive SCSI Reference* (GA32-0466).

The 3592 tape drives allow append operations to data already on WORM cartridges, and allow overwriting of file marks and other non-data attributes to provide application transparency. However, they do not allow data overwriting under any circumstances. Once full of data, WORM cartridges cannot be reused or erased by the drive and must be physically destroyed or bulk degaussed to delete data. For full tape application usage, certain trailer and label record overwrites are allowed.

Capacity scaling and segmentation

The 3592 tape drive supports capacity scaling for tape cartridges of media types JA, JB, JC, and JD over a broad range of capacities. The effect of capacity scaling is to contain data in a specified fraction of the tape. This yields faster locate and read times. Alternatively, you can purchase economy tapes (the JJ, JK, or JL media type) to achieve this faster performance.

The 3592 J1A tape drive divides tape into longitudinal segments. Using this capability, it is possible, for example, to segment 300 GB (279.39 GiB) data tapes into two segments: one segment with 64.42 GB (60 GiB) very fast access, and another 200 GB (186.26 GiB) segment for additional capacity. You can purchase 300 GB (279.39 GiB) data tapes that are pre-formatted in these segments, or you can segment and capacity scale them at a later time. Segmentation is only available within a specified range of capacity scaling settings. Capacity scaling is not supported for economy or write-once-read-many (WORM) tapes. For information about implementing segmentation and capacity scaling, refer to the README files that pertain to your device driver on the web:

`http://www.ibm.com/support/fixcentral`

For more technical information regarding WORM, capacity scaling, and segmentation, see also the *IBM 3592 Tape Drive SCSI Reference* (GA32-0466).

All TS1120 and later tape drives also support multiple format options, such as scaling and segmentation modes, to allow you to trade capacity for improved access times. While 256 settings of the Capacity Scaling byte (and resulting fractional capacities) are supported on these drives, the following three primary settings are recommended for use:

- Full capacity default mode
- 20% scaled fast access mode (20% capacity scaled, front of tape used). The Capacity Scaling byte is x'35'.
- Performance scaling for 87% capacity and a segmented format with recursive accumulating backhitchless flush (RABF) capability (a non-volatile caching technique) for the full cartridge. For WORM firmware for the 3592 tape drives, the Capacity Scaling byte is x'E0'.

These settings are fully certified and are available as labeled and initialized part-numbered cartridges. For the exact Mode Select commands and settings that are necessary to invoke scaling, see the *IBM 3592 Tape Drive SCSI Reference* (GA32-0466).

Scaling support in drive

Capacity scaling in the TS1120 and later tape drives is controlled by the host program performing a Scaling operation. This is performed using the Capacity Scaling byte and the Capacity Scaling Valid control bit in Mode page X'23'. These tape drives do not change current cartridge scaling unless a SCSI Mode Select command that specifies Mode Page X'23' (with appropriate non-default parameter settings) is received while the cartridge is positioned at the beginning of the tape. The drive can sense and report the scaling state of the current medium by using a Mode Sense command that specifies Mode Page X'23'. The default unscaled capacity is 300 GB (279.39 GiB) for a JA cartridge in J1A density, 500 GB (465.66 GiB) for a JA cartridge in E05 density, 700 GB (651.93 GiB) for a JB cartridge in E05 density, and 1 000 GB (931.32 GiB) for a JB cartridge in E06 density. The default

unscaled capacity for a JY cartridge in E07 density is 4 TB (3.64 TiB). The default unscaled capacity for a JZ cartridge in E08 density is 10 TB (9.1 TiB).

- The cartridge can be rescaled from any current Capacity Scaling byte value to any supported new value. The tape is logically erased by this (End of Data mark written at beginning of tape), but not physically erased as with the long erase command. Scaling or rescaling one cartridge does not cause rescaling of the next cartridge; an explicit command must be issued for each cartridge to be rescaled.
- The drive provides the option of setting the scaling values of N/256ths of full capacity, where N ranges from X'16' (22 -- equals about 8% capacity) to X'EC' (236 -- equals about 92%).
- For scaling factors N, between X'4B' and X'EB', the drive scales to the specified amount and creates a fast-access 20% capacity segment in the beginning of the scaled region.
- At all scaling factors, the drive supports early warning at the end of the scaled region (with the appropriate unit attention to inform the software that it should flush buffers and close volume) and reports a physical end-of-tape check condition at the end of the scaled region, just as it would if unscaled tape had reached the real physical end of the tape.

Capacity scaling is not offered on any of the short length (economy) cartridge types (JJ, JK, or JL), or on the WORM cartridges (JW, JX, JY, JR, JY, and JZ). Capacity scaling is only offered on the JA, JB, JC, and JD cartridge types.

Three important attributes are controlled by the setting of the Capacity Scaling byte value:

- The total Medium Capacity
- The ability to perform the RABF function on an entire cartridge, including last wraps
- Information about whether the format is segmented. If the format is segmented, a fast-access segment is created on the front part of the tape followed by a larger remainder segment that occupies the remainder of the tape. The fast access segment is always filled (written) first, followed by the filling of the remainder segment. For some applications that want improved access attributes for partially filled cartridges but still want to use full capacity (if required) without re-scaling, this option is available.

It is important to note that the scaled state and attributes (segmentation, RABF) of the cartridge format is retained when a cartridge is reformatted between the J1A and E05 logical formats, although the exact resulting used capacity as a percentage of full capacity is not identical for all mapped settings.

3592 data cartridge

This section describes the capacity, construction, operation, and components of the IBM 3592 Enterprise Tape Cartridge.

The 3592 tape drive has a bidirectional read/write head with an Enterprise Tape 3592 format. The 3592 J1A writes or reads eight tracks at a time; the TS1120 tape drive and TS1130 tape drive write or read 16 tracks at a time. The TS1140 tape drive and TS1150 tape drive write or read 32 tracks at a time. The capacity of 3592 data cartridges varies by drive model and recording format. See the 3592 tape cartridges table in “Overview of 3592 tape drive media” on page 177 for these details.

TS1120 and newer tape drives that are encryption-enabled encrypt the data after compression.

Figure 53 shows an IBM 3592 tape cartridge and its components.

#	Component	#	Component
1	Cartridge case	5	IBM product label
2	Cartridge bar code label	6	Cartridge door
3	Volume serial (VOLSER) number	7	Write-protect switch
4	Label area	8	Stacking indent

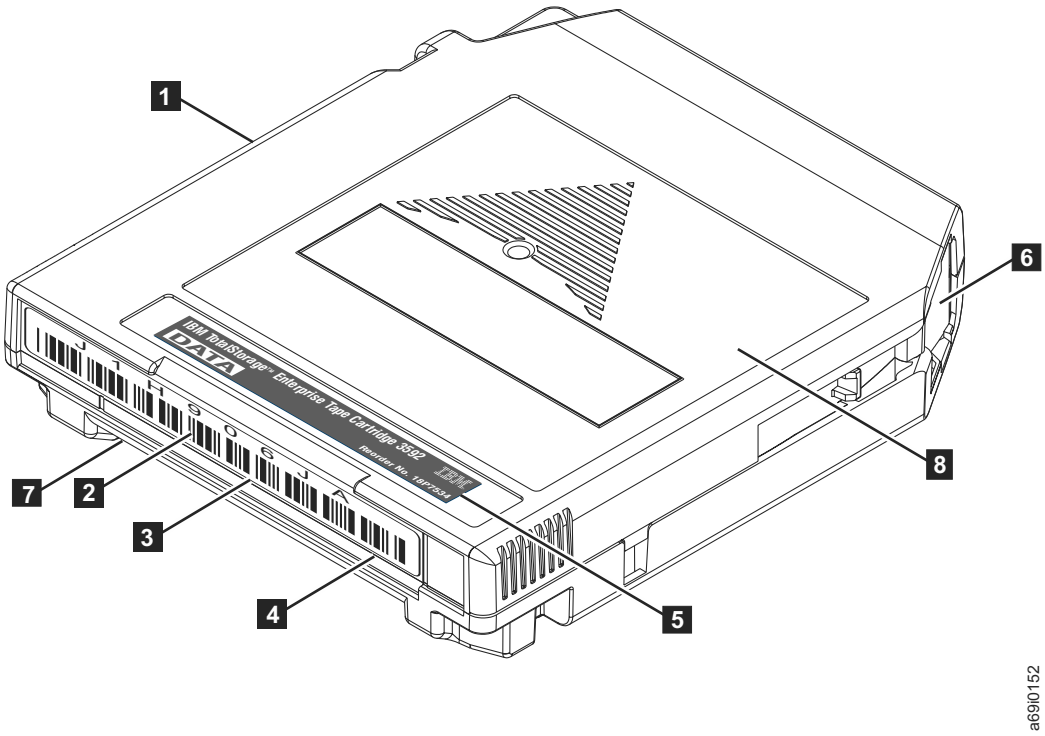


Figure 53. Components of the IBM 3592 tape cartridge

Through its vision system, the TS3500 tape library identifies the types of cartridges it contains during an inventory operation. The bar code reader reads the VOLSER (see 3 in Figure 53) of the cartridge bar code label 2 that is in the label area 4 of the cartridge. If your cartridge does not have a pre-attached bar code label and you attach one to it, place it entirely within the recessed label area. (See 3 and 4 as an example of proper placement.) The label must be flat to within 0.5 mm (0.02 inches) over the length of the label and have no folds, missing pieces, tears, or any extraneous markings. Failure to follow these placement requirements results in degraded readability.

The IBM product label 5 specifies the type of cartridge: data, economy, WORM, or cleaning. The indent on the top of the tape cartridge 8 is for stacking cartridges on top of each other. No labels are to be affixed in this area.

The cartridge door 6 protects the tape from contamination when the cartridge is out of the drive. When you insert the cartridge into the drive, a threading

mechanism pulls the tape out of the cartridge, across the drive head, and onto a non-removable takeup reel. The head can then read or write data from or to the tape.

Each data cartridge includes a write-protect switch **7** that you can set to prevent data from being overwritten or erased from the tape by the drive.

You can order tape cartridges with the bar code labels included, or you can order custom labels.

The 3592 data cartridge has a nominal cartridge life of 20,000 load and unload cycles. The quantity of load and unload cycles to reach this number depends on the environment in which the tape is used.

Cartridge memory in 3592 tape cartridges

Each 3592 data cartridge contains a passive, contactless, silicon storage device called cartridge memory (CM).

The CM module holds information about that specific cartridge, the media in the cartridge, and the data on the media. The cartridge and media information is stored in a protected, read-only area of the CM. When the cartridge is loaded into the drive, a CM reader in the drive uses a contactless, radio-frequency interface to read the information. The media's performance statistics are stored in an unprotected, read/write area of the CM module. Prior to when the cartridge is unloaded, these statistics are updated by the CM reader. They are maintained by a portion of the drive's microcode known as the Statistical Analysis and Reporting System (SARS). Each cleaning cartridge also contains a CM module, which tracks the number of cleaning uses and the location of the used cleaning media.

3592 cleaning cartridge

To help prevent errors caused by debris, it is important to clean the tape path of the 3592 tape drives and to manually clean the outside of its data cartridges, when needed.

For each TS3500 tape library, IBM supplies a specially labeled IBM 3592 cleaning cartridge with the first 3592 tape drive in the library. This cleaning cartridge may be used in all 3592 tape drives.

If the symbol is...	It means
	**Attention:** Insert only clean and undamaged cleaning cartridges into a tape system. Before you insert a cartridge into a drive or storage slot, inspect the cartridge for damage or debris. **Damaged or dirty cartridges can reduce system reliability and cause the loss of recorded data.** If debris appears on the cartridge, wipe the outside surfaces with a lint-free cloth lightly moistened with water. Do not allow any liquid to contact the tape. Ensure that all cartridge surfaces are dry and that the leader pin is in place (see 1 in Figure 54 on page 187) before you load the cartridge.

The cleaning of the tape path in the drive is an automatic procedure initiated by the drive when changes in drive performance generate a request for cleaning. This occurs when more than 5000 mounts have occurred, when more than 20 full file passes of data have been processed, or when the drive detects a degraded head or channel condition. If you load an expired cleaning cartridge, the drive will eject the cartridge and post a status message to indicate that cleaning was not performed. Failure to clean a drive can result in buildup of debris on the read/write head and drive malfunction. If no cleaning cartridges are installed in the library, or if the available cleaning cartridges have reached the maximum number of 50 uses, cleaning cannot be completed. For information about different cleaning methods (automatic, host, or manual), see “Methods of cleaning drives” on page 70. Also refer to the sections about cleaning drives, enabling or disabling automatic cleaning, and enabling automatic eject of expired cleaning cartridges in the *IBM TS3500 with ALMS Operator Guide*.

Note: It is the operator's responsibility to monitor the use of all cleaning cartridges and to remove and replace expired cartridges as necessary. In order to determine cleaning cartridge usage, learn to use SNMP traps to receive notification about expired cartridges. For steps to remove a cleaning cartridge or to enable automatic eject of expired cleaning cartridges, refer to the appropriate sections in the *IBM TS3500 with ALMS Operator Guide*.

Note: It is the operator's responsibility to monitor the use of all cleaning cartridges and to remove and replace expired cartridges as necessary. Use the to monitor cleaning cartridge usage, remove an expired cartridge, or enable automatic eject of expired cleaning cartridges.

Before you insert a cartridge into a drive or storage cell, inspect the cartridge for damage or debris. **Damaged or dirty cartridges can reduce system reliability and cause the loss of recorded data.** If debris appears on the cartridge, wipe the outside surfaces with a lint-free cloth lightly moistened with water. No visible water residue or droplets should be observable on the cartridge during or after the wiping effort.

Attention: Do not allow any liquid to contact the tape itself. Special care should be made to never allow liquid water to enter the cartridge which can potentially wick into the layers of the tape and cause them to adhere to each other. This creates the risk that the coatings may pull out during unwind.

Ensure that all cartridge surfaces are dry and that the leader pin is in place (see **1** in Figure 54) before you load the cartridge.

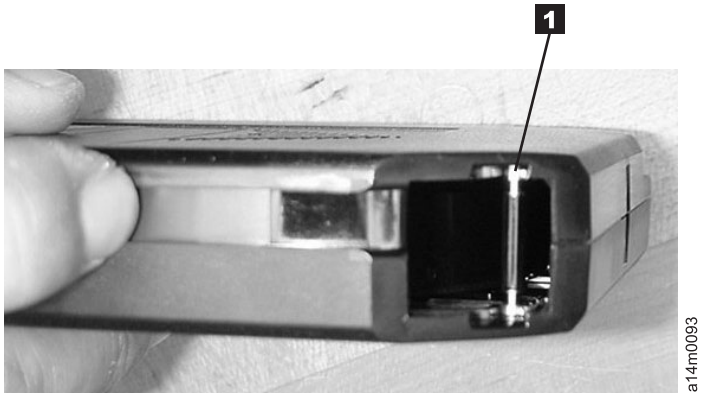


Figure 54. Leader pin in proper position in the 3592 cleaning cartridge (the cartridge door is manually retracted)

While the cleaning is in process, the 8-character message display on the drive shows the message, `CLEAN*`.

The IBM 3592 cleaning cartridge contains a cartridge memory (CM) device that automatically keeps track of the number of times it has been used. Cleaning cartridges need to be replaced after 50 uses. Automatic cleaning is only available if the appropriate cleaning cartridges are installed in the library and have remaining use.

The physical characteristics of the 3592 cleaning cartridge distinguish it from the 3592 data cartridge. The product label on the top of the cartridge is white, with the word `CLEANING` printed on it. In place of the write-protect switch, there is a non-moveable light gray block (see **1** in Figure 55 on page 188). If you order cleaning cartridges with pre-attached labels, the first three characters of the volume serial (VOLSER) number **2** are `CLN`. The cartridge door (see **1** in Figure 56 on page 188) is also light gray.

#	Component
1	Non-moveable light gray block
2	Sample label for cleaning cartridge

Figure 55. Characteristics that identify the 3592 cleaning cartridge

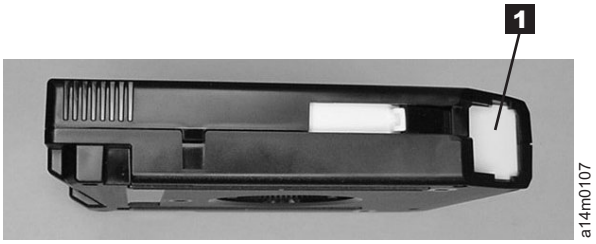


Figure 56. Door of the 3592 cleaning cartridge

Before a drive can be cleaned, you must ensure that an IBM 3592 cleaning cartridge is loaded in the library. You can load multiple cleaning cartridges and store them in any cartridge storage slot except the slot that is reserved for the diagnostic cartridge). To determine whether one or more cleaning cartridges are loaded, or for information about inaccessible cartridge storage slots, refer to the *IBM TS3500 with ALMS Operator Guide*.

3592 diagnostic cartridge

Information about the appearance and usage of the 3592 diagnostic cartridge.

The 3592 diagnostic cartridge is a cartridge with verified media that is reserved for diagnostic purposes only. In the TS3500 tape library, one storage slot is reserved in the first Model L22 or Model D22 frame for the 3592 diagnostic cartridge. The slot is located at Column 1, Row 1. During a service call, your IBM service representative uses the cartridge to ensure that the tape drives run correctly and to specification. The volume serial (VOLSER) number for the diagnostic cartridge is specified as shown, where a space occurs after `CE` and `xxx` equals three numerals: `CE xxxJJ` (for J1A, TS1120, and TS1130 tape drives) or CE xxxJK (for TS1140 tape drives and TS1150 tape drives). The diagnostic cartridge that is stored in the reserved slot should be the cartridge type that is used for the majority of drives in the library. In the event that the other type of 3592 diagnostic cartridge is required, the library requests it.

A new diagnostic cartridge is shipped with the TS1140 tape drive and TS1150 tape drive field install feature (feature code 1675) if it is the first drive of that type in the frame.

3592 bar code label

Each 3592 data, cleaning, and diagnostic cartridge that is processed by the TS3500 tape library must bear a bar code label.

The label contains:

- A volume serial (VOLSER) number that you can read
- A bar code that the library can read

When read by the library's bar code reader, the bar code identifies the cartridge's VOLSER to the tape library. The bar code also tells the cartridge type: data (JA), extended data (JB), advanced type C data (JC), advanced type D data (JD), economy (JJ), advanced type C economy (JK), advanced type D economy (JL), economy WORM (JR), WORM (JW), extended WORM (JX), advanced type C WORM (JY), advanced type D WORM (JZ), cleaning, or diagnostic cartridge. Figure 57 on page 190 shows a sample bar code label for the IBM 3592 Enterprise Tape Cartridge.

You can order tape cartridges with the labels included, or you can order custom labels. The labels have a peel-and-stick backing. The bar code must meet predefined specifications. The recommended specifications include (but are not limited to):

- Eight uppercase alphanumeric characters, where the last two characters must be JA, JB, JC, JD, JJ, JK, JL, JR, JW, JX, JY, or JZ.
- Label and printing to be non-glossy
- Nominal narrow line or space width of 0.500 mm (0.019 in.)
- Wide to narrow ratio of 2.75:1
- Minimum bar length of 7.0 mm (0.27 in.)

To determine the complete specifications of the bar code and the bar code label, visit the web at http://www.storage.ibm.com/media/tapecartridges/index.html. Under Enterprise storage media, select 3592 tape cartridges. Under Learn more, select Barcode Label Specification for use with 3592 Tape Media. Under Content, select the PDF file to view the *Label Specification for IBM 3592 Cartridges when used in IBM Libraries*. You can also contact your IBM sales representative for this specification.

When attaching a bar code label to a tape cartridge, place the label only in the recessed bar code label area (see Figure 57 on page 190). A label that extends outside of the recessed area can cause loading problems in the drive or the library.

Attention: Do not place any type of mark on the white space at either end of the bar code. A mark in this area may prevent the TS3500 tape library from reading the label.

By using the Tape Library Specialist web interface, you can configure the library so that it reports to the server all eight characters of the VOLSER on the bar code label or only the first six characters. To configure a six-character VOLSER, refer to the section about enabling or disabling the reporting of a six-character VOLSER in the *IBM TS3500 with ALMS Operator Guide*.

Note: If you suspect that the library is having problems reading the bar code labels, you can slow the scanner speed as part of problem determination. You can slow the scanner speed rather than replace all labels, or you could slow the scanner speed while you wait for an opportunity to relabel the media. Depending

on the severity of the problem, the error recovery procedure for poor labels may greatly exceed the time lost by slowing the scanner. If you have cartridge bar code labels that meet the LTO bar code label specification, there is no need to slow the scanner speed.For information about slowing the scanner speed, see the section about adjusting the scanner speed in the *IBM TS3500 with ALMS Operator Guide*.

To order bar code labels, see "Ordering 3592 bar code labels" on page 204.

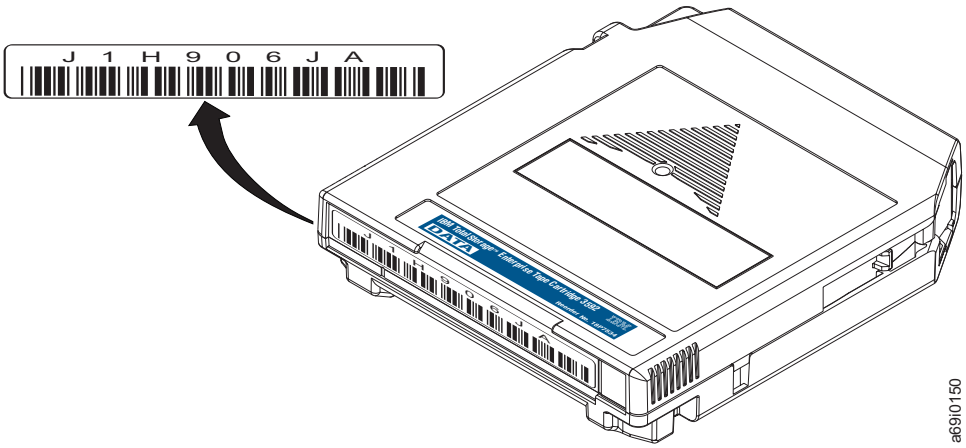


Figure 57. Sample bar code label on an IBM 3592 tape cartridge. The volume serial number (J1H906JA) and bar code are printed on the label.

Guidelines for using 3592 bar code labels

Apply the following guidelines whenever you use bar code labels:

- Use only IBM-approved bar code labels.
- Do not reuse a label or reapply a used label over an existing label.
- Examine the label before you apply it to the cartridge. Do not use the label if it has voids or smears in the printed characters or bar code (an application's inventory operation will take much longer if the bar code label is not readable).
- Position the label within the recessed bar code label area.
- Verify that the label is smooth and parallel, and has no roll-up or roll-over. The label must be flat to within 0.5 mm (0.02 in.) over the length of the label and have no folds, missing pieces, or smudges.
- Do not place other labels on any other cartridge surfaces. They might interfere with the ability of the bar code reader to read the bar code or cause the cartridge to get jammed.
- Use peel-clean labels that do not leave a residue after they are removed. If there is glue residue on the cartridge, remove it by gently rubbing it with your finger; do not use a sharp object, water, or a chemical to clean the label area.
- Before you apply a new label, remove the old label by slowly pulling it at a right angle to the cartridge case.
- Remove the label from the label sheet carefully. Do not stretch the label or cause the edges to curl.
- With light finger pressure, smooth the label so that no wrinkles or bubbles exist on its surface.

Guidelines for using Silo-style bar code labels

There are certain guidelines for using Silo-style bar code labels on 3592 tape cartridges.

The TS3500 tape library with firmware level 7368 or higher can also read Silo (Sun StorageTek Powderhorn 9130) style bar code labels on 3592 tape cartridges. In order for the library to read these labels, the following requirements apply:

- Bar code Compatibility Mode must be enabled on the TS3500 tape library
- The bar code reader must have a Microscan brand scanner.

  Note: This scanner is standard on most Lx3 libraries. However, if you are unsure or if the scanner is not reading the labels, contact your IBM Service Representative. The service procedure for verifying that the type of scanner is documented in RPQ 8B3510.
- The guidelines for using Silo-style bar code labels with the TS3500 tape library must be followed.

Proper placement of the bar code label is required for optimum bar code scanner performance. Follow these placement guidelines for Silo-style bar code labels on 3592 tape cartridges:

- Ensure that the label is top justified and centered within the recessed label area. The VOLSER label should not fall into the media type label area.
- Ensure that the label is applied to the cartridge with the bars facing down (text on top and bars on the bottom).
- Ensure that the label is applied straight, as a crooked label may cause label reading problems.

In addition to these specific guidelines, also adhere to the general label guidelines that are listed in “Guidelines for using 3592 bar code labels” on page 190.

Note that the bar code scanner only reads the VOLSER. If a single character media type identifier is applied, it is ignored by the library. Also, it is difficult to read the label of a cartridge mounted in the drive. Slower operation and repeated read attempts may be observed. This is normal for these labels.

Setting the write-protect switch on a 3592 cartridge

Use the write-protect switch to prevent data from being written to a 3592 tape cartridge.

The position of the write-protect switch on the 3592 tape cartridge (see Figure 58) determines whether or not you can write to the tape.

- To write data to or erase data from the cartridge, set the switch to **1** . This exposes a square hole.
- To prevent data from being overwritten or erased from the cartridge, set the switch to **2** . This covers the hole.

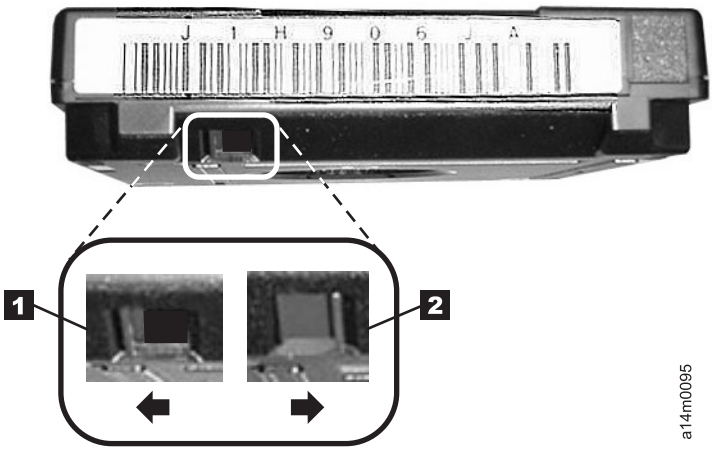


Figure 58. Setting the write-protect switch on the 3592 tape cartridge

Handling 3592 tape cartridges

Incorrect handling or an inhospitable environment can damage IBM 3592 tape cartridges or their magnetic tape. To avoid damage to your tape cartridges and ensure the continued high reliability of your IBM 3592 tape drives, handle them properly as described in the following topics.

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

Provide training for using 3592 tape cartridges

Provide proper training for anyone that is handling 3592 tape cartridges.

It is recommended that you take the following precautions to ensure the 3592 tape cartridges are handled properly.

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

Ensure proper packaging of 3592 tape cartridges

3592 tape cartridges must be packed and shipped according to specific guidelines in order to ensure they are not damaged during transport.

To avoid damage to 3592 tape cartridges, adhere to the following guidelines for packaging and shipping:

- When you ship a cartridge, ship it in its original or better packaging.
- Use only shipping containers that securely hold the cartridge in place during transportation. Such containers can be procured from Perm-A-Store on the web at `www.turtlecase.com`. The 3592 tape cartridges support racks and storage containers that are designed for 3590 tape cartridges.
- Never ship a cartridge in a commercial shipping envelope. Always place it in a box or package.
- If you ship the cartridge in a cardboard box or a box of a sturdy material, ensure that these precautions are taken:
  - Place the cartridge in polyethylene plastic wrap or bags to protect it from dust, moisture, and other contaminants.
  - Pack the cartridge snugly; do not allow it to move around.
  - Double-box the cartridge (place it inside a box, then place that box inside the shipping box) and add padding between the two boxes.

Provide proper acclimation and environmental conditions for 3592 tape cartridges

Certain conditions are required to ensure the safety and quality of 3592 tape cartridges.

- Before you use a cartridge, let it acclimate to the normal operating environment for a minimum of 24 hours. If you see condensation on the cartridge, wait an additional hour.
- Ensure that all surfaces of a cartridge are dry before inserting it.
- Do not expose the cartridge to moisture or direct sunlight.
- Do not expose recorded or blank cartridges to stray magnetic fields of greater than 50 Oersteds (4000 ampere/meter), such as 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 proper conditions for storing and shipping the cartridges.

Perform a thorough inspection of 3592 tape cartridges

After purchasing a 3592 tape cartridge and before using it, perform the following steps:

- Inspect the cartridge's packaging to determine potential rough handling.
- Ensure that no moisture or condensation exists on or in the cartridge shell or media.
- 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 welded and held together with screws; separating them destroys the usefulness of the cartridge.
- Inspect the cartridge for damage before using or storing it.
- Check that the leader pin is properly positioned.
- Ensure that labels are affixed in a manner that does not adversely affect drive operation. Labels must only be affixed in the recessed bar code label area provided on the cartridge. No labels should be placed in the indent on the top of the cartridge.
- 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.

Handle the 3592 tape cartridge carefully

Handle 3592 tape cartridges carefully to ensure they do not get damaged.

- Do not drop the 3592 tape cartridge. If the cartridge drops, slide the cartridge door back and ensure that the leader pin is properly positioned.
- Avoid mechanical loads that would distort the cartridge's shape.
- Do not handle tape that is outside the cartridge. Handling the tape can damage the tape's surface or edges, which may interfere with read or write reliability. Pulling on tape that is outside the cartridge can damage the tape and the brake mechanism in the cartridge.
- Do not stack more than six cartridges.
- Do not degauss a cartridge that you intend to reuse. Degaussing the tape erases the servo tracks and makes the tape unusable. An attached host can be used to

run a Data Security Erase if the data on the tape needs to be physically erased. This physically overwrites the data on the tape without damaging the servo tracks.

Repositioning a leader pin in a 3592 cartridge

Move a leader pin into its proper position in a 3592 tape cartridge in the event that the pin is improperly positioned.

Before you begin

If you see this symbol:	Take this action:
	**Attention:** Use a repaired tape cartridge only to recover data and move it to another cartridge. Continued use of a repaired cartridge might void the warranties of the drive and the cartridge.

If the leader pin in your 3592 tape cartridge becomes dislodged from its pin-retaining spring clips, you must use the IBM Leader Pin Reattachment Kit (part number 18P8887) to reposition it.

A leader pin that is improperly seated inside a cartridge can interfere with the operation of the drive. Figure 59 shows a leader pin in the incorrect 1 and correct 2 positions.

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

- Plastic or blunt-end tweezers
- Cartridge manual rewind tool (from the Leader Pin Reattachment Kit, part number 18P8887)

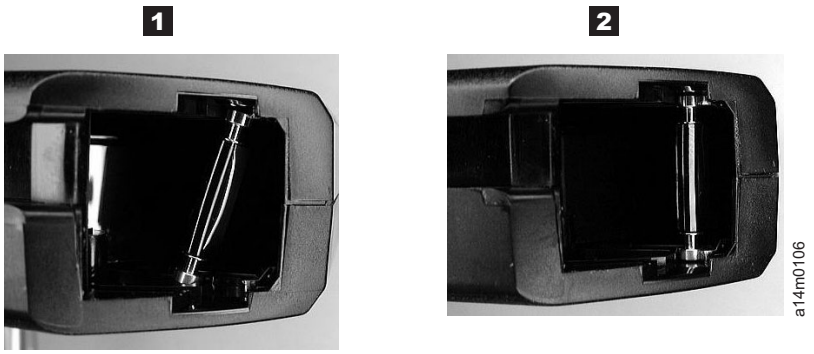


Figure 59. Leader pin in the incorrect and correct positions in a 3592 tape cartridge. The cartridge door is open and the leader pin is visible inside the cartridge.

To reposition the leader pin, perform the following steps.

Procedure

1. Slide open the cartridge door (see 1 in Figure 60 on page 196) and locate the leader pin 2 (you may need to shake the cartridge gently to roll the pin toward the door).
2. With plastic or blunt-end tweezers, grasp the leader pin and position it in the pin-retaining spring clips 3 .

3. Press the leader pin gently into the clips until it snaps into place and is firmly seated.
4. Close the cartridge door.

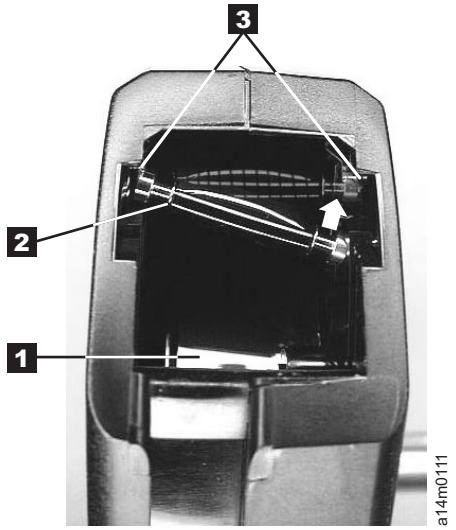


Figure 60. Placing the dislodged leader pin into the correct position. The cartridge door is open, showing the leader pin out of position.

5. To rewind the tape, insert the cartridge manual rewind tool (see **1** in Figure 61) into the cartridge's hub **2** and turn it clockwise until the tape becomes taut.

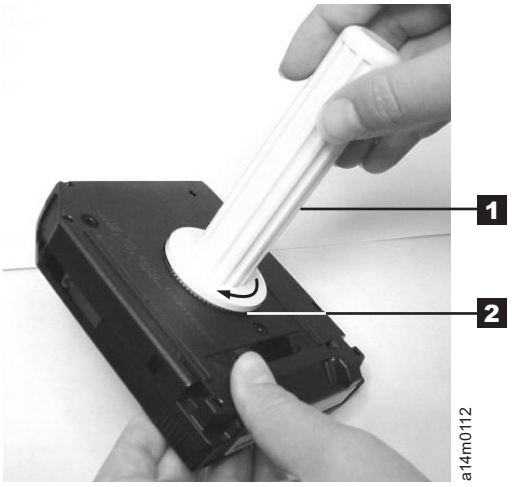


Figure 61. Rewinding the tape into the cartridge

6. Remove the rewind tool by pulling it away from the cartridge.

Environmental and shipping specifications for 3592 tape cartridges

There are specific operating, storage, and shipping requirements for 3592 tape cartridges.

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

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

Attention: Depending on how many drives you have installed in the frame, the temperature inside the frame may be as much as 5°C (9°F) above the temperature outside the frame. To ensure continued reliability of your media, be sure to take this temperature difference into account when you set up the environment around your library.

When you ship a cartridge, place it 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 60 lists the environmental conditions for operating, storing, and shipping IBM 3592 tape cartridges.

Table 60. Environment for operating, storing, and shipping the IBM 3592 tape cartridge

Environmental Specifications			
Environmental Factor	**Operational Storage[1,3]**	**Archival Storage[2,4]**	**Shipping**
Temperature	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 (noncondensing)	20 to 80%	20 to 50%	5 to 80%
Wet bulb maximum temperature	26°C (79°F)	26°C (79°F)	26°C (79°F)
Magnetic field	Stray magnetic field at any point on tape not to exceed 50 Oersteds (4000 ampere/meter).		

Notes:

1. Operational storage equals less than 6 months.
2. Archival storage equals greater than 6 months.
3. Cartridges shall be stored under these conditions if they will also be used in a drive during storage.
4. Cartridges shall be stored under these conditions for archiving.

Disposing of 3592 cartridges

Dispose of 3592 tape cartridges according to federal and other regulations.

Under the current rules of the U.S. Environmental Protection Agency (EPA), regulation 40CFR261, the IBM 3592 tape cartridge is classified as non-hazardous waste. As such, it may be disposed of in the same way as normal office trash. These regulations are amended from time to time, and you should review them at the time of disposal.

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

If a tape cartridge must be disposed of in a secure manner, IBM recommends that you use a qualified service provider to degauss and destroy the media.

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

Cartridge quality and library maintenance

Monitor the cartridges and library regularly to identify cartridges that need to be replaced to ensure proper operation of the tape drives and library.

The 3592 tape cartridge provides high performance and reliability with IBM magnetic tape cartridge drives when the cartridge is properly handled and stored. As stated previously, repeated handling or inadvertent mishandling can damage the physical parts of the cartridge and make it unusable.

The magnetic tape inside the cartridge is made of highly durable materials. However, the tape wears after repeated cycles in the tape system. Eventually, such wear can cause an increase in tape errors.

Track the error data available by monitoring both the cartridge and cartridge library performance. By monitoring error data, you can identify and replace cartridges that are no longer acceptable for continued use.

Proper maintenance of the TS3500 tape library helps to keep IBM magnetic tape cartridge systems operating in a reliable and efficient manner.

Ordering 3592 media supplies

Order more 3592 tape cartridges and other related media supplies by using any of the methods that are described in this topic.

You can order media supplies in two ways, by using the 3599 Tape Media method, or by using part numbers. The 3599 Tape Media method is available for ordering all types of data and cleaning cartridges. This method is typically used for ordering larger quantities and for ordering initialized or pre-labeled cartridges. Media supplies can also be ordered by using part numbers through IBM-authorized distributors.

Ordering 3592 media supplies by using the 3599 tape media method

If you order media by using the 3599 tape media method, IBM Enterprise Tape Media 3599 provides the ability to order unlabeled, pre-labeled, initialized, and bulk-packaged data cartridges in a variety of combinations. You can also order cleaning cartridges. See Table 61 for a list of data cartridges that can be ordered by using the 3599 tape media method.

With the 3599 tape media method of ordering, model numbers are used to identify the cartridge types, and feature code combinations are used to specify the quantities, labeling, and initialization options. Table 61 shows a few examples of ordering options for each cartridge type. Note that additional feature codes are required to completely specify all the characteristics that you want of the cartridges. Orders may be placed by calling 1-800-IBM-CALL (1-800-426-2255).

Table 61. Descriptions of 3599 tape media features.

3599 Model	Media ID/ Feature Code	Feature Code for Labeling, Initialization, and Quantity		Format	Individual Cartridge Capacity[2, 5]	Description
		Regular	RFID[1]			
011	JA/9030	1020	1021	9082	640 GB (596.05 GiB)	20-pack 3592 Data cartridges, labeled and initialized
				9081	500 GB (465.66 GiB)	
				9080	300 GB (279.39 GiB)	
012	JA/9030	2020	2021	N/A[3]	500 GB (465.66 GiB)	20-pack 3592 Data cartridges, labeled, not initialized
					300 GB (279.39 GiB)	
013	JA/9030	3020	N/A	N/A	500 GB (465.66 GiB)	20-pack 3592 Data cartridges, not labeled and not initialized
					300 GB (279.39 GiB)	
014	JB/9032	4020	4021	9084	1 600 GB (1490.12 GiB)	20-pack 3592 Extended Data cartridges, labeled and initialized
				9082	1 000 GB (931.32 GiB)	
				9081	700 GB (651.93 GiB)	
015	JB/9032	5020	5021	N/A	700 GB (651.93 GiB)	20-pack 3592 Extended Data cartridges, labeled, not initialized
016	JB/9032	6020	N/A	N/A	700 GB (651.93 GiB)	20-pack 3592 Extended Data cartridges, not labeled and not initialized
420	JC/9035	4211	4221	9084	4 TB (3.64 TiB)	20-pack 3592 Advanced Type C Data cartridges, labeled and initialized
520	JC/9035	5221	5231	N/A	4 TB (3.64 TiB)	20-pack 3592 Advanced Type C Data cartridges, labeled, not initialized

Table 61. Descriptions of 3599 tape media features (continued).

3599 Model	Media ID/ Feature Code	Feature Code for Labeling, Initialization, and Quantity		Format	Individual Cartridge Capacity[2, 5]	Description
		Regular	RFID[1]			
620	JC/9035	6200	N/A	N/A	4 TB (3.64 TiB)	20-pack 3592 Advanced Type C Data cartridges, not labeled and not initialized
425	JD/9036	4251	4261	9085	10 TB (9.1 TiB)	20-pack 3592 Advanced Type D Data cartridges, labeled and initialized
525	JD/9036	5251	5261	N/A	10 TB (9.1 TiB)	20-pack 3592 Advanced Type D Data cartridges, labeled, not initialized
625	JD/9036	6250	N/A	N/A	10 TB (9.1 TiB)	20-pack 3592 Advanced Type D Data cartridges, not labeled and not initialized
E11	JJ/9050	1120	1121	9082	128 GB (119.21 GiB)	20-pack 3592 Economy cartridges, labeled and initialized
				9081	100 GB (93.13 GiB)	
				9080	60 GB (58.88 GiB)	
E12	JJ/9050	1220	1221	N/A	60 GB (58.88 GiB)	20-pack 3592 Economy cartridges, labeled, not initialized
E13	JJ/9050	1320	N/A	N/A	60 GB (58.88 GiB)	20-pack 3592 Economy cartridges, not labeled and not initialized
430	JK/9052	4300	4310	9084	500 GB (465.66 GiB)	20-pack 3592 Advanced Economy cartridges, labeled and initialized
530	JK/9052	5300	5310	N/A	500 GB (465.66 GiB)	20-pack 3592 Advanced Economy cartridges, labeled, not initialized
630	JK/9052	6300	N/A	N/A	500 GB (465.66 GiB)	20-pack 3592 Advanced Economy cartridges, not labeled and not initialized
435	JL/9054	4351	4361	9085	2 TB (1.8 TiB)	20-pack 3592 Advanced Economy cartridges, labeled and initialized
535	JL/9054	5351	5361	N/A	2 TB (1.8 TiB)	20-pack 3592 Advanced Economy cartridges, labeled, not initialized
635	JL/9054	6350	N/A	N/A	2 TB (1.8 TiB)	20-pack 3592 Advanced Economy cartridges, not labeled and not initialized

Table 61. Descriptions of 3599 tape media features (continued).

3599 Model	Media ID/ Feature Code	Feature Code for Labeling, Initialization, and Quantity		Format	Individual Cartridge Capacity[2, 5]	Description
		Regular	RFID[1]			
021[4]	JW/9040	2120	2121	9082	640 GB (596.05 GiB)	20-pack 3592 WORM cartridges, labeled and initialized
				9081	500 GB (465.66 GiB)	
				9080	300 GB (279.39 GiB)	
022[4]	JW/9040	2220	2221	N/A	500 GB (465.66 GiB)	20-pack 3592 WORM cartridges, labeled, not initialized
					300 GB (279.39 GiB)	
023[4]	JW/9040	2320	N/A	N/A	500 GB (465.66 GiB)	20-pack 3592 WORM cartridges, not labeled and not initialized
					300 GB (279.39 GiB)	
024[4]	JX/9044	2420	2421	9082	1 000 GB (931.32 GiB)	20-pack 3592 Extended WORM cartridges, labeled and initialized
				9081	700 GB (651.93 GiB)	
025[4]	JX/9044	2520	2521	N/A	700 GB (651.93 GiB)	20-pack 3592 Extended WORM cartridges, labeled, not initialized
026[4]	JX/9044	2620	N/A	N/A	700 GB (651.93 GiB)	20-pack 3592 Extended WORM cartridges, not labeled and not initialized
440	JY/9046	4400	4410	9084	4 TB (3.64 TiB)	20-pack 3592 Advanced WORM cartridges, labeled and initialized
540	JY/9046	5400	5410	N/A	4 TB (3.64 TiB)	20-pack 3592 Advanced WORM cartridges, labeled, not initialized
640	JY/9046	6400	N/A	N/A	4 TB (3.64 TiB)	20-pack 3592 Advanced WORM cartridges, not labeled and not initialized
445	JZ/9049	4455	4465	9085	10 TB (9.1 TiB)	20-pack 3592 Advanced Type D WORM cartridges, labeled and initialized
545	JZ/9049	5451	5461	N/A	10 TB (9.1 TiB)	20-pack 3592 Advanced Type D WORM cartridges, labeled, not initialized
645	JZ/9049	6450	N/A	N/A	10 TB (9.1 TiB)	20-pack 3592 Advanced Type D WORM cartridges, not labeled and not initialized

Table 61. Descriptions of 3599 tape media features (continued).

3599 Model	Media ID/ Feature Code	Feature Code for Labeling, Initialization, and Quantity		Format	Individual Cartridge Capacity[2, 5]	Description
		Regular	RFID[1]			
E21[4]	JR/9042	3120	3121	9082	128 GB (119.21 GiB)	20-pack 3592 Economy WORM cartridges, labeled and initialized
				9081	100 GB (93.13 GiB)	
				9080	60 GB (58.88 GiB)	
E22[4]	JR/9042	3220	3221	N/A	100 GB (93.13 GiB)	20-pack 3592 Economy WORM cartridges, labeled, not initialized
					60 GB (58.88 GiB)	
E23[4]	JR/9042	3320	N/A	N/A	100 GB (93.13 GiB)	20-pack 3592 Economy WORM cartridges, not labeled and not initialized
					60 GB (58.88 GiB)	
017	JA	7005	N/A	N/A	cleaning, 50 uses	5-pack 3592 Cleaning Cartridges, with media identification labels
017	JA	7006	N/A	N/A	cleaning, 50 uses	5-pack 3592 Cleaning Cartridges without media identification labels

Notes:

1. Radio frequency identification labels
2. For more details about individual cartridge capacities, see the tables Types of IBM 3592 tape cartridges and Capacity of 3592 tape cartridges.
3. N/A = Not applicable
4. This product is no longer available for order by this method. Refer to "Ordering 3592 media supplies by using part numbers" to order this media type.
5. For cartridges that are not initialized, the actual cartridge capacity is dependent on the format used to write the cartridge.

Ordering 3592 media supplies by using part numbers

Table 62 on page 203 lists the data cartridges and media supplies that you can order for 3592 tape drives by using part numbers. The different methods for ordering are listed at the bottom of the table.

You can use one of the following methods to order the cartridges and media supplies shown in Table 62 on page 203 by part number:

- Order by part number through an IBM-authorized distributor (for the closest distributor, visit the web at `http://www.ibm.com/storage/media`).
- If you do not have Internet access, order the cartridges from any authorized IBM business partner or your IBM sales representative.
- Call 1-888-IBM-MEDIA.

Table 62. Ordering 3592 media supplies by using part numbers

Brand name	Tape Cartridge[1]	Type	Capacity[2]	Part number
IBM Enterprise	3592 Standard read/write	JA	E06 format: 640 GB (596.04 GiB) E05 format: 500 GB (465.66 GiB) J1A format: 300 GB (279.39 GiB)	18P7534
IBM Enterprise	3592 Extended read/write	JB	E07 format: 1600 GB (1490.12 GiB) E06 format: 1000 GB (931.32 GiB) E05 format: 700 GB (651.93 GiB)	23R9830
IBM Enterprise	3592 Advanced Type C Data	JC	E08 format: 7TB (6.37 TiB) E07 format: 4 TB (3.64 TiB)	46X7452
IBM Enterprise	3592 Advanced Type D Data	JD	E08 format: 10 TB (9.1 TiB)	2727263
IBM Enterprise	3592 Economy read/write	JJ	E06 format: 128 GB (119.21 GiB) E05 format: 100 GB (93.13 GiB) J1A format: 60 GB (58.88 GiB)	24R0316
IBM Enterprise	3592 Advanced Type C Economy	JK	E08 format: 900 GB (838.19 GiB) E07 format: 500 GB (465.66 GiB)	46X7453
IBM Enterprise	3592 Advanced Type D Economy	JL	E08 format: 2 TB (1.8 TiB)	2727264
IBM Enterprise	3592 Economy WORM	JR	E06 format: 128 GB (119.21 GiB) E05 format: 100 GB (93.13 GiB) J1A format: 60 GB (55.88 GiB)	24R0317
IBM Enterprise	3592 Standard WORM	JW	E06 format: 640 GB (596.04 GiB) E05 format: 500 GB (465.66 GiB) J1A format: 300 GB (279.39 GiB)	18P7538
IBM Enterprise	3592 Extended WORM	JX	E07 format: 1 600 GB (1490.12 GiB) E06 format: 1 000 GB (931.32 GiB) E05 format: 700 GB (651.93 GiB)	23R9831
IBM Enterprise	3592 Advanced Type C WORM	JY	E08 format: 7TB (6.37 TiB) E07 format: 4 TB (3.64 TiB)	46X7454
IBM Enterprise	3592 Advanced Type D WORM	JZ	E08 format: 10 TB (9.1 TiB)	2727265
IBM Enterprise	3592 Cleaning		Cleaning, 50 uses	18P7535

Notes:

1. Be sure to order bar code labels for all cleaning and data cartridges. Order volume serial (VOLSER) labels separately.
2. Cartridge capacities vary depending on tape drive and format. See Table 59 on page 178 for more detailed information.

Ordering supplies for repairs

It is recommended that you keep the **Leader Pin Reattachment Kit** to maintain your cartridges. This kit contains the necessary tools to reattach the leader pin to the tape. It includes the rewind tool, which can be used to add tension to a tape if the leader pin is displaced. To order the kit, call 1-888-IBM-MEDIA to order as IBM part number 18P8887.

Ordering 3592 bar code labels

Order labels from one of the following authorized suppliers of bar code labels for 3592 tape cartridges.

Bar code labels with volume serial (VOLSER) numbers are required for 3592 tape cartridges that are used within a library. You can order these labels separately from the IBM data cartridges and cleaning cartridges.

Attention: The IBM TS3500 is designed to work with bar code labels that meet the specifications and requirements set forth in the *Label Specification for IBM 3592 Cartridges when used in IBM Libraries*. The label providers listed below have demonstrated the ability to produce finished bar code labels that meet the foregoing specifications and requirements. This information is provided for the convenience of TS3500 tape library users only, and is not an endorsement or recommendation of such providers. IBM is not responsible for the quality of bar code labels procured from sources other than IBM. This information is applicable to bar code labels actually printed by the listed companies. IBM has not reviewed the quality of any labels produced by software or services offered by such companies which allow users to print labels on their own printing equipment.

Table 63. Authorized suppliers of custom bar code labels

In the Americas	In Europe and Asia
Dataware PO Box 740947 Houston, TX 77274 U.S.A. Telephone: 800-426-4844 or 713-432-1023 Fax: 713-432-1385 http://www.datawarelabels.com/	Not applicable
Tri-Optic 6800 West 117th Avenue Broomfield, CO 80020 U.S.A. Telephone: 888-438-8362 or 303-464-3508 Fax: 888-438-8363 or 303-666-2166 http://www.tri-optic.com	EDP Europe Limited 43 Redhills Road South Woodham Ferrers Chelmsford, Essex CM3 5UL U.K. Telephone: 44 (0) 1245 322380 Fax: 44 (0) 1245 323484 http://www.edpeurope.com/media-labels.html
Netc, L.L.C.[1] 100 Corporate Drive Trumbull, CT 06611 U.S.A. Telephone: 203-372-6382 Fax: 203-372-0676 http://www.NetcLabels.com	Netc Europe Ltd[1] The Old Surgery 5a The Pavement North Curry TA3 6LX Somerset U.K. Telephone: 44 (0) 1823 491439 Fax: 44 (0)1823 491373 http://www.NetcLabels.co.uk
	Netc Asia Pacific Pty Ltd[1] PO Box 872 Cooroy QLD 4563 Australia Telephone: 61 (0) 7 5442 6263 Fax: 61 (0) 7 5442 6522 http://www.NetcLabels.com.au
Note: 1. This is an authorized supplier for radio frequency identification (RFID) labels.	

Chapter 6. Using the Fibre Channel interface

This section introduces the use of the Fibre Channel interface with the TS3500 tape library.

The IBM TS3500 uses a Fibre Channel interface (*port*) to communicate with servers.

Your IBM Service Representative must perform setup and Fibre Channel configuration of the library.

Overview of Fibre Channel interface

This section gives a basic description of the Fibre Channel interface that is used by the TS3500 tape library.

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

To communicate with a server, the IBM TS3500 uses a Fibre Channel interface (also called a *port*). In accordance with the standards of the American National Standards Institute (ANSI), the port runs Fibre Channel Protocol (which includes SCSI commands on the Fibre Channel) with ANSI-defined Fibre Channel Tape Support. The method by which the drive and server communicate is determined by the type of topology in which they reside and the type of connection that you choose.

Physical characteristics of the Fibre Channel interface

This section describes the ports and protocol used by the Fibre Channel interface for the TS3500 tape library.

Ultrium 1, Ultrium 2, Ultrium 3, and Ultrium 4 tape drives each contain one Fibre Channel interface (called a port). The Ultrium 5 and Ultrium 6 tape drives and all 3592 tape drives contain two ports. A Fibre Channel port runs SCSI protocol with Fibre Channel tape support.

The host server attaches to the library by using fiber cables that connect directly to a drive canister or through the library's patch panel. Connections are as follows:

- The canisters for the Ultrium 5, Ultrium 6, and TS1140 and TS1150 tape drives have two independent LC Duplex FC-8 fibre connections.
- The canisters for the TS1120 and TS1130 tape drives have two independent LC Duplex FC-4 fiber connections.
- The canister for the 3592 J1A has two independent LC Duplex FC-2 fiber connections.
- The canister for the Ultrium 4 tape drive has one LC Duplex FC-4 fiber connection.
- The canister for the Ultrium 3 tape drive has either one LC Duplex FC-4 fiber connection or one LC Duplex FC-2 fiber connection.

- The canister for the Ultrium 2 tape drive has one LC Duplex FC-2 fiber connection.
- The canister for the Ultrium 1 tape drive has one SC Duplex FC-1 fiber connection.

Cables and speeds of Fibre Channel drives

This section defines the types of cables that are used by Fibre Channel drives in the TS3500 tape library. It also gives the speeds for varying lengths of cables.

The Fibre Channel drives in the TS3500 tape library use these cables:

- TS1140, TS1150, Ultrium 5, and Ultrium 6 tape drives that are equipped with 8 Gbps hardware use LC duplex, 50-micron fiber optics cables and operate at 8 Gbps, 4 Gbps, 2 Gbps, and 1 Gbps
- TS1120, TS1130, and any Ultrium 4 tape drives that are equipped with 4 Gbps hardware use LC duplex, 50-micron fiber optics cables and operate at 4 Gbps, 2 Gbps, and 1 Gbps
- 3592 J1A, Ultrium 2, and any Ultrium 3 tape drives that are equipped with 2 Gbps hardware use LC duplex, 50-micron fiber optics cables and operate at 2 Gbps and 1 Gbps
- Ultrium 1 tape drives use SC duplex, 50-micron fiber optics cables and operate at speeds of 1 Gbps

The library can be used in a 62.5-micron-cable Storage Area Network (SAN). However, the cable that connects the library to the SAN must be a 50-micron cable because the library uses 50-micron cables internally.

The maximum distances that the TS3500 tape library supports on a Fibre Channel link is determined by the link speed, the type of fiber (50 or 62.5 micron), and the device to which the library is attached.

If your library attaches to a host bus adapter (HBA), refer to the documentation for the HBA for the supported cable distances.

When a port in the library is attached to a system, as in a Storage Area Network (SAN), 50 micron cables are used internally within the library. Therefore, a 50-micron cable should be used for the attachment. In addition, the attenuation of the cable varies by cable type and number of connectors used. Typical supported distances of the various 50-micron cables are shown in Table 64.

Table 64. Supported cable distances

Data rate/Link speed	M5 (OM2) cable	M5E (OM3) cable	M5F (OM4) cable
8 Gbps	50 m (164 ft.)	150 m (492 ft.)	190 m (623 ft.)
4 Gbps	150 m (492 ft.)	380 m (1 247 ft.)	400 m (1312 ft.)
2 Gbps	300 m (984 ft.)	Not specified	Not specified
1 Gbps	500 m (1640 ft.)	Not specified	Not specified

Refer to your switch vendor to determine what is supported for the switches in your SAN.

The cable connections between each drive and each server are housed in a patch panel that is located at the rear of the base frame or at the rear of any expansion frame that contains drives.

Supported topologies

This section discusses the ways that the Fibre Channel drives in the TS3500 tape library connect to other Fibre Channel end points.

Fibre Channel devices (such as the TS3500 tape library and a server) are known as nodes and have at least one port through which to receive and send data. The collection of components that connect two or more nodes is called a topology. Fibre Channel systems consist solely of two components: nodes with ports and topologies.

Each port uses a pair of fibers: one fiber carries data into the port, and the other carries data out of the port. The fibers in the channel are optical strands. The fiber pair is called a *link* and is part of the topology. Data is transmitted over the links in units known as *frames*. A frame contains an address identifier that gives the fabric and node for which the frame is destined.

The TS3500 tape library can be attached in a two-node configuration, either directly to a switch as a public device (switched fabric) or directly to a host bus adapter (HBA) as a private device (direct connection). Depending on whether it has been attached through an Ultrium 1 tape drive (as an L_port), attached through 3592 tape drives or Ultrium 2 and newer tape drives (as any supported topology), or configured by using vital product data (VPD) settings, the library automatically configures to an L_port or an N_port when it boots. The type of connection also depends on whether the drive recognizes the connection as a loop or a fabric connection:

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

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

The TS3500 tape library supports two topologies: two-node switched fabric and two-node direct connection. Table 65 on page 208 lists the topologies in which the library can operate, the Fibre Channel server connections that are available, and the port (NL, N, FL, or F) through which communication must occur. The sections that follow describe each topology.

Table 65. Choosing the port and topology through which your Fibre Channel connection can be made

Drive Port Configuration	Type of Fibre Channel Port to Which the Drive Port Connects			
	Server Port (HBA) (Private - Direct Connection)		Switch Port (Public - Switched Fabric)	
	Point-to-Point Topology (N_Port)	Arbitrated Loop Topology (FC-AL)		Fabric Topology (F_Port)
		(L-Port)	(FL_Port)	
Drive port configured to operate as L_Port[1]	Invalid system configuration	L_Port	L_Port	Invalid system configuration
Drive port configured to operate as N_Port[2]	N_Port (not supported)	Invalid system configuration	N_Port (switched fabric)	N_Port
Drive port configured to operate as LN_Port[2]	N_Port (not supported; will force L_Port attempt)	L_Port	L_Port	N_Port
Drive port configured to operate as NL_Port[2]	N_Port (not supported; will force L_Port attempt)	L_Port	N_Port	N_Port

Notes:

1. Applies to Ultrium 1, 2, 3, 4 or 3592 tape drives.
2. Applies to Ultrium 2, 3, 4, 5, 6, or 3592 tape drives.

Two-node switched fabric topology

Two or more Fibre Channel end points can interconnect through a device called a switch. The Fibre Channel architecture supports up to 256 ports through each switch.

A switched fabric allows all of its ports to simultaneously use the Fibre Channel's full architectural bandwidth. To determine the switches to which you can directly attach the TS3500 tape library, visit the Web at:

`http://www.ibm.com/servers/storage/support/san/index.html`

Switches include a function called zoning. This function allows you to partition the switch's ports and share access to a drive. For more information about sharing access, see “Sharing drives on a Storage Area Network” on page 215).

The two-node switched fabric topology supports two protocols:

- Use the two-node switched fabric loop protocol when attaching the library to an FL_port. This protocol is supported when you attach the library through the Ultrium or 3592 tape drives.
- Use the two-node switched fabric protocol when attaching the library to an F_port. This protocol is supported when you attach the library through 3592 tape drives or Ultrium 2 and newer tape drives.

Two-node direct connection topology

A two-node direct connection occurs when two Fibre Channel end points are connected together. The difference is in the topology. Either Arbitrated Loop or Point-to-Point topology is usable, but both end points must use the same topology. Most Fibre Channel adapters have settings that allow selection of the topology or they default to the loop topology when they are not directly connected to a fabric. In addition, the TS3500 tape library allows you to set the drive port to any of these topologies. To set a port to a topology, see the section about viewing or changing Fibre Channel port speeds and topologies in the *IBM TS3500 with ALMS Operator Guide*.

Use the Arbitrated Loop (L_port) topology in a two-node direct connection. This topology is supported when you attach the TS3500 tape library through Ultrium or 3592 tape drives. Use of the Point-to-Point topology in a two-node direct connection in the library to an N_port is not supported.

Fibre Channel addressing

This section defines and lists the default Loop ID and Arbitrated Loop Physical Address (AL_PA) for each Ultrium tape drive and 3592 tape drive that communicates in a Fibre Channel topology.

Each Ultrium tape drive and 3592 tape drive in a TS3500 tape library must have a Loop ID and corresponding Arbitrated Loop Physical Address (AL_PA) to communicate in a Fibre Channel topology. Table 66 lists the default Loop IDs and AL_PAs for each drive in the library.

The AL_PAs defined here are used when connecting to other devices in Arbitrated Loop topology only. When connected in a switched fabric point-to-point topology, the AL_PA is assigned by the fabric and these AL_PAs are not used.

Note: In Table 66, the values for Port 2 do not apply to tape drives that have a single port.

Table 66. Default Loop IDs and their associated AL_PAs for drives with single or dual ports. For drives with single ports, use the values for Port 1; for drives with dual ports, use Ports 1 and 2.

Drive	Frames 1, 7, 13		Frames 2, 8, 14		Frames 3, 9, 15		Frames 4, 10, 16		Frames 5, 11		Frames 6, 12	
	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA
Row 1												
Port 1	17	X'CC'	33	X'B1'	49	X'97'	65	X'71'	81	X'54'	97	X'39'
Port 2	81	X'54'	97	X'39'	18	X'CB'	34	X'AE'	17	X'CC'	33	X'B1'
Row 2												
Port 1	18	X'CB'	34	X'AE'	50	X'90'	66	X'6E'	82	X'53'	98	X'36'
Port 2	82	X'53'	98	X'36'	19	X'CA'	35	X'AD'	18	X'CB'	34	X'AE'
Row 3												
Port 1	19	X'CA'	35	X'AD'	51	X'8F'	67	X'6D'	83	X'52'	99	X'35'
Port 2	83	X'52'	99	X'35'	20	X'C9'	36	X'AC'	19	X'CA'	35	X'AD'
Row 4												
Port 1	20	X'C9'	36	X'AC'	52	X'88'	68	X'6C'	84	X'51'	100	X'34'
Port 2	84	X'51'	100	X'34'	21	X'C7'	37	X'AB'	20	X'C9'	36	X'AC'

Table 66. Default Loop IDs and their associated AL_PAs for drives with single or dual ports (continued). For drives with single ports, use the values for Port 1; for drives with dual ports, use Ports 1 and 2.

Drive	Frames 1, 7, 13		Frames 2, 8, 14		Frames 3, 9, 15		Frames 4, 10, 16		Frames 5, 11		Frames 6, 12	
	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA	Loop ID	AL_PA
Row 5												
Port 1	21	X'C7'	37	X'AB'	53	X'84'	69	X'6B'	85	X'4E'	101	X'33'
Port 2	85	X'4E'	101	X'33'	22	X'C6'	38	X'AA'	21	X'C7'	37	X'AB'
Row 6												
Port 1	22	X'C6'	38	X'AA'	54	X'82'	70	X'6A'	86	X'4D'	102	X'32'
Port 2	86	X'4D'	102	X'32'	23	X'C5'	39	X'A9'	22	X'C6'	38	X'AA'
Row 7												
Port 1	23	X'C5'	39	X'A9'	55	X'81'	71	X'69'	87	X'4C'	103	X'31'
Port 2	87	X'4C'	103	X'31'	24	X'C3'	40	X'A7'	23	X'C5'	39	X'A9'
Row 8												
Port 1	24	X'C3'	40	X'A7'	56	X'80'	72	X'67'	88	X'4B'	104	X'2E'
Port 2	88	X'4B'	104	X'2E'	25	X'BC'	41	X'A6'	24	X'C3'	40	X'A7'
Row 9												
Port 1	25	X'BC'	41	X'A6'	57	X'7C'	73	X'66'	89	X'4A'	105	X'2D'
Port 2	89	X'4A'	105	X'2D'	26	X'BA'	42	X'A5'	25	X'BC'	41	X'A6'
Row 10												
Port 1	26	X'BA'	42	X'A5'	58	X'7A'	74	X'65'	90	X'49'	106	X'2C'
Port 2	90	X'49'	106	X'2C'	27	X'B9'	43	X'A3'	26	X'BA'	42	X'A5'
Row 11												
Port 1	27	X'B9'	43	X'A3'	59	X'79'	75	X'63'	91	X'47'	107	X'2B'
Port 2	91	X'47'	107	X'2B'	28	X'B6'	44	X'9F'	27	X'B9'	43	X'A3'
Row 12												
Port 1	28	X'B6'	44	X'9F'	60	X'76'	76	X'5C'	92	X'46'	108	X'2A'
Port 2	92	X'46'	108	X'2A'	29	X'B5'	45	X'9E'	28	X'B6'	44	X'9F'
Note: Loop IDs are given in decimal format and AL_PA values are given in hexadecimal format.												

You can change a Loop ID by using the library's operator panel or Tape Library Specialist Web interface (refer to the section about changing the Loop ID in the *IBM TS3500 with ALMS Operator Guide*. Using a method called hard addressing, the drive then automatically selects the corresponding AL_PA, which is the identifier that devices use to communicate. Valid Loop ID values range between 0 and 125. The higher the number of the Loop ID (which relates to AL_PA), the higher the priority of the device in the loop.

You can also specify Loop IDs that allow the drive to dynamically arbitrate the AL_PA with other Fibre Channel devices on the loop. This method avoids conflicts over the address and is called soft addressing. To dynamically arbitrate the AL_PA, specify a Loop ID of 126 or 127.

For a complete list of Loop IDs and their corresponding AL_PAs, see Table 67 on page 211.

Table 67. Valid Loop IDs and their associated AL_PAs for Ultrium tape drives and 3592 tape drives in the IBM TS3500

7-bit Loop ID (decimal)	8-bit AL_PA (hexadecimal)	7-bit Loop ID (decimal)	8-bit AL_PA (hexadecimal)	7-bit Loop ID (decimal)	8-bit AL_PA (hexadecimal)
0	X'EF'	43	X'A3'	86	X'4D'
1	X'E8'	44	X'9F'	87	X'4C'
2	X'E4'	45	X'9E'	88	X'4B'
3	X'E2'	46	X'9D'	89	X'4A'
4	X'E1'	47	X'9B'	90	X'49'
5	X'E0'	48	X'98'	91	X'47'
6	X'DC'	49	X'97'	92	X'46'
7	X'DA'	50	X'90'	93	X'45'
8	X'D9'	51	X'8F'	94	X'43'
9	X'D6'	52	X'88'	95	X'3C'
10	X'D5'	53	X'84'	96	X'3A'
11	X'D4'	54	X'82'	97	X'39'
12	X'D3'	55	X'81'	98	X'36'
13	X'D2'	56	X'80'	99	X'35'
14	X'D1'	57	X'7C'	100	X'34'
15	X'CE'	58	X'7A'	101	X'33'
16	X'CD'	59	X'79'	102	X'32'
17	X'CC'	60	X'76'	103	X'31'
18	X'CB'	61	X'75'	104	X'2E'
19	X'CA'	62	X'74'	105	X'2D'
20	X'C9'	63	X'73'	106	X'2C'
21	X'C7'	64	X'72'	107	X'2B'
22	X'C6'	65	X'71'	108	X'2A'
23	X'C5'	66	X'6E'	109	X'29'
24	X'C3'	67	X'6D'	110	X'27'
25	X'BC'	68	X'6C'	111	X'26'
26	X'BA'	69	X'6B'	112	X'25'
27	X'B9'	70	X'6A'	113	X'23'
28	X'B6'	71	X'69'	114	X'1F'
29	X'B5'	72	X'67'	115	X'1E'
30	X'B4'	73	X'66'	116	X'1D'
31	X'B3'	74	X'65'	117	X'1B'
32	X'B2'	75	X'63'	118	X'18'
33	X'B1'	76	X'5C'	119	X'17'
34	X'AE'	77	X'5A'	120	X'10'
35	X'AD'	78	X'59'	121	X'0F'
36	X'AC'	79	X'56'	122	X'08'
37	X'AB'	80	X'55'	123	X'04'

Table 67. Valid Loop IDs and their associated AL_PAs for Ultrium tape drives and 3592 tape drives in the IBM TS3500 (continued)

7-bit Loop ID (decimal)	8-bit AL_PA (hexadecimal)	7-bit Loop ID (decimal)	8-bit AL_PA (hexadecimal)	7-bit Loop ID (decimal)	8-bit AL_PA (hexadecimal)
38	X'AA'	81	X'54'	124	X'02'
39	X'A9'	82	X'53'	125	X'01'
40	X'A7'	83	X'52'	126	X'00'
41	X'A6'	84	X'51'	127	– –
42	X'A5'	85	X'4E'	– –	– –

LUN assignments

Definition of the logical unit number (LUN) for a Sequential Access device (drive) and the Medium Changer device (library).

The logical unit number (LUN) for the Sequential Access device (the SCSI term for a drive) is always LUN 0, and the LUN for the Medium Changer device (the SCSI term for the library) is always LUN 1 (all other LUNs are invalid addresses). These devices are compatible with the SCSI-2 or SCSI-3 standard. For information about the SCSI commands for the tape drives, see the *IBM LTO Ultrium Tape Drive SCSI Reference* or *IBM 3592 Tape Drive SCSI Reference*. For information about the SCSI commands for the library, see the *IBM TS3500 SCSI Reference*.

Note: The Medium Changer SCSI ID is the same as the SCSI ID for Drive 1, Frame 1. You can enable additional drives to optionally provide Medium Changer (LUN 1) addressing by configuring more than one logical library or by enabling additional control paths (refer to the sections about configuring the library with partitions or changing a control path in the *IBM TS3500 with ALMS Operator Guide*).

Using World Wide Names

This section discusses the World Wide Name (WWN) addresses that the TS3500 tape library assigns to drives. The WWN does not change when the drive is swapped or replaced, and host parameters do not need to be changed or reconfigured.

Normally, blocks of World Wide Name (WWN) addresses are assigned to manufacturers by the IEEE Standards Committee, and are built into devices during manufacture. In the case of the TS3500 tape library, however, the library assigns World Wide Node Names and World Wide Port Names to the drives. This technique is referred to as “library-centric world wide names.” Potential drive slots are each assigned a WWN which does not change when a drive is swapped or replaced.

In the TS3500 tape library, a WWN for a drive is implemented through an algorithm that uses the frame serial number of the library and the drive's position within the library. Only the last two digits change within the library. The second-to-the-last digit represents the frame number (starting at 0 for Frame 1) and the last digit is the drive row (starting at 1). The WWN of the drive is location-dependent and not device-dependent. That is, each time that the drive is reset or powered on, the library reestablishes the WWN so that a drive in frame x, row y always keeps the same WWN, even if the drive is replaced. The design of a

WWN is such that if a drive needs service or replacement, host parameters do not need to be changed or reconfigured. The library's configuration can also easily survive a reboot. The following sections describe methods that involve World Wide Names in resolving these issues.

Using persistent binding to ensure SCSI ID assignment

When a server is booted, devices are discovered and assigned SCSI target and LUN IDs. It is possible for these SCSI assignments to change between boots. Some operating systems do not guarantee that devices will always be allocated the same SCSI target ID after rebooting. Also, some software depends on this association, so you do not want it to change. The issue of SCSI ID assignment is addressed by persistent binding.

Persistent binding is a host bus adapter (HBA) function that allows a subset of discovered targets to be bound between a server and device. Implemented by a World Wide Node Name (WWNN) or World Wide Port Name (WWPN), persistent binding causes a tape drive's World Wide Name to be bound to a specific SCSI target ID. After a configuration has been set, it survives reboots and any hardware configuration changes because the information is preserved. If a drive needs to be replaced, the new drive assumes the WWNN of the old drive because the WWNN for the drive is location-dependent within the library. Because the WWNN does not change, persistent binding does not need to be changed which would cause an outage.

Using zoning to isolate devices and enhance security

For security reasons, it is important to limit the devices that a server or servers can recognize or access. Also, some performance configurations and Storage Area Network (SAN) configurations can result in a device being seen multiple times from the same server. For example, if you have two host bus adapters (HBAs) from the same server connected to a tape drive in the TS3500 tape library, the drive will be detected and appear as two logical devices. That is, there will be two special files for one physical device. Zoning can address these issues.

Zoning allows you to partition your SAN into logical groupings of devices so that each group is isolated from the other and can only access the devices in its own group. Two types of zoning exist: hardware zoning and software zoning. Hardware zoning is based on physical fabric port number. Software zoning is defined with the World Wide Node Name (WWNN) or World Wide Port Name (WWPN). While zoning can be reconfigured without causing an outage, some zoning configurations can become complicated. The advantage of the library's WWNN implementation is that you can avoid the exposure of introducing zoning errors because you do not have to change the zoning configuration if a drive needs service or replacement.

Connectors and adapters

This section provides Web sites that give information about the latest connectors and adapters for the TS3500 tape library.

The TS3500 tape library is supported by a wide variety of servers (mainframe hosts), operating systems, and adapters. These attachments can change throughout the product's life cycle. To determine the latest attachments, visit the following Web sites or contact your IBM Sales Representative.

- For a list of compatible software, operating systems, and servers for Ultrium tape drives, visit the web at http://www-03.ibm.com/systems/storage/tape/ts3500/index.html. Under **Learn more**, select **Independent Software Vendor (ISV) matrix for LTO**.
- For a list of compatible software, operating systems, and servers for 3592 tape drives, visit the Web at `http://www.ibm.com/servers/storage/tape/drives`. Under the appropriate section for the specific drive, select `Product details`. Then, under `Learn more`, select `Independent Software Vendor (ISV) matrix`.

Connecting the library to IBM i, System i, and iSeries

This topic provides information that is necessary for connecting the TS3500 tape library to a Power System running IBM i or to aSystem i or iSeries server (mainframe host).

The IBM i or OS/400 operating system supports a maximum of:

- 96 tape drives per logical library
- 32 tape drives per library device description
- 16 devices per IOP-based tape adapter (a device is a media changer or tape drive)
- Up to 128 devices per IOP-less (Smart IOA) tape adapter

  Note: Although the IOA allows for a greater number, the 32 tape drives per library device description still applies.

The System i or iSeries does not require or allow you to set the Fibre Channel adapter settings. The adapter automatically detects the connection type and device addressing. IBM i or OS/400 support is as follows:

- For V5R1, the adapter supports:
  - A single target with multiple LUNs
  - 1 Gbps connection
  - For a Fibre Channel-Arbitrated Loop topology, connection through an L_ port to a device, hub or switch
  - Does not support fabric
- For V5R2 and later, the IOP-based adapters support:
  - Up to 16 devices, including multiple targets and multiple LUNs (each LUN on each target counts as a device)
  - 1, 2, or 4 Gbps connection (but will negotiate for the maximum speed supported by the connection.)
  - For a Fibre Channel-Arbitrated Loop topology, connection through an L_ port to a device, hub or switch
  - For a point-to-point topology, connection through an N_port to an F_port
- For V6R1 and later running Power 6 hardware, the IOP-less (Smart IOA) adapters support:
  - Up to 128 devices, including multiple targets and multiple LUNs (each LUN on each target counts as a device)
  - 4 or 8 Gbps connection
  - For a Fibre Channel-Arbitrated Loop topology, connection through an L_ port to a device or switch
  - For a point-to-point topology, connection through an N_port to an F_port

The System i or iSeries Fibre Channel IOP-based adapter does not support D-mode Alternate IPL. The Alternate Installation function is used to restore a system from a Fibre Channel-attached device. With Alternate Installation support, the system is loaded from a compact disc (CD) and directed to the Fibre Channel-attached device for a restore from the tape that contains the saved data. The code on the CD is only used to get the restore from tape started. All code and program temporary fixes (PTFs) are restored from the tape that contains the saved data.

The V6R1 IOP-less (Smart IOA) adapters do support D-mode or Alternate IPL from Fibre Channel attached tape devices.

When enabled in the TS3500 tape library, the Advanced Library Management System (ALMS) allows for changes in the logical library and drive configurations without taking the library off-line. These changes are not transparent to System i or iSeries and IBM i or OS/400 servers that are attached to any logical libraries that have changed. Any time that changes are made to the logical library or device configuration, you must reset the associated adapter or perform an initial program load (IPL) of the associated system to reconfigure the changes.

For additional information, see *The LTO Ultrium Primer for IBM eServer iSeries Customers* available on `http://www.redbooks.ibm.com`.

Sharing drives on a Storage Area Network

This section gives guidelines for sharing drives with software and systems.

With Storage Area Network (SAN) components, the possibilities for connecting multiple systems and multiple drives have increased. Not all software and systems are designed to share drives. Before you install a drive that would allow two systems to share it, check that the systems and their software support sharing. If your software does not support sharing, note that Fibre Channel switches have a zoning capability to form a SAN partition. For systems that do not cooperate, use zoning to prevent the systems from sharing the same drive. You can remove zoned partitions as you upgrade software and system levels.

Chapter 7. Frame capacity

This section introduces the quantity of LTO Ultrium tape cartridges and 3592 tape cartridges that the TS3500 tape library supports, depending on whether the Capacity On Demand or Capacity Expansion Features are installed, the upper and lower I/O stations are used, and a specified quantity of drives are installed.

Capacity of Model L22, D22, L23, D23, and S24 Frames

This section gives the type of eligible Capacity On Demand feature and quantity of drives, I/O slots, and storage slots for L22, D22, L23, D23, and S24 frames.

Table 68. Quantity of storage slots in L22, D22, L23, D23, and S24 frames. The quantity depends on the type of Capacity On Demand feature installed, whether the upper and lower I/O stations are used, and the quantity of drives in a frame.

Type of Frame	Type of Capacity On Demand (CoD) Feature	Quantity of Drives	Quantity of I/O Slots	Quantity of Storage Slots
L22, L23	No CoD (Entry)	0 to 12	16	58
L22, L23	Intermediate CoD	0 to 12	16	117
L22, L23	Full CoD	0 to 4	16	260
			32	222
L22, L23	Full CoD	5 to 8	16	248
			32	210
L22, L23	Full CoD	9 to 12	16	237
			32	199
D22, D23[1]	N/A[2]	0	0	400
			64[3]	240
D22, D23[1]	N/A	1 to 4	0	383
			64[3]	223
D22, D23[1]	N/A	5 to 8	0	371
			64[3]	211
D22, D23[1]	N/A	9 to 12	0	360
			64[3]	200
S24	No CoD (Base)	0	0	600
S24	HD CoD (Maximum)	0	0	1000

Notes:

1. If the L frame is not an L22 or L23, then the first D frame of a mixed media library will have one less storage slot to accommodate a diagnostic cartridge.
2. N/A = not applicable.
3. The 64 Additional I/O Slots feature (FC 1656) is only available on frame model D23.

Capacity of Model L32 and D32 Frames

This section gives the quantity of drives and cartridge storage slots in Model L32 and D32 frames that do not have the Capacity Expansion feature. It also gives the quantity of cartridge storage slots in L32 and D32 frames that have the Capacity Expansion feature and differing numbers of I/O slots.

Table 69. Quantity of storage slots in Model L32 and D32 frames. The quantity depends on whether the Capacity Expansion feature is installed, whether the upper and lower I/O stations are used, and the quantity of drives in a frame.

Type of Frame	Quantity of Drives	Quantity of Slots in Frame (without Capacity Expansion Feature)	Quantity of Slots with Capacity Expansion Feature and 26 or 30 I/O Slots	Quantity of Slots with Capacity Expansion Feature and 10 I/O Slots
L32	1 to 4	141	229	281
L32	5 to 8	113	201	253
L32	9 to 12	87	175	227
D32	0	440	N/A (see Note)	N/A
D32	1 to 4	N/A	423	423
D32	5 to 8	N/A	409	409
D32	9 to 12	N/A	396	396
Note: N/A = not applicable.				

Capacity of Model L52, D52, L53, D53, and S54 Frames

This section gives the type of eligible Capacity On Demand feature and quantity of drives, I/O slots, and storage slots for Model L52, D52, L53, D53, and S54 frames.

Table 70. Quantity of storage slots in Model L52, D52, L53, D53, and S54 frames. The quantity depends on the type of Capacity On Demand Expansion feature installed, whether the upper and lower I/O stations are used, and the quantity of drives in a frame.

Type of Frame	Type of Capacity On Demand (CoD) Feature	Quantity of Drives	Quantity of I/O Slots	Quantity of Storage Slots
L52, L53	No CoD (Entry)	0 to 12	16	64
L52, L53	Intermediate CoD	0 to 12	16	129
L52, L53	Full CoD	0 to 4	16	287
			32	245
L52, L53	Full CoD	5 to 8	16	273
			32	231
L52, L53	Full CoD	9 to 12	16	261
			32	219
D52, D53[1]	N/A[2]	0	0	440
			64[3]	264
D52, D53[1]	N/A	1 to 4	0	422
			64[3]	246
D52, D53[1]	N/A	5 to 8	0	408
			64[3]	232
D52, D53[1]	N/A	9 to 12	0	396
			64[3]	220
S54	No CoD (Base)	0	0	660
S54	HD CoD (Maximum)	0	0	1320

Notes:

1. If the L frame is not an L32, L52, or L53, then the first D frame of a mixed media library will have one less storage slot to accommodate a diagnostic cartridge.
2. N/A = not applicable.
3. The 64 Additional I/O Slots feature (FC 1655) is only available on frame model D53.

Chapter 8. Tape encryption overview

The Tape encryption overview describes tape encryption in the TS3500 tape library.

The IBM TS1120 (3592 Model E05) and later tape drives can encrypt data as it is written to any size IBM Enterprise tape cartridge 3592, including WORM cartridges. The IBM TS1040 LTO 4 and later tape drives can also encrypt data as it is written to any LTO 4 or later data cartridge. Encryption is performed at full line speed in the tape drive after compression. (Data is compressed more efficiently before it is encrypted.) This capability adds a strong measure of security to stored data without any processing usage and performance degradation.

The following three major elements comprise the tape drive encryption solution:

The encryption-enabled tape drive

The TS1130 Model E06 tape drives and the LTO 4 and later drives are encryption-capable. All TS1120 Model E05 tape drives with Feature Code 5592 or 9592 are encryption capable. Encryption capability means that they are functionally capable of performing hardware encryption, but this capability is not yet activated. To perform hardware encryption, the tape drives must be encryption-*enabled*. Encryption can be enabled on the encryption-capable tape drives through the Tape Library Specialist Web interface. Refer to the appropriate section in the *IBM TS3500 with ALMS Operator Guide* for information about how to enable encryption.

Note: FC 1604, Transparent LTO Encryption, is required for system-managed or library-managed encryption on LTO tape drives. It is not required for application-managed encryption.

Encryption key management

Encryption involves the use of several kinds of keys in successive layers. How these keys are generated, maintained, controlled, and transmitted depends upon the operating environment where the encrypting tape drive is installed. Some data management applications, such as Tivoli Storage Manager, can perform key management. For environments without such applications, or environments where application-independent encryption is necessary, IBM provides a key manager to perform all necessary key management tasks. Provided key managers include:

- The IBM Encryption Key Manager component for the Java™ platform
- The IBM Security Key Lifecycle Manager (formerly the Tivoli Key Lifecycle Manager

The “Managing encryption” on page 222 provides more information.

Encryption policy

This is the method that is used to implement encryption. It includes the rules that govern which volumes are encrypted and the mechanism for key selection. How and where these rules are set up depends on the operating environment. See “Managing encryption” on page 222 for more information about each of the available methods.

Note: In the tape storage environment, the encryption function on tape drives (desktop, stand-alone, and within libraries) is configured and managed by the customer. It is not configured and managed by the IBM System Services Representative (SSR). In some instances SSRs are required to enable encryption at a

hardware level when service access or service password controlled access is required. Customer setup support is by field technical sales specialist (FTSS), customer documentation, and software support for encryption software problems. Customer "how to" support is also provided with the support line contract.

Managing encryption

There are three methods for managing encryption in the TS3500 tape library.

A key manager is a software program that assists IBM encryption-enabled tape drives in generating, protecting, storing, and maintaining encryption keys. The encryption keys encrypt information that is being written to tape media (tape and cartridge formats), and decrypt information that is being read from tape media.

IBM currently supports the IBM Security Key Lifecycle Manager (formerly Tivoli Key Lifecycle Manager) with the TS3500 tape library.

The key manager operates on z/OS®, i5/OS, AIX, Linux, HP-UX, Sun Solaris, and Windows. It is a shared resource that is deployed in several locations within an Enterprise. It can serve numerous IBM encrypting tape drives, regardless of where those drives are installed (for example, in tape library subsystems, connected to mainframe systems through various types of channel connections, or installed in other computing systems.)

The key manager uses a key store to hold the certificates and keys (or pointers to the certificates and keys) required for all encryption tasks. Refer to the appropriate documentation for detailed information about the key manager and the key stores it supports.

Three methods of encryption are available:

1. System-managed encryption (SME)
2. Application-managed encryption (AME)
3. Library-managed encryption (LME)

These methods differ in three ways:

- Where the encryption policy engine resides
- Where key management occurs for your encryption solution
- How the key manager is connected to the drive

Your operating environment determines which method is the best for you. Key management and the encryption policy engine can be in any of the environment layers shown in Figure 62 on page 223

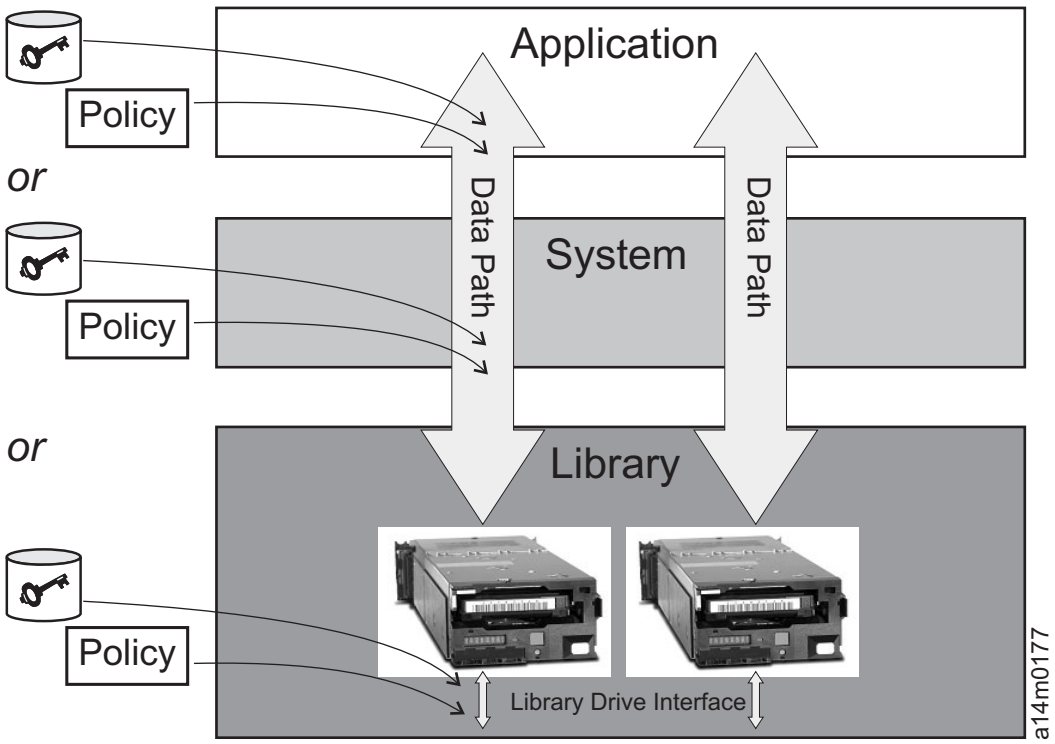


Figure 62. Possible locations for encryption policy engine and key management

Application layer
Initiates data transfer for tape storage, for example Tivoli Storage Manager.

System layer
Everything between the application and the tape drives, for example the operating system, z/OS DFSMS, device drivers, and FICON/ESCON controllers.

Library layer
The TS3500 tape library, which contains an internal interface to each tape drive installed in the library.

Planning for application-managed encryption

Application-managed encryption (AME) is useful in operating environments that run an application that is already capable of generating and managing encryption policies and keys, such as Tivoli Storage Manager.

With AME, policies that specify when encryption is to be used are defined through the application interface. The policies and keys pass through the data path between the application layer and the encrypting tape drives. Encryption is the result of interaction between the application and the encryption-enabled tape drive, and does not require any changes to the system and library layers. Because the application manages the encryption keys, data volumes that are written and encrypted using the application-managed encryption method can be read only by the same software application that wrote them. A key manager is not required by, or used with, application-managed tape encryption.

Note: The capability to use AME is not pre-set. The logical library must be set to use AME.

Application-managed tape encryption on TS1120, LTO 4 and later tape drives can use either of two encryption command sets:

- The IBM encryption command set developed for the key manager
- The T10 command set defined by the InterNational Committee for Information Technology Standards (INCITS)

For more information about setting up application-managed encryption for Tivoli Storage Manager, visit IBM Knowledge Center at http://www-01.ibm.com/support/knowledgecenter/ and go to **Cloud & Smarter Infrastructure** > **Tivoli Storage Manager**.

Planning for system-managed encryption

System-managed encryption (SME) is useful in System z operating environments, but can also be used in Open Systems environments.

Note: The capability to use AME is not pre-set. The logical library must be set to use SME. SME is not available for LTO drives. It is available only on 3592 drives.

Open Systems

Encryption policies specifying when to use encryption are set up in the IBM tape device driver. System-managed tape encryption and library-managed tape encryption interoperate with one another. In other words, a tape encrypted using system-managed encryption can be decrypted using library-managed encryption, and vice versa, provided they both have access to the same keys and certificates. Otherwise, this may not be feasible.

For details on setting up system-managed encryption on tape drives in an AIX, Linux, Windows, or Solaris environment, see the *IBM Tape Device Drivers Installation and User's Guide* (GA32-0565) and the *IBM TS3500 with ALMS Operator Guide*.

System z

Encryption policies that specify when to use encryption are set up in z/OS DFSMS (Data Facility Storage Management Subsystem) or implicitly through each instance of IBM device driver. Additional software products such as IBM Integrated Cryptographic Service Facility (ICSF) and IBM Resource Access Control Facility (RACF®) can also be used. Key generation and management are performed by the key manager that is running on the host or externally on another host. Policy controls and keys pass through the data path between the system layer and the encrypting tape drives. Encryption is transparent to the applications.

For TS1120 and newer 3592 tape drives connected to an IBM TS7700 virtualization engine (VE), encryption key labels are assigned on a per-storage pool basis using the TS7700 Management Interface. DFSMS storage constructs are used by z/OS to control the use of storage pools for logical volumes, resulting in an indirect form of encryption policy management. For more information, see the white paper, *IBM TS7700 Series Encryption Overview*, available at http://www.ibm.com/support/docview.wss?&uid=ssg1S4000504.

For details on setting up system-managed encryption on TS1120 and newer 3592 tape drives in a System z platform environment, see *z/OS DFSMS Software Support for IBM TS1140, TS1130, and TS1120 tape drives (3592)*, SC26-7514.

Planning for library-managed encryption

Library-managed encryption (LME) is useful for encryption-enabled tape drives in an open-attached TS3500 tape library.

Note: The capability to use LME is not pre-set. The logical library must be set to use LME.

Bar code encryption policies, which are set up through the Tape Library Specialist web interface, can be used to specify when to use encryption. In such cases, policies are based on cartridge volume serial numbers. Library-managed encryption also allows other options, such as encryption of all volumes in a library, independent of bar codes. Key generation and management are performed by the key manager. Policy control and keys pass through the library-to-drive interface, therefore encryption is not apparent to the applications.

Library-managed encryption, when used with certain applications such as Symantec Netbackup or the EMC Legato NetWorker, includes support for an internal label option. When the internal label option is configured, the encryption-enabled tape drive automatically derives the encryption policy and key information from the metadata that is written on the tape volume by the application. Refer to the appropriate section of the *IBM TS3500 with ALMS Operator Guide* for more information.

Notes:

- If you use LME and IBM device drivers that run on Open Systems platforms (AIX, HP-UX, Linux, Solaris, Windows), information for bulk rekey is available in the *IBM Tape Device Drivers Installation and User's Guide* (GA32-0565), available on the web: http://www-01.ibm.com/support/docview.wss?rs=577 &uid=ssg1S7002972 .
- When you use LME, an extra Ethernet cable must be attached, preferably to a different network switch. The extra cable is for redundancy and better backup job reliability.
- When you use LME with LTO 5 or later LTO tape drives, the IBM Security Key Lifecycle Manager (formerly the Tivoli Key Lifecycle Manager) is required as the key manager.

System-managed encryption and library-managed encryption interoperate with one another. In other words, a tape encrypted using system-managed encryption can be decrypted when using library-managed encryption, and vice versa, provided they both have access to the same keys and certificates. Otherwise, this action might not be feasible.

The following components are required to use encryption:

- Encryption-enabled tape drive
- Keystore
- Key manager

Configuration prerequisites for encryption

This topic provides an overview of the library configuration prerequisites for using encryption in the TS3500 tape library.

Before you can use the encryption capability of encryption-capable tape drives, you must ensure that certain hardware and software requirements are met. The

following information provides an overview of the library configuration prerequisites for ensuring successful implementation of encryption in a TS3500 tape library.

The TS3500 tape library with the Advanced Library Management System (ALMS) enabled can have a mix of both LTO and 3592 tape drives supporting various encryption configurations across several logical libraries. The rules for setting up encryption differ based on whether you use Library-Managed Encryption (LME), System-Managed Encryption (SME), or Application-Managed Encryption (AME). Table 71 presents an overview of these rules.

Table 71. Tape drive configuration for encryption

Drive types	Library setup (for libraries with ALMS)
LTO tape drives **Note:** Feature code 1604 is required to enable encryption on LTO Ultrium 4 and newer tape drives if using LME or SME.	• Encryption can be enabled with a mix of both encryption-capable (LTO Ultrium 4 and later) drives and drives that are not encryption capable (LTO Ultirum 2 and Ultrium 3). • Any LTO Ultrium 4 and later drives in the library can be encryption enabled with LME, AME, or SME, however FC 1604 is required for LME and SME. • When using LME with Ultrium 5 and later tape drives, the Tivoli Key Lifecycle Manger (TKLM) is required as the key manager.
3592 tape drives	• If using LME or AME, all drives in a logical library must be encryption capable for encryption to be enabled. • If using SME in a library with ALMS, it is possible for the library to consist of a mix of encryption-capable drives and drives that are not encryption capable.
Mixed (LTO and 3592) Drives	• Encryption can be enabled only on the 3592 tape drives, only on the LTO Ultrium tape drives, or on both. • If you want to enable encryption only on 3592 drives, follow the rules above for 3592 libraries. • If you want to enable encryption only on LTO drives, follow the rules above for LTO libraries. • If you want to enable encryption on both, adhere to the rules above for each, respectively.

Note:

- In order for encryption to be supported in the TS3500 tape library, the rules presented in Table 71 must be followed. Failure to adhere to these rules may result in problems when enabling encryption.
- The following feature codes are required when setting up encryption in the TS3500 tape library.
  - FC 9900, Encryption Configuration
  - FC 1604, Transparent LTO Encryption (required for LTO Ultrium 4 and newer tape drives if using LME or SME)
  - FC 1690, Advanced Library Management System

- For more information about configuring the TS3500 tape library for encryption, refer to the section about setting up and using encryption in the *IBM TS3500 with ALMS Operator Guide*.

Accessibility

Accessibility features help users who have a disability, such as restricted mobility or limited vision, to use information technology products successfully.

Accessibility Features

The following list includes the major accessibility features in the *IBM TS3500 with ALMS Introduction and Planning Guide*:

- Keyboard-only operation
- You can use screen-reader software and a digital speech synthesizer to hear what is displayed on the screen.

Keyboard navigation

This product uses standard Microsoft; Windows navigation keys. You can navigate the *IBM TS3500 with ALMS Introduction and Planning Guide* information from the keyboard by using the shortcut keys for your browser or screen-reader software. See your browser or screen-reader software Help for a list of shortcut keys that it supports.

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rusemi

Glossary

This glossary defines the special terms, abbreviations, and acronyms used in this publication and other related publications.

Numbers

2:1 or 3:1 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. In 3:1 compression, three times as much data can be stored with compression as can be stored without compression.

2N Twice the amount of a system's electrical power load. If the system has 2N power supplies, then there are two power supplies available for every load, which means greater redundancy and availability of electrical power. For example, the Enhanced Frame Control Assembly of the TS3500 offers a 2N power design with no single point of failure or single point of repair.

3588 tape drive
See *IBM 3588 tape drive Model F3A*, *IBM TS1030 tape drive Model F3B*, *IBM TS1040 tape drive Model F4A*, *IBM TS1050 tape drive Model F5A*, *IBM TS1040 tape drive Model F5C*, *IBM TS1060 tape drive Model F6A*, and *IBM TS1040 tape drive Model F6C*

3592 tape controller Model J70
See IBM 3592 tape controller Model J70.

3593 tape system
The IBM 3953 tape frame Model F05 and the IBM 3953 library manager Model L05.

A

A Ampere.

AAP See *authorized assembler program*.

ac See *alternating current*.

accessible cartridge storage slots
Within the TS3500, units that can contain tape cartridges and that are recognizable to the library by both a physical address (such as F01-C05-R19) and a SCSI element (logical) address (such as 1112(X'458'). Accessible cartridge storage slots do not include I/O station slots or the inaccessible slots that are reserved for the diagnostic cartridges. The quantity of accessible cartridge storage slots per frame varies, depending on the quantity of drives that are installed in the frame.

accessor controller
The logic card for the cartridge accessor. The accessor controller handles accessor motion requests, including calibrations, moves, and inventory updates. It also provides centralized management for other aspects of the entire library, including configuration, insert and eject operations, automatic drive cleaning, and determination of element status.

ac line voltage
The input voltage (in volts) that is required by the TS3500 or TS4500 for normal operation.

Activity screen
The primary screen on the touchscreen of the TS3500. The Activity screen gives the level of firmware in the library, shows whether the library is ready, not ready, or initializing, and tells the quantity of tape cartridges currently in the I/O stations. The screen also indicates the current activity being performed, the volume serial (VOLSER) number of the cartridge associated with the activity, and a history of previous activities. The Activity screen leads to the Main Menu.

adapter
See *adapter card*.

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

addressable cartridge storage slots
See *accessible cartridge storage slots*.

Advanced Interactive eXecutive (AIX)
A UNIX operating system developed by IBM that is designed and optimized to run on POWER® microprocessor-based hardware such as servers, workstations, and blades.

Advanced Library Management System (ALMS)
The next generation of IBM's patented Multi-Path Architecture. ALMS enables logical libraries to consist of unique drives and ranges of VOLSERs, instead of fixed locations. It offers the ability to assign tape drives to any logical library by using the IBM Tape Library Specialist Web interface. Logical libraries can also be added, deleted, or easily changed without disruption.

aggregate sustained data transfer rate
For all of the drives in the TS3500 or TS4500, the sum of their average throughput of uninterrupted data.

AIX See *Advanced Interactive eXecutive*.

ALMS See *Advanced Library Management System*.

AL_PA
See *Arbitrated Loop Physical Address*.

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

alternating current (ac)
An electric current that reverses its direction at regularly recurring intervals.

amp Ampere.

ampere (A, amp)
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.

Arbitrated Loop Physical Address (AL_PA)
An 8-bit value used to identify a device in an arbitrated loop. Device ports communicate by using AL_PAs.

audit The process of moving cartridges in an HD slot in order to scan each barcode label.

authorized assembler program (AAP)
A training program for selected IBM Business Partners that enables them to purchase incomplete machines and parts, and provides them with the knowledge to assemble the components into a final configured product for sale to customers.

automatic cleaning
A method by which the library automatically responds to any tape drive's request for cleaning by beginning the cleaning process. An operator enables automatic cleaning by using the menus on the library's touchscreen or the web interface.

automatic inventory
A survey of the location of cartridges in the library. The inventory is performed when the library is powered on, or whenever the front door of any frame is opened and closed during operation.

B

backhitch
When the speed of the host server is slower than that of the drive, the action of stopping the tape, rewinding some distance, and restarting.

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

Backup recovery and media services (BRMS)
A software program that runs on OS/400 and allows a business to plan, control, and automate the backup, recovery, and media management services for its AS/400 systems.

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

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

bar code reader
Located on the dual-gripper transport mechanism of the library, a laser device specialized for scanning and reading bar codes and converting them into either the

ASCII or EBCDIC digital character code. The bar code reader reads the bar code on the labels of cartridges or at the rear of empty storage slots.

base frame
The primary unit of the TS3500 tape library. The base frame is distinguished from an expansion frame by its I/O stations and operator panel. The base frame includes a rail assembly for the cartridge accessor and up to 12 tape drives.

bel Ten decibels.

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

bpi Bits per inch.

bridge A storage controller that forms a bridge between two external I/O buses.

British thermal unit (Btu)
The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at a specified temperature.

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

BRSM See *Backup recovery and media services*.

Btu See *British thermal unit*.

bulk load
To manually insert large quantities of tape cartridges into a tape library's empty storage slots.

bus See *SCSI bus*.

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

C

calibration
Adjustment, tuning.

calibration sensor
Located on the cartridge accessor of the TS3500 tape library, the component that provides the means to find certain positions within the library very precisely during the calibration operation.

Call Home
A feature that allows the TS3500 tape library to report failures to a support center.

CAN See *Controller Area Network*.

CAP See *cartridge assignment policy*.

capacity
See *media capacity*.

Capacity expansion feature
Applicable only to the base frame of the TS3500 tape library, the cartridge storage slots that are located on the interior of the front door and enabled for additional storage. The Capacity Expansion Feature increases the maximum quantity of storage slots in the base frame.

Capacity on Demand
A feature that adds capacity to the library and that is only available through the field. See also *High Density Capacity on Demand*.

cartridge
See *tape cartridge*.

cartridge accessor
The mechanism in the TS3500 tape library that moves cartridges between the storage slots, tape drives, and the I/O stations. The accessor includes the X-axis motion assembly, Y-axis motion assembly, pivot assembly, cartridge gripper, bar code reader, and calibration sensor.

cartridge assignment policy (CAP)
With the TS3500 tape library, a method that is used to automatically assign cartridges to a logical library by using beginning and ending volume serial number ranges that are set by the user. See also *VOLSER ranges*.

cartridge cache
Non-HD slots (Tier 0) selected as preferred locations for frequently used cartridges. The library firmware tracks the most recent usage of each cartridge as a means to arbitrate which cartridges should be maintained in the cartridge cache.

cartridge gripper
An electromechanical device on the cartridge accessor of the TS3500 tape library that gets or puts cartridges from or to a storage slot, tape drive, or I/O

station. Two grippers (Gripper 1 and Gripper 2) are located on the pivot assembly of the accessor. One gripper can grip a single cartridge.

cartridge inventory time
The amount of time required for the TS3500 tape library to determine whether each cartridge storage slot in the library is empty or full.

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

cartridge memory
See *LTO cartridge memory*.

cartridge move time
The time required for a cartridge accessor to pick a cartridge from a slot (or drive), move the cartridge to a drive (or slot), pivot (if required), and insert the cartridge into the drive (or slot).

cartridge storage slot
One of several containers that are mounted inside the frames of the TS3500 tape library and are used to store tape cartridges. See also *HD slot*.

caster One of four wheels that are mounted in swivel frames and used to support the weight of the library.

CETool
Used with the TS3500 tape library, CETool is a software program that is used by IBM Service personnel (also known as customer engineers or CEs) to update library and drive firmware, configure Call Home, collect library and drive logs, back up and restore the configuration for non-volatile random access memory (NVRAM), and perform other service-related tasks.

cell top cap
Located on each column of storage slots within the TS3500 tape library, a plastic component to which a bar code label holder can be attached. The library uses the bar code label to establish the boundary of a logical library.

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

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

clearance
The distance by which one object clears another or the clear space between them.

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

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

controller
A device that coordinates and controls the operation of one or more input/output devices (such as sensors and actuators), and synchronizes the operation of such devices with the operation of the system as a whole.

control path
(1) Designated by the operator of the TS3500 tape library, a logical path into the library through which a server sends standard SCSI Medium Changer commands to control a specific logical library.

(2) A tape drive that is designated by the operator of the TS3500 tape library to manage communication to and from a server and the library.

control path failover
In the event of a command failure, an optional feature of the TS3500 tape library that enables the host device driver to resend the command to an alternate control path for the same logical library. The device driver initiates error recovery and continues the operation on the alternate control path without interrupting the application.

current
The quantity of charge per unit of time. Measured in amperes (amps, A).

D

daisy-chain
To serially interconnect a series of SCSI connectors for multiple devices on the SCSI bus.

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

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

data compression
See *compression*.

Data Facility Storage Management Subsystem (DFSMS)
An operating environment that helps automate and centralize the management of storage. To manage storage, DFSMS provides the storage administrator with control over data class, storage class, management class, storage group, and automatic class selection routine definitions.

data transfer element (DTE)
In SCSI terms, a tape drive.

data transfer element (DTE) address
In SCSI terms, the physical location of a tape drive.

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

dB Decibel.

dc Direct current.

decibel
A unit of measure that expresses the ratio of two amounts of electric or acoustic signal power that is equal to 10 times the common logarithm of this ratio.

decrypt
To decipher data.

In Cryptographic Support, to convert ciphertext into plaintext. See also *encrypt*.

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.

destage
The movement of a cartridge from the cartridge cache to an HD slot. A destage occurs automatically when the cartridge cache is full.

device Any hardware component or peripheral device, 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.

DFSMS
See *Data Facility Storage Management Subsystem*.

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

differential
See *high voltage differential*.

Direct flight
An automation technology that passes tape cartridges over intermediary libraries in a TS3500 tape library shuttle complex.

disable
To make nonfunctional.

door safety switch
Located on each frame of the TS3500 tape library, a mechanism that automatically turns off the power to the cartridge accessor whenever you open the front door.

drive See *tape drive*.

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

DTE See *data transfer element*.

dual-gripper transport mechanism
Located on the cartridge accessor of the TS3500 tape library and mounted on the pivot assembly, the device that contains

the two grippers that get and put cartridges into storage slots, drives, or the I/O stations.

E

eject To remove or force out from within.

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

element address
The SCSI term for the host's view of a cartridge location.

email See *electronic mail*.

enable
To make functional.

encrypt
In Cryptographic Support, to systematically scramble information so that it cannot be read without knowing the coding key. See also *decrypt*.

encryption
The conversion of data into a cipher. A key is required to encrypt and decrypt the data. Encryption provides protection from persons or software that attempt to access the data without the key.

encryption key manager
A software program that assists IBM-encrypting tape drives in generating, protecting, storing, and maintaining encryption keys, which encrypt information written to and decrypt information read from tape media.

enhanced frame control assembly
The power structure for models L23, D23, L53, and D53. The assembly combines drive power, library power, and dual ac power cord capabilities into a 2N power design with no single point of failure or single point of repair.

enhanced node cards
Node cards with increased synchronous dynamic and nonvolatile random-access memory (RAM).

error-recovery procedures (ERP)
Procedures designed to help isolate and, where possible, to recover from errors in equipment. The procedures are often used with programs that record the statistics of machine malfunctions.

Ethernet
A 10-Mbps base band local area network that allows multiple stations to access the transmission medium at will without prior coordination, avoids contention by using carrier sense and deference, and resolves contention by using collision detection and delayed retransmission.

Expanded I/O Station
On the front door of the TS3500 tape library, the lower compartment into which you insert and remove cartridges into and from the library. Both stations are accessed by the cartridge accessor.

expansion frame
A unit that can be added to the base frame of the TS3500 tape library. The expansion frame includes a rail assembly for the cartridge accessor and up to 12 tape drives or HD storage slots.

F

FCA See *frame control assembly*.

FCB Frame control box. See *frame control assembly*.

Fibre Channel
A high-speed, full-duplex, serial communications technology that is capable of interconnecting LTO tape drives and 3592 tape drives to servers which are separated by as much as 11 kilometers (7 miles). Fibre Channel technology combines features of the input/output (I/O) and networking interfaces.

Fibre Channel address
For a tape drive that uses a Fibre Channel interface, an identifier (such as an AL_PA or Loop ID) that enables other device ports to communicate with that drive.

Fibre Channel cable
The cable that connects a Fibre Channel tape drive to another device. The conductive element within the cable is constructed of either copper wires or optical fibers. Generally, copper wires are used for short distances (up to 30 meters or 98 feet); optical fibers are used for longer distances. Fiber-optic cabling is referred to by mode or the frequencies of

light waves that are carried by a particular cable type. Multi-mode fiber cables are generally used for distances up to 500 meters (1640 feet) and with short-wave (780 nanometer) laser light. Single-mode fiber cables are used for distances greater than 500 m (1640 feet) and with long-wave (1300 nanometer) laser light.

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

FICON/ESCON-enabled products
Any of the IBM tape products equipped with Fibre Channel (FICON) or Enterprise System Connection (ESCON) interfaces to allow attachment to the System z server (mainframe host).

field replaceable unit (FRU)
Any piece of hardware that is complete, contained, and manufactured or assembled as a whole unit and can be replaced in the field by a customer engineer (CE).

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

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

floating home cell
The concept of actively managing cartridge placement by picking an optimal new home for cartridges being demounted. HD libraries use a floating home cell approach for the entire library.

frame In Fibre Channel technology, a unit of transmission that includes delimiters, control characters, information, and checking characters.

See *library frame*.

frame control assembly (FCA)
The assembly is a group of parts that consists of a frame control box (FCB), one or two 37 V power supplies for the cartridge accessor, operator panel, and I/O stations, and an MCC card pack that runs the firmware that controls the ac and dc power distribution in the . The assembly also provides an RS-422 communication port to each tape drive in a frame. The FCB contains 3 circuit protectors, 10 ac outlets for powering the tape drives and all other components in that frame, and a receptacle for the incoming main ac power.

front door
Located at the front of each frame in the TS3500 tape library, the swinging barrier by which entry is closed or opened to the frame.

FRU See *field replaceable unit*.

FTP See *file transfer protocol*.

FTP site
Any electronic repository of information that uses the File Transfer Protocol (FTP) for transferring files to and from servers. Use of an FTP site requires a user ID and possibly a password.

full capacity expansion
A feature that increases the initial capacity of the TS3500 tape library models. Model L22, L23, L52, and L53 frames. Models L22 and L23 increase from 58 to 199 or 260 cartridge slots for 3592 tape cartridges. Models L52 and L53 increase from 64 to 219 or 287 cartridge slots for LTO tape cartridges.

full duplex
Simultaneous transmission and reception of data between two nodes of a network.

G

GB See *gigabyte*.

Gb See *gigabit*.

Gbps Gigabits per second. One gigabit equals 1 000 000 000 bits.

get (1) In library operation, the act of a cartridge gripper retrieving a tape cartridge from a storage slot, drive, or I/O station.

(2) In Simple Network Management Protocol (SNMP), a request for information about the library that the operator issues through a monitoring server and which is transmitted by SNMP.

get-response
The information that is provided in response to an SNMP get.

GiB One gibibyte (GiB) = 1,073,741,824 bytes.

gigabit (Gb)
1 000 000 000 bits.

gigabyte (GB)
1 000 000 000 bytes.

H

HA See *high availability*.

HACMP
See *High Availability Clustered Multiprocessing*.

HBA See *host bus adapter*.

HD CoD
See *High Density Capacity on Demand*.

HD frame
See *High density frame*.

HD slot
See *High density slot*.

HD2 frame
See *High density frame*.

head See *drive head*.

heat output
The amount of heat (in kBtu/hr) that the TS3500 tape library dissipates during normal operation.

hertz (Hz)
A unit of frequency equal to cycle per second.

heterogeneous
Of unlike kind.

hex, hexadecimal
(1) Pertaining to a selection, choice, or condition that has 16 possible different values or states.

(2) Pertaining to a fixed-radix numeration system, with radix of 16.

(3) Pertaining to a system of numbers to the base 16; hexadecimal digits range from 0 through 9 and A through F, where A represents 10 and F represents 15.

high availability (HA)
A product that contains redundancy to continue work in case of a set of (but not all possible) failures. A library that is HA contains two separate cartridge accessors.

High Availability Clustered Multiprocessing (HACMP)
An IBM AIX solution that automatically detects system or network failures and eliminates a single point of failure by managing failover to a recovery processor. High availability clustering refers to the linking of two or more computers, one of which can provide operation if the other one fails.

High Density Capacity on Demand
Applicable only to expansion frame models Sx4 and Sx5, a feature that adds licensed capacity to the library.

High density frame
An expansion frame that contains HD slots. An HD2 frame is a second-generation HD frame that is capable of being installed in the leftmost position (frame 1) of the library. Drive-capable HD2 frames support up to 16 HD2-compatible tape drives when positioned as frame number 2 or higher. Models L25, L55, D25, D55, S25, and S55 are all HD2 frames. Non-HD2 frames cannot be upgraded to HD2 frames.

High density slot
A four-deep or five-deep container for cartridges in an HD frame.

High Voltage Differential (HVD)
A logic signaling system that enables data communication between a supported server and the TS3500 tape 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*.

homogeneous
Of the same kind.

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

host bus adapter (HBA)
An adapter that provides I/O processing and physical connectivity between a server and storage.

host cleaning
A method that enables the host (server) to detect the need to clean a tape drive and to control the cleaning process. Host cleaning with a cleaning cartridge is only supported when automatic cleaning is disabled, and only for the logical library in which each cleaning cartridge is stored.

HTTP See *Hyper Text Transfer Protocol*.

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

HVD See *High voltage differential*.

Hyper Text Transfer Protocol (HTTP)
The primary Internet protocol that is used to connect to most web servers. HTTP delivers content for web pages or downloads files.

Hz Hertz.

I

IBM IBM 3592 tape controller Model J70
Located in the 3953 tape frame Model F05, a device that links the IBM eServer™ zSeries server (mainframe host), the L05 library manager, and the tape drives in the TS3500 tape library.

IBM Tape Library Specialist web interface
A platform-independent, web-based interface that allows a user to configure and monitor the TS3500 tape library from a remote location.

IBM TS3500 tape library
Also known as the 3584 tape library, a device that can be attached to one or more supported servers and used to write data to and from magnetic tape. The library can include up to 16 frames and 192 drives, and any combination of LTO tape drives in LTO frames, and 3592 tape drives in 3592 frames.

IBM TS4500 tape library
Also known as the 3584 tape library, a device that can be attached to one or more supported servers and used to write data to and from magnetic tape. The library can include up to 4 frames and 64 drives.

IBM Tivoli Storage Productivity Center (TPC)
A software solution that manages storage infrastructures in Open Systems environments.

ID Identifier.

IEE See *import/export element*.

IEEA See *import/export element address*.

IEEE Institute of Electrical and Electronics Engineers.

IMC See *Integrated management console (IMC)*.

import/export element (IEE)
In SCSI terms, an I/O slot.

import/export element address (IEEA)
In SCSI terms, the location of an I/O slot.

inaccessible cartridge storage slot
In the TS3500 tape library, a cartridge storage slot that is designated for the diagnostic cartridge, which is used during service procedures. The Models L22, L23, L32, L52, and L53 base frames each contain one inaccessible cartridge storage slot for a diagnostic cartridge at physical address F01,C01,R01. Additionally, the first expansion frame of a different media type (3592 or LTO) in a mixed media library contains one inaccessible cartridge slot for a diagnostic cartridge at physical addresses Fxx,C01,R01 (where xx equals the first expansion frame for the second type of media).

independent software vendor (ISV)
A company that makes and sells software products that run on one or more computer hardware or operating system platforms.

initial program load (IPL)
(1) The initialization procedure that causes an operating system to commence operation.

(2) The process by which a configuration image is loaded into storage at the beginning of a work day or after a system malfunction.

(3) The process of loading system programs and preparing a system to run jobs.

initialize
To format a magnetic tape, write a label (VOLSER) on the tape, and leave the tape empty except for the system files containing the structure information. All former contents of the tape are lost.

initializing
The act of performing an inventory on the TS3500 tape library.

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

input/output (I/O) station
On the front door of the TS3500 tape library, one or two compartments into which you insert and remove cartridges into and from the library. Both stations are accessed by the cartridge accessor.

inrush current
The momentary peak current (in amperes) into the TS3500 tape library when the ac line voltage is first applied.

insert Pertaining to the TS3500 tape library, a term used to describe the act of putting a tape cartridge into an I/O station or storage slot.

install (1) To set up for use or service.

(2) The act of adding a product, feature, or function to a system or device either by a singular change or by the addition of multiple components or devices.

Integrated management console (IMC)
With the TS4500 tape library, a built-in platform for tools that are used to manage the library.

interchange
The ability to process (read or write) given tape data on any one of a set of tape devices that support the form factor and recording format of the tape data.

interchange application
The preparation of tapes for use on other systems or devices, either local or remote, or the use of tape data prepared by another system.

intermediate capacity expansion
A feature that increases the initial capacity of Lxx frames. Models L22 and L23 increase from 58 to 117 cartridge slots for 3592 tape cartridges. Models L52 and L53 increase from 64 to 129 cartridge slots for LTO LTO tape cartridges. Models Lx5 increase from 100 to 200 slots.

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

interposer
An adapter-like device that allows a connector of one size and style to connect to a mating connector of a different size and style.

inventory
(1) A survey of tape cartridges in the library and frames.

(2) To make an inventory of.

I/O station
See *input/output station*.

IPL Initial program load.

ISV See *independent software vendor*.

K

kBtu KiloBtu.

key label
An alias to a encryption key (cipher) used by the encryption key manager.

key manager
In cryptography, a software application that manages one or more secret encryption keys.

key manager address
In cryptography, the IP address of an encryption key manager.

keystore
A database of private keys and their

associated digital certificate chains used to authenticate the corresponding public keys.

KiB One kibibyte (KiB) = 2^{10} bytes = 1,024 bytes.

KiloBtu
1 000 Btu's.

KiloVolt
1 000 volts.

kilowatt
1 000 watts.

kVA KiloVolt.

kW Kilowatt.

L

label See *bar code label* or *radio frequency identification label*.

label area
On the LTO tape cartridge or 3592 tape cartridge, a recessed area next to the write-protect switch where a bar code label must be affixed.

LAN See *local area network*.

LCD See *liquid crystal display*.

LDAP See *lightweight directory access protocol*.

leader pin
On the LTO tape cartridge and 3592 tape cartridge, a small metal column attached to the end of the magnetic tape. During tape processing the leader pin is grasped by a threading mechanism, which pulls the pin and the tape out of the cartridge, across the drive head, and onto a take-up reel. The head can then read or write data from or to the tape.

leveling jackscrews
Located on the bottom the TS3500 tape library, one of four screw-operated jacks for raising or lowering the library.

library frame
The basic unit of the TS3500 tape library. The frame includes the hardware support structure, covers, mechanisms, and parts. Two types of frames are available: base frames (Models Lxx) and expansion frames (Models Dxx and Sxx).

library manager
See *IBM 3953 library manager Model L05*.

library power switch
Located on the front of the TS3500 tape library, a toggle switch that enables you to turn the power to the library on and off.

license key
A key or password that is required to enable advanced function.

lightweight directory access protocol (LDAP)
A set of protocols used to access information directories. LDAP, an open protocol, is based on the standards contained within the X.500 standard, but is significantly simpler. And unlike X.500, LDAP supports TCP/IP, which is necessary for any type of Internet access.

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 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 LTO format focuses on high capacity. The LTO format is the preferred format when capacity (rather than fast access) is the key storage consideration.

line frequency
The frequency (in hertz) of the ac line voltage that the TS3500 tape library requires for normal operation.

link In Fibre Channel technology, the physical (optical) connection between two nodes of a network, which includes the combination of the link connection (the transmission medium) and two link stations, one at each end of the link connection.

liquid crystal display (LCD)
A low-power display technology used in computers and other I/O devices.

load Pertaining to the TS3500 tape library and following the insertion of a tape cartridge into a cartridge storage slot, the act (performed by the cartridge accessor) of

transferring the cartridge from the storage slot to the drive and of positioning the tape (performed by the tape drive) for reading or writing by the drive head.

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

load point
The beginning of the recording area on magnetic tape.

load-to-ready time
After a cartridge has been inserted into a drive, the amount of time between when the drive threads the tape and when the drive becomes ready to accept server commands.

local area network (LAN)
(1) A computer network located on a user's premises within a limited geographical area. Communication within a local area network is not subject to external regulations; however, communication across the LAN boundary may be subject to some form of regulation.

(2) A network in which a set of devices is connected to other sets of devices for communication and that can be connected to a larger network.

local authentication
The process of validating a user identity to the system according to the local operating system account to which the user logged in. If the user is authenticated, the user is mapped to a principal.

logical library
With the TS3500 tape library, a set of cartridge storage slots and tape drives that are defined as a library by an operator. The ability to create logical libraries makes it possible for similar and dissimilar hosts (servers) to share its robotics. As a result, hosts can simultaneously run separate applications in separate logical libraries.

logical library bar code label
A specially coded label that can be affixed to the tops of storage slot columns and drives inside the TS3500 tape library. The tape library reads the labels and uses them to establish the boundaries of one or more logical libraries.

logical library configuration
A way of using the TS3500 tape library so that its robotics are shared by homogenous (similar) and heterogeneous (dissimilar) servers. The TS3500 tape library can be partitioned into individual logical libraries that independently communicate with individual servers via individual control paths.

logical unit number (LUN)
A number associated with the target address of a drive. The server uses the number to identify the address of the drive.

loop ID
In Fibre Channel technology, the identifier that the TS3500 tape library assigned to an LTO or 3592 tape drive. The ID is based on the drive's physical location within the library and is used by other devices in the topology to communicate.

Low Voltage Differential (LVD)
A low-noise, low-power, and low-amplitude electrical signaling system that enables data communication between a supported server and the TS3500 tape library. LVD signaling uses two wires to drive one signal over copper wire. The use of wire pairs reduces electrical noise and crosstalk.

LTO See *Linear Tape-Open*.

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

LTO-CM
See *LTO cartridge memory*.

LUN See *logical unit number*.

LVD See *Low Voltage Differential*.

M

m Meter.

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

Management Information Base (MIB)
Units of managed information that specifically describe an aspect of a system, such as the system name, hardware number, or communications configuration. A collection of related MIB objects is defined as an MIB. The TS3500 tape library can use the MIB to interpret problem alerts that are transmitted by SNMP traps.

management GUI
See *TS4500 management GUI*.

manual cleaning
A method by which an operator selects a menu option from the touchscreen of the TS3500 tape library or IBM Tape Library Specialist Web interface to perform cleaning on one or more of its tape drives.

master console
See *system console*.

MB See *megabyte*.

Mbps Megabits per second.

MCA See *Medium Changer assembly*.

MCC See *Medium Changer card pack*.

MCP See *Medium Changer card pack*.

mebibyte (MiB)
1•048•576 bytes.

media The plural of *medium*.

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

media-type identifier
Pertaining to the bar code on the bar code label of the IBM LTO tape cartridge, a 2-character code (Lx), that represents information about the cartridge. L identifies the cartridge as one that can be read by devices that incorporate LTO technology; x indicates the generation of cartridge; T, U, V, and Wrepresent different generations of WORM cartridges.

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

Medium Changer assembly (MCA)
In the enhanced frame control assembly power structure, the device that facilitates communication between host applications and the library. The MCA is located above the drives and the fixed power trays in model L23, D23, L53, and D53 frames. It houses two Ethernet ports for connection to the Tape Library Specialist Web interface or a system console.

Medium Changer card pack (MCC or MCP)
In the TS3500 tape library, a circuit board that provides a communication path to each tape drive (via the RS-422 interface) so that library commands can be funneled from the tape drives to the accessor. It includes one RS-422 interface allotted for each drive in the frame. It also provides management and service interfaces to outside servers. For each library frame that contains at least one drive, there is one MCP. The electronics of the card pack are located in the FCB.

Medium Changer Device
In SCSI terms, an instrument that moves removable storage units from and to storage slots and tape drives. The TS3500 tape library is a Medium Changer Device.

megabyte (MB)
1 000 000 bytes.

metal-particle tape
In the LTO and 3592 tape cartridges, tape that uses very small, pure metal particles (rather than oxide coatings) in the magnetic layer.

meter In the metric system, the basic unit of length; equal to approximately 39.37 inches.

MiB One mebibyte (MiB) = 1,048,576 bytes.

MIB See *Management Information Base*.

middleware
A vague term that refers to the software between an application program and the lower-level platform functions.

micron
One millionth of a meter (.000001 m).

Microsoft Systems Management Server (SMS) and Clustered Server Environments
A solution from Microsoft that automatically detects system or network failures in Windows operating systems and eliminates a single point of failure by managing failover to a recovery processor.

mid-range systems
A set of multi-user servers with a hard disk capacity of between 50 GB and 250 GB.

mixed drive types
The concept of using both LTO and 3592 tape cartridges in the TS3500 tape library. A library can consist of frames that house all LTO tape cartridges or all 3592 tape cartridges, but the two types of cartridges cannot be mixed in a single frame. However, both types of cartridges may be inserted or removed from the library through the base frame, provided that a lower I/O station is installed for the 3592 tape cartridges.

mixed media configuration
Different media and drive technologies, such as the LTO tape drive and the 3592 tape drive. LTO 1, LTO 2, and LTO 3 drives and media are not considered mixed media, but are considered different generations of the same type of media.

Model J1A
See *IBM 3592 tape drive Model J1A*.

mount The act of making a tape available for processing by a specific tape device. A mount consists of removing the cartridge from a drive, returning it to its storage slot, collecting another cartridge from a storage slot, moving it to the drive, and loading it into the drive.

mount/demount cycle
See *mount*.

mounted
The state of a tape while it is available for processing by a specific tape device.

mount throughput
The number of cartridges that a tape library can mount in a one-hour period.

N

N A measure of the electrical power load in a system. If there are N loads in the system, N power supplies are required to power all of the loads.

N/A Not applicable.

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

NetView
(1) Pertaining to an IBM licensed program that is used to monitor a network, manage it, and diagnose its problems. The NetView® licensed program can be used to provide network management services for OSI Communications Subsystem. (2) A network management product that can provide automated operations and rapid notification of events.

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

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

node In Fibre Channel technology, a communicating device.

node card
Within the TS3500 tape library, one of four circuit assemblies (accessor controller card, motor driver assembly, Medium Changer card pack, and operator panel assembly) that communicate with each other.

nominal
Approximate.

nominal power
The amount of power (in kilowatts) that the TS3500 tape library dissipates during normal operation.

non-addressable cartridge storage slot
See *inaccessible cartridge storage slot*.

nondisruptive firmware update
The ability to update drive or library firmware without scheduling downtime. The TS3500 tape library provides the ability to perform a nondisruptive update for its library firmware, as well as firmware for all 3592 tape drives and LTO 2 and later LTO tape drives.

non-volatile memory
Types of memory that retain their contents when the power is turned off. ROM is nonvolatile, whereas RAM is volatile.

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 4π centimeters of axial length.

operating environment
The temperature, relative humidity rate, and wet bulb temperature of the room in which the TS3500 tape library routinely conducts processing.

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

operator panel
A functional unit that controls the TS3500 tape library. The unit's LCD touchscreen provides information about the operation of the library.

operator panel controller
Within the TS3500 tape library, a circuit board that facilitates communication between the accessor controller and the operator panel. The controller provides input to and output from the LCD, and senses and locks the I/O stations. In addition, the LCD activity and service menus are executed in the operator panel controller with support from the accessor controller and the drives (via the Medium Changer card packs).

optimized dual gripper
An electromechanical device that is mounted on the pivot assembly and gets or puts cartridges from or to a storage slot, tape drive, or I/O station.

P

partition
A fixed-size division of storage.

patch panel
Located at the rear of the base or expansion frame in a TS3500 tape library, an optional unit that houses the fiber cable connections between the servers and the individual drives.

Pause key
On the touchscreen of the TS3500 tape library, a touch key that causes the cartridge accessor to park itself and provide clear access to the library's interior when you power off the library or open the front door. The pause key enables quick recovery when you power on the library or close the front door.

PB Petabyte.

PDF See *Portable Document Format*.

Petabyte
1•000•000•000•000•000 bytes.

ping (1) A command that calls an IP address.

(2) The act of issuing a command that calls an IP address.

pivot assembly
On the cartridge accessor of the TS3500 tape library, a group of parts that provides a mounting platform for the gripper mechanism and the bar code reader. The pivot assembly is capable of 180° rotation about the vertical axis.

point load
On a floor, one or more locations where the weight of an object is concentrated.

point-to-point topology
In communications, the physical or logical arrangement of nodes in a network to facilitate data transmission between two locations without the use of any intermediate display station or computer.

port (1) A system or network access point for data entry or exit.

(2) A connector on a device to which cables for other devices such as display stations and printers are attached.

(3) The representation of a physical connection to the link hardware. A port is

sometimes referred to as an adapter; however, there can be more than one port on an adapter.

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 email, 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.

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

power cord plug
On a power cord, the male fitting for making an electrical connection to a circuit by insertion into a receptacle.

power distribution unit (PDU)
A unit that provides ac distribution within a TS3500 tape library frame by supplying multiple internal ac outlets from a single external ac power cord.

power off, powered off
(1) To remove electrical power from a device.

(2) The state of a device when power has been removed from it.

power on, powered on
(1) To apply electrical power to a device.

(2) The state of a device when power has been applied to it.

power-on indicator
Located beside the library power switch on the operator panel, a green light that, when lit, indicates that dc power is available within the TS3500 tape library.

power receptacle
The mounted female electrical fitting that contains the live parts of the circuit.

power supply
The electrical component of a computer system that converts standard ac current to the lower voltage dc current used by the computer. The amount of current a power supply can provide is rated in amperes.

power switch
See *library power switch*.

prestage
The movement of a cartridge from an HD slot to a cartridge cache. See also *destage*.

protocol
The meanings of, and the sequencing rules for, requests and responses used for managing a network, transferring data, and synchronizing the states of network components.

put Pertaining to the TS3500 tape library, to place, by means of a robotic device, a tape cartridge into a storage slot, drive, or I/O station.

Q

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

R

RABF See *recursive accumulating backhitchless flush*.

radio frequency identification labels
An adhesive bar code label with an embedded radio frequency identification tag that can be used to track tape cartridges.

rail system
Within the TS3500 tape library, the support structure over which the cartridge accessor moves.

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

ready The operating condition that the TS3500 tape library is in when the host applications can interact with it.

recursive accumulating backhitchless flush (RABF)
A non-volatile caching technique used by the 3592 tape drives.

rekey In cryptography, the process of encrypting a data key a second time by using the public key of another party to create an additional externally encrypted data key. The cartridge can then be shipped to a business partner that holds the

corresponding private key which allows the data key to be unwrapped and the tape decrypted on a different encryption-capable 3592 tape drive.

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

remote authentication
The process of validating the user ID and password that are supplied by a user for a remote system to which the user requires access. If the user is authenticated, the user is mapped to a principal.

remote support
See *Call Home*.

Remote Technical Assistance Information Network (RETAIN)
Used by IBM Service Representatives, an internal host-based software application that contains records of service problems with IBM hardware and software, as well as tips on how to deal with the problems.

remove
Pertaining to the TS3500 tape library, a term used to describe the act of taking a tape cartridge out of an I/O station.

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

RETAIN®
See *Remote Technical Assistance Information Network*.

RFID See *radio frequency identification labels*.

robotics
The cartridge accessor and any associated mechanisms that move a tape cartridge within the TS3500 tape library.

RS-422 interface
An electrical interface standard approved by the Electronic Industries Association (EIA) for connecting serial devices. The RS-422 standard, which supports higher data rates and greater immunity to electrical interference, is an alternative to the older RS-232 interface and uses individual differential signal pairs for data transmission. Depending on data transmission rates, RS-422 can be used at distances to 1,275 m (4,000 ft). The RS-422 interface also supports multi-point connections.

S

SAN See *Storage Area Network*.

SARS See *Statistical Analysis and Reporting System*.

SC1 Model SC1. See *Shuttle connection*.

scratch cartridge
A labeled cartridge that is blank or contains no valid data, that is not currently defined, and that is available for use.

scratch encryption policy
A means of identifying to an ecryption-enabled tape drive which scratch cartridges will be encrypted on the next attempt to write from the beginning of the tape. A scratch encryption policy specifies what scratch cartridges to encrypt; it does not indicate which cartridges are currently encrypted. When used with library-managed encryption, a policy optionally lets you control cartridge encryption by VOLSER ranges in all logical libraries.

SCSI See *Small Computer Systems Interface*.

SCSI-2
A variation of the SCSI interface. See *Small Computer Systems Interface*.

SCSI bus
(1) A collection of wires through which data is transmitted from one part of a computer to another.

(2) A generic term that refers to the complete set of signals that define the activity of the Small Computer Systems Interface (SCSI).

SCSI address
See *SCSI ID*.

SCSI connector
One of the set of all female and male connectors on the SCSI bus.

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

SCSI element address
A value that defines a logical location in the TS3500 tape library to the SCSI interface. This logical address is represented on the operator panel or IBM Tape Library Specialist Web interface as `xxxx(yyyh)`, where `xxxx` is a decimal value and `yyyh` is a hexadecimal value. It is assigned by the library and used by the server when the server processes SCSI commands. The SCSI element address is not unique to a storage slot, drive, or I/O slot; it varies, depending on the quantity of drives in the library, whether the Capacity Expansion feature is installed, and whether an Expanded I/O Station is included.

SCSI ID
The hexadecimal representation of the unique address (0-F) that is assigned to a SCSI device. This identifier would normally be assigned and set in the SCSI device during system installation.

search time
The average time it takes for a tape drive to locate the starting point of a block of data.

secure sockets layer (SSL)
Protocol for transmitting private documents via the Internet. SSL uses a cryptographic system that uses two keys to encrypt data - a public key known to everyone and a private or secret key known only to the recipient of the message. Many web sites use the protocol to obtain confidential user information, such as credit card numbers. By convention, URLs that require an SSL connection start with https: instead of http:.

sequential access
The processing of information on a tape cartridge in a manner that requires the device to access consecutive storage locations (logical blocks) on the medium.

Sequential Access Device
In SCSI terms, a tape drive.

serial number
See *volume serial number*.

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

service clearance
Surrounding the TS3500 tape library, the space required for an IBM Service Representative to perform maintenance on the unit.

service location protocol
(SLP) Protocol that provides a framework to allow networking applications to discover the existence, location, and configuration of networked services in enterprise networks. With SLP, the user only needs to know the description of the service he is interested in. SLP is then able to return the URL of the service that the user wants.

service ratings
The values for criteria associated with an electrical power cord. The criteria include maximum voltage, current, phases, and wires.

ship group
The group of supplies, cords, or documentation that is shipped with the TS3500 tape library.

shipping environment
The temperature, relative humidity rate, and wet bulb temperature of the environment to which the TS3500 tape library is exposed when being transferred from one location to another.

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

shuffle
In HD frames, the process of moving cartridges in lower tiers into the gripper or other available slots in order to access cartridges in higher tiers.

shuttle car
The mechanism that carries one tape cartridge through the shuttle connection to another library string. Each shuttle car carries one tape cartridge at a time.

shuttle complex
Two or more parallel high density (HD)

library strings that are interconnected by one or more shuttle connections.

shuttle connection
Also referred to as Model SC1, the shuttle connection is comprised of one shuttle car, two or more shuttle stations, and one or more spans between these shuttle stations. Each shuttle connection supports one shuttle car.

shuttle span
One or more shuttle spans are linked together in order to form a shuttle connection between HD frames in parallel library strings. Shorter shuttle spans support distances between library strings ranging from 762 mm (30 in) to 1 524 mm (60 in). Longer shuttle spans support distances between library strings ranging from 1 524 mm (60 in) to 2 743.2 mm (108 in).

shuttle station
The shuttle station mounts on top of an HD frame. It consists of a base pad and a shuttle slot. The shuttle slot docks into the base pad. When the shuttle slot is all the way down into the frame station it can accept or deliver a cartridge. Each shuttle station has its own import/export element (IEE) address.

Simple Network Management Protocol (SNMP)
In the Internet suite of protocols, a network management protocol that is used to monitor routers and attached networks. SNMP is an application layer protocol. Information on devices that are managed is defined and stored in the application's Management Information Base (MIB).

single-phase power
Pertaining to the TS3500 tape library, electricity that is transmitted via three wires (line, neutral, and ground), with a line-to-neutral voltage of 200-240 V ac

SLP See *Service Location Protocol*.

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.

SMI-S See *Storage Management Initiative - Specification*.

SMI-S Agent for Tape
See *Storage Management Initiative - Specification (SMI-S) Agent for Tape*.

SNMP
See *Simple Network Management Protocol*.

Specialist web interface
A platform-independent, web-based interface that allows a user to configure and monitor the TS3500 tape library from a remote location.

See also *TS4500 management GUI*.

speed matching
The ability of the LTO 2 and later LTO tape drives to adjust their native data rate as closely as possible to the net host data rate (after data compressibility has been factored out).

SSL See *Secure Sockets Layer*.

stand-alone
Pertaining to operation that is independent of any other device, program, or system.

Statistical Analysis and Reporting System (SARS)
Firmware that is built into the 3592 tape drives and the LTO tape drives and which is used by the drive during problem

determination to identify which single-character display code, ASC/ASCQ, and/or TapeAlert to report.

StE See *storage element*.

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

storage element (StE)
In SCSI terms, a cartridge storage slot.

storage environment
The temperature, relative humidity rate, and wet bulb temperature of the environment in which the TS3500 tape library is non-operational and being stored for future use.

Storage Management Initiative - Specification (SMI-S)
A design specification of the Storage Management Initiative (SMI) that was launched by the Storage Networking Industry Association (SNIA). The SMI-S specifies a secure and reliable interface that allows storage management systems to identify, classify, monitor, and control physical and logical resources in a Storage Area Network (SAN).

Storage Management Initiative - Specification (SMI-S) Agent for Tape
Software that is used by management software to communicate with storage devices in a SAN environment. The SMI-S Agent for Tape communicates by using the Web-Based Enterprise Management (WBEM) protocol, which allows management software to communicate with the TS3500 tape library.

sustained data transfer rate
Between the server and the tape drive, the average transfer rate of data across the SCSI interface to and from the tape drive during a transition from one end of the tape to the other end.

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

system console
A service tool that monitors the tape library and other components for early detection of unusual conditions and for error information that the components send to IBM's Remote Technical Assistance Information Network (RETAIN).

T

TapeAlert
A patented technology from Hewlett-Packard that monitors the status of a tape device and media, and detects problems as they occur.

TapeAlert flags
Status and error messages that are generated by the TapeAlert utility and display on the host console. The messages indicate the type of problem and tell how to resolve it.

tape cartridge
A removable storage device that consists of a housing containing a belt-driven magnetic tape wound on a supply reel and a takeup reel.

tape drive
A data-storage device that controls the movement of the magnetic tape in a compatible tape cartridge. The tape drive houses the mechanism (drive head) that reads and writes data to the tape.

tape frame
See *IBM 3953 tape frame Model F05*.

Tape System Service Application (TSSA)
A set of software tools residing on the integrated management console (IMC) that aid in both local service and remote support of the attached TS4500 tape library. These tools are identical to those provided by the IBM TS3000 system console (TSSC), an externally rack-mounted system console.

target A SCSI device that performs an operation requested by the initiator. A target can also be an initiator.

TB Terabyte.

TCP/IP
See *transmission control protocol/Internet protocol*.

terabyte
1 000 000 000 000 bytes.

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

terminator
(1) A part used to end a SCSI bus.

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

tier The depth of a cartridge location in an HD slot.

Tivoli Storage Manager (TSM)
An IBM client/server product that provides storage management and data access services in a heterogeneous environment. TSM supports various communication methods, provides administrative facilities to manage the backup and storage of files, and provides facilities for scheduling backups.

Tivoli Storage Productivity Center (TPC)
See *IBM Tivoli Storage Productivity Center*

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

touch keys
On the touchscreen of the TS3500 tape library, an array of small, touch-sensitive keypads that lets you select and navigate through menus. To acknowledge that it has been pressed, a touch key initiates an audible beep (if enabled) whenever you press it. The audible beep is the default.

touchscreen
See *liquid crystal display*.

TPC See *IBM Tivoli Storage Productivity Center* ..

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

transfer rate
See *data transfer rate*.

transmission control protocol/Internet protocol (TCP/IP)
(1) The Transmission Control Protocol and the Internet Protocol, which together provide reliable end-to-end connections between applications over interconnected networks of different types.

(2) The suite of transport and application protocols that run over the Internet Protocol.

TS4500 management GUI
A web-based interface that allows users to configure, administer, monitor, and manage the TS4500 tape library locally from the IMC or from a remote location. See also *TS4500 integrated management console (IMC)*.

TSM See *Tivoli Storage Manager*.

TSSA See *Tape System Service Application*.

two-node arbitrated loop
In Fibre Channel technology, the connection of two nodes that communicate directly (without the use of a switch) and use the same protocol.

two-node switched fabric loop
In Fibre Channel technology, the connection of two or more nodes that may not use the same protocol and communicate by using a switch.

two-phase power
Pertaining to the TS3500 tape library, electricity that is transmitted via three wires (line, line, and ground), with a line-to-line voltage of 200-240 V ac. Sometimes referred to as *single phase power*.

U

Ultra SCSI
See *Small Computer Systems Interface*.

Ultra160 SCSI
See *Small Computer Systems Interface*.

Ultra2 SCSI
See *Small Computer Systems Interface*.

Ultra3 SCSI
See *Small Computer Systems Interface*.

Ultra320 SCSI
See *Small Computer Systems Interface*.

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

unload
Pertaining to the TS3500 tape library, a term used to describe the act of the drive unthreading the tape from the internal tape path and returning the leader block to the tape cartridge.

URL See *uniform resource locator*.

V

V Volt.

V ac Volts ac (alternating current).

vital product data (VPD)
Pertaining to the TS3500 tape library, information about a product such as a library, drive, or node card. The VPD may include a machine type, model number, serial number, part number, or level of firmware.

void In character recognition, the inadvertent absence of ink within a character outline.

VOLSER
Volume serial number.

VOLSER ranges
With the TS4500 tape library, a method that is used to automatically assign cartridges to a logical library by using beginning and ending volume serial number ranges that are set by the user. See also *Cartridge assignment policy*.

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

volume serial number (VOLSER)
A number that a computer assigns to a tape cartridge when it prepares (initializes) the cartridge for use.

VPD See *vital product data*.

W

W Watts.

watt A metric unit of measure of power; the power required to keep a current of one ampere flowing under a potential drop of one volt; about 1/736 of one horsepower.

Web See *World Wide Web*.

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

World Wide Node Name
In Fibre Channel technology, the fixed, 64-bit name assigned to a device by its manufacturer and used to identify participants in a topology. The World Wide Node Name will be unique if the manufacturer has registered a range of addresses with the IEEE.

World Wide Port Name
Within a parent node, a unique 64-bit name that is assigned to a node port. The World Wide Port Name aids the accessibility of the port.

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

WORM
See *write once read many*.

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

write once read many (WORM)
A technology that allows data to be written only once to LTO 3 and later LTO tape cartridges and all 3592 tape cartridges. After being written, the data cannot be altered, but can be read any number of times.

write protected
A tape cartridge is write protected if some logical or physical mechanism causes the device that is processing the tape to prevent the program from writing on the tape.

write-protect switch
Located on LTO and 3592 tape cartridges, a switch that prevents accidental erasure of data. Pictures of a locked and unlocked padlock appear on the switch. When you slide the switch to the locked padlock, data cannot be written to the tape. When you slide the switch to the unlocked padlock, data can be written to the tape.

X

X-axis and Y-axis motion assemblies
Within the TS3500 tape library, a group of parts that provides the motive force to move the accessor side to side (on the X-axis) and up and down (on the Y-axis).

Y

Y-axis motion assembly
See *X-axis and Y-axis motion assemblies*.

Z

zoning
A method of subdividing a storage area network into disjoint zones, or subsets of nodes on the network. Storage area network nodes outside a zone are invisible to nodes within the zone. Moreover, with switched SANs, traffic within each zone may be physically isolated from traffic outside the zone.

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with ALMS
Introduction and Planning Guide

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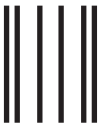

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